Enhancing surgical training by audio-visual simulation with hazard cognitive training and reflection tools: a design-based study in laparoscopic cholecystectomy

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Abstract

Background

Surgical training has become more challenging in the UK with the reduction in training time and the reduced training opportunities, making every training opportunity precious. This study aims to address this curriculum challenge by enhancing surgical training and assessment in the surgical training environment.

Methodology

Using a design-based approach a two-step design was created. Step One involved creating an online, standalone, Cognitive Hazard Training module. It uses videos of real operations to mentally train candidates to recognise, anticipate and avoid hazards during the operation. An online example of this Module was created for laparoscopic cholecystectomy.

The second design step was a Reflective Formative Assessment. The trainee and supervisor reviewed the trainee's video-recording of a supervised-operation which involved reassessing the trainee's performance to enhance feedback and reflection.

Design feasibility was tested in the Northern Deanery training environment and the feasibility study was complemented by a theatre observation study to capture the details of the complex surgical training environment.

Results

The feasibility of this two-step design was tested with 2 experts, 32 trainees and 15 trainers. Trainee and trainer qualitative feedback was collected, via semi-structured interviews. Users' feedback along with multiple additional data from the operation-recordings and video-review session were analysed and triangulated to improve the design and establish the feasibility and role of this style of video-review in the current surgical training. Observational data was also collected during live surgery in theatre to identify any factors affecting safety and training.

Discussion

This study has developed a novel approach to enhance surgical training, which has been tested and has received overwhelming support from both supervisors and their trainees. Cognitive Hazards Training steepened the learning curve and increased adherence to safety. The videoed operations were found to be an excellent teaching tool, which enhanced feedback and reflection. It increased trainees' confidence and competence by tailoring the training to their individual needs. The success of this work forms the foundation for future development and testing of this new approach to surgical skills training in the UK.

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List of Abbreviations

A&E	Accident and Emergency department
ADEPT	Advanced Dundee Endoscopic Psychomotor Trainer
ARCP	Annual Review of Competence Progression
ATLS	Advanced Trauma Life Support
CCT	Certificate of Completion of Training
EWTD	European Working Time Directive
EMI	Extended matching items
F1	Foundation Year One Doctor
F2	Foundation Year Two Doctor
F1	Foundation doctor Year 1
FRCS	Fellowship of the Royal College of Surgeons
GMC	General Medical Council
HR	Human Resources
ICSAD	Imperial College Surgical Assessment Device
ISCP	Intercollegiate Surgical Curriculum Programme
JCST	Joint Committee on Surgical Training
MCQ	Multiple choice questions
NHS	National Health Service

NOTSS	Non-technical surgical skills
OSATS	Objective Structured Assessment of Technical Skill
OSCE	Objective Structured Clinical Exam
OOPR	Out of Programme Period for Research
PBA	Procedure Based Assessment
RAM	Random Access Memory
R&D	Research and Development
RITA	Record of In Training Assessment
SMOTS	Scotia Medical Observation and Training System
SHO	Senior House Officer
SPR	Specialty Registrar
WBA	Workplace Based Assessment
WYSIATI	What You See Is All There Is
WHO	World Health Organization

Declaration

The material contained in this thesis has not previously been submitted for a degree in Durham University or any other institution. All the work presented here is the sole work of the author and no-one else.

Statement of Copyright

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Chapter One: Introduction

1.1 Introduction to chapter one

The search for safer surgical practice is the driving force behind the project described in this thesis. This research is seeking to answer the competency based curriculum challenge: what is the best way to enhance surgical training and assessment given the time reductions experienced by the current surgical training environment. Surgical practice is a combination of operative competency and cognitive (non-technical) skills such as decision making and communication. In fact cognitive skills are the major player in surgical safety. This has been clearly shown in analysing surgical mistakes made by fully qualified and technically competent surgeons (1). Despite the current advancement in technology as well as cognitive theory, assessment is still lagging behind, with a major emphasis on behavioural technical competency.

1.2 Study background

Surgical practice is under great pressure to maintain public trust in the current era. Media coverage of several high profile cases, linking surgical operations to patient harm, has highlighted concerns (2-5). The accumulating evidence suggests that half to two thirds of surgical patients suffer safety risks which vary from one surgical specialty to another (6-8). Furthermore, evidence has linked avoidable deaths to surgeons' false perceptions of their own ability, which was clearly emphasised following the Bristol Royal Infirmary case (9). The cascading flow of media reports about similar incidents has raised the demand for a better surgical skills assessment system to prevent the damaging effects of surgical errors (10).

The outcome of a surgical operation comes from the combined effort of a multidisciplinary team consisting of a surgeon, an anaesthetist, and theatre and ward staff. Currently, adverse outcomes which are labelled as a surgical death and are attributed to a consultant surgeon by name, are listed in public domain documents. Surgeons are currently asked to publish their death outcomes (11) but the same does not apply to other medical consultants. This discrepancy highlights the public concern about surgical errors.

These concerns are amplified by the reduction in available training time as a result of the implementation of the European Working Time Directive (EWTD) (12, 13). This reduction has a double impact on surgical training opportunities. The first effect is straightforward: that of time constraints, which means that trainees will have to reach competency within a fifth of the previously recommended training time (12). The second effect comes indirectly by reducing training opportunities. Consultants' time is restricted through the application of the European Working Time Directive. This restriction drives trusts to utilise consultants' time differently. It is well known that an operation led and performed by a supervised trainee takes longer than a similar one led by a consultant. Hospitals prefer to replace training lists with consultant led service lists, further shrinking trainees' operative exposure (14).

The combined effect of reducing trainee numbers and the EWTD forces hospitals to abandon the old apprentice style training. Consultants used to have a dedicated team made up of a Specialist Registrar (SPR), Senior House Officer (SHO) and one or two Foundation Year One Doctors (F1s). This team used to work together electively as well as during emergency on-call cover, providing continuity of care and training. In this former arrangement the consultant would have the time to assess his/her own trainees' capabilities and train them according to their needs. At the end of the day surgical training, similar to any other high-stakes practice, requires the consultant to know trainees' limitations and to assign operative opportunities that would suit their current skill level.

Currently a trainee is attached to two or three consultants within the same specialty, breaking the old commitment to individual training implied by the old apprentice style. Trainees also rotate to cover on calls with various consultants they have not worked with before. In this current environment consultants find themselves in a difficult situation. They cannot simply, or even safely, allocate the current operative opportunity to a trainee they have just met and they do not have the time or capacity to assess each and every rotating trainee. They are forced to perform the procedure, or at least a major part of it, themselves, reducing the already shrinking training opportunities.

To add to the detriments of reduced training time and shrinking training opportunities, surgical practice is expanding. This is due to the frequent introduction of new technologies and surgical procedures. Those new techniques and new operations require extra skills to be added to surgeons' current skills bank. Examples of such techniques include laparoscopic surgery and robotic surgery. Sir Alfred Cuschieri (15) described the addition of laparoscopic surgery as the biggest unaudited expansion in surgical practice history.

The conflict of increasing the surgical skills required and decreasing training time is quite clear. Two-thirds of consultant surgeons surveyed expressed deep concern over the suitability of the end product of such a shortened training programmes (16). Crofts (14) argued that operations available during trainees' training period cover only two- thirds of the minimum recommended number of operations to reach competency. In other words, even if trainees perform all available operations, which is highly unlikely, they will still be a third short of the minimum number of operations recommended to reach competency. Evidence of such an effect has begun to emerge, with surveys showing the offers of certain specialised operations such as fundoplication and hiatus hernia operations in a shrinking number of hospitals. This indicates the limited consultant capability to safely perform such operations, forcing their referral to other centres. Also alarming are the voices in favour of appointing fresh graduate trainees to sub-consultant grades, which is still currently opposed by the British Medical Association and the association of surgeons in training (17). Those voices echo the current concern about the quality of the final training product and the need to enhance the current training or further train the graduates in a supervised environment.

To answer such challenges, and support surgical training in the light of limited time availability; the competency based curriculum was created (18-20). Assessment is considered the weakest link in outcome-based education (21) and since the competency based curriculum is a form of outcome-based education, it will inherit the same criticisms. The process of surgical skills assessment, both summative and formative, is currently criticised because of a lack of objectivity and standardisation (21).

This establishes the need for a new assessment system to enhance as well as assess surgical training outcomes. In order to create such a system, we need to start with an analysis of the currently assessment system. The next step would focus on using the best evidence-based tools available, as well as having an insight into the process of surgical skills acquisition as a cognitive process and drawing from the relevant learning and training theories.

1.2.1 Current assessment practice

Currently surgical SPRs are assessed annually or bi-annually in the Review of Competence Progression (ARCP) using the Workplace Based Assessment (WBA) forms (22) and the operation logbook. Passing the final Fellowship of the Royal College of Surgeons (FRCS) exam is expected within the later years of training before applying for the General Medical Council (GMC) Certificate of Completion of Training (CCT). The FRCS exam is a summative knowledge exam with a clinical case discussion component. As a summative assessment it is not designed to provide feedback to improve training, nor is it intended to assess surgical operative or cognitive skills. Such assessments are the remit of the WBA.

A description of WBA is available on the Intercollegiate Surgical Curriculum Programme (ISCP) website. It is a formative assessment with a primary purpose of providing feedback and enhancing as well as assessing trainees' skills during their supervised practice (22). It is also used as a tool to aid academic supervisors in their mid and final placement assessment and to help build the evidence needed for the annual ARCP assessment. WBA includes various forms to assess diagnostic skills and other aspects of surgical training, but the only form with direct relevance to surgical operation is the Procedure Based Assessment (PBA) (23). PBA has six general assessment domains and a global assessment part (Appendix 1). Feedback spaces are provided in each of the six domain items for surgeons to give constructive feedback to their trainees. The last global assessment part provides four competency levels. Those levels vary from 'novice' to a fully 'competent surgeon' (23). The form aims to assess technical competency but it provides some hints to knowledge and non-technical skills assessment in an integrated manner without referring to them as such. Taking the PBA for Laparoscopic cholecystectomy, for instance, scattered examples of the various components of non-technical skills are found (Appendix 2, Table 1).

Cognitive (non-technical) skills play an important role in surgical outcomes as discussed earlier in the Introduction. Spencer attributes three quarters of operation skills to decision making and one quarter to surgical dexterity (24), while Gawande *et al.* linked 43% of surgical errors to communication breakdown (1). Such findings establish the importance of non-technical skills in surgery. In other words if we take into consideration that assessment strongly influences learning and assessment content reflects our value for the subject assessed (25, 26), non-technical skills should become a part of surgical skills assessment. This will enhance the value of non-technical skills and provide trainees with the feedback needed to improve their performance in this vital aspect of surgical practice. Such implementation will eventually reduce the risks and errors in surgery, serving the final intention of the assessment tools (10).

PBA should be completed directly after observing the supervised procedure to provide the immediate feedback needed to enhance learning. Unfortunately, in my experience as a surgical trainee this is highly unlikely in the rushed clinical practice with limited time availability. Forms are usually completed by the supervisor and the trainee a significant length of time after the surgical procedure. The trainee and the educational supervisor’s memory will fade and they will struggle to remember the procedure details. As a result, the assessment/feedback session becomes a box-ticking exercise with limited benefits. Even in the ideal situation of post-observation completion of forms, missing or limited feedback has been identified by the Sheffield Research Group (27). This finding was observed despite the likely Hawthorne effect resulting from researchers’ presence and direct observation suggesting a much lower feedback value in everyday practice. Failing to provide feedback is a major detriment to this formative assessment form and it weakness the assumptions made about the benefits of using these formative assessment tools to enhance learning.

1.3 The need to create a new formative assessment design

In the light of the previous discussion I established the need for a better cognitive training and formative assessment system to enhance feedback and accelerate training in the current situation of shrinking training opportunities, with equal emphasis on the technical and cognitive aspects of surgical training. Such a system would answer the competency based curriculum challenge of accelerating trainees' progress to full competency, while enhancing patient safety by improving the quality control of the final training product: surgeons.

The aim of this thesis is:

To create a new cognitive hazard training and a reflective, formative, assessment design and test its feasibility to enhance and potentially accelerate surgical training

The objectives of the research are:

1) To critically analyse the relevant literature to inform the design.
2) To create a prototype of the new cognitive hazard training and reflective formative assessment design using the laparoscopic cholecystectomy procedure as a model.
3) To test the feasibility of the new design in the Northern Deanery training environment and conduct an observational study in theatre to capture the complex surgical training environment.
4) To make recommendations for future research and future design modifications in this field.

Chapter Two: Literature review

2.1 Introduction

The previous chapter discussed the background of the study including the challenges faced in current surgical training. These can be summarised as higher public expectations, expanded surgical practice, shrinking training opportunities and the loss of the old apprentice style training. The last challenge incorporated consultant difficulty in constantly assessing newly rotating trainees to safely allocate training opportunities. To answer such challenges trainers have looked to other industries as a source of inspiration (28).

This chapter is not a formal systematic literature review, since the specific literature is very scant, and a number of different fields need to be discussed to gain the needed breadth and insight for this research, making it impractical to formally review each of them. Rather it is a narrative literature review, guided by information scientists and librarians and by discussion with colleagues and the supervisory team. This chapter will compare current surgeon and airline pilot training and the utility of simulation training. This will be followed by an alternative comparison with another transportation modality: the car, and driver training. Then I will present the theoretical background to support the development of the new cognitive hazard training and reflective formative assessment design in the light of the best evidence-based knowledge to enhance learning which will include a discussion of the cognitive theory and educational learning theory. The new design will be presented in the next chapter.

2.2 Inspiration from other hazardous industries

The standards and methods for assessing surgical skills are under growing pressure. Media coverage escalated the concerns that surgeons have a false perception of their own ability, leading to avoidable deaths. Focus on surgical procedures safety after cases of significant clinical failures such as the Bristol Royal Infirmary hospital case (1, 9, 10) led to the comparison between surgery and aviation (29) as two hazardous industries. This trend led to proposals to use the same pilot training principles to train surgeons, recommending mandatory simulation training before any patient encounter (28). Simulation training was presented as a possible solution to replace the missing training opportunities. In other words, training outside theatre to full competency on a surgical simulator with the associated simulator assessment would hopefully cover the training/opportunity gap and provide the magical buy out solution. To assess the reality of such a proposal and evaluate the real similarity between surgical and aviation environments, further insights into both industries are needed.

2.2.1 Surgery and aviation

Research in aviation showed a highly standardised environment. Such standardisation enabled the autopilot to become a standard component in all large aeroplanes (30). The first fully automated transatlantic flight, under autopilot control, took place in 1947. Currently the autopilot can do everything during flight from taking off to landing. In fact the autopilot is the only way to control large aeroplanes in many flight phases due to the effect of temperature on aeroplanes' parts and surrounding air turbulence (30). It is well established that full manual control is not possible in such flights and would limit performance (30). In other words human pilot interference with autopilot control during commercial aeroplane flights would result in more turbulence and increased risks. Simulation is the only way to train commercial pilots in the absence of real flight training opportunities in the air and qualified pilots can go straight from simulation training to flying a commercial aeroplane in the presence of a more experienced colleague.

However, simulation training is not mandatory for small aeroplanes and air training lessons are still offered for such training. In fact small aeroplane pilot training is structured in a supervised one-to-one training with a trainer. Such training uses a clear structure of task allocation and clear language to facilitate such allocation to prevent confusion. This is quite clear by using structured dialogue such as ‘I have control’, ‘You have control’ between trainer and trainee. There is also a great emphasis on reaching full competency. This is clearly demonstrated by considering solo aviation as a major step to be reached only after thorough satisfactory assessment.

Lessons from aviation standardisation and checklists were successfully implemented in the relevant aspects of anaesthetic and surgical practice. Examples of such implementation are the standardisation of anaesthetist equipment and the use of the World Health Organization (WHO) checklist in theatre (31). Such use no doubt enhances patient safety by reducing non-standardisation in the surgical environment when possible and structuring team communication. Adaptation of such useful safety interventions from any domain are always welcomed, but it should be adopted with special consideration to the surgical environment's unique features.

However, many more lessons should still be learned from aviation. Maybe the most pressing examples are the stressed importance of solo aviation and cognitive training. Trainees are not allowed to fly alone without being fully competent and thoroughly checked. Trainees' personal safety is taken really seriously. Carrying other passengers is not even allowed by fully qualified pilots without recent flying experience. In other words, caring for other passengers is a huge step going beyond full qualification. In contrast, accident and emergency departments (A&Es) are usually run at night by junior doctors with no on-site support. The same applies for Hospital at Night teams of nurses and F1 doctors. The absence of senior support and instructive feedback clearly undermines junior training, increases mistakes and carries a patient safety hazard (32).

The above mentioned examples of successfully adopted aviation intervention should not mask the real differences between aviation and surgical environments. Isreb and Attwood (33) discussed the major differences between aviation and medical practice, especially surgery, due to the complexity of human anatomy, physiology and diseases and the lack of a standardised approach to operations. Grote *et al*.(34) compared pilots to anaesthetists in theatre. They stressed the highly standardised environment in aviation compared to the lack of standardisation in medical practice. Such differences in standardisation implies differences in behavioural requirements. They demonstrated that anaesthetists in theatre have implicit coordination, high leadership, more understanding of each other's behavioural clues and a shared process to determine the correct action rather than pre-set instructions. On the other hand, coordination in aviation is explicit resulting from the pre-set instructions due to the highly standardised environment. Grote *et al*. (34) went on to argue that high leadership might be harmful in the case of pilots, in contrast to medicine. In other words, the skills needed for a non-standardised medical environment are completely different from the skills needed in the standardised pilots' environment.

2.2.2 Surgical simulation

As mentioned in the discussion above, simulated training is the only way to train commercial pilots due to the mandatory use of autopilot in large aeroplanes. Aviation simulation is so real it enables the direct move from competent simulation training to commercial aeroplane flights in the presence of a senior colleague. This is certainly not the case in surgery. Currently no form of auto-surgeon is available as the non-standardisation in surgery requires human driven operations (35). The few robots available for surgical procedures are simple slave mechanical devices, such as the Da Vinci robot, that only work with direct human interactions. They are simply a more sophisticated form of a laparoscopic instrument (35).

Simulation offers an advantage in basic skills acquisition. Rosser *et al*. (36) have already established the benefits of a short basic laparoscopic course in surgical training regardless of surgical trainees' age, experience and sex distribution. Unfortunately, the same does not apply above basic skills level. In the presence of a less standardised environment and the lack of authenticity of simulation training to real life experience, simulation cannot equip surgeons with the practical skills needed for daily surgical practice. Zendejas *et al* (37) conducted the first randomised control trial in simulation-based mastery training. They trained the experimental group to full competency on surgical simulation. Then they used time, inpatient admission, urinary retention and peritoneal tear to compare the control and experimental groups. They found a statistically significant difference between the two groups in the first operation following this extensive training. This difference is controversial as peritoneal tear is not considered by many as a complication, neither are inpatient admission nor urinary retention. Yet even this controversial difference in the first operation disappeared in subsequent operations. Despite their argument about time gain and possible economic advantage of such mastery training, the instructor time loss and the cost of such training outweigh any benefit by six-fold. The experimental group were only one operation better than their colleagues despite training to mastery in simulation.

Simulation, technical (motor surgical) training beyond a basic level is unrealistic as it is time consuming in an era of training time restraint. It does not equip trainees with the needed skills to replace lost training opportunities and offers very little benefit, as clearly shown by Zendejas *et al* (37). Contrary to the public fear, enhanced by media coverage, supervised surgical training does not compromise patient safety. It is well proven that teaching hospitals have a better or at least a comparable outcome to non-teaching hospitals after case-load correction (38). Similar results emerged from laparoscopic training courses with comparable patient outcomes between supervised trainee and consultant led operations (39). Safety cannot be reached by the mere focus on motor surgical skills training to produce fully competent technicians. Professionalism is the higher form of competency with built-in reflection, self-limitation awareness and lifelong learning traits (40). Professionalism can only be reached and assessed in supervised operation training to provide the needed role modelling and early clinical contact (41, 42). The search for a solution to the challenges currently faced should work on maximising the benefit of supervised theatre training by making every moment count.

2.2.3 Surgeons and drivers

Patient safety concerns were the main reasons for the comparisons between surgeons and pilots, as the both have hazardous environments (29). This comparison starts with the assumption that aviation is the transport modality with the highest risk. Careful safety examination shows the fallacy of such an assumption. Aviation is not the most hazardous transportation, in fact it is far safer than driving. Evidence has shown that it is twenty six times safer to fly than to drive a car (43). Yet it is still standard to learn driving with an instructor on the road.

It might be more reasonable to compare surgery to driving or small aeroplane supervised training. Drivers, like surgeons, operate in a minimally standardised environment with many variations while on the road. Drivers have an agreed thinking process to avoid hazards faced but no step-by-step instructions. Surgeons have to deal with anatomical and pathological variety in the same innovative way drivers use to navigate various obstacles on the road. Furthermore, a fully auto-driven vehicle is still far from reality, despite the Google auto-car extended trial programme, and the likelihood of having a surgical autopilot in the near future is even more doubtful (35).

Analysing the UK driving test's assessment tools provides insight into this similarity. The driving test has two parts: theoretical and practical (44, 45) . The theoretical part consists of multiple choice questions (MCQ) to assess knowledge and hazard perception clips to check learners' awareness. Those clips would check potential drivers' ability to analyse and identify real life hazards on the road. They work as cognitive training to map the driver's brain with the safety clues needed, as will be discussed in the cognitive theory later on in this chapter. The above theoretical training is usually followed by a period of instructor facilitated training on the road when it is illegal for the learner to drive alone. Once the learners are fully trained they sit the practical test. This involves on-road driving assessment with an examiner armed with a check list. To establish the driving test framework applicability to surgical skill training we need to have an insight into the available literature on learning and surgical skill acquisition.

2.3 Surgical skill acquisition

Using the theory for psychomotor skills training, surgical skills acquisition can be divided into three phases: cognitive, associative, and autonomous (46). In other words students start by having knowledge about the skill, and then they practice it to reduce the gap between their performance and the expert's until they become experts themselves. Despite the conflicting theories about motor skills acquisition (46, 47), they all agree about the role of feedback. This role comes in the second step to facilitate reducing the performance gap and reaching the expert level required. In this simplified explanation, reducing the performance gap is the aim of the whole learning process.

A closer look reveals the importance of the performance gap realisation. Isreb *et al*'s (48) laparoscopic length measurements' precision study showed that experts were no better than learners in the absence of a reference point. In this study candidates were asked to measure 150 cm on a piece of string attached in a laparoscopic training kit. Specialist registrars' measurements were slightly better than the consultant surgeons' laparoscopic measurements in the absence of instrument marking. Comparing the trainee performance to the expert's performance is the basis for internal feedback (49, 50).

Keeping in mind the possibility that experts might repeat the same mistakes due to their lack of ability to perceive their errors (9), we discover the importance of a reality check, demonstrated by Olsen *et al* (51). In this study, trainees in emergency medicine were asked to rate their performance after they had carried out emergency intubations, but before reviewing their video-tape recordings of this procedure. Then they were asked to review the tape and compare their rating with their actual performance. On viewing the video, they saw mistakes that they were previously unaware of, especially the most frequently occurring. This discrepancy between their perceived ability and their actual performance is called perceived self-efficacy (52). Reducing perceived self-efficacy is essential for learning and moving towards the level of expert.

Rogers *et al.* (53) showed the added value of external feedback in enhancing the learning process. A student might understand that he/she did not achieve the aimed-for skill, but without the expert support he/she will struggle to find the necessary steps to correct the error. This again highlights the importance of immediate corrective feedback (54).

Looking at the wider picture, surgical skill acquisition is part of the surgical training curriculum. This curriculum is run by the Royal College of Surgeons and the Deaneries to train young doctors to become surgeons. It provides the National Health Service (NHS) with the trained surgeons needed and it is accountable to the General Medical Council (GMC). In other words, the surgical training programme ticks all the boxes for the social efficiency theory described by Schiro (55). Applying this theory adds two extra important components: evaluation and assessment. Evaluation helps teachers to refine their teaching methods and approaches. Assessment, on the other hand, serves a dual role. It provides students with the feedback needed to facilitate and stimulate learning through the repeated formative assessments. It also serves as quality control comparing the student’s performance with the defined objective (55), using the final summative assessment. This provides the programme with the supporting evidence to prove its efficacy to the monitoring bodies: the GMC, the NHS, the Royal Colleges and the general public. In this context, steps to improve assessment will facilitate learning by providing the needed feedback and improving the quality control check within the surgical training programme making sure the final products, surgeons, are safe to operate (10).

2.4. Linking cognitive theories to learning theories

After establishing the importance of feedback and assessment on surgical skills acquisition I will discuss cognitive and learning theories. Learning is a mental cognitive task. Linking cognitive theories to learning theories would widen the current understanding of the learning process.

2.4.1 Cognitive and thinking theories

In his book "Thinking Fast And Slow" Kahneman (54) presented the best available evidence about human thinking and learning process. Kahneman described a putative two system model operating constantly within our heads. System One provides the quick thinking, easy judgement and superficial information analysis, while System Two deals with the deep thinking and reasoning. Unlike System One, System Two consumes a lot of energy and a major share of the limited brain resources. Aware of such limited resources, System Two prioritises the use of those resources and engages only in the case of high demand such as important decisions and deep thinking activity. Such engagement results in pupil dilatation and high glucose consumption similar to intense physical activity. It also risks tunnel vision and missing important clues in the environment.

System One operates automatically and constantly under the lax supervision of System Two. In fact this control might be reduced even more, at times when System Two is affected by mental overload, tiredness or intoxication. This relaxed control is responsible for the narrow vision experienced in cases of mental occupation with a task such as not perceiving the walking gorilla by being distracted by counting in the famous basketball video (56). System One provides impressions, and feelings which might change to beliefs and attitudes after being processed by System Two. Due to its limited demands on resources and energy, System One provides a case of cognitive ease which is associated with a pleasant relaxed mood. As a result, System One is the default system in use.

Despite the clear benefit and value of System One in our daily tasks, such use, comes with a price. System One is biased with its superficial processing of available information from memory and lacks awareness of its limitations. System One does not question the truth behind the presented information or superficial decisions, as such doubt is unpleasant, and that is a System Two task. System One answers questions using memory and content, in a form of a ‘‘what you see is all there is’’ pattern (WYSIATI), while neglecting missing evidence. This property results in narrow-view decisions associated with a false feeling of decision security. System One is particularly sensitive to coherent story explanations, even if they have to be invented, rather than waiting for root cause analysis. It takes emotional decisions and replaces hard questions with simpler ones. An example is replacing a judgement about product utility with an impression of seller likability. System One is more sensitive to changes and is losses. It neglects quantity above a certain level and frames decisions in isolation missing important links which can lead to difficulties later. These limitations of System One will be important in the results and final discussion of this thesis.

System Two can programme System One to perform skilled actions and judgements after adequate training. Kahneman described the requirements for successful training as the presence of a regular environment, the availability of adequate practice and immediate clear feedback with clear instructions to correct mistakes committed during practice. Such training moves the demand from System Two to System One and facilitates the transition from difficult, tunnel-vision novice in-training to easy automatic expert practice. System Two can also programme System One to look for certain patterns and raise attention to their presence and importance. An example of such training is present in rapid hazard recognition while driving. Such training reduces errors and enhances skill acquisition.

However, it is important to have a reality check because experts might be unaware that they are making the same mistake repeatedly due to a lack of ability to make accurate self-assessments. (9, 48). Pronin *et al.* (57) argued that we view others' mistakes in an objective way, but struggle to realise our own errors. This is due to the bias of motivation and content used to analyse self-performance. Dror (58) argued about the value of error recovery training, using cognitive theory. He suggested an intermediate phase of error recognition in others using interactive video-clips to provide informative feedback in a similar manner to the hazard perception clips used in the UK driving test. The clips progress from simple exaggerated mistakes to more subtle errors. Trainees have to identify the possible recovery plans at the end of the process, after being offered such plans earlier in the training. This would eventually help trainees to recognise their own mistakes and reduce them (58).

Applying this theory in surgical training and practice provides valuable insight. Training requires a standardised or semi-standardised environment with immediate correcting feedback and adequate practice opportunities. It also requires mental programming to identify hazard patterns and initiate mental warnings. Such training explains the importance of hazard perception videos in the UK driving test and its applicability in surgical skills training.

In light of this theory, trainees start using System Two during their training with narrowed vision to the hazard clues around. They rely on their trainers to keep them out of trouble and provide them with the necessary feedback to progress. The importance of senior support and feedback were clearly shown by Kroll *et al.* in their qualitative study of junior doctors' error (32). However, junior doctors might only grasp the necessary feedback to progress in that particular operation and ignore the rest of the developmental feedback due to the narrow vision caused by System Two engagement in early training. Such a narrow vision will diminish the value of immediate feedback and highlight the need for good reflective feedback after the operation. Unfortunately, PBA is failing in practice to provide a vehicle for such feedback, leaving a gap to be filled by my proposed system as will be highlighted later.

As training progresses, System One takes over and performs the skilled tasks, alarming System Two to kick-in, only if pre-trained hazard patterns are identified. Cognitive training to spot possible hazards would fast track surgical training by providing this important training outside theatre. Cognitive hazard training would also enhance patient safety and focus theatre training. Trainees in theatre will focus on sharpening their pre-acquired cognitive skills and practise the remaining cognitive and technical skills to perfection.

Despite hazard awareness skills, surgeons can get into trouble in two situations as explained by the theory earlier. This could happen if surgeons are completely relaxed as in the case of a simple straightforward operation or with a complex procedure when System Two becomes over engaged and relaxes its grip on System One. The best safety net in both cases is to reduce mental overload; in other words stop cutting and start thinking. Empowering staff to communicate any spotted hazard is another great safety net as well. The latter could have saved a wrong kidney resection case if the operating team had taken on board a medical student comment (59).

Cognitive training plays an important role in enhancing surgical safety and reducing patient harm. The same effects were also seen in aviation safety. Cognitive factors resulting from pilots' incorrect assessment of risk are the driving force behind the majority of fatal accidents (60). To compare and utilise such a theory further insights into skill acquisition are needed. Those principles along with System One limitations will play a major role in the results analysis and discussion in the last four chapters of this thesis.

2.4.2 Situated learning theory

In the first chapter I explained the challenges presented by the breakdown of the old apprentice system of the consultant designated team. SPRs are no longer attached to one consultant in their rotations. They are attached to the unit and work with various consultants within the hospitals to cover on-calls and various duties. This situation has created a need to constantly assess the training needs and abilities of many rotating SPRs by many consultants. It has also broken the conventional implied training agreement between a consultant and his/her designated trainee.

Currently one-to-one training in this sense has definitely been replaced, and the modern training situation might be harder to understand, theoretically, under the apprenticeship principle. Lave and Wenger's (61) situated learning model provided an extended view to understand modern training. They considered learning as an integrated aspect of social practice. Working environments are communities of practice with novice trainees considered as peripheral participants. They start with limited activities and progress from peripheral to more central roles as they interact and learn from senior members of the community. In this theory, work participation is the means to acquire and learn a skill. Legitimate access to such a community of practice and to work activity is vital to achieve learning. In this sense access and acceptance of the novice in the practice society becomes a form of membership. Factors limiting access to training opportunities or interaction with other community members would restrict learning or stop it completely. Lave and Wenger (61) referred to practical examples of situated learning communities with clear examples of such factors. Those examples carry a real similarity to the modern medical and surgical training environment.

The first was the apprenticeship style of Yucatec midwives. The trainee in this example is usually the female relative of the midwife. They work together for a prolonged period of time and duties assigned to the trainee increase as trust is built up, with frequent indirect assessment of the trainee's competency. This example shows the importance of assessment and trust in allowing access to training opportunity. The same pattern was formerly the case in the old consultant led team of trainees. Currently trainees work in the hospital or unit, which represents the community of practice, and their access to training opportunities would certainly improve if the consultant had a robust and trusted assessment system in use. Such a system would provide the consultant with a trusted measure of trainees' current competency level and eliminate the need to personally assess each new rotating trainee within the hospital. This is one of the expected benefits of the proposed cognitive hazard training and reflective formative assessment design in this research. It also supports the argument for longer rotations to give trainees better training opportunity access and reduce the need to rebuild trust.

The second example was the case of Vai and Gola tailors in Liberia. The trainees learn garment production processes in a reversed manner. They start by learning to sew the pieces cut by the master to know how they fit together first; then they progress to cutting the parts themselves as they build up their skills. In other words, they learn the hazard associated with cutting the wrong pieces of fabric, by observing their trainer first, before progressing to perform the task themselves. In such training, trainees work their way in from a more peripheral to a more central role within real time practice, but in a structured manner to reduce costly errors of wasted garments. They also build better hazard understanding before performing the risky task themselves.

The next contrasting two examples showed the importance of interacting with other community members and the effect of a reduction in training access due to staff limitations. In the case of Naval Quartermasters, trainees learn by watching and interacting with their seniors. They learn competent behaviour and get their navigation calculation checked again by the seniors, using the same method of navigation. Such checks reduce the error margins and provide trainees with immediate feedback. In contrast, supermarket managers in the meat cutters example tend to maximise trainees' utility by getting them to specialise in repeated focused skills, with great reluctance to rotate them around various tasks. They also placed them to work in isolation from other trainees, limiting their ability to learn other skills by watching others. As a result, learning was severely limited and progress to a more central practice role was severely impaired. This example has some similarity to the current hospital management challenges with emergency on-call rota forcing trainees to miss elective training opportunities, working in isolation at night with limited emergency operations especially in district general hospitals.

The final example is the Alcoholics Anonymous groups, where members progress from a peripheral to a central role by learning the professional language to communicate and reconstruct their stories. Such professional communication is vital in medical training and was usually associated with competency. When novices deviate from using the professional language this increases team tension (62).

The above discussion shows the relevance of the Legitimate Peripheral Participation (LPP) pattern in modern medical training. It provides a way of understanding the various challenges faced in training in the current community of hospital practice. It values legitimate access to the work/training opportunity and the interaction with other community members as a way of learning. It also stresses the importance of hazard training as well as increasing the validity and reliability of the current assessment methods as a mean of enhancing trainees’ access to training opportunities.

2.4.3 Reflective Learning

Reflection is a deliberate examination of personal practice to create a new understanding of the relevant experience and promote learning. Kolb and Fry (63) described a cycle of learning with an experience followed by reflection, conclusion, planning for change and applying the plans in a new experience. Despite their description of a cycle of learning it might be easier to understand the process as a spiral of progression. With this view, reflection provides the means to progress in the spiral manner, while the lack of progress keeps trainees stuck in the initial cycle of repeated experience without progress. Westberg (64) argued that there was a loss of training benefit in the absence of reflection. If trainees rush from one experience to the next without reflection, due to the current time restraint, they will not gain the educational value, despite the intensive training experience. In this sense reflection is the corner stone to improve performance and benefit from the available training opportunities (65).

Schon (66) divided reflection into two components: reflection-in-practice and reflection-on-practice. Reflection-in-practice represents the thinking process within the experience or the operation in the surgical case. It represents the mechanism to make step-by-step decisions while operating. Reflection-on-practice, on the other hand, is the step taken post-procedure to rethink the performed action and plan steps for future improvement.

Boud *et al.* (67) expanded further on reflection-on-practice, expressing the importance of removing negative feeling associated with the experience and focusing on re-evaluating the action. Such a focus draws the attention back to the motivation and personal bias used to justify one's own actions as discussed earlier (57). Tavris and Aronson (68) provided a better insight into the effect of personal bias in blinding judgement. They describe the self-justification process as a way to reduce dissonance between personal beliefs and unwanted or unexpected outcomes. This dissonance is painful and to reduce this pain, mental protection mechanisms kick in to explain and justify action, blinding insight into the real problem. Such blindness works against taking corrective action. A clear evidence of real performance together with a personal motivation to improve would be the essential components required to overcome such justification.

Reflection has been implemented in various ways in medicine. Appraisals were promoted as a form of self-reflection with an improvement agenda agreed between the trainee and the appraiser (69). This practice is carried out annually for all surgical trainees. It works as an annual check to detect underperforming trainees. It is not intended however to provide reflective practice on daily training opportunities. Reflective portfolios were designed to cover daily practice. These are implemented for undergraduate medical students. Rees and Sheard (70) investigated student attitude towards this tool. They found a correlation between students' self-rated reflection ability and their enthusiasm for the tool. In other words, involvement with the portfolio depends on their reflection orientation, with limited student appreciation of such a tool. Reflection aims to change behaviour and requires full and active trainee engagement. The above result seriously reduced the effectiveness of the tool. Similar criticism could be extended to the Joint Committee on Surgical Training (JCST) reflective portfolio (20).

Finally, reflection evoking case vignettes were also used with questioned ability to measure behavioural changes (71). Such use might hint to the use of case-based discussion forms in the current work-based assessment (22) with the same questioned behavioural outcome.

PBA could be considered as a form of reflection-on-action, but as previously discussed, a delay in completing the PBA would affect memory recall and missed feedback would seriously limit its value (Section 1.21). None of the above mentioned tools will provide the firm performance evidence to challenge and promote a behavioural changes agenda.

To overcome justification bias, Dror presented error recovery training, using cognitive theory (58). He suggested an intermediate phase of error recognition in others to facilitate own-error recognition. The value of cognitive training using hazard video-clips was described earlier in this chapter. However, its value lies in programming System One to detect early hazard clues and alert System Two to take appropriate recovery actions. Once mistakes were committed cognitive dissonance would seek consistency and justification. The best way to overcome these cognitive biases is to create a reality check. This might take the shape of feedback provided by colleagues or supervisors as described in current assessment practice. However, despite the importance of the PBA form, it still may not provide the trainee with the objective evidence they require to eliminate denial. Feedback might not be recognized, and accepted, and may be rejected and not acted on.

Westberg suggested using video recordings of trainees' practice to enhance self-assessment and improve acceptance of the reality of their practice (64). Sport athletes improve faster if they spend some time critically reviewing and analysing their performance instead of focusing on mere practice (64). Reviewing trainees' own-video recordings would provide them with objective clues about their performance and allow them to detect their mistakes with support from their trainers. This would create an internal correction agenda, which will be better followed, rather than an external supervisor enforced agenda. This idea will be discussed further later in this chapter (Section 2.5.1).

2.5 The need for multiple assessment levels and tools

Miller (26) established the need for multiple assessment tools to measure clinical skills. Despite the current trend to use the Kirkpatrick evaluation model in medical education (72), I will be referring to Miller's assessment pyramid in this thesis as it focuses on the transition from the passive role of learning knowledge to the active role of using skills in practice . Kirkpatrick is an evaluation tool to evaluate the practical benefit of training and the application of such learning in the workplace. Miller's assessment pyramid contains four levels and provides a useful framework for clinical skills assessment (see Figure 1). Miller's pyramid better serves my aim to analyse the value of the current assessment tools and would allow me to rank them and choose the most suitable level for my proposed design.

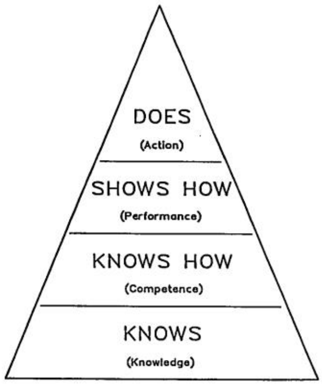


Figure 1: Quotation taken from Miller's paper "The assessment of clinical skills/competence/performance."(26)

Although not completely developed at the time he wrote his article, Miller hinted at the use of multiple choice questions (MCQ) and extended matching items (EMI) in assessing the knowledge covering the first two or even three levels in his pyramids. Case and Swanson (73) provided a comprehensive guide to constructing both question types.

Miller's pyramid clearly distinguishes knowledge at level one from practical knowledge at level two (knows how). Such practical knowledge could be expanded to include cognitive hazard training as was discussed earlier and will be discussed further in the new design in chapters three and four.

The third level could be covered by the objective structured clinical exam (OSCE) as Miller argued (26). This might be the case in other clinical fields but it is challenging to adopt in surgical operations for two reasons. First, it is possible to hire a standardised patient for clinical examination but not for surgical operations.

Secondly, OSCE exams provide only a segment (snapshot) of the clinical skills needed and do not reflect skill progression.

The remaining fourth level necessitates on-the-job assessment (26). To cover this level we need to split operative skills into their component parts. Spencer attributes three quarters of operation skills to decision making and one quarter to surgical dexterity (24), while Gawande *et al*'s. study linked 43% of surgical errors to communication breakdown (1). Such findings establish the importance of non-technical skills in surgery. Cognitive non-technical skills also play an important part in other disciplines' safety. Flying skill deficiency is not the major safety threat in aviation. As I have already indicated, cognitive factors resulting from pilots' poor assessment of the risks are the fundamental cause of the majority of fatal accidents (60).

Taking into consideration the two facts: that assessment strongly influences learning, and assessment content reflects our value for the subject assessed (25, 26), cognitive (non-technical) skills should become a part of our surgical skills training and assessment, as argued in the previous chapter. This would enhance the value of non-technical skills and provide trainees with the feedback tool needed to improve their performance in this vital aspect of surgical practice. Such implementation would eventually reduce the risks and errors in surgery, serving the ultimate intention of the assessment tools, and drive up performance (10). While cognitive surgical training is still novel, and will need further development, an assessment tool for non-technical surgical skills (NOTSS) behaviour rating system already exists. However it does require trained assessors in order to be implemented (74).

Reviewing the available assessment tools for surgical dexterity shows a variety of methods (75), interestingly, none of which perfectly cover the highest level in Miller's pyramid. Surgery is a team effort and operation results are usually attributed to supervisors rather than trainees (75). Audit findings are hard to assess, and require a high volume of errors to identify statistical significance and thus are not the best method to prevent damage before it occurs, as currently demanded (10). This is the argument against the use of the final product as an assessment tool in surgery. The logbook, religiously maintained by all surgical practitioners, is a quantitative measure only. Similar to audits, logbooks fail to provide the needed qualitative performance feedback to guide learners' progress (75, 76). This brings us back to the early argument about the role of feedback (48-51, 53) and perceived self-efficacy (9, 52).

Observations with checklists and rating scales are well established assessment methods, despite the lack of standardisation in real surgical operations (75) due to anatomical or pathological variations. Examples of such methods are found in the objective structured assessment of technical skill (OSATS) (77) and procedure based assessment (PBA) (23). PBA was discussed in the first chapter as it is the standard assessment tool in the current surgical training programme. PBA has six general assessment domains and a global assessment part (Appendix 1). Feedback spaces are provided for each of the six domain items for surgeons to give constructive feedback to their trainees. The last global assessment part provides four competency levels varying from novice to a fully competent surgeon (23). The form aims to assess technical competency but it provides some hints to knowledge and non-technical skills assessment in an integrated manner (Appendix 2, Table 1).

As discussed in Chapter One (Section 1.2.1), PBA must be completed directly after the observed procedure, which is rarely the case in rushed clinical practice. Retrospective form filling risks memory fading and the assessment/feedback form becomes a box-ticking exercise with limited benefits. Unfortunately, the Sheffield Research Group (27) identified missing or limited feedback even when forms were completed immediately post-observation. Failing to provide feedback is a major setback for formative assessment and undermines the base for using these tools to enhance learning.

Lastly, the benefits of technical, surgical simulation training beyond basic surgical skill acquisition were outlined earlier. This section will discuss the use of simulation as an assessment tool. Shah *et al.* (75) discussed the various virtual reality and dexterity analysis systems available. Those include among others, the Imperial College Surgical Assessment Device (ICSAD) which involves attaching a motion tracker to a surgeon's hand and providing numerical feedback, and the advanced Dundee endoscopic psychomotor trainer (ADEPT) which uses basic laparoscopic simulated tasks and generates computerised feedback using standard variables such as time and contact errors.

Virtual reality assessment does not provide the best assessment tools for four reasons. Firstly, they fail to address the highest level in Miller's pyramid as they do not provide assessment of performance at the job (26). Secondly, despite the movement of some of these tools to real operative assessments, they are highly technically demanding and have limited educational value. They fail to provide clear feedback to facilitate trainees' skill acquisition, despite the attempts to mimic real operations (78). Gipps (79) argued against the use of mere numerical feedback and considered it counterproductive.

''Feedback from teacher, which helps the student with the second of these stages, needs to be of the kind and details which tells the student what to do to improve, the use of grades or 'good,7/10' marking cannot do this. Grades in fact may shift attention away from the criteria and be counterproductive for formative purposes'' (Page 73).

Thirdly, they fall short compared to other forms of assessment. In a trial to improve ICSAD reality, Docis *et al.* described the addition of a synchronised video recording of the procedure (80). Comparing the new tool to the blinded expert videotape review with a rating scale confirmed the validity and reliability of the latter (81). Finally, I refer back to Zendejas *et al*'s (37) randomised control trial, discussed in the surgical simulation chapter. In that study the experiential group failed to gain more than one operation advantage despite training to mastery on surgical simulation. It would be reasonable to conclude that simulation assessment is not suitable either for regular formative or for summative assessment in surgery.

2.5.1 Audio-visual role in assessment and learning

Traditional teaching methods in surgery rely on clinical experience and supervisor feedback. The current advancement in technology has provided extra tools for teaching. Some of those tools are well known, and used, such as Power Point and projectors, whilst others have not been fully utilised yet, for example video-recording. Video recording is used to enhance athletes' performance (82). It has also been used in medical education. Guerlain *et al.* (83) developed a laparoscopic surgery perceptual judgement course using multiple video sections from various surgical procedures. Videos established the level of performance, which is far better than text in describing complex procedures which led NASA to sponsor a just-in-time step-by-step video guide to help astronauts performing emergency medical procedures (84). Dr. Bruce Jarrell, the chief surgeon from Maryland University summarised the advantages of video recording when he said ‘‘A picture is worth ten thousand words’’ (85).

Recent studies have focused more on the audio-visual role as a performance feedback tool. Performance feedback is a vital component for successful training as discussed earlier (29, 46, 47, 49, 50, 53, 54). Olsen asked emergency medicine residents (51) to report their mistakes, especially the most frequently occurring, before reviewing their actual recorded performance. Viewing of their own videotape-presents trainees with objective evidence of their performance, helping them to improve their self-assessment ability (86). It also provides the student with the opportunity to discover their mistakes, and creates a self-improvement agenda which is more likely to be implemented than an external agenda forced on them by the trainer (64).

As a result video-review enhances training and reduces time to reach competency. Cauraugh *et al.* (87) videotaped surgical candidates performing a McVay hernia repair twice with a teaching period in between. They were randomised into a traditional teaching group and an experimental group. The experimental group reviewed their video recordings on a split screen with the videotape of an expert performing the same steps. This session was facilitated by an expert surgeon. The experimental group had a statistically significant improvement in instrument handling and surgical technique compared with the traditional teaching group. Mistakes were repeated in the traditional teaching group. The overall surgical time was significantly reduced with the experimental group. Using the sensory-motor integration theory they argued that the split screen facilitated the video-review sessions and exposed candidates to more spatial clues and ‘‘perceptual-based cognitions’’, improving their instrument handling and overall ‘‘procedural knowledge’’. It also provided the residents with an expert reference point by enabling them to compare their own performance to that of the expert (88). Early recognition of the importance of cognitive clues in the learning thinking process is inspiring in the light of the newly available evidence discussed earlier in this chapter (54).

These improvements in training are echoed through the literature in relation to both time spent on training and better outcomes. Scherer *et al.* (89) noticed no improvement after three months of verbal feedback following use of the Advanced Trauma Life Support (ATLS) protocol. This was evident despite being video recorded during resuscitation. However, an improvement in half of the desired behaviours occurred one month after reviewing of the team-members' own-tapes. This improvement continued throughout the remaining study period. Goldman *et al.* (90, 91) showed surgical, technical and non-technical skills improvement in the video group including correcting exposure inadequacy, reducing indecisive inflexible actions and reducing irrelevant motions. Brinbach *et al.* (92) videotaped twenty two trainee anaesthetists and randomised them into two groups: one reviewed their own videotapes, and the other received standard teaching. The video-review group achieved higher overall grades, and improved to a greater degree than the non-video-review group by the end of the rotation and were the only group to continue to improve after the mid-rotation evaluation. This study suggests some skills are facilitated by video review, such as, aseptic technique and needle control.

Video-review seems to facilitate non-technical skill acquisition as well. Such an effect should lead to patient safety enhancement due to the previously described non-technical skills safety role in surgery. Santora *et al*'s (93) study of adherence to ATLS protocols showed improvement in surgical resident leadership skills in the later part of their study when the video reviews were introduced, and a reduction in failure to meet ATLS standards. Resident postgraduate training level did not influence their overall performance, suggesting the role of videotape review rather than the natural learning curve.

In another study, resuscitation team leaders identified and improved missed systems examinations and poor communication after reviewing their own tapes (94). Townsend et a1 (95) demonstrated a reduction in resuscitation times after introducing an educational video-review resuscitation programme especially for severely injured patients. The video-review group had significantly more unexpected survivors when compared to the Major Trauma Outcome Study database (96). Improving non-technical skills should translate into a better outcome as described previously. As a result such enhancement in resuscitation survival rate in the last study is not a really surprising result.

The Royal Melbourne Hospital study in Australia (94) provided the legal ground for carrying out video recording in practice. Covering the study under the hospital quality assurance activity umbrella protected it from any legal actions. Quality assurance legislation provided the study with the needed legal protection from the freedom of information act and coroner inquiry. As such, neither the patient nor relative signed approval, this was not seen as necessary as long as CCTV warning signs were displayed and no identifiable information was captured in the recordings (94, 97). Maryland trauma centre had no medico-legal issues within their 11 years video recording practice (97).

A trainee’s own video-review serves as a way of reflecting on their practice. Review sessions take place in a calm environment away from the action. This helps to isolate any associated emotions and facilitate reflection. This set up accords well with reflective theory (66). Schon argued that reflection-in-action and reflection-on-action are the two activities needed for professionals to learn from experience, as discussed earlier. If students fail to reflect on their practice they will simply gain no benefit from their training regardless of how intense it is. Rushed practice would increase the risk for medical errors and patient harm (64).

Despite the clear benefits from video-review, it has been challenging to introduce such a tool in everyday surgical education practice for two reasons. First, the focus of many surgical video assessment studies used blinded assessors armed with a rating scale. Those studies confirmed the value of video-based assessment rating scales in surgical skills assessment and reported positively on the feedback value of video review and the use of rating scales (98). However, they rightly argued against the use of this approach as it required excessive reviewer time for the assessor. This disadvantage is very hard to ignore in the case of using blinded video assessment but would be eliminated if videos were reviewed by trainees themselves in the way described in the new design to be presented in the next chapter.

Secondly, due to the historical technical difficulty in tape recording, video-review was challenging to implement and use routinely. This difficulty might be hard to imagine in the era of digital recordings. However, with improvements to video recording machines and reductions in size, recording is used easily today: laparoscopic intra-abdominal operation recording is carried out with a simple press on the recording button of the laparoscopic stack. Further synchronised recording will become standard in the new digital theatres gradually being installed across the country. Furthermore, various recording and synchronising systems have become commercially available and implemented in various degrees in trusts all over the country. An example of such a systems includes the Scotia Medical Observation and

Training System (SMOTS) (99) which is available in various trusts in the Northern Deanery and will be discussed in detail in later chapters.

In conclusion, a review of operations using video-recording offers the best tool to make the most of every training opportunities and shorten the time needed to reach competency. It improves technical and non-technical skills far more than the traditional teaching methods. This is vitally important in the current era of reduced training opportunities. Video-review of one’s own practice facilitates reflection and lifelong learning. Those two strengths along with raising awareness of one’s blind spots, provide the basis for improved professionalism. Having a holistic approach to clinical practice leads to improved professionalism and to achieving the aims of outcome-based curriculum (21). Professionalism is ranked the highest in clinical competency and guarantees better and safer practice (40).

2.6 Chapter summary

This chapter questioned the trend of comparing surgeons with commercial pilots in the search for safer surgical assessment and training. It established the relevance of the hazard awareness test used for driving to surgical assessment and the limitations of the current assessment tick-box practice. It also reviewed the available cognitive and learning theories. Finally, it reviewed the available skills assessment tools and established the use of video-review to benefit and enhance both technical and non-technical skills acquisition. This will provide the basis for presenting the cognitive hazard training and reflective formative assessment design in the next chapter.

Chapter Three: Presenting the new design

3.1 Introduction

As discussed in earlier chapters, surgical skills assessment in the UK relies on completion of the Procedure-Based Assessment forms (23). These detailed procedure-specific forms should ideally be completed by the supervisor and the trainee, directly after the surgical procedure to provide corrective feedback. In practice the trainee and the educational supervisor are often both tired after the procedure and rarely fill in the form the same day, or even fill in the feedback sections at all. Unfortunately the delay between the procedure and the form filling, reduces accurate recall. As a result, the assessment or feedback session becomes a box-ticking exercise with limited feedback benefit.

In Chapters 1 and 2, I discussed the need to create a new cognitive hazard training and reflective formative assessment design to assist as well as assess surgical skills acquisition. I have established the importance of enhancing the assessment process validity by providing objective evidence of trainees' performance in the form of viewing their own video of their practice. This tool facilitates reflection and internal feedback as surgical trainees review their own tapes to help them identify their own learning needs. It also eliminates denial and justification and provides a behavioural correction value beyond any verbal feedback. In this sense video-review maximises the use of every available training opportunity and reduces the timescale for reaching mastery. This tool could also provide consultants and programme directors with objective evidence about trainees' progress. This helps in establishing trust in trainees' capabilities and increases the likelihood of them offering extra training opportunities. Training could also be focused on individual trainees' strengths and weaknesses. Those benefits would collectively save training time and achieve the competency-based curriculum promises. I also established the safety value of mental (cognitive) training, by programming System One to recognise hazard patterns and alert System Two to intervene and prevent the damage before it happens.

In Chapter Two I challenged the analogy drawn between surgeons and commercial pilots, introducing a new comparison with drivers. I also proposed the relevance of the UK driving test system (100) to surgical skills assessment using Miller's clinical skills' assessment pyramid (26) and I linked the UK driving test to the best known cognitive theories.

In this chapter I will present my new surgical cognitive hazard training and reflective formative assessment design in order to drive learning. It will incorporate the best available educational tools and current technology advancement to enhance assessment. The ultimate intention of this design is to achieve the potential of the competency-based curriculum, to accelerate surgical training and enhance patient safety. However due to the PhD timescale limitation this project will focus on the first steps of creating the design and testing its feasibility within the UK training environment. I will also present the main reason to deviate from the current UK driving test model. This will be followed by discussing the obstacles and hurdles encountered in creating the prototype for laparoscopic cholecystectomy and describing the design details in the chapters to follow.

3.2 Proposed cognitive hazard training and reflective formative assessment design

I am proposing a design similar to the UK driving test, taking into consideration all the previously mentioned arguments about various assessment components. This design needs to use specific real-life hazard videos to train System One to recognise the clues to potential risks and alert System Two. This is the vital part in cognitive safety training. In other words, this design has to be procedure-specific to pinpoint the specific risks related to that procedure. As a result I have constructed a cognitive hazard training and reflective formative assessment design for laparoscopic cholecystectomy as an example, a prototype, of the new design.

My new design has two steps: Step One is a Cognitive Hazard Training and Step Two is a Reflective Formative Assessment. This design is summarized in Table 2. Although I presented my research design as an assessment to the research participants as will be described later in this thesis, the two design steps are planned in a way to mix training with assessment using cognitive training in Step One and reflective practice in Step Two.

Step One has a combination of multiple choice questions (MCQs), extended matching items (EMIs), and single-line free text questions. It also contains anatomical and laparoscopic drawings as well as images and live operation videos. Those elements were selected with great care to represent the common risks and dangerous mistakes during laparoscopic cholecystectomy. I have designed the training module as a standalone online hazard training resource. This training module progressed from simple questions to complete case management scenarios to facilitate cognitive training. I also divided it into four sections to signpost trainees and reduce the burden of shifting candidates' attention between various topics. Such mental shifting could lead to tiredness and reduce information retention as a result of the mental overload as described by Kahenman (54). Such mental overload would counteract the intended cognitive training.

Video-clips included the common mistakes made during the laparoscopic cholecystectomy procedure. The clips aim to programme trainees' brains to detect hazard clues and initiate recovery plans. They are similar to (58) error recovery theory, hoping to facilitate error self-detection by detecting errors in others in the first instance. It will train System One to detect hazard patterns and warn System Two to engage (54).

Once trainees pass the first step of the design they will move on to supervised practice to build up their technical and non-technical skills. Trainees' supervised laparoscopic cholecystectomy operation is filmed in a synchronised fashion to record the laparoscopic field inside the abdomen and the overall surgical environment within theatre. The two recording fields are merged in a synchronised split screen file using dedicated software. The resulting video will show surgical action and instrument manipulation as well as staff interaction.

Step Two covers the higher level in Miller's Pyramid. The trainee will review the recording with his/her supervisor and fill in the Procedure Based Assessment form

(PBA) (23). Despite the importance of non-technical skills I opted not to incorporate the Non-technical surgical skills (NOTSS) rating system (74) in my research. This decision was taken due to the time limitation and the need to have special training to correctly use this rating form. Such training is not available to the majority of my research target group. The trainees' journey in this new design is shown in Figure 2.

Proposed events in my Design	
Step 1	Cognitive Hazard Training; MCQ, EMI and Single-line free text questions in sections with the relevant sketch images and real life hazard and video clips highlighting mistakes to enhance safety, reduce bias and improve self-limitation awareness
Step 2	Reflective formative assessment using the trainees' own videos of their practice and reviewing them to facilitate reflection and assess technical skills by using the PBA form and enhance trainer feedback.

Table 2: Event sequence in the proposed design.

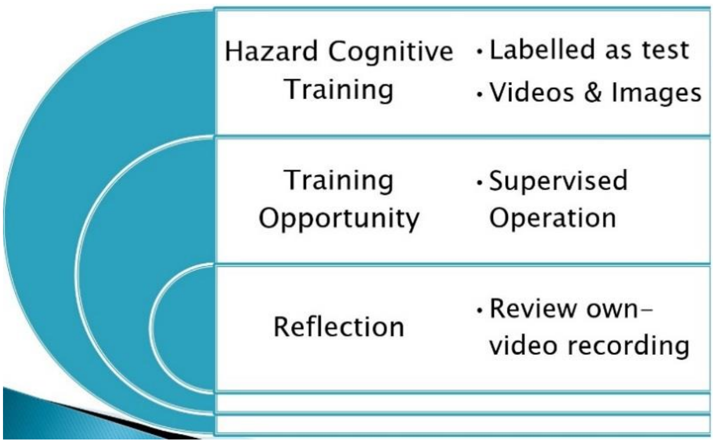


Figure 2: Trainees' learning journey within the new Design

3.3 Explaining the reasons to deviate from the UK driving test structure

The initial plan was to design the assessment system Step One, in a similar way to the UK driving knowledge and hazard test. In other words, to start with knowledge questions followed by assessment of the hazard perception clips as in the driving test structure. This plan was changed after consulting the available cognitive literature discussed in Chapter Two.

Kahneman (54) described the possibility of training System One to detect hazard clues and warn System Two. Such training would be best facilitated by providing a familiar environment with a realistic sequence. Despite the lack of standardised steps to perform surgical procedures, they usually follow certain phases. To translate Kahneman's theory into surgical practice we needed to train System One to detect clues for specific possible hazards in each phase within the surgical operation. Such a sequence would help the brain to look for certain clues at certain times within the operation. This would reduce and focus brain training by providing a certain order.

Taxing the brain to answer knowledge questions about various parts of the operations, then presenting the hazard clips about those parts again, would create an artificial split and would not reflect the real experience within the operation. It would force candidates to flip back and forth between operation steps causing tiredness and shifting the attention away from the intended hazard-spotting training.

As a result the new design organised the cognitive hazard training module in a merged fashion. I also divided the module into four main sections and divided the sections into various parts to signpost the shift from one topic to the next. This is to highlight the expected risks in each step and reduce the mental shifting between various tasks.

The UK driving test part two (Practical Test) relies on direct observation by an examiner armed with a check list. The examiner has to test the driver and tick the check list while maintaining safety on the road. This is possible in driving exams as the test follows certain known routes and the driver has been trained to full competence or very close to full competence by their driving instructor. In other words the practical test is a summative test of competency for a trained driver with limited risky behaviour, allowing examiners to focus mainly on the test, while maintaining safety, with no training component.

Surgical training and assessment is far from the driving test scenario described above. Consultant surgeons are busy assisting and teaching trainees and they are scrubbed for sterility so they cannot touch normal pen and paper. They have to train trainees with variable degrees of competency and frequently assess their progress using the PBA forms. Current recommendations advise that each trainee should carry out 40 WBAs per year. Consultant surgeons are more like driving instructors carrying out training and frequent assessments simultaneously while keeping an eye on the operation’s progress and the patient’s safety. They cannot tick the check list during the procedure as well as carrying out all those tasks even if they manage a way to overcome sterility issues. As a result PBA forms are usually completed after the operation list on one of the consultant's admin/free days relying on recall which is subject to decay over time. To overcome this problem I used the video-review session of trainees' operations to provide objective performance evidence and improve trainers' feedback.

Video-review facilitates trainees' reflective practice as discussed in Chapter Two. They review their own performance in a stress-free environment and reflect on it (66). Multiple studies (in relation to open surgery, anaesthesia, music and sport) have demonstrated the benefit of this practice in improving skills and improving trainees' ability to self-assess as described in Chapter Two. Reviewing one's video of practice facilitates internal feedback and helps to focus training on individual trainee needs. It shortens training time by making the best of the available training opportunity and enhances safety by allowing improvement beyond traditional training. The benefit of such practice was studied previously in various fields, as mentioned in Chapter Two, but was technologically difficult to conduct on a large scale in the theatre environment. Technology advancement has recently overcome this difficulty.

As the majority of surgical consultants will scrub to assist their trainee during surgical procedures, video-review will give them the chance to reflect on their teaching styles. In this sense consultants are evaluating their teaching style and giving trainees direct performance feedback. This overcomes assessors' time wasting as the result of reviewing blinded videos which was the only disadvantage of video assessment argued by Aggarwal (98). Video-review will also enhance the validity and reliability of the surgical skills assessment by providing objective performance evidence.

Video-review will also allow trainers to assess trainees' non-technical skills, if they have the training to do so. When consultants review the operation videos with their trainees they will not be occupied by mentoring and observing their trainees' operative action. This will leave them free to focus on assessment and feedback of technical and non-technical skills, thus avoiding competing duals roles (101). To compensate for supervisors' involvement in theatre Crossley *et al* used non-surgeon assessors to mark the NOTSS form. Such a step deprived trainees of their trainers' feedback and casts some doubts about the assessment value.

As discussed in earlier chapters, the surgical environment has a special character, distinguishing it from other disciplines. Such distinction presents a different set of skills in communication and coordination. Grote *et al.* established the unique implicit coordination and higher leadership required in the theatre environment (34). This will affect leadership and situation awareness interpretation by non-surgical assessors, limiting their ability to judge those domains as was the case in other studies (101, 102).

I opted not to include NOTSS in my research due to the lack of widely available training for my target group. However I am arguing that my structure will facilitate the use of this form and overcome the obstacles described in the literature once such NOTSS training becomes available.

3.4 Chapter summary

This chapter described the new cognitive hazard training and reflective formative assessment design principles and the reason to modify the design from the current UK driving test model. The next chapter will detail the challenges encountered and the hurdles that I had to overcome in creating the practical example for laparoscopic cholecystectomy assessment. I will describe the steps taken to create each part and the logic behind using the selected clips and materials along with a detailed description of the final assessment product.

Chapter Four: Putting the design into production

4.1 Introduction

In the previous chapter I laid the foundation for my new design starting with the UK driving test as a model and finishing with the new cognitive hazard training and reflective formative assessment design. As design-based research, establishing the principle foundation for the intended formative assessment was the first step in the process. This step was followed by creating a practical example of the system and putting it to the test by conducting a feasibility study.

In this chapter I will describe my journey in creating a practical example of my design for laparoscopic cholecystectomy. I will also mention the difficulties faced throughout the process in finding the suitable materials, getting the legal permissions to use them, solving the technical and design challenges in processing the material to serve the intended value within the system and the ethical challenges encountered in planning and conducting the feasibility study.

4.2 Moving from design to reality

I described my plan to create a two-step design: Cognitive Hazard Training and Reflective Formative Assessment. The Cognitive Hazard Training module should have a combination of multiple choice questions (MCQs), extended matching items (EMIs), and single-line free text questions. It should also have anatomical and laparoscopic drawings as well as real-operation videos and images. Those elements will be selected to represent the common risks and dangerous mistakes made during laparoscopic cholecystectomy. This selection is essential to achieve the intended hazards training under the cognitive theory mentioned in Chapter Two and ultimately improve patients' safety. The Reflective Formative Assessment will use the trainee's synchronised video recording in the review sessions to overcome memory fading. It will enhance reflective practice allowing trainees to gain the maximum benefit from the available training opportunities.

To move this plan from the planning stage into reality, I had to define the main points to be covered in the Cognitive Hazard Training module as well as finding the suitable real-operation hazard and relevant videos illustrating the mistakes. I also had to find practical mobile equipment to video-record the operations and merge the two videos, inside and outside the abdomen in a synchronised fashion into one file as described in the previous chapter. I needed to plan the whole feasibility study to be compatible with the NHS Caldicott approval framework and information security safeguards in various trusts. As trainees rotate between multiple trusts within the Deanery it was important for the feasibility study to check the practicality of using such an assessment system in a wide range of NHS trusts. I chose the Northern Deanery trusts to conduct my feasibility study as my PhD was registered at Durham University and I chose Northumbria Healthcare NHS Trust to be the lead trust as one of my supervisors was working there.

As described before, this new design is procedure specific as the majority of the hazards and mistakes are unique for each operation however, the generic steps involved can be used to inform an equivalent programme for any given procedure. I created an assessment example for laparoscopic cholecystectomy which will be described in this chapter. I worked in parallel to create the two steps in the assessment system: Cognitive Hazard Training and Reflective Formative Assessment. I was faced, however, with different challenges in each of those steps. As a result I will explain each step's creation and the challenges separately.

4.2.1 Creating a Cognitive Hazard Training module

The first step to create the Cognitive Hazard Training module, following the logic explained earlier, was to identify the important phases in the operation and the possible mistakes and complications encountered in each phase. Despite my background as a surgical registrar I found this step to be really challenging. I started by reviewing the benign biliary tract diseases in the commonly used Companion to Specialist Surgical Practice series (103). This series is the unofficial standard read for all UK surgical registrars and it comes in the top reading list in all Fellowship of the Royal College of Surgeons (FRCS) preparation websites. I then progressed to hold multiple discussions with my surgical supervisor and the other Upper GI consultants at Northumbria Healthcare NHS Trust. Despite emerging from those discussions and from my reading with a preliminary list of possible topics and complications, this list was simply just a list of desirable ideas or a shopping list (Appendix 3, Table 3). It was not possible to commit to any design or content without having any available materials, in the form of hazard and mistake videos and images, to use in the module. So I had to start working on finding those materials first and then design my module around them.

I wanted to include: indications for conducting the operation, anatomical variations, checking for a clear plan to progress from one step to the next, complication and complication management, with a possible list of desirable hazard videos. I even considered using simulation to simulate some hazards initially before ruling that out, as I will discuss later in this chapter. I had also to consider getting the legal copyright holders' permission to use the material, a way to process the materials once obtained and a way to present the assessment to trainees. Needless to say, as the module contained hazard videos, paper assessment was not an option and a computerised version was the way forward to present the cognitive hazard training module to trainees. However, computer presentation could be in many forms and the decision taken between them will be discussed later on in this chapter.

Again, for the purpose of simplicity, I will present the path to obtain the copyright permission, to process and to use the images and videos separately.

4.2.1.1 Images

I used multiple images in my module but the ones referred to specifically in this section are the images of the Laparoscopic views and corresponding cystic artery anatomical variations. Those images are used for a specific purpose.

As discussed in earlier chapters, cognitive training plays an important role in aviation safety. Military pilots receive cognitive training in the form of sketches with exaggerated differences and contrasts to recognise various jet fighters from the first glance (104). This information plays a vital role in those pilots' engagement plan as various enemy aeroplanes require various responses. In this sense, it was important for the pilots' safety to achieve recognition of enemy aeroplanes fast.

To apply this in the field of surgery, my search led me to coupled anatomical and laparoscopic drawings. I accessed those images via the website showing Skandalakis's Surgical Anatomy which had those pages on public display in 2014, but at the time of writing this chapter, these can only be viewed via a different website (105). Those drawings contain a series of coupled images, one representing the cystic artery anatomical variation and the other representing the corresponding laparoscopic view.

As laparoscopic cholecystectomy is carried out through keyhole surgery, surgeons have to rely on the laparoscopic camera to capture the intra-abdominal view and present the video on the laparoscopic stack monitor. This video output on the monitor has a two-dimensional presentation of the intra-abdominal three-dimensional environment. The surgeon then has to interpret this two-dimensional view and manoeuvre his instruments in the three-dimensional real environment inside the patient's abdomen. In this setting the surgeon cannot have real views as would be the case in open surgery, and laparoscopic views become his only way to assess the situation, detect the hazards and deal with those hazards throughout the procedure.

In this sense, any help in highlighting the possible anatomical variations within the laparoscopic view is vital to improve the operation's safety. This is because surgeons have to modify their plans and approach to safely deal with those anatomical variations. Missing such hazard clues might result in clipping or cutting the wrong structure with various complications. As a result, those anatomical/laparoscopic images play a vital role in operation safety and needed to be incorporated in my new assessment.

I emailed the publishing company for permission to use those images and they referred me to the chapter author as he was the copyright holder. After frequent email reminders he replied declining to grant the permission as he was given permission to use them himself by the original drawing copyright holder. He informed me that the original drawing copyright holder has passed away and his permission was granted to use the images for the anatomical book only. The original images were black and white but, with the original drawing copyright holder's permission, the author colour modified them in the anatomical book chapter.

Due to the safety importance of those images, I was desperate to use them in my mental training and assessment material. I conducted a focused search which led me to the original black and white drawings (106). I contacted the publisher and I was given permission to use and edit the drawings in my assessment material as part of my PhD as long as it is for non-profit academic use and on a restricted invitation access only.

I was then faced with a dilemma. As I now had permission for using the original black and white images, should I go back to request permission to use the coloured version from the anatomical book or should I even colour them myself? Referring back to the cognitivist explanation for using the drawings in military training (104), simplifying reality while exaggerating the possible real life difference are the key principles in enhancing learning. In reality arteries do not have a red colour, either in laparoscopic view or in open surgery. In fact the only time you see red colour in surgery is after you have made a mistake and cut the artery. It is important to realise artery variation as structural position variation without being distracted by unrealistic colours. In this sense using black and white images would be more realistic and better to achieve the intended teaching purpose.

While editing and processing the bile duct injury video, I had to contact the copyright holder for the anatomy chapter to gain permission to use bile duct injury classification images. He was kind enough to grant permission under the same conditions of non-profit academic research with invitation-only access to surgical trainees. The combination of time spent gaining the needed permission to use copyright images and the material creation spanned over two years of this thesis.

Next I will describe the search for the hazard videos and the process followed to gain permissions. Then I will describe processing the material and the editing journey.

4.2.1.2 Videos

The main reason for using hazard videos and those containing mistakes was to provide cognitive hazard training to improve operation safety. Videos are used to mentally train System One to detect hazards and alert System Two to take the appropriate safety actions, as discussed in Chapter Two. To achieve such an intention video clips must represent real hazards encountered in the target operation, which is laparoscopic cholecystectomy in our case. Current surgical operation simulation machines lag behind in reality and struggle to equip surgeons with the operation skills needed, beyond basic training. In fact, extensive training to full competency in surgical operation simulation failed to provide a benefit beyond the first real operation in Zendejas's randomised control trial (37). As a result, I ruled out the use of simulated videos and I started to search for real operation hazard videos for my module.

Using my topic shopping list described earlier (Appendix 4, table 3), I started a video search for hazard and complication videos. It became apparent, as the search continued, that the materials needed are available on YouTube. However those videos were rarely labelled according to the hazard presented, except in severe complication cases such as common bile duct injury or serious hazardous anatomical variations in the cystic artery origin. This forced a wider search on all available laparoscopic cholecystectomy videos across YouTube. This wider search entailed watching every encountered operation video looking for specific moments of hazards or unusual anatomy.

It also became apparent that it was not possible to use multiple whole-operation videos of twenty five to fifty minutes in my assessment. Such use would make the assessment time unrealistically lengthy. This would put off candidates and risk them missing the intended mental hazard training. I was faced with the need to find a legally acceptable way to download YouTube videos and edit them in a way to highlight the targeted hazard and complication moments.

Despite the availability of many YouTube download tools and sites on the net, the YouTube copyright document does not give a clear permission path to follow. Even though those operation videos were uploaded onto YouTube under the education category, there was no clear line to say you are allowed to download them for educational purposes. It was only clear that I would be allowed to stream them online, which was not practically possible in my case due to the video length.

Faced with these vague permission criteria, I emailed Durham University legal department for help. I was advised by the legal department to email the YouTube copyright email address but was warned that they will most probably refer me to the copyright holders for permission. Within the same period I had a discussion with Durham University Educational IT experts and I was advised to create the assessment in a computerised form and host it on the University website with an invitation-only access to simplify the images' and videos' copyright permission granting process. Needless to say I was chasing free access permission. However the University IT department recommended that I purchase the material needed on a set number of users rather than viewers basis. This was because trainees might start the video then stop the module to resume it later due to emergency calls or other circumstances. This was clearly important advice but fortunately I managed to get all my targeted materials permissions free of charge.

I sent a detailed email to YouTube copyrights asking for permission to download those videos and explaining my research had an academic, non-profit educational aim, which would be in line with the educational category under which those YouTube videos were uploaded. After sending two email reminders I received an answer a month later to say:

'*We cannot grant rights to any screenshots or footage of third-party content on our site. Please follow up with the individual content owners regarding the rights to this footage. You may be able to contact the user through YouTube's private messaging feature*'.

The YouTube private messaging feature is a hidden built-in feature within YouTube. I had to search the net to find some guidance to using it. The process starts after watching the operation video on YouTube and identifying it as a possible material candidate. I then had to subscribe to the video uploader channel. Such subscription was not possible without logging in to YouTube first with my google username and password. I then had to go to the subscribed channel where I found multiple subheadings: 'Home', 'Videos', 'Playlists', 'Channels', 'Discussion' and 'About'. Under the 'About' subtitle there is a Send Message button to send a private message to the channel owner. Those messages get sent to the owner's Gmail account but, despite the recent increase in popularity, this is still not the default email account for most people. As a result, I had one response only and that response was sent to my Gmail account. I did put my University email address in the messages sent using the YouTube private messaging feature and I was not expecting a reply through Gmail. I noticed the reply a month later as I do not check my Gmail account. I use a Nexus (Google brand) phone and Gmail started to send push notifications for new mails after a software update by Google. I noticed a push notification of a new mail. When I clicked enter to check the email, I was faced with the receipt for the book bought and two emails from one YouTube channel owner giving permission and offering to help in training me to upload and edit my videos.

Due to that lucky email discovery I came to the conclusion that it was highly unlikely that I would get any more answers through the YouTube private messaging feature. Firstly, it was two months down the line since the first wave of emails, with one answer only, despite frequent reminders. Secondly, if I do not check my Gmail account then most probably other people did not either. I had to look for a different way to contact the video/channel owners to make sure my message would reach them.

Checking the information provided by owners on the ‘About’ subtitle in their YouTube channel, I found a variety of information about the individual. Some provided their name, others their work title, work address, a website link and even an alternative email address or a contact number in some rare cases. Those pieces of information were used to search the web for further contact details to ask for permissions. I contacted people via Facebook, twitter, and comments on the channel owner's newly uploaded videos. I expressed my interest in the videos and asked for an email address for further communication.

I frequently needed to send two to three reminders, with a couple of weeks in between, to get an initial response; however permissions were usually quick after the first response. All the above communications were followed by a detailed email from my Durham University account to provide the video-owner with a brief description of my research aims and objectives. I stressed in my email the invitation-only access and the non-profit academic educational purpose of my research. I also stated that the research is aimed for UK surgical registrars' training benefit. I explained the need to download and edit the videos to shorten them to suit my assessment within a set time limitation.

I managed to gain permissions from all the successfully contacted owners except one owner. This copyright owner showed some hesitancy and asked me to provide the full context for using the video and the reason for selecting a near miss video in my assessment. He gave reluctant permission in the end and I opted not to use his video in my assessment as better alternatives were found during the design process. All other successfully contacted owners gave full permission to use all their videos. One owner gave full permission to use his own generated materials as he had uploaded other owners' material into his channel.

Despite that success in gaining permissions from the successfully contacted channel owners, I was faced with challenges in reaching other owners. Some channels were inactive for many years and communication led to dead ends despite following all possible leads over a reasonably long period of time. Other channels had no owner information to follow up. Those videos were marked as for streaming only, as streaming is allowed within YouTube copyright, without the need for further permissions.

As I discussed above, I needed to view all the available laparoscopic cholecystectomy operations to look for possible hazards and anatomical variation due to the lack of clear labelling of such videos. It became a repeated cycle of searching for videos, viewing them and chasing the copyright holders while looking for more videos. This repeated process enabled me to reduce the time wasted in gaining the permissions as it was incorporated in the same period to search and watch a huge number of full length surgical operation videos.

As I was given full permission to use all channel content by many of the channel owners, I conducted a further detailed video review to search through all the permitted videos. I created a list of the permitted videos with their detailed review and the non-permitted streaming only videos that I considered important material for my assessment (Appendix 4).

Armed with the granted copyright holders' permission I went back to Durham University's legal department for further guidance. I was instructed to email YouTube copyrights again, mentioning the granted permissions and asking for permission to download those videos from YouTube. I was faced with the exact same reply wording:

‘*We cannot grant rights to any screenshots or footage of third-party content on our site. Please follow up with the individual content owners regarding the rights to this footage. You may be able to contact the user through YouTube's private messaging feature*’.

I sent the reply to the University legal department and they were happy to consider it as evidence that YouTube have no extra copyrights over those videos. I was given the green light, by the legal department, to download and edit the videos and I was also provided with a supportive email from the university legal department to include in my ethical approval application (Appendix 5).

4.2.1.3 Material editing

In his error recovery theory Dror (58) described the use of interactive video clips to enhance error detection. He used interactive flash files, progressing from simple exaggerated mistakes to more hidden errors. Trainees had to come with the possible recovery plans at the end of the process after being offered such plans earlier in the training. This would eventually help trainees to recognise their own mistakes and reduce them (58). I was advised early in my project, by Durham University Educational IT Department, that such interactive flash files will not be supported by the expected adaptation of the HTML5 in World Wide Web in the near future. HTML5 is a programming language used, since October 2014, to present the content on the World Wide Web. Any content not supported by this language will simply not work online. As a result, the interactive flash file creation plan was unpractical in the light of the approaching technology change in the World Wide Web. I opted, with the Durham University Educational IT Department’s support, to use simple images and video clips integrated within my multiple choice, extended matching items and single-line free text questions.

I used Paint software to process the images. I downloaded the images using the Print Screen button and pasted them onto a Paint software blank file. I then enlarged the images to facilitate deletion of any marks or arrows with minimal effect on the images. I split the coupled laparoscopic/anatomical images into their separate components to use them as matching items, as will be described in the next chapter.

Many of the uploaded videos on YouTube were already processed to present the hazards or the anatomy variation. They included music, live comments, labels and integrated explanatory images or diagrams. Those additions rendered these videos as not suitable as they revealed the answers. There was a need to remove such additions to allow the materials to be incorporated in the assessment. To do that, videos had to be downloaded first and then processed with a dedicated video editing software.

YouTube video clips were downloaded using the https://en.savefrom.net/ website. The video files were then edited using Windows Movie Maker 2012 (Build 16.4.3528.0331). This is a free application in the Windows Essentials 2012. The software was used to select certain parts of the whole operation file and remove the rest of the operation. Those parts were merged to create a shorter video file containing the intended hazard. Music and comments were deleted except in one video where the comment served to stress the message from the clip.

As the software enabled me to have full freedom in processing the videos, I managed to cut the labelled sections and inserted explanatory images. I opted to use some of those images and sketches for the feedback after the questions to further stress the message. This process required careful planning and early integration of those videos in the early versions of the assessment materials as per the example in Appendix 6. Some clips required two to three small sections to be selected and merged while others required more cuts to shorten the operation, especially in the Common Bile Duct injury and Complication section of the assessment (Appendix 7). While processing and planning this particular question I felt the need for further visual clarification to stress the bile duct injury classification. This led me to contact the anatomical chapter author for permission to use the bile duct injury images as described in the previous image section. Those images were processed again using the same image methodology described above.

Video processing was quite demanding and required a computer with high specifications. I initially processed the videos using Windows Movie Maker on an old computer with Pentium Dual-core processor 2.6 GHz and 4 GB Random Access Memory (RAM). The process worked normally and the software presented the intended sections normally. It was only when I checked the resulting saved video files that I realised the problem. The resulting video files were pixilated and unclear.

The whole process was repeated using a newer laptop with Core i5-3230M 2.6GHz processor and 8 GB RAM. This computer held enough processing power to produce good quality output video files.

One unpermitted video clip was deemed essential as no alternative video clips were found with the same hazard. It presented erroneous clipping of the right hepatic artery, identifying the mistake by realising the liver ischemic signs, removing the clips and showing liver ischemia recovery. The copyright holder of this clip was not contactable and the decision was made to use this clip as streaming but to highlight the essential moments in a comment under the link to allow trainees to skip parts of the video to save time without missing those key moments (Appendix 6). Other less important unpermitted clips were labelled as nonessential extra examples.

Initial question drafts were further refined. Web links and section times were replaced with the name of the processed output videos. Questions were regrouped in pages to convey clearer unified messages and reduce brain shifting further. Unpermitted streaming videos were grouped together after each corresponding section: Artery, Bile duct and Complication. A button was created next to the optional extra video title to enable trainees to email the YouTube links to their email addresses for future review if they choose to do so.

Multiple checks were carried out by supervisors and colleagues to check the content, spell check the questions and check the shortened clips' clarity, prior to confirmation of the final draft. This draft, along with the processed images and videos, was then sent to the Durham University Educational IT Department to be uploaded on the University website. Uploading the material was carried out by one of Durham University Educational IT experts, it required a couple of correction cycles before the online Cognitive Hazard Training module was ready. This online module, described in the next section, was then piloted with two external experts before being used in the feasibility study.

4.2.1.4 Online Cognitive Hazard Training module

As described in the previous section, the Cognitive Hazard Training module was uploaded onto the Durham University website. The uploaded module had a dedicated control Blackboard page at the University hosting website. This page allowed me to add candidates' details and divide them into groups according to their level: juniors, SPR 1, SPR 2, staff grades and consultants. After adding candidates' details I could send them an invitation email from Blackboard. It also enabled me to monitor the last time candidates logged into the module. I could check if they manage to complete the module but I could not see candidates' individual answers. The Blackboard page has a button to generate an aggregated Excel sheet with all candidate results.

Candidates received an invitation email with a link to the secure module website. This link automatically fills up the candidate's unique username and password generated by the system. Links are automatically generated by Blackboard and I had no way of knowing individual passwords. I could however request the system to send username and password reminders to the candidates if needed.

The module was presented to the candidates as an assessment to grab their attention and increase engagement as a way to maximise cognitive training. Once logged in, candidates were presented with the introductory page (Appendix 8). This page contained a welcome message explaining the “assessment” aimed to allow candidates to check their knowledge and support their professional development by mentally training them to anticipate and avoid possible surgical hazards. The introductory page showed the four section divisions and their parts. It also explained the plan to watch videos from real operations and the difference between the mandatory assessment videos and the optional extra examples to expand further on some topics. Those extra examples could be skipped while taking the assessment and their YouTube links could be emailed to the candidate’s email address for a later review. The introductory message has a line to explain that the copyright permissions were obtained on condition of a restricted access via username and password and that the access would expire once the candidate had finished the “assessment”.

4.2.1.4.1 Section One (Diagnosis)

Section one had two questions to cover diagnosis and the operation main safety step: Critical view technique (Appendix 9). The diagnosis question is an extended matching item (EMI) with five options and four case scenarios. I chose the case wordings carefully to maintain the same information sequence and phrases as much as possible while clearly presenting the important differentiating features for each scenario. This was intentionally used to allow quick information scanning for knowledgeable trainees while giving as few hints for guessing as possible to juniors.

Each of the four case scenarios had a drop down menu to choose from the five possible answers (Perforation, Cholecystitis, Ascending cholangitis, Pancreatitis, Gastritis). Case Scenarios covered cholecystitis as this is the main indication for Laparoscopic cholecystectomy. They also covered Perforation, Pancreatitis and Gastritis as they represent very important differential diagnosis. Ascending cholangitis was included in the answer options without a matching scenario. I felt that it was important to incorporate this option to check that the candidates did not mix it up with any of the presented scenarios. However, I chose not to include it in the scenarios as it represents an emergency case with no indications for Laparoscopic cholecystectomy, the operation chosen in this procedure specific assessment.

The second question in section one was a single answer multiple choice question (MCQ) about the critical view technique which was an important safety step in laparoscopic cholecystectomy.

If the two questions in this part were answered correctly, the feedback page would be shown (Appendix 10) and candidates could progress to the next section. On the other hand, if question two and/or one or more of the question one scenarios were answered wrongly the system would highlight the correct choices with a blue tick (✓) and the wrong choices with a red cross (×). Candidates would be given one chance to correct the wrong answers, after which marking and feedback would be shown even if they made another mistake. In other words candidates had two attempts only, to answer the questions in the page before being presented with the correct answers and progressing to the next question. I chose the two attempts to allow room for making a mistake while preventing multiple guesses.

This logic continued throughout the module except in single-line free text questions where the system was set to accept certain words and allow one attempt only. In those questions the computer program marked the answer with a blue tick (✓) or a red cross (×) and provide the feedback simultaneously without allowing a second attempt. I was not sure that the module would manage to recognise all wording variance so I chose this approach to test the system and avoid candidates' frustration. I planned to manually analyse those answers and provide a plan to improve the designs at the end of my PhD project. It was important to remember this was a design-based PhD project to test a feasibility study. It was conducted to test the design feasibility, analyse the results, suggest modifications and report the learning benefits. It was also important to remember that this module was a formative assessment with the aim of mental training. It was not a summative, pass/fail, assessment and leaving the free text questions computer marked or unmarked would did not affect the design aims. This module aimed to expose trainees to the important risks and mistakes in laparoscopic cholecystectomy and mentally prepare them to spot hazard signs and generate damage mitigation plans. In fact this module did not provide a score at the end. The answers were corrected and candidates were given feedback as they progressed.

4.2.1.4.2 Section Two (Artery)

After finishing section one, candidates progressed to Section Two which was titled Artery. This section had six parts: five mandatory and one optional (as before the section optional section contained material that could only be accessed by streaming it). Each part contained one or more questions presented on one screen. Candidates had to progress in a linear way through this module from one section to the next and from one part within the section to the next. They were not allowed to skip sections or parts of a section. This was deliberately set to reduce mental tiredness by preventing brain shifting back and forth between topics. It was also set to allow the creation of a comprehensive systematic design from start to finish. Module elements progressed from simple to more complex scenarios and the design built up knowledge in a progressive manner. This will become clearer later in this online Cognitive Hazard Training description.

Candidates could stop the module at any point and their progress would be recorded and saved by the system. They could return to the module later and their progress would be shown on the introductory page (Appendix 11). They would see a green tick next to the parts and sections completed. Those parts could be re-entered to refresh the memory by checking previous answers and feedback. Candidates however, could not retake the test and their previous answers could not be modified. The next section to be completed was shown in a green colour without a green tick next to it and the remaining parts and sections would be faint as they were not yet available (Appendix 11). Candidates would simply continue their progress by picking up from the last point they had reached.

The first part in the Artery Section has two questions (Appendix 12). The first question was a multiple choice question (MCQ) with a single correct answer. It asked about the most common cystic artery anatomical variation and the answer was cystic artery doubling. The second question in this part was an extended matching item (EMI) with four laparoscopic view images. Each image had four anatomical sketches to choose from. Those images were the result of editing the coupled laparoscopic views/anatomical sketches described in the image processing section above. They had been split into their components with the marks and arrows removed. Laparoscopic views were selected as the base image and the anatomical sketches were chosen as the options in this EMI question. This arrangement replicated a real life scenario. Surgeons operate using the laparoscopic view presented on the laparoscopic machine's screen as discussed before. They have to interpret possible anatomical variation corresponding to the laparoscopic views displayed on screen and take steps to deal with the anatomical elements safely. The same logic was used in this EMI question. Candidates had to match the laparoscopic view with the corresponding anatomical variation sketches. Those sketches were presented next to the laparoscopic view and candidates made their choice from a drop down window. Once a choice was made the rest of the anatomical sketches disappeared, leaving the selected sketch only next to the laparoscopic view (Appendix 13). This was done to reduce mental overload by removing any distraction by the other sketches and enabling trainees to double check their answer. After matching all the images in this question, candidates hit the Next button to submit their answers. The correct answers were marked with a blue tick (✓) and the wrong answers marked with a red cross (×). Candidates were allowed another attempt to correct their mistakes as discussed before. Feedback was provided with the original coupled images (Appendix 14) displayed below the marked questions after the second attempt or after the first attempt if all answers were correct.

To summarise this part, trainees were asked about the most common cystic artery anatomical variation in question one. They were then questioned about matching the laparoscopic views with the corresponding cystic artery anatomical variations. This information was emphasised further by providing the coupled images as feedback.

Part Two of the Artery section put those learned laparoscopic/anatomical variation clues into practice by showing two short videos and asking about possible cystic artery anatomical variation (Appendix 15). This was followed by marking the answers and providing four extra feedback videos (Appendix 16). As described in the video editing section of this chapter, YouTube videos were downloaded, and shortened by selecting the important parts and using those parts in questions or feedback as needed. The first and second feedback videos represent an advanced stage of dissection from the previously presented two operation videos in this question. Each video showed the anatomy safely dissected in the corresponding operation and the duplicated artery clearly viewed before being clipped. A message was provided before each of those two feedback videos, to stress the different internal fat distribution affecting the level of difficulty in identifying anatomical structures in the two operations. Those two messages (*Artery identification might be easy in a thin gallbladder*) and (*but would require further dissection in a fatty gallbladder*) are displayed before the first and second feedback videos respectively (Appendix 16).

The third and fourth feedback videos developed the problem further. They were preceded by the following hazard warning message (*Identifying anatomical clues help predicting and planning to manage possible risks. Those risks might be simple bleeding in this case*). Then the third and fourth videos showed bleeding as a result of missing the anatomy variation clues. The third video represented simple bleeding from one of the operations presented earlier within this question. The fourth video displayed bleeding that was more difficult to control (from another operation from YouTube not presented before in this question).

The feedback page ended with the following message (***Note:*** *Artery cauterization is the preferred method for this expert surgeon. Many surgeons might use clips. We are not recommending any particular method in this assessment. Our focus is on identifying risk clues and planning to mitigate any predicted problem using the surgeon's experience and preferred techniques.*). This message was added to stress the module position about the bleeding control methodology used in the fourth feedback clip. The surgeon in this clip used a fair amount of cauterization which is a method used to control bleeding by burning tissues using heat generated by a special medical device. Although this is a known method and can be used safely in expert hands it can still evoke discomfort and hazard worries among some surgeons. I felt the need to make clear the module material's neutral position about this bleeding control method to eliminate misinterpretation of the message intended. The fourth feedback video represented difficult to control bleeding, resulting from missing anatomical clues. This scenario was a possible event encountered in operations and it was not a criticism of the operating surgeon's skills. This clip served the module aim to stress the importance of picking up clues to avoid such bleeding. Dealing with bleeding after it occurs is left to surgeons' skills and the approach they would feel safe to use. Recommending one method over others was not part of this module's aims.

Part Three of the Artery Section had a multiple choice question with a video showing the cystic artery originating from the right hepatic artery (Appendix 17). The feedback screen had a video from the same operation just before clipping (Appendix 18). As discussed earlier, in the video processing section of this chapter, I removed voice comment, music, illustrations and any additions inserted in the selected videos. This was done to reduce distractions and prevent revealing the answer before candidates had attempted to answer the question. I opted however to leave the surgeon's verbal comments in this feedback video clip as it delivered a very important safety message. The verbal comments in this clip was: (*note that both the cystic artery and the cystic duct were clipped at the same time not at different times during the surgery. Critical views were obtained by both the primary surgeon and the assisting surgeon before any clips were placed*). This was very important to further stress those safety clues and serves the module aim without distracting from the hazard shown in this clip.

Part Four asked two questions about the consequences of missing the anatomical hazard presented in Part Three, and the way to recover from this mistake if it happened (Appendix 19). I chose the single-line free text question format as it was more challenging than MCQ. This escalating question level format followed the error recovery theory for mental training logic (mentioned previously in Chapter

Two). Dror suggested an intermediate phase of error recognition in others using interactive video clips. Clips, in Dror's theory, progress from simple exaggerated mistakes to more hidden errors. Trainees are asked to generate possible recovery plans at the end of the process after being offered such plans earlier in training (58).

Part Four built on the information already learnt. Questions in this section progressed from asking about the most common anatomical cystic artery variation to providing laparoscopic clues about possible encountered anatomical variation. This was followed by multiple practice opportunities with escalated difficulty and complication seriousness. Candidates were asked to generate a recovery plan in the fourth part after being shown bleeding controlled scenarios earlier.

As mentioned earlier, candidates had one attempt to answer the single-line free text questions. The system marked the answers by green tick or red cross marks and showed the model answer with a feedback video (Appendix 20). The feedback video in this part was different from all the other videos in this module so far. It was not a processed uploaded video like the others. It was streamed directly from YouTube. This video shows the effect of clipping the right hepatic artery in the form of liver ischemic colour changes. It also illustrates the surgeon's hazard recognition and recovery from this mistake before cutting the clipped artery. The surgeon reacted to the detected mistake by removing the clips and checking liver recovery signs. All in all, the surgeon in this clip managed to recognise the hazard clues and mitigate the mistake well, avoiding permanent damage.

Unfortunately, the owner of this video could not be contacted despite best effort. However, this video was really important to complete the aim of the module's hazard-training. The only feasible option was to stream the video directly from YouTube as I could not download and edit it without the owner's permission. By taking this decision I accepted the video length and the added music. I added a message above the clip, in the feedback page, to warn about the clip length and to highlight the key moments in the video. The message also included a line to further highlight the risk of missing the ischemic clues and cutting the clipped artery (*Missing the hazard and failing to recover after applying the clips would have resulted in right hepatic abscess and the need for a lobectomy.*).

If I had managed to gain the video clip owner's permission I would have removed the music and reduced the video into three short video slices. I would have taken one slice to show artery clipping and asked about the possible laparoscopic clues resulting from making such a mistake. This would have been followed by another slice showing the liver ischemic colour change and requested candidates to generate a recovery plan. Finally, I would have shown a slice of removing the clips and the liver colour recovery along with the warning message about the consequences of missing the mistake and cutting the artery. This would have been the ideal situation but failing to gain permission forced me to use the current described format.

Part five presented yet another laparoscopic view video and asked about the corresponding cystic artery anatomical variation which was the cystic artery originating from the gastroduodenal artery in this question (Appendix 21). In the feedback and marking page candidates were shown two extra videos with further intra-operation artery variation (Appendix 22). These were edited videos with further rare examples of cystic artery anatomical variations encountered and dealt with safely by different surgeons. I left the on-screen labels and arrows, naming the viewed anatomical structures, in those videos to prevent confusion and reduce mental overload. Those videos show extreme and very rare anatomical variation examples so it would be fair to say many will find the presented anatomy challenging. However, the message from this chapter was to pick up any clues that the anatomy faced might not be a standard anatomical distribution and to be cautious: Involve System Two, (as described in the cognitive theory section in Chapter Two of this thesis) to safely dissect the anatomical structures and establish a critical view before any clipping. A critical view should be established by more than one surgeon if possible, as stressed by the voice comments in the feedback clip in Part Three. Even after clipping, the surgeon should check visual clues before cutting as this might prevent damage as was the case in the feedback clip in Part Four. This message was further stressed by the written on-screen comments in the first feedback clip in this part.

Part Six was the final part of the Artery section and it included optional streaming videos which could be skipped by the candidates (Appendix 23). Candidates however had the option to email those YouTube videos' links to their email address for a later review. This could be done by pressing the Email Links button at the top right hand side of the screen. Each of the three optional videos was preceded by a message to highlight the hazard/anatomical variation and the key points in the video (they were chosen from the pool of videos I was unable to gain permission to download) to further stress the message in this section and provide extra training opportunities if trainees wished to watch them. They were not however included as part of the module to keep the message focused and keep the module within a reasonable time length.

4.2.1.4.3 Section Three (Bile Duct)

The third module section was labelled Bile Duct. It has eight parts with the last part marked as optional. Part one contained two MCQs (Appendix 24). The first question was a single answer MCQ about the most common cause of a bile duct injury during laparoscopic cholecystectomy, which was the surgeon's misinterpretation of biliary anatomy. The second question required more than one answer and checked the candidates' knowledge about intra-operative cholangiogram indications. The feedback screen expanded by explaining the hazard caused by the tenting effect. (*Tenting effect happens as a result of the normal technique used to expose the field during laparoscopic cholecystectomy. It does change the normal anatomy. However such a change should be accounted for during the operation. This is explained more in the video lecture at the end of this section (page 8)*).

Part Two has one MCQ (Appendix 25). This question showed a video clip highlighting the main dissection and clipping moment in an operation and asked candidates to choose the name of the dissected and clipped structure from the list of options. The feedback screen named the structure as the common bile duct. It also prepared candidates to expect a clip from an advanced stage of the same operation (Appendix 26).

Part Three video clip showed the full scale damage as a result of cutting the clipped duct and asks for the injury's Bismuth-Corlette classification (see Appendix 27). It also had a warning message about the hazard caused by the low image quality in this operation (*In the last two videos the overall image quality was very poor and should be considered a risk in itself. In a modern operating theatre a much clearer image should be achieved*). The feedback screen showed the injury illustration sketch inserted by the YouTube video owner (Appendix 28). This sketch was cut off the video section used in the question, to prevent revealing the answer, also it was used as an extra illustration tool in the feedback page.

Part Four had two MCQs, questioning the reasons behind the damage presented in Part Three and the expected management plan (Appendix 29). This part teaches candidates about potential root causes of the damage and takes the message further. Rather than asking about the critical view mentioned in Section Two of the module, this question used the practical steps for creating such a view as an option to check candidates' awareness. Dissecting the gall bladder off the liver to expose Calot's triangle was an essential step to establish the critical view. This option was added to the other two causes for the damage: *Failure to reflect the gall bladder upwards to check behind the Calot's triangle* and *Poor quality image* (Appendix 30). The last two causes should not have distracted candidates from the main safety step in this operation which was the critical view that has been stressed in Section Two. The second question in Part Four highlighted the scale of the damage caused by reminding candidates about the complex procedure needed to repair the resulting complication.

Part Five requested that candidates match the laparoscopic view presented in an operation video clip with the possible anatomical damaged sketches (Appendix 31). It followed a similar methodology to the matching question in Section Two part one by presenting the selected sketch below the question (Appendix 32). Once the answer was submitted by pressing the Next button the feedback page would be presented with a note describing the patient's full recovery, following a successful repair in a tertiary centre four months after the injury (Appendix 33). This message was an indirect reminder about the need for a tertiary centre referral due to the complex nature of the procedure needed to repair such damage.

Part Six MCQ showed a video of an accessory duct (Appendix 34 and 35). The two clips used in the question and in the feedback page were extracted from a single YouTube video. This YouTube video presented a dilemma in the processing phase. It displays the name of the cystic duct and the accessory bile duct clearly in the video. After multiple attempts to split the video in various ways I found it helpful to leave the cystic duct name on screen as it would eliminate any confusion with the common bile duct injury scenario explored in the last few parts. This on-screen label worked as a signpost to tell candidates that we are switching topic. I had to cut the part showing the name of the accessory off the video clip and merge the parts before and after to create the video used in the question. The removed video part with the accessory duct's name showing was used as feedback.

Part Seven started with a scenario setting message (*During laparoscopic cholecystectomy the surgeon encountered some difficulty in isolating the cystic duct, forcing him to undertake retrograde dissection. The gallbladder attachment to the common bile duct is very wide (1.5 cm)*). This message was followed by an operation video clip showing the last step in gallbladder dissection with an abnormal cystic duct or rather the absence of it. This clip was followed by two questions (Appendix 36). The first question was a management MCQ question allowing more than one option and the second question asked about the eponymous name used to describe this presented pathology. Feedback followed the same principles and provided two videos (Appendix 37). The first feedback video showed the management steps taken by the surgeon in the operation and the second video showed an example of Mirizzi type I syndrome which was the other variation of Mirizzi type II syndrome presented in the operation above. This feedback video had on-screen marks and drawings to highlight anatomical elements and re-stress the importance of establishing critical view.

Part Eight was an optional part, with the ability to email links to candidates' email addresses by a press of a button (Appendix 38). It had three extra bile duct injury video examples and two extra accessory duct video examples. They were all YouTube streaming videos with the content highlighted and the important points clearly displayed before each video. The first bile duct video was approximately eight minute long and was about bile duct injury, with possible clues to spot and avoid such danger and best injury repair approaches. The second and third videos presented the following: (*the detection of bile duct iatrogenic injury, during laparoscopic gastrectomy, with a primary repair*) and (*A CBD injury, during* *laparoscopic cholecystectomy due to low dissection and the omitting of the critical view technique*). The two accessory bile duct examples showed different methods of dealing with this anatomical variation after it had been identified. Those optional videos were selected from the pool of videos that I was not able to gain permission to download and process. They stressed the message further, and provided extra training opportunities if candidates wished to watch them. If processing those clips had been permitted they would have been included in the module essential part but they were excluded currently to keep the module time length reasonable.

4.2.1.4.4 Section Four (Complications)

Section Four was named Complications and it was the final section in this module. It had nine parts. Parts Five and Six did not contain any questions (as will be explained later). Part one sets the scene with a scenario followed by a single answer MCQ (Appendix 39 and 40). Part Two has a video clip of the CT chosen to answer part one and a follow up management question (Appendix 41 and 42). The same logic continued in Part Three by presenting a laparoscopic video which was the option chosen in Part Two and asks the candidates to generate a management plan, to deal with the leaking accessory duct, using a single-line free text question format (Appendix 43). The feedback page contained two videos (Appendix 44). The first presented the surgeon dealing with the leaking accessory duct and the second showed a video from the patient’s first operation where the accessory duct was missed, causing this complication. This last video clip had two messages. The first hinted at the importance of reflection and learning from one’s own slips (*By reviewing the old operation video the surgeon identified the missed duct in the* *original operation*) and the second message hinted at the absence of bile leak in the original operation which might have falsely reassured the surgeon and contributed to missing the accessory duct (*Note: the absence of bile leak in the original operation post duct cauterization did not stop the complication seen above*).

Part Four started a new scenario and presents a video clip followed by a single-line free answer question to name the complication shown in the video (Appendix 45). The feedback page showed another section from the same operation with an on-screen label to show the answer. Again this was cut from the first video and used as feedback.

Part Five showed an example of an exceptionally difficult case forcing the surgeon to take extreme measures and open part of the bowel wall during dissection (Appendix 46). No question was asked in this part due to the exceptional difficulty of the case. I also left anatomical on-screen labels to guide the candidates. Exposure to such a rare situation was considered enough to make surgeons aware of such extreme cases.

Part Six was a YouTube streaming video of a diathermy bowel injury identified and managed during the laparoscopic operation (Appendix 47). Highlights about the key moments were given to guide candidates not to skip those minutes if they played the video fast. Diathermy injury was an important hazard to avoid in laparoscopic surgery. Candidates should be aware of this hazard and its management. This video was again streamed as I failed to get processing permission.

Part Seven used a CT scan image which asked a single-line free test question about the diagnosis (Appendix 48). This was followed by three feedback images obtained from the operation (Appendix 49).

Part Eight used MCQs to ask about the strange laparoscopic video finding at the start of the procedure (Appendix 50 and 51), while Part Nine closed the module by presenting a video of a port side bleeding management and asked for the used instrument name and alternative management plans (Appendix 52 and 53).

This whole design follows all the previously discussed cognitive training theories. It incorporated military pilot cognitive training by using sketches of exaggerated differences and contrasts, to recognise various jet fighters from the first glance (104). This important safety training was replicated by the use of the laparoscopic view and anatomical variation images in Section Two and some sketches in Section Three and Four. Dror's error recovery theory mentioned in Chapter Two of this thesis was also incorporated here. Dror suggested an intermediate phase of error recognition in others using interactive video clips, progressing from simple exaggerated mistakes to more hidden errors. Trainees were asked to generate possible recovery plans at the end of the process after being offered such plans earlier in training (58). The same logic was used in this module as videos progressed from simple mistakes to more complex scenarios and trainees were asked to generate management plans in the free text questions after being offered those steps in the feedback videos or as MCQ options to choose from. Kahneman's (54) putative two system model was also accounted here by providing multiple training opportunities with immediate corrective feedback to train System One to spot hazards and alert System Two to engage. This training was also facilitated by reducing mental tiredness by restricting topic shifting and signposting candidates by the on-screen labels in the cases with the extreme anatomical variations.

In summary this was a stand-alone cognitive hazard training online module. It incorporated all the previously discussed cognitive training methods and was created to cover a wide range of hazards that could occur during a surgical operation. It was packaged under an assessment label, to grab attention and engage candidates. The results of piloting this test will be presented in the methodology chapter to follow and the feasibility study results will be discussed in the Chapter Six.

4.2.2 Reflective Formative Assessment

As discussed before in Chapter Three, Reflective Formative Assessment is the second step after the Cognitive Hazard Training in the proposed design. After finishing the online cognitive hazard training module, trainees experienced a supervised laparoscopic cholecystectomy operation which was filmed in a synchronised fashion to record the laparoscopic field inside the abdomen and the overall surgical environment within theatre. The resulting video showed trainees' action and instrument manipulation as well as trainees' interaction with the staff.

The initial plan was to use a standard security camera system to record the synchronised video. I tried the Swann security system DVR4-1400. I managed to connect one input line to the output from the laparoscopic monitor in an empty theatre between operations and used the second input line with an attached camera to record the space around the operating theatre table so I could record the surgeon along with the assistant. The security camera system recorded both fields, which represented intra- and extra- abdominal fields used in theatre, and displayed them on the security system monitor in a synchronised fashion. Unfortunately, the image quality was poor and the system did not allow the extraction of a synchronised split-screen video. Each field was saved and extracted separately, forcing the need to use special video editing software to synchronise the two video files. Due to the poor video quality and the difficulty in getting the video-editing software to recognise the output video file format, using the security camera system was abandoned.

I then recorded the external filed (trainee/trainer view) with a dedicated video recording camera. I used a Sony Handycam HDR-XR160E video camera to record this theatre view. This camera records high definition HD images and has built-in storage hardware and a built-in microphone. Video extraction was very simple using the camera USB port. The intra-abdominal view was extracted via USB memory stick from the laparoscopic recording machine in the laparoscopic stack. Such extraction was not technically demanding and I faced no problems in dealing with a wide variety of laparoscopic stacks in the recruitment sites (hospitals). The two video files were synchronised and merged into one file using Adobe Premiere Pro CS6 software. A detailed description of such a synchronised process can be easily found on YouTube. The hardest part was to synchronise multiple files but once it had been done a couple of times the preparation time dropped massively. It was still time consuming to do the processing after the preparation and it took around two to three hours in the majority of the files I worked on (Appendix 54). I will not discuss the preparation or processing details in this chapter but I will provide practical advice for anyone interested in following such a path. The computer video card played a considerable role in the video editing as well as having a dedicated high specification card which shorten the processing time. The laptop used to process video synchronisation in this research had a standard video card. As a result I had to rely on the software processing via the main processor rather than having the high specification video card processor to do the job. I had to accept the couple of hours processing time but I would highly recommend having a dedicated high specific video card for anyone repeating this video editing and synchronisation process.

As I progressed to the feasibility study in the last year of my PhD, synchronisation and recording systems became widely available. A system called Scotia Medical Observation and Training System SMOTS was available in some trusts around the Northern Deanery. It is a system specifically designed for medical use (99). Trusts varied in their SMOTS implementation and security setting as some trusts restricted the system use to the emergency department while others allowed a wider access around various departments including surgery. I will explain more about the security setting in the ethical approval part of the Methodology chapter (Chapter 5). I mentioned this system here as it would provide an ideal way to implement my design and smooth all the hurdles facing the Reflective Formative Assessment. I had to use the synchronisation method described above using the dedicated software in my feasibility study in all the recruitment sites except one where I used the SMOTS. In that site I sent an email to the person in charge the day before the operation. SMOTS was set up in theatre the next day with minimal steps and the recorded synchronised video was provided securely to the operating consultant to review with the trainee. The process was really smooth with no connection problems, no special preparation and no processing time delay. This will be explained further in Chapter Seven.

Each trainee was invited to review the synchronised split-screen recording together with his/her supervisor and complete the Procedure Based Assessment form (PBA) (23). In the feasibility study the PBA was filled in after the procedure and the process was repeated after the video review session. This was done to help in analysing the effect of adding the video review, as will be described again in the Methodology chapter.

Despite the importance of non-technical skills I opted not to incorporate the Non-technical surgical skills (NOTSS) rating system (74) forms in my research. This decision was taken due to the time limitation and the need to have special training to correctly use this form. Such training was not available to the majority of my research target group.

4.3 Chapter summary

In this chapter I explained my journey to create a practical example of my two-step design for laparoscopic cholecystectomy following the generic design principles described in Chapter Three. This design is procedure specific as the majority of hazards and risks are unique for each operation. However, the steps involved can be replicated to inform an equivalent programme for any given procedure.

The next chapter will be the methodology. It will cover the all the research principles and research rigor. This will be followed by three result chapters and a discussion and recommendation chapter.

Chapter Five: Methodology

5.1 Introduction

In the previous chapters I set out the foundation principles behind my design. I explained the design and detailed the practical phases to create the two-step laparoscopic cholecystectomy cognitive training and reflective formative assessment design. This was the first part in this design-based research. In this chapter I will write about the design-based research principles and rigour. I will also explain the study design, ethical procedures, recruitment, sampling, data sources, the analytical approach and the research tools used in the feasibility study and the in-theatre qualitative observational study.

5.2 Epistemology and research theory

5.2.1 Design-based research

Collins (107) and Brown (108) were the first to propose the use of a design-experiments methodology in education. Design-based research treats education as an applied field. Researchers using this methodology are interested in enhancing students' learning by employing multiple varieties of approach, in the form of curriculum or framework, in the complex field of the social world or classroom social environment (109). Students are treated as co-researchers and they help in modifying as well as identifying the design usage (109). Context is an important aspect of the research and not a variable to be controlled as in the other forms of research (109). Those principles might be hard to grasp and a comparison with a more familiar type of research might help in this quest. Barab & Squire (109) provided a helpful explanatory table, adapted from Collins (1999), to compare psychological experimentation and design-based research across seven categories. This table shows the main characteristics of the more familiar experimental research such as laboratory-based research, aiming to test a hypothesis by using fixed procedures. It simplifies the situation by focusing on testing one or two variables and treats participants as subjects. It isolates learners to reduce the number of variables and holds those variables constant to focus on one tested variable. In contrast design-based research occurs in real life where learning actually occurs. As a result it takes a more flexible approach. It usually starts with a design that is meant to be revised after the feasibility or testing phase. It focuses on testing all aspects of the design and tries to paint a full picture of the design usage in real life. It is interested in capturing the complicated learning in society or in the environment in all its complexity, including the social interaction between participants in their real-life learning environment. It also aims to involve a wide variety of participants to capture their expertise both in enhancing the design and informing the data analysis. In Table 4 (below) I summarise my research using the same seven criteria in the above referenced table.

Barab & Squire (109) argue that the main interest of design-based research is not limited to validating a particular curriculum, as is the case of a formative evaluation methodology.

Category	My research
Research location	It is not laboratory based. It is based in a real surgical training environment in the hospitals within the Northern Deanery
Variables	I took into account trainees’ variable backgrounds, interactions, operative approaches and different supervision levels in theatre (trainers scrubbed, un-scrubbed, or distant supervision)
Research focus	I did not focus on fixing variables, I rather accepted the complex learning environment as well as accepting all possible variables in operative approaches and supervision levels with a planned observation study to capture such variables.
Procedures	I carried out a flexible and accommodating design with a plan to be revised after the piloting and the feasibility testing phase
Social interaction	I did not isolate trainees but rather accounted for various interactions between trainee, trainer, nurses and anaesthetist. The design also encouraged interaction in the video-review session.
Finding characterization	I did not focus on hypothesis testing. I tested all design components and real implementation value in surgical training
Participants’ role	Participants were interviewed to gain their views and help modify the design and identify its practical value in the real surgical training environment. Theatre observation study was also conducted to gain further theoretical insight into the complex surgical training environment

Table 4: Comparing my design to the standard psychological experimentation.

It extends beyond that to the production of generic steps or theoretical principles that can be used to inform an equivalent programme and advance human understanding about thinking, learning or other theoretical knowledge in the field. In other words it aims to produce local learning benefit as well as theoretical knowledge enhancement.

Barab & Squire (109) provided a table showing examples of such local impact and theoretical knowledge advancement in five projects to further explain this dual research role. They even go further and argued that proving the local value of the design was an essential requirement to trusting the theory generated by the research. They cited Dewey's 1938 book, *Logic: The Theory of Inquiry*, to stress the pragmatic philosophical argument behind design-based research as it focuses more on the practical value of the generated theory than its theoretical claim to truth. In other words, it is hard to trust a theory generated by a design that failed to show a practical local value.

To put this in perspective, in my research I started by identifying the local gap and the theoretical principles to be used in my design. I then designed a two-step cognitive training and reflective formative assessment and created a practical example, of the first step, in the form of an online multi-element Cognitive Hazard Training module for laparoscopic cholecystectomy. This was cross-checked by my surgical supervisor and piloted using two external experts. So far those steps are similar to an experimental pharmaceutical researcher aiming to create a drug modification, for instance. The pharmaceutical researcher would usually identify the principles and choose the best theoretical path, then create the modification and test it in vitro. An in vivo test is left to other pharmaceutical PhD researchers to take on in a series of multiple projects in advance of a real human trial. Such laboratory in vitro tests, or experts' in my case, are not enough in the educational design-based research, as mentioned earlier in this section. Design-based educational research sets out to demonstrate the local value of the design and generate a theoretical knowledge advancement. As a result, I conducted a feasibility study to test the local benefit of the design and involved the participants in identifying its strength and weaknesses with an aim to gain further theoretical insight into the surgical skills acquisition process. A theatre observational study was also conducted to help capture the complicated surgical training with all its complexity, as required by the Design-Based Research. This will be explained further in the research structure later in this chapter.

5.2.2 Epistemology

Theoretical perspectives refer to the philosophical stances guiding the research design. I will give a brief summary of the theoretical perspectives in research although my approach as a design-based research is pragmatic, as discussed in the section above, and cannot be pinpointed to a specific perspective.

Illing (110) provided a guide to understanding the various theoretical perspectives by comparing three main areas of difference: 1- ontology, epistemology and methodology, 2- knowledge, values and ethics and 3- the researcher characteristics and role in each approach. Illing defined epistemology as the theory of knowledge and ontology as the study of being as the latter is interested in the nature of reality.

5.2.2.1 Positivism

Positivism originated from studying the natural world. The aim was to identify rules and laws that can predict data. Much research is focused on cause and effect and controlling data.

The assumption is that data can be removed from human bias and be unambiguous. It is assumed that the impact and bias of the human researchers can be controlled, removed and access to data can be objective. The aim is to train the researcher to ensure that human influence is excluded. Research procedures are followed religiously and controlled. Hypothesis testing is used to test and confirm or refute the hypothesis.

5.2.2.2 Post-positivism

Post-positivism shares the positivism assumption of the existence of a real reality but accepts it is limited in reaching such reality due to human (researcher) influence and the complex research process. Access to reality is the main hurdle and it is accepted to be difficult and somehow limited in this approach. The researcher is still seen as the independent expert with special research training. However, due to the acceptance of the limitations of human researcher, limits are set in reaching the reality, and further steps and tools are added such as data triangulation and the use of qualitative as well as quantitative methods to further enhance the results. The focus here has shifted from proving to falsifying the hypothesis. A study about surgical training, that was drawing on a Post-positivist perspective would seek to measure training and predict who might be trainable or not in the future or predict the time needed to achieve such training.

5.2.2.3 Critical theory

In this approach, the reality is a moving ground. It is created or shaped over time by society interactions, history and culture (110). It is also influenced by the researcher's and other research stakeholders' values. Research results can only be generalised if similar circumstances occur. Researchers play a facilitator role and aim to challenge the status quo in the studied society, taking into account the social factors and norms. The aim in this approach is to give a voice to the powerless groups and stimulate a change and empowerment in the current structure. Ethics moves in this approach from an external step decided by an external body to an internal step built into the research structure. In this approach participants should be fully informed with no deception or blindness to the research question. A study about surgical training in critical theory might identify how surgical training evolved over time through history and seek to empower struggling trainees who appear to be undervalued in a certain context or placements.

5.2.2.4 Constructivism

Reality here is not only a moving ground, it is subjective and multiple. Reality varies according to individual groups and different or even conflicting realities can live alongside each other. Findings are informed by researchers' values and the two-way interactions between the researcher and the research participants. Researchers play a participant as well as a facilitator role and research participants take a more active role in shaping the study and the findings. The focus here is shifted to reaching a shared consensus and create new understanding which create new constructs. Ethics plays the same internal role with further emphasis on fully informed consent. A study on surgical training using this perspective would consider a focus on gaining understanding. Therefore the study would seek, for example, understanding about struggling trainees who failed their ARCP.

5.2.2.5 Participatory action research

Reality here is both subjective and objective and it is reached by a collaboration between the researcher and the participant. It has four components: experiential, presentational, propositional (conceptual) and practical, and can only be reached by full participation in real life action. In this research the dividing line between researchers and participants disappears as researchers become subjects and participants become co-researchers. Research here is a sort of self-reflection by the researcher and validity is enhanced by participating in the action. Generalisability to similar situations could be suggested but require relevance confirmation. A study about surgical training using this perspective might start with an issue or problem and work with the participants to change or sort the participants' dilemma.

5.2.2.6 Conclusion

In summary the above theoretical perspectives create a full spectrum, moving from the view that there is a real reality which can be measured objectively to the view that reality is multiple and access to it is subjective. The aim of my research is to identify a method to enhance surgical skills acquisition using cognitive hazard training and reflective formative assessment. The first step of cognitive hazard training draws on post-positivism. It assumes that there is a way of improving knowledge and it is measurable. The reflective formative assessment part however draws on post-positivism in reviewing the reality of the videos to inform surgical competency and on constructivism by combining the perspective of both the supervisor and the trainee about surgical training, trust building and surgical safety. Such constructivism approach is helped by conducting the theatre observational study alongside the design feasibility study to capture the complex surgical training environment and various realities about feedback, training and team interactions.

5.3 Data analysis approach

Data analysis usually comes late in methodology chapters but I opted to mention the data analysis approach early as it does affect the study design or, to be more specific, the data collection plan. The researcher approach to data analysis follows the aim of the study and the adopted theoretical perspective. If the study is aiming to provide a voice for the participant, the research role will become a simple editing and presentation task. If further insight is intended from the data analysis various approaches can be followed (111). These are considered below.

5.3.1 Thematic content analysis

Content analysis is a common analysis approach in health studies and it aims to identify the reoccurring themes in the data (111). It can stop at reporting the themes identified or it can use a more in-depth analysis to identify trends or relationships in the data. A deeper approach aiming to generate a new theory would require the use of either a grounded theory or framework analysis (111).

Thematic analysis has a number of advantages. It is a flexible approach, suited to a wide range of research questions. The approach can be applied to different types of data (e.g., interview transcripts, audio and video recordings), and is appropriate to capture participants' perceptions and experiences (112)

5.3.2 Grounded theory

This is a method to generate theory from the data using a cyclical approach in which the data is analysed as it is collected and the findings are compared with the next set of data until reaching saturation where no further themes emerge (111). Due to its cyclical nature this method is usually known as the 'constant comparative method' (111). It constantly challenges emerging theory and pursues outlier cases (111). Many studies claim a grounded theory approach when they have only implemented some aspect of it in their data analysis without reaching the theory development level.

5.3.3 Framework analysis

This is another in-depth analytical approach but it is aimed more towards policy analysis rather than general theory development as in grounded theory (111). It uses mapping as a way to aid the analysis and support the defined concepts and relationships in the data for the policy makers (111). Such mapping preserves the integrity of the responses which are charted in a framework or a table across the intended themes.

5.3.4 My analytic approach

Overall, I conducted a thematic analysis to evaluate the new two-step design (using interview data from the Cognitive Hazard Training and Reflective Formative Assessment) and to capture any relevant contextual factors (using theatre observation data). I tried as far as possible to complete the analysis of one or two transcripts before conducting further interviews. By doing this, trends were identified in the early interviewed cases and further checks were made with later data collection by modifying some questions in my interview schedule and developing further questions. Interviews were carried out until reaching data saturation.

I followed the six phases of thematic analysis described by Braun and Clark (113). These included 1) familiarising yourself with the data; 2) generating initial codes; 3) searching for themes; 4) reviewing themes; 5) defining and naming themes; and 6) producing a report (113). This analytical approach produced themes which reflected the evaluative aims of the research (theory-driven); as well as themes that emerged from the data (data-driven).

Analysis began by familiarising myself with the data (Braun and Clarke, phase 1). This involved reading and re-reading each line of each transcript, identifying important or interesting sections of text, and annotating my thoughts, responses and possible interpretations. My initial efforts to identify themes was exploratory, I was looking for content that was either highly relevant to the research question, content that I considered a major contributor to understanding something novel, or text that had high prevalence (ideas that are repeated generating a clear pattern). These patterns became easier to identify and more obvious as analysis across transcripts continued. I developed initial codes about what each important segment of text was saying (Braun and Clarke, phase 2). This simplified and organised the data as it allowed me to identify descriptions and ideas that were similar (therefore creating a pattern), and which were distinct. I collected all material coded the same (given the same name) together so that each segment could be compared with the other segments in that code for verification, or for recoding. I tried to keep the selected text for coding in the context of its surrounding text, as Braun & Clarke recommend, therefore some of the quotations selected for reporting the results are long, where this context is important.

The third analysis phase required me to refocus on the research questions to identify broader level themes. This involved identifying similarities and differences between the codes to identify themes, as well as important codes that didn’t fit with, or were distinct from any other codes. I was careful to ensure I didn't try to homogenise particularly unique cases, and in these instanced, I followed them up separately. The relationships between these "candidate themes" were tested in discussions with my supervisors, and by considering the dataset as a whole (phase 4). I assessed whether the themes had relationships to each other, and whether they were each an accurate reflection of all I had learned from the research. Finally, I began to give the themes names (phase 5) that served to accurately represent the meaning of the coded data within them, as well as to answer my research questions. I selected and highlighted extracts of material from each theme that could be used to demonstrate my account of the data in the results chapters (phase 6). I used my own memos and notes to help identify the contribution each theme was making and how it helped answer my research questions.

5.4 The study design

The study design was planned early in the research process to achieve the aim of the design-based research in identifying the local value of the proposed design and to generalise to a broader theoretical knowledge in the field. Such initial planning was guided by the broad literature review and the proposed assessment system in Chapter Three (Section Two). It was clear from the discussion in that chapter that the design would follow a structure similar to the UK driving test with some special deviation as discussed in Chapter Three (Section Three). However, the initial design had to be modified during the research process to accommodate the availability of the hazard videos and to deal with the challenges faced during the material creation process presented in Chapter Four. The design was also affected by the legal and ethical considerations as will be mentioned in the ethics subsection to follow (Section 5.6).

5.4.1 Participants and data sources

Participants and their progress within the research journey were discussed earlier in previous chapters but will be highlighted again here to summarise the research data sources.

To demonstrate the value of the newly designed system in enhancing surgical trainees' learning and skill acquisition, I have to show that the cognitive hazard training module was designed appropriately for the level of specialty registrars (SPR) as they are the doctors in training who are learning to operate. I wanted to reassure the reader that the module was calibrated at the right difficulty level and was not too simple i.e. at non-specialised trainee level such as foundation doctors' year one or two (F1 or F2). The cognitive hazard training module was packaged as an assessment to engage candidates' and maximise their concentration, hence SPRs were invited to sit the knowledge and hazard test.

Although F1and F2 doctors do surgical placements, they are usually involved in patients' care in the wards and do not get involved in theatre training until they choose surgery as a training path. As a result my recruitment plan involved three participant levels (Figure 3).

The first level was F1 and F2 doctors, or junior doctors as they will be grouped in this research. As this group was recruited to demonstrate the relevance of the Cognitive Hazard Training (knowledge and hazard assessment) to SPR level, they were invited to test that part only with a plan to interview them after they had finished this part. The interview aimed to gain further insight into their experience, the module difficulty and any recommendation they might have.

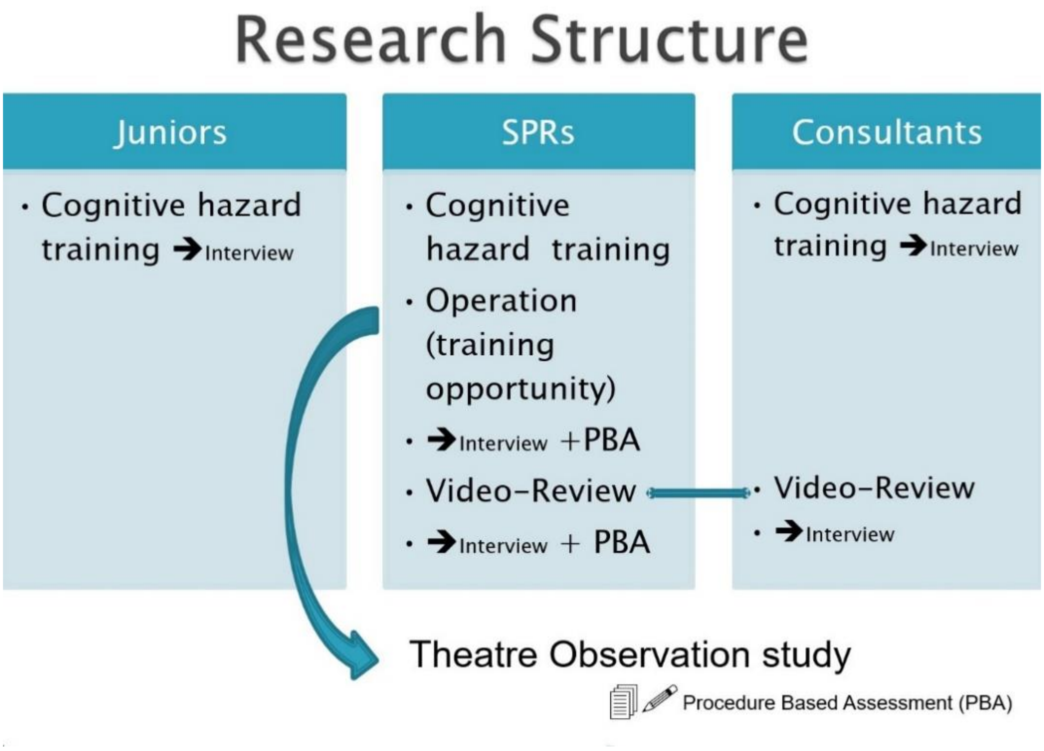


Figure 3: Diagram to show the study structure.

The second level was the SPRs. This group was divided into three subgroups while completing the cognitive hazard training module as mentioned in the previous chapter to facilitate the online test data analysis, but they were all treated as one group throughout the research. SPRs were invited to sit the knowledge and hazard test. They then progressed to perform a supervised laparoscopic cholecystectomy operation in theatre as per their usual training. The supervised operation was recorded in the synchronized split-screen manner described in Section 4.2.2 of this thesis. The interview for the cognitive hazard training was deliberately delayed until after the operation recording to reduce the effect of enhancing the educational value of the cognitive hazard cognitive training by artificially re-visiting the experience with the interview. In other words, I wanted to avoid the indirect memory enhancement resulting from refreshing trainees' memory by interviewing them directly after they completed the knowledge and hazard test which was in reality a form of cognitive hazard training.

Memory enhancement effect might be of more value in the case of a simple memory recall but I suspect it would have limited value in the case of hazard perception in surgery which requires complex information processing. However, the interview was delayed to prevent any possible interaction with the results and to follow the natural process when the tool is applied in practice without the research.

Normally trainees would take the online cognitive hazard training module and progress to the supervised training opportunity. The operation will be recorded and reviewed as a reflective practice. This process was summarised in Chapter Three (Figure 2). In this sense the delayed interview plan follows the aim of the design-based research to demonstrate the effect of the new structure in the natural environment.

I planned to record ten operations in this feasibility study. This was to be followed by the delayed cognitive hazard training interview in all the recorded cases. However, due to the busy and unpredictable surgical training environment, an interview was not feasible directly after the operation video-recording in two cases and had to be delayed. In these two cases the interview occurred at the same time as the post recording-review interview, due to the trainees' scheduled commitments.

As is the natural tendency of any research with multiple steps, recruitment works in a pyramid fashion rather than a linear one. I expected that I would need to recruit more than ten trainees to record the first ten operative opportunities. As a result I planned to conduct the cognitive hazard training interviews for any remaining SPRs after I finished the ten planned operation recordings.

The participating SPRs reviewed their operation recording with their supervising consultant as a form of reflection and feedback. The video-review session was audio-recorded to aid analysis. SPRs were interviewed post video-review to gain further insight into their experience of reviewing their own operation and review the system as a whole. They were asked about the utility of the whole system and about any suggested improvements or modifications.

The third level involved the consultants. They participated in the research in two ways. They joined the research to test the Cognitive Hazard Training and provided an expert opinion about its value and any practical steps to improve it. They were also involved as supervising consultants. In this case they supervised their trainee during the operation and completed the Procedure Based Assessment form (PBA) directly after the procedure. Such immediate post-operative form filling is the ideal practice to avoid any memory loss and provide trainees with the best feedback. However, it rarely happens like this in real life. As the consultants usually have a dedicated operation list they are usually very busy on their operation day and therefore delay the PBA form to a later date.

The PBA is the current standard practice in surgical training for formative assessment and it is meant to capture as well as enhance performance feedback. I stressed the importance of testing the new structure in the natural environment in the design-based research and I accept that the PBA form does not usually get filled in on the same day, and certainly rarely directly post procedure. As the form was not part of my intervention I wanted to compare any feedback enhancement of my intervention to current feedback system.

The supervising consultant was asked to review the trainee's recorded operation along with the trainee. This video-review session was audio-recorded as mentioned above. The plan was to interview the supervising consultant post video-review to gain his/her opinion about its value and practicality in normal surgical practice along with any suggestions to improve it.

Supervisors were asked to complete another PBA form after the review session. As consultants have a dedicated operation list they are usually very busy on their operation day and do not have time to review videos. At the same time I needed time to process the video for the review session in the manner described in the previous chapter. As a result the video-review session took place on a different day in the consultant's office, days and sometimes weeks after the operation.

It seemed that the delay would reduce recall and it would be impossible for the consultant to remember the previous grades awarded in the first PBA, filled out directly after the operation. I did not expect a major difference in the two PBA forms as I thought consultants would use their knowledge about their trainee's ability rather than the direct observation during the procedure to fill in the PBA form, but this was a personal view that needed to be confirmed.

Ideally, in retrospect, the same consultant should have taken both the expert and the supervisor role but, going back to my study aim to check the value of the proposed system in real life, I did not consider having a dual participation role as a requirement in my research. Firstly, not all clinical supervisors are aware of all teaching or training resources available to their trainees. Secondly, clinical practice is really busy and even if consultants wish to play a dual role they might not find enough free time to finish the cognitive hazard training module before their trainees progress to the recorded operation or the review session. This delay might halt or prevent the SPR progressing up through the system. As my intervention was aimed at SPRs I therefore could not justify such a delay. Furthermore, if a consultant was happy to be in the supervisor role only, I could not justify excluding his/her SPR if the SPR showed commitment to the research and put in the effort to finish the knowledge and hazard test.

This exception applied only to consultants. SPRs were the main target of the new design and they were not to be allowed to progress to step two until they had finished the cognitive hazard training.

As I was present in theatre to supervise and operate the video-recording equipment I wanted to take the opportunity to conduct a theatre observation study to capture the complicated surgical training environment in all its complex aspects. This study was carried out to achieve the design-based research aims and help generate more theoretical understanding in the field. Observation was carried out at the same time as video-recording the operation. I observed and recorded ten, laparoscopic cholecystectomy, operations over the study period and I structured my observational records and hand-written notes to contain information about the team interactions, surgical training and safety, specifically looking for any events that interrupted the operation's progress. I also noted and in some cases audio recorded my thoughts and own interpretations about what I had seen. These data were analysed using the same steps as described above for the interview analysis, by constantly comparing notes across observations and identifying segments of text to code, and categorising the codes according to patterns of regularly occurring descriptions and concepts, for theming. Theatre video-recordings were also reviewed (if needed) as a method of validation of the recording of events made, and thus also adding validity to the observations. This aimed to help understand the complex training environment and to complement and maximise the benefits of video-recording. This is a standard methodological approach and will build on previous research in such a field (114).

5.4.2 Data sources summary

To summarize, data sources in this research include:

1. Knowledge and hazard online assessment (Cognitive hazard training) results grouped in levels for anonymity.
2. Juniors' (F1 & F2) post knowledge and hazard interviews.
3. SPRs' post knowledge and hazard interviews.
4. Consultants' post knowledge and hazard interviews.
5. Operative video-recordings.
6. Video-review audio recorded session.
7. SPRs' post video-review interviews.
8. Consultants' post video-review interviews.
9. Post operation and post video-review PBA forms.
10. Theatre observation study.

5.5 Reflexivity

Reflexivity or declaring the researcher background is an essential part of qualitative research. Qualitative analysis requires the researcher's interpretation of the data to extract meanings or themes as well as conveying various points of view. In this sense the researcher's background and position should be clearly declared to enable the reader to make an informed judgment about the data analysis and the possible effect of the researcher on the process.

My background as a surgical SPR was mentioned briefly in the previous chapter, however I felt the need to fully declare my background in this part before the ethics and R&D approval, as this background will be repeatedly referred to in the ethics and R&D process.

I am a surgical SPR with a national training number in general surgery. I finished my ST3 training year at the Yorkshire and Humber Deanery and took three years of approved out of programme period for research (OOPR) to do this PhD between October 2013 and October 2016. I returned to training in October 2016 at the Yorkshire and Humber Deanery with an application to transfer to Health Education England North East (previously known as the Northern Deanery). The transfer application was made in August 2016 at the final stages of my data collection as I had a change in family circumstances. The transfer was agreed at the end of October 2016 after the end of my data collection and actual transfer took place in February 2017. During my research, which was based in the Northern Deanery hospitals, I was not part of the training programme in the Northern Deanery and did not know about the transfer result within the data collection period. This explanation is important to declare as the ethical approval committees were keen to ensure that I did not have any power or authority to pressurise juniors to participate in my research.

Having a surgical background meant that I was familiar with the surgical training environment in theatre and could fit in to this environment without risking my safety, patients' safety or the sterility of any equipment. I was also able to place my recording equipment in theatre and manage it with minimal interference in theatre.

I also have a theoretical background in medical education as I hold a diploma in medical education from Dundee University. I conducted some small projects about learning and surgical training but I have no previous experience in large scale medical education research and I have not conducted any major qualitative study in the past.

I created the new design under the supervision of my surgical supervisor Professor Attwood but I do not believe such a design would have been possible without my background in surgery. I would argue that such a design needed an advanced understanding of the procedure steps and hazards to allow the researcher to review the YouTube content, isolate the relevant risky moments, extract, edit and sometimes join various segments from the same video to create the hazard material needed. I also had to make sense of the available materials and create a sensible training resource around them.

Having said that, such a background might create some prejudice about unusual surgical approaches and I tried my best to keep open minded and provide neutral comments about any materials identified. I had also to be aware of other trainee biases and had sometimes to make notes to say this was the surgeon's preferred approach and we were not recommending it. I had the material checked by my surgical supervisor and piloted it with external experts.

My supervisory research group included a surgical supervisor and three medical education experts with various special interests, allowing an open discussion and providing a wealth of expertise in qualitative, quantitative, educational, social and cognitive research.

My PhD research was self-funded. I secured five thousand pounds grant from Northumbria Healthcare NHS Foundation Trust to fund the start of my research and I won the first prize in the Bright Ideas in Health Awards 2011 in the Training and Education Category for my research idea and received £2500 as a financial prize. I funded my research with locum SPR shifts and held a bank clinical fellow contract or zero hours contract with Northumbria trust to provide internal locum SPR cover for the trust and help in my ethical approval process as will be mentioned in the next chapter.

5.6 Ethics and R&D approval

I have already touched on some aspects of the legal and ethical challenges facing my research in the previous chapter while discussing the creation of the new design materials. In this section of the thesis I will explain some of the details and challenges I experienced to gain ethical and research and development (R&D) approval for this research. Some ethical steps might be routine but some challenges were specific to my research and explaining those in detail might help guide future researchers in this field.

5.6.1 Legal copyrights

I contacted the head of the ethical approval committee at the start of my research and was advised to liaise with the legal department regarding the copyright permissions as discussed in the previous chapters. I discussed the process used to obtain the YouTube videos owner's permission in the previous chapter, and that the legal department was satisfied that YouTube reply does imply that YouTube does not have any further copyright over and above the channel owner's.

I also obtained the permission to use the anatomical/laparoscopic images via contacting the publisher copyright officer Mr F K. Initially I tried to get the permission through the publisher website. The choices in the drop list for the reason to use material were confusing and as I needed to download and split the images as described in the previous chapter I thought I needed a more extensive option rather than simple academic use. The website suggested a high fee for using the material so I contacted the copyright officer to check I had made the right choice. Mr F K established that I should have chosen the option (use in a thesis/dissertation) and was happy to provide a free of charge permission for academic use. The permission was initially for fifty users. The permission also included the initial project title.

Copyright concerns were fully covered as mentioned in the previous chapter and the legal department provided a supportive letter to satisfy Durham University ethical approval committee requirement (appendix 5).

As my research progressed further and recruitment expanded I contacted Mr F K again to increase the users' number. By that time Mr F K had moved to another department and he kindly put me in touch with the new copyright officer Ms C D. She kindly referred me back to the website and asked me to choose (use in a thesis/dissertation) as a reason to use the materials. I placed the request and used the current thesis title and the new permission did not provide any user number restriction.

5.6.2 Ethical application process

The process of applying for Durham University ethical approval included two changes in the research protocol due to various concerns about data security. I started the application process by preparing the NHS ethical approval form to be presented along with the research protocol, the consent forms, information sheets and the researcher and supervisor team CVs.

5.6.2.1 Usual ethical consideration

Within the application I mentioned the plan to use hazard videos from the available real life surgical operation recordings on YouTube. I reassured the committee that those videos are publicly available online and only show the inside of the patient's abdomen with no identifiable information. Unfortunately, streaming the videos was not reliable as advertisements could appear or there may be a delay from the start which could shift the target section needed for the design. Materials were used with owners' permission and the copyright clearance was checked by Durham

University’s legal department. Videos were downloaded and sections were used when permissions were granted. Others may be streamed if owners are not contactable within time and despite the researcher’s best effort to do so (some accounts had no activities for years and no replies to emails were received).

I also mentioned that surgical trainees are familiar with these types of recordings as it is their daily experience in theatre, but the design would concentrate the experience that could otherwise take years to be acquired. I stressed the plan was to use a username and password invitation to access the material hosted on the University website. The access was provided free of charge for candidates as it was for academic purposes.

I stressed the fact that participation in the research was on a voluntary basis and with informed consent. I provided copies of consent forms and information sheets for each candidate group: patients, juniors, SPRs and consultants. I also attached the study flow chart (Appendix 55) and the semi structured interview themes (Appendix 56). I explained the synchronised recording process mentioned in the previous chapter and the plan to consent patients for video recording using the Northumbria Healthcare Trust standard digital recording consent form (Appendix 57). If other trusts had their own consent form those would be used in each trust respectively.

Patients were not to be exposed to any risks. This was an educational oriented study and although it would video-record live operations, it would not change the normal training supervised operation in any way. A senior surgeon was in charge of the operation guiding the trainee and intervening as needed to prevent any harm. Patients were asked for consent for the video recording. They were also reassured that their decision whether to participate or not would not influence their healthcare in any way. Patients were provided with information sheets to explain the research aims and an explanation about the study. They were given a copy of the information sheet but not a copy of the operation recording and told they were free to withdraw from the study at any time. Patients were assured that recording would not be started until they were covered with drapes and it would be stopped before the drapes were off, thus ensuring anonymity. They were also assured that the researcher would only record the operation with no change planned to the normal operation. The focus of the study was on the trainee assessment and feedback not the patient.

Patients undergoing laparoscopic cholecystectomy were recruited on the day of the surgery and consented for video recording the operation. There was no plan to identify or select patients as they were not the target of the educational study. Identification of suitable cases for recording was left to the consultant in charge. Consultants usually make such decisions based on their knowledge of trainees' capability and the complexity of the case judged by patient body habitus and the ultrasound scan report. The researcher simply recorded the procedure for the benefit of providing feedback to operating trainee, with no intention to identify the patients. Ideally more time should be provided between giving the information sheet and consenting the patients (a couple of days or even a week). However, practically, the patients could not be identified earlier by the researcher. Suitable patients were identified by the supervising consultant on the day of the surgery after meeting the patients and reviewing their notes. The supervising consultant needed to consider the trainee's level, operation difficulty and time pressure on the day, before making a decision. As a result the researcher would have to approach the patient, explain the research and obtain the consent on the day of surgery.

Only the operating trainee and consultant attended the video-review session with the researcher, if allowed, otherwise the researcher stayed out of the review session and collected the completed assessment form. The researcher interviewed the trainee and the consultant after the end of the video-review session separately if feasible. If they were unhappy with something they had said after the interview they had the opportunity to withdraw any statements. The staff were made aware that any comments they made would not affect the trainee assessment. Participation was entirely voluntary. The interviewees had control of when to take part.

5.6.2.2 Storage and video-review

Storage and video review were the points that raised multiple questions and required two changes in the research plan before reaching the final version. My initial plan was to store the consent forms, the interview files and the synchronised surgical operation recording at Durham University as it was the standard in university-based-research. I also planned to get the consultants and the surgical SPR to review the surgical operation video recording using the research laptop or tablet, both locked with a password. Durham University ethics committee advised me that if the material was stored in the university or in any place other than the NHS facility I would need an NHS information sharing agreement which was a requirement from

2015. They also advised speaking to the Caldicott officer at Northumbria Healthcare NHS Foundation Trust as it is the leading trust and to the IT department in the University to make sure that the laptop or tablet had the same encryption level as the NHS standard encryption.

To overcome the material storage problem and the encryption level needed, the plan was modified. The new plan was to store the material at Professor Atwood's office at Northumbria Healthcare NHS Trust, the operation video recording was to be stored on the supervising consultant's office desktop computer, and the consultant was to have full ownership of the video as per the NHS regulation. As a result the review was to take place in a locked room at the same hospital in which the procedure took place. This plan was discussed over the phone with the Information Governance Officer at Northumbria Trust and the appropriate Caldicott form was completed. The ethical application form, protocol, information sheets and consent forms were modified accordingly.

Before submitting the revised forms to the University Ethics Committee I received a call from the Information Security Officer at Northumbria Trust. He returned from his holiday and upon reviewing the Caldicott form he called me to inform me that the revised plan did not satisfy the information security requirement as the NHS desktop computers were not encrypted. He kindly offered to meet me to draw up a revised plan. Together we created a new plan to satisfy the information security requirement in the NHS while allowing the best possible research outcome.

In this revised plan, the operation recording was to be stored for the review session in a secure folder on the Trust Intranet. This folder contained sub-folders allocated to each supervising consultant. Each subfolder was accessible only by the researcher and the named supervising consultant for the operation. So operation recordings remained as NHS property owned by the Trust. This arrangement was repeated in each trust joining the study (eight trusts in total in the Northern Deanery). An additional copy of the operation-recordings from trusts other than Northumbria was stored in a separate subfolder at Northumbria Healthcare NHS Foundation Trust, the main data analysis site. This additional copy was created with the consent of the supervising consultant, the SPR and the Caldicott Guardian. No copy was taken if permission was denied. The secure subfolder at the Northumbria Trust secure intranet drive, hosting all the video recordings from all trusts was accessible only by the researcher (to support the observational study analysis of the PhD). An NHS encrypted hard drive was used to transport the video recordings (in a lockable case) from the trusts to Northumbria Trust, the main data analysis site. This encrypted hard drive was stored securely in a lockable cabinet in Prof Stephen Attwood's office at Northumbria Trust. In addition a logbook was used to log the hard drive in and out of the office.

All the forms were modified for a third time and gained the approval of Durham University Ethics Committee (Appendix 58). Forms were then submitted to the NHS North East - York Research Ethics Committee. The NHS committee raised a few points. They wanted more time for the patients to think about research participation and suggested providing the information sheet to all laparoscopic cholecystectomy patients at the pre-assessment time. This suggestion was discussed with the supervisory team. We wrote back to the committee to express that we understand the committee's point about pre-warning the possible patients. However, possible cholecystectomy operation numbers in each trust would be in the range of thousands and we would be recruiting between 25-50 patients in total. In fact the end number was only 14. All patients approached for recording their operation agreed with no hesitation and none withdrew their consent. We were keen to follow the committee's instruction without raising unnecessary anxiety in the vast majority of patients as most were not to take part in the research. We agreed to add the following additional patient information: All patients attending the nurse pre-assessment clinic for elective cholecystectomy were to be informed that their operation video might be used for the analysis of training quality. That they might be approached by a researcher on the day of their hospital admission if their consultant deems it suitable. Further information would be provided and participation would be optional if they were invited into the study. This statement was sent as an email to all nurses involved in pre-assessment.

The second point concerned the research plan in case of identified mal-practice. I highlighted the fact that the supervising consultant was in charge of the operation and the researcher was not to interfere with any treatment plans. I also pointed out the statement at the end of the research protocol: Any hazard identified with their proposed actions would be communicated anonymously to the Trusts and the Deanery. Also the information sheets submitted with the application had the following sentence under "Will my taking part in this study be kept confidential? " "In cases of litigation we may be legally obliged to disclose any recordings."

The committee suggested that the consultant would only be approached if the trainee agreed to take part in the study. Again I responded by appreciating that the committee did not want to disturb consultants unnecessarily if they would not be recruited in the absence of a recruited trainee. However I stated that such a point would certainly be relevant if consultant/trainee were coupled. Unfortunately the old apprentice training style is long lost and trainees and supervisors rotate within each trust randomly. So a consultant designated trainee no longer exists. Currently any consultant will supervise any trainee within the deanery (usually within the same trust but that is no longer consistent).

The current submitted IRAS application form has the following statement at the third paragraph of question (A27-1) which hopefully covered the point raised by the committee (Higher surgical trainees are the main focus of this study. So consent goes in three stages. I start by trainee recruitment then recruit his/her supervising consultants (trainees these days work for more than one consultant). Once I have the pair (trainee and trainer) recruited and consented, the consultant will then identify the suitable patient to be recruited. The consultant would take into account theatre list time pressure, trainee skills and operation difficulty judged by patients' ultrasound scan result; all are points to inform such a decision. If the patient was not happy to join the study another suitable patient would be identified by the supervising consultant within the same list or future lists.).

All forms were further checked, revised if needed and submitted and the committee kindly provided a favourable opinion (Appendix 59). I also attach all forms in the appendix section (Appendix 60, 61, 62, 63, 64, 65, 66, and 67).

5.6.3 R&D approval

As stated previously, my research was about surgical skills acquisition with a main focus on surgical SPRs. The principle idea of the research could be applied to any practical procedure but the hazard training part was operative specific and I had chosen laparoscopic cholecystectomy to create a practical example of my research. As my target groups were clinicians and my focus operation was a surgical procedure my research was hospital based. I planned the research at eight trusts in the Northern Deanery and set Northumbria Healthcare NHS Foundation Trust as my main site. My sites were: Northumbria Healthcare NHS Trust, Newcastle Upon Tyne Hospitals NHS Foundation Trust, Gateshead Health NHS Foundation Trust, South Tyneside NHS Foundation Trust, City Hospitals Sunderland NHS Foundation Trust, Durham and Darlington, North Tees and Hartlepool NHS Foundation Trust and North Cumbria Acute Hospitals NHS Trust. South Tees Hospitals NHS Foundation Trust was the only Northern Deanery trust to be excluded as a site due to logistical reasons.

To carry out my research in each site I had to apply for and gain R&D approval and Caldicott approval in each trust. I also needed to contact the IT department in each trust to create the secure folders to hold the video recording videos at their trust website secure intranet folder as described above. Despite having gained the NHS committee ethical approval which included a site specific form for each of the eight sites, I had to complete a slightly modified application form for each site, answer different requests, and some sites even requested a face to face meeting. One trust asked me to get financial clearance to make sure my research would not cause the trust any financial burden. This financial clearance was to be processed by a part time officer and this step delayed the approval for a whole month in that particular trust.

This process was very complex and time consuming. It left me wondering about the main reason behind such a complex system. To my mind, centralizing the ethical approval process through the NHS ethical application website was a step to streamline and simplify the application. It should help reduce the processing time in each trust and leave the R&D to deal with local concerns specific to the trust. The forms to be completed should be standard across all the NHS trusts and as long as the research protocol was the same forms should not be repeatedly completed in a slightly different version in each R&D department in each trust. The same should apply to Caldicott forms. The same information security principles were used across the NHS and the form should be standardised and filled in once, unless there is a research specific different arrangement in the site. As a researcher conducting his first multi-site research, the NHS ethical approval was an extra step rather than a streamlined simplifying step. The repeated R&D approval and different form versions need serious reviewing as they were complicating the research process.

Trusts varied in their application processing speed and one trust did not engage at all despite frequent reminders. The only reply was that my study was not a commercial study and commercial studies take priority. Another trust delayed the process until the end of the recruitment period. So despite having the Caldicott and R&D approval the site was never open for recruitment. At the end of recruitment for the online cognitive hazard training six trusts took part, however video-recordings, video -reviews and candidates' interviews occurred in seven hospitals in four trusts.

Running multi-site research was a tedious and time consuming task; however it highlighted issues with relevance to the ethical and legal aspects of my research.

5.6.4 Out Of Programme Research (OOPR) contract implication

As I explained earlier, I hold a national training number and took an out of programme three year period for research (OOPR) which was approved by the Yorkshire and Humber Deanery and the Associate Postgraduate Dean (Leeds). Having an approved OOPR means that I maintained my number, I attend yearly Annual Review of Competence Progression (ARCP) and I return to a guaranteed and reserved training post at the end of the three year period. To my mind that arrangement meant an unpaid leave with a continuation of my employment status in the NHS.

Such employment status is important when carrying out NHS based research. If you are an NHS employee you need an access letter from the Human Resources (HR) officers after they check you have the initial identity, security and other necessary checks from your employing trust. If you are not an NHS employee you require an NHS passport to be processed by your main site. NHS passport application and processing is time consuming as HR needs to do all the pre-employment checks.

In the early stages of my research I held a bank clinical fellow post which represented a zero hour contract to provide some internal locum cover for the Trust and when the contract ended I started my ethical approval process. I contacted Northumbria Trust R&D to check if I required an NHS passport and after presenting my OOPR approval letter the HR at the Trust were happy that I was an NHS employee on leave and I did not require a passport as my checks were already done, I worked in the NHS and I was guaranteed a return to work after my approved leave. They read the OOPR approval letter and reached the same conclusion that I was an employee on unpaid leave. As R&D departments at various trusts processed the application at different speeds I was asked by the R&D department at one trust to get a NHS letter of access proforma and confirmation of pre-engagement checks form signed by my employer. I approached the Yorkshire and Humber Deanery. The Deanery referred me to the HR department at Doncaster and Bassetlaw Hospitals NHS Foundation Trust as the lead employing trust for the southern part of the Deanery. HR at Doncaster and Bassetlaw Hospitals NHS Foundation Trust were happy to sign the form confirming the pre-engagement checks were carried out for me but when contacted by the R&D department of the research site, they stated that I was no longer employed by the Trust and my contract was terminated as I was out of training for a long period (three years). I contacted Yorkshire Deanery and they confirmed my leave was approved but they claimed no power over the contract matter. I also contacted HR at Northumbria Trust and they were surprised to hear that Doncaster HR considered a long period of an approved leave was a good enough reason to terminate the contract. As I was providing locum cover for Northumbria Trust, and to avoid the time needed to process a research passport, Northumbria managers agreed to give me another bank clinical fellow zero hours contract and sign off my pre-engagement letter to facilitate the research at the other sites around the Northern Deanery.

I appreciate that such problems might be unique to my case as the majority of trainees undertake funded research where they have an employment contract and salary paid by the research hosting trust. However, such a contract definition has important implications. Is it legal to terminate someone’s contract while they are on an approved leave on the basis of the leave length? It is normal for instance to keep employment status in an unpaid leave for one year sabbatical leave. I do not have a legal background and don’t know the answer to such a question but, if the NHS was keen for trainees to be involved in research, such matters should be discussed and clarified.

This matter was communicated to the Yorkshire and Humber Deanery. I was told the matter would be discussed at the Deanery level but no outcome has been communicated to me as yet despite having an ARCP at the end of my OOPR period and re-joining the training programme in October 2016. I moved my training to the

Northern Deanery in February 2017 and have no further links with Yorkshire Deanery.

5.6.5 Scotia Medical Observation and Training System (SMOTS) security arrangements

I explained about the availability of the Scotia Medical Observation and Training System (SMOTS) in Chapter Four. I was introduced to SMOTS through an advertising stand at a conference at the start of my research. The system was too expensive for my research budget so I did not entertain the idea of using it in my research. I progressed my theoretical framework and created the material and the synchronization process described in the previous chapter.

While applying for R&D approval at Gateshead I was told that the SMOTS system existed in Gateshead and it might be a better way of running the recorded part of my research at the Trust. I was introduced to the Simulation & Education Technical Officer at the Trust who was appointed to manage the system. I met the officer to discuss the security around the operation recordings as that was one of the major information security requirements in my research. I was advised that the SMOTS security setting met all requirements. The system was set up at Gateshead so that it could be controlled by one person: the Simulation and Education Technical Officer. Recordings were carried out in a secure way and none of the SMOTS system users could access ongoing recordings or saved recordings without special access assigned by the officer. SMOTS allowed a synchronized split screen recording and the camera was held on a mobile stand that could easily be moved around. The stand can accept output from any recording machine and I was reassured by the officer that the system was tested in theatre and took the output from the standard laparoscopic stacks used in the Trust.

The officer informed me that he was available to set this up if given one day's notice, however longer notice would be appreciated. He also pointed out that the system was easily controlled by an application on the desktop and he could assign access to control the process so recording could start after the patient was covered with the sterile drapes and stop at the end of the operation before the removal of the drapes so patient identity remained anonymised.

Gateshead had a video releasing form (Appendix 68) and upon receiving a signed form from all the people in the recording the officer would release a copy of the recoding to the permitted person (the consultant in charge or the researcher). In this sense Gateshead SMOTS settings covered all the requirements for information security and provided the best vehicle to carry out my research idea in real life. I used the system to conduct the recording in Gateshead with good results and the resolution of the recorded video was good.

I checked with the other sites and SMOTS was either not available or restricted to certain areas and used like CCTV with continuous recording which did not fit the theatre environment. In the sites where the system was available on mobile bases the security setting prevented such use in theatre. The system was set so any user with a log-in access to the system could view recordings live as they were recorded or review any recording available on the system. Such settings were not compatible with my research information governance settings and deemed the system unsuitable for my research. I would recommend Gateshead SMOTS security setting as a live role model to facilitate any future learning or educational research.

5.7 Piloting

As previously discussed, in Chapter Four, step one in my design which was introduced to the candidates as the Knowledge and Hazard assessment was a cognitive training tool packaged as assessment to maximise participants' attention and help gain the desired learning objectives. After creating a practical example of this assessment for laparoscopic cholecystectomy and uploading it online, the test was checked and fine-tuned by myself and my surgical supervisor, Professor Stephen Attwood.

Further proof checks were carried out to identify any possible mistakes or slips in the instructions or contents, and the test was piloted by two consultant general surgeons outside the Northern Deanery. These two consultants were approached through the British Syrian Medical Association Council who kindly accepted to post an advertisement to their members' mailing list. I was then provided with the email address and phone number of two general surgical consultants, one with hepatobiliary interest and the other one with upper gastrointestinal interest. Both consultants were experts in laparoscopic cholecystectomy as surgeons and as trainers.

An email invitation was sent containing the automatically generated username and password as explained in Chapter Four. The two experts completed the online module. Their impressions and opinions were obtained via telephone interview. This was recorded, transcribed and analysed accordingly.

5.7.1 Themes from the experts during the piloting phase

5.7.1.1 Overall value

The feedback was overwhelmingly positive. Both experts highly valued the online module benefits for trainees.

> ‘‘I would say in general they are good and useful to trainees. Yes, if you watch all the video it take some time but I think it is time well spent because what you gain, is worth having spent that time’’ (Expert 1, piloting phase)

5.7.1.2 Approach

They both agreed that the online assessment approach was unique. Expert 2 suggested that they were conducting a course with a similar aim but using live training and discussion of possible anatomy variation rather than the online comprehensive aspect in the online module.

> *‘‘E: Materials are similar in principle to a course we used to run at the deanery level for trainees. We used discussions around possible danger-clues with some images and some live operation links. We talked trainees*

through scenarios of vascular variations and multiple risks.'' (Expert 2, piloting phase)

This expert even went on to ask if it the programme would be available to use for his own trainees.

''Would it be possible to use those materials for teaching, once you have finished your PhD?'' (Expert 2, piloting phase)

5.7.1.3 Content

They also agreed that the materials were all relevant and no content needed to be removed from the online module.

''The MCQs are very relevant, I think it covered most of the problems encountered in surgery like identifying the anatomy and bile duct, artery…etc. I think what you have is really good'' (Expert 2, piloting phase)

They shared concern about the quality of a couple of the video clips in the module. Those were two videos in the complication section of the online module and it was the quality of the images that was suboptimal.

''The videos quality is suboptimal. I understand you took them from YouTube so it might not be possible to do much about that.'' (Expert 2, piloting phase)

Although both experts were disappointed with the video quality, when asked about removing those two clips they both opted to keep the videos as they represent important complications but they would prefer them to be replaced with better quality alternative clips, if such replacements become available.

> *''No, I think you what you covered is quite relevant. Everything should stay''* (Expert 1, piloting phase)

5.7.1.4 Suggestions

There were however four main comments on improvements, two from each expert. The first was about the need to add further clarifications and comments, even voice comments, about the complications and what went wrong. The expert also advised adding clips of scenarios about bleeding, especially using the Pringle Manoeuvre. This is an emergency surgical manoeuvre to minimise bleeding. He argued that bleeding was more common than the other complications and it was important to prepare trainees to deal with it.

> *''One more could be added (on) how you deal with bleeding in the course of lap chole and how you apply pressure, how you do things for example or take a swab and just control the bleeding. So, because yes, bile duct injury could happen but the chance of that happening is about one in a thousand in contrast to bleeding (which) is more common and also get familiar on how to deal with it if it happens''* (Expert 1, piloting phase)

The last suggestion was not proposed by the second expert but when prompted he did agree with the first expert about the importance of calmness in dealing with bleeding. He did however, come up with two different suggestions. The first was about the clarity of instructions, especially before the multiple-choice questions which permitted selecting more than correct answer. He suggested enhancing the clarity of the instructions but he admitted that he used his mobile phone to look at the material so he might have missed the instructions.

> *‘‘The instructions on the multiple choice questions were not clear. I chose one answer not realising that you need to choose more than one answer. I used my mobile to check the materials and there was no clear instructions on such questions. You need to address that for further clarity.’’* (Expert 2, piloting phase)

The second suggestion was about the management scenario in the bile leak/ accessory duct case. The expert agreed that the management options provided were the ideal situation but he suggested that the majority of the hospitals would follow a more practical approach due to the limited availability of the CT scan.

> *‘‘You used CT as the investigation of choice. I do agree this is the ideal modality, but realistically some hospitals might sit tight and observe in the first period, or used ultra sound scan, USS scan. Although USS is operative dependent and if you don’t have an experience sonographer a bile leak will be missed. You described the ideal modality but I don’t think this is a common practice in reality’’* (Expert 2, piloting phase)

5.7.1.5 Responses to pilot themes

The suggestions from the experts needed to be dealt with before starting the feasibility study so I met with my surgical supervisor and we discussed the suggestions in detail. Discussion centred on the effect of implementing such suggestions on the study overall aim within the previously discussed literature review.

The first suggestion was about expanding the explanation about the complication scenarios. As the aim of the hazard perception clips was to train System One, to spot hazards and engage System Two, further explanation would be counterproductive. Such detailed explanation would be helpful in the form of a lecture but it would not serve the intended mental training purpose. The aim here was to provide a training opportunity with direct corrective feedback in the most condensed and concise way and with the minimal possible interruption. That was the reason behind using the video clips from the same operation in the feedback and in the progressive management scenarios. I felt that further explanation would extend the time needed to complete the training and distract the mind from concentrating on the clips. If trainees knew what went wrong this extra explanation would simply disengage them, and if they did have doubts they could always discuss this with their consultants, colleagues or even the researcher in the post MCQ interviews.

The second suggestion was also challenging. Simple bleeding clips were available in the material although mainly in the optional part. They did not go as far as the Pringle Manoeuvre. I considered expanding the material further by forcing some of the optional clips to become mandatory. Would I search for further clips with Pringle manoeuvre knowing that it is unlikely to be needed and it would require practical practice to master?

Again by returning back to the aim of the hazard training I opted not to change the current material. The Cognitive Hazard Training module aimed to mentally train System One to spot hazards and engage System Two, not to replace trainees' normal training with their supervisors. As a result common daily hazards should be covered by the normal training, and unusual but dangerous hazards are needed in the material. The material should condense the possible hazards that might be encountered and if missed would present a risk, not the daily encountered simple bleeding. It cannot also replace the need for practical hands on training.

The third suggestion was about the clarity of the instructions. Going back to the online material the instructions were present and the comment was not shared by the first expert. The second expert accepted limited vision by using his mobile to view the materials. As a result I opted to circulate the material as it was but added a question in the post MCQs interviews about instruction clarity.

Finally, there was the suggestion about the practical versus ideal management scenario. After extensive discussion I opted to keep the current management plan. I felt that as training and teaching material I should teach the optimal text book management. Practical management forced by local needs and limitations is up to each individual surgeon and trust and should not affect the ideal management teaching.

5.7.2 Research plan modifications

This piloting phase showed me the need to improve my interview technique especially in using probing questions to encourage the candidates to share more information and provide further details about the topic in question. It also highlighted the possibility of missing intended questions or mixing the intended question order in the absence of written questions to refer to during the interview. As a result I designed an interview schedule list for each of the future candidate categories: junior doctors for post MCQs interview, SPRs for post MCQs and post video review interviews, and consultants for post MCQs and post video review interviews.

Each category list was designed to fit on one A4 page to serve as an easily accessible memory aid during the interview. Questions within each list were designed in respect of the category expertise but with as much cross categories standardization as possible. It also contained probing sub-questions to be used if needed. Interview schedules were cross-checked by the supervisory team and modified accordingly to reach the final attached version used in the research (Appendix 69, 70, 71, 72 and 73).

5.8 Sampling

5.8.1 Sampling methods

Sampling is an important step in qualitative research. As a qualitative research sample is usually smaller than in quantitative research, it is important to ensure a representative sampling to include a wider range of views and opinions (115).

Probability sampling is usually used in quantitative research. In this method the sample is selected using a random method. On the other hand non-probability sampling is usually used in qualitative research as researchers are usually interested to understand social processes and a full representative sample is less important in such research (116).

Purposive sampling is frequently used in qualitative research. In this method the population is divided into groups that suit the aim of the research (117). Those groups could be age, sex, or trainee grade in my case. This sampling method allows the researcher to collect data relevant to the phenomena under investigation.

Theoretical sampling originated with the discovery of grounded theory. Sampling here is informed by the emerging theory and the researcher seeks to collect more data to inform the ongoing analysing as themes emerge and categories are identified from further analysis of the data (117). In other words each data collection cycle informs the sampling method for further data collection.

Convenience sampling collects data from the sample that is easy to access by the researcher. This could be students living in a certain hall of residence or the first people to come to the clinic for example.

5.8.1 Research sampling method

I used a convenience sampling approach in this research. However, some aspects of purposive sampling could also be claimed, as possible candidates were divided into groups according to their grades and all surgical trainees and surgical consultants in any trust that gave R&D clearance were approached for recruitment as long as they performed laparoscopic cholecystectomy.

I approached the general surgical department clinical directors or any consultants with an interest in education to find out about the surgical department meeting dates to present my research and ask interested trainees and consultants to provide their email address. I could have gained many consultants’ email addresses from the trust website but I thought without a face to face invitation the emails might get ignored. I wanted the initial commitment of someone voluntarily writing his/her email address to encourage further participation.

Junior doctors were the hardest group to recruit as they were reluctant due to feeling that the research was not relevant to their level. They were also harder to find as they were very busy in the wards especially in the current NHS environment with a significant shortage of doctors on the ground.

Patients were only approached after the consultant and trainee agreed a suitable operation recording day and a suitable patient. The plan was to record ten cases. None of the patients approached refused to join the research. So the total number of patients approached was fourteen.

5.9 Setting

This has been almost fully discussed in various previous parts of the thesis so far (Sections (3.2) (3.3) and Chapter 5). The cognitive hazard training (knowledge and hazard assessment) module was hosted on Durham University website with invitation and username and password access. Operative recordings took place in theatre with the qualitative theatre observation study carried out in parallel. Video-review sessions were held at the supervising consultant's office. Interviews were held at the trainee's and consultant's hospital and forms were stored in the same manner described in the ethical section above.

5.10 Data collection and analysis

I have already described the various data sources in the relevant section in the study design (Section 5.4). Cognitive hazard training online module results were downloaded from the hosting university website for analysis. Both PBA forms were compared before and after the video-review session. Three candidates wanted to have their first PBA assessment as an official assessment at the ICSP training website and kindly two of them emailed me an electronic copy.

Interviews were conducted on a face to face basis. Despite being fluent in English and working as a surgical SPR in the UK for almost ten years, English is not my first language. I wanted to have the extra benefit of being able to read candidates' body language as well as give them the chance to read my non-verbal clues. I am also more familiar with face to face history taking through my clinical practice.

Semi-structured interviews were used to allow flexibility and enable the researcher to follow up responses to drive further explanation and deeper understanding. However the pilot study exposed the need for more structure during the interviews. Piloting also showed the need to probe to help me think while processing candidate responses.

All interviews and video-review sessions were audio recorded and professionally transcribed. Transcriptions were thematically analysed by the researcher. This involved the six phases identified by Braun and Clark (113) as was described earlier in sections 5.3.4 and 5.4.1.

As I had a dual role in theatre to operate the recording equipment and conduct the observation study I was keen to reduce distraction to the minimum by limiting the written comments and use self-audio recording reminders after the case. I was also keen not to be seen as an observer with a check list. To minimise my impact on the theatre team, especially the circulating nurses who stay at the back of the theatre to hand needed equipment to the scrub nurse. I was aware that the presence of the recording equipment and the knowledge that voice as well as images had been recorded would affect and alter some of the usual interactions among the nurses. I was initially sceptical about the possibility of such behavioural alteration and even questioned the value of the observation study. To my surprise I identified some valuable observations which will be discussed later in the relevant result chapter (Chapter Eight).

5.11 Chapter summary

In this chapter I have provided a flavour of the epistemology and research theories with a main focus on design-based research. I covered data analysis approaches and described the study design along with the ethical considerations and difficulties faced during the legal, ethical and R&D approval which might be relevant to future researchers in the field. I briefly described the recruitment, data sources, settings, data collection tools and data analysis as I was conscious not to repeat the steps described in previous chapters so far.

In the next chapters I will report on the results of each part in the study: cognitive hazard training, reflective formative assessment (video-review) and theatre observational study.

Chapter Six: Results of Cognitive Hazard Training (knowledge and hazard) feasibility test

6.1 Introduction

In the previous chapter I discussed the methodological approach along with the feasibility study design and tools. I also explained about the ethical and R&D approval process and the challenges faced in each step. I presented the online module piloting results and the research plan modification including the modified interview schedules (Appendix 69-73).

In this chapter I will discuss the result of testing the feasibility of the first part of the design. This is the cognitive hazard training online module's feasibility testing results. Next chapter (Chapter Seven) will present the result of testing the feasibility of the second design part; reflective formative assessment (recorded operation video-review) and the design overall result when both parts were applied together. The final results chapter (Chapter Eight) will contain the qualitative theatre observational study. The thesis will then end with the discussion chapter, the recommendation and future work chapters (Chapter Nine).

6.2 Recruitment and candidates' distribution

The process of recruitment was briefly described in the previous chapter. After receiving the R&D clearance I approached the general surgical department in each hospital through the help of one of their consultants, either the clinical director or an educationally oriented consultant in the department. I booked a slot and presented my research at the department meeting to the consultants, SPRs, staff grades and any junior doctors attending the meetings. I then circulated a paper to collect the email addresses of any interested candidates.

As junior doctors were usually busy in the wards, I visited the wards repeatedly at various times and dates to catch up with the available junior doctors and briefly explain my research. If they showed any interest in joining the research I collected their email address.

I sent two emails to each interested candidate. One email came from my Durham University email with the information sheet and consent form. The other was generated by the online module page at Durham University Blackboard. This email included the website anonymously generated username and password along with a link to direct the candidate to the website and automatically fill in the username and password for an easy access. As explained in Chapter Four I had no control over the username and password creation process. I was able to check if candidates had logged onto the website and the last time they did so. The website control page allowed me to send a reminder email and showed me if anyone had finished the assessment.

To summarise, the research was presented to all candidates in the surgical department with no exclusion or selection as long as they were involved in Laparoscopic cholecystectomy operations. Candidates receiving an invitation email with a username and password were those who had already showed an interest by providing their email addresses. As I explained in the previous chapter I was keen not to send invitation emails blindly without presenting my research first as such blind emails might be ignored. I wanted to have some sort of candidates' commitment to the research first. I was however aware that, as the paper is circulating around, some candidates might feel peer pressure to add their emails despite not being really interested in taking part in the research.

Invitations were sent to the 93 candidates who showed interest by providing their email address as described in this section. These included 13 junior doctors (F1 and F2), 37 consultants and 43 SPR level doctors. The 43 SPR level doctors were divided into three categories depending on their training status and training level. SPRs with a national training number were divided into SPR1 and SPR 2 to represent their level at the national training programme; first or last three years respectively. Doctors without a national training number were grouped as staff-grades.

This distribution was done on the online Durham University IT system hosting Blackboard to facilitate analysis as the website anonymously groups the test results according to the assigned group. Individual results cannot be generated and are only known by the candidate taking the test. The main idea behind the sub-group division was to check whether there was a difference in the online module results according to SPR training/experience level. Staff grades were usually experienced doctors and I felt it would be better for the analysis to group them separately.

The three senior trainees , two SPRs and the staffgade doctors, sub-group split were limited to the online module results analysis only and the three sub-groups were treated exactly the same throughout the research. Interviews were analysed according to the original three categories: junior doctors, SPRs and consultants. However, in my interviews I strived to have an almost equal number of trainees in each of the three SPR sub-groups, as shown in Table 5, to ensure I had a sufficient number of trainees to invite to interview in each of the subgroups.

	Junior	SPR1	SPR2	SG	Consultants	Total
Invited	13	15	21	7	37	93
Link never opened	7	6	7	1	20	41
Introductory page only	0	0	2	1	2	5
Started	6	9	12	5	15	47
Finished	3	7	10	3	10	33

Table 5: Cognitive hazard training online module candidates' dissemination and progress.

6.2.1 Research dropout rate

Table 5 summarises the candidates' numbers who agreed to participate in the study, right through to the numbers who finally completed the Cognitive Hazard Training. Overall 93 candidates received an invitation email. Almost half (41 candidates) did not open the link to the module's online hosting website. I assumed that those candidates might have provided their email addresses due to the peer pressure effect and had no intention to take part in the research. However, this supposition is not supported by any evidence. I considered approaching those candidates at the end of my research to gain their perspective and understand the reason behind this initial high dropout. I did however dismiss such an action for two reasons. Firstly, the first part of my design was the cognitive hazard training module which was delivered online. Engagement with the online assessment, or in this case, the lack of such engagement, would be an indication of consent withdrawal. Secondly, the aim of my research was to assess the local benefit of the design, and to progress the current theory and understanding about surgical skills acquisition. Investigating an initial research drop out, did not further support or address either of those two aims.

Five candidates opened the link to the online module page and observed the introductory page but did not progress beyond that point and did not submit any answers. Those five candidates were from the senior group; senior SPRs and consultants. The introductory page did mention the time needed to finish the online module and I was not sure if that had had an effect on the decision to quit at that point. So, to summarise so far, the majority of the candidates dropped out before being exposed to the online materials (46 out of the total 61 dropout).

As mentioned in Chapter Four, the online module was divided into pages or screens with a varying number of questions. Candidates progressed from one online screen to the next by submitting the answers to the current screen. The number of candidates who submitted the answers to at least one online assessment screen was 47 and, of those, 33 finished the whole assessment. In other words, 14 candidates dropped out after they had some level of exposure to the assessment. Such late dropouts were more prominent at the junior doctor level, with half of the candidates (50%; 3/6) dropping off at an early stage, as will be discussed later in this section. This was not seen at SPR 1 trainee level with most completing the training (78%; 7/9) and the same for SPR2 (10/12). As the research was mainly aimed at SPR level I was reassured by such a high SPR completion rate. Staff grades' dropout rate was (40%; 2/5) and consultants' rate was (33%; 5/15). I was expecting a higher dropout at the consultant level as they are a busy group and were providing an expert check for material below their level. I cannot comment much about the staff grade dropout rate, as this was a small sample.

6.2.2 Cognitive hazard training online module interviews

Interviews were conducted following the research plan explained in the methodology chapter (Chapter Five). Junior doctors and consultants were approached after they had finished the online module and face to face meetings were arranged to conduct the interviews. SPRs interviews were delayed till after the operation recording as was explained in the methodology chapter. One candidate was excluded from the interview process after admitting a rushed suboptimal test completion via the mobile phone and skipping some videos. This candidate's individual online result could not be retrospectively isolated and deleted.

	Junior	SPR1	SPR2	SG	Consultants	Total
Finished	3	7	10	3	10	33
Interviewed	2	6	8	2	9	27
Male/Female	0/2	1/5	7/1	2/0	9/0	19/8

Table 6: Cognitive hazard training interview.

In total, 27 interviews were conducted to reach data saturation point. Effort was made to ensure equal numbers were represented in the groups and subgroups. I targeted the full range of surgeons who would be involved in this procedure such as the educationally active members of the training committee and the full list below. Laparoscopic cholecystectomy procedures are usually carried out or supervised by general surgeons with an Upper Gastroenterology surgical interest. Occasionally the targeted procedures are carried out by vascular or colorectal consultants, hence these surgeons were also targeted to wider participation. Two hepatobiliary surgeons were amongst those who completed the MCQs. However, delays caused by R&D approval did not permit sufficient time to allow me to interview either of them before the end of the research data collection period.

6.3 Data organization and analysis preparation

The University blackboard website hosting the online module allowed the submitted test answers to be downloaded into an Excel sheet format. This downloaded Excel sheet had four columns: the candidates numbered from one to 47, group or sub-group, question number and the submitted answer. As the module allowed two attempts at some questions the number of answers varied depending on the number of attempts taken. Questions included a mixture of MCQs and open texts. However, 14 candidates did not complete the whole assessment, and stopped at different points. The results were too complicated for an automated organisation and the output had to be organised and marked manually (Table 7)

A detailed individual question validation and analysis, for the online module, is beyond the scope of this research. As discussed in Chapters Three and Four, the online (Knowledge and Hazard) module was not designed as a real assessment or test. It was planned as a stand-alone cognitive hazard training resource to enhance safety. It aimed at training candidates to pick up the hazard clues and generate hazard avoidance or a mitigation plans. It was presented as an assessment to enhance concentration and engagement. In this sense, the online programme was planned as a progressive module with four sections to signpost and reduce mental overload. The different sections were not separate test components and as a result should not be validated or compared separately.

Interviews were audio-recorded, professionally transcribed and thematically analysed (113). I will discuss the amalgamated analysis of the results submitted online and the interviews in the following section.

		Q1a	Q1b	Q1c	Q1d	Q2	Q3	Q4a	Q4b	Q4c	Q4d	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
		V	IV	I	II	E	A	I	III	IV	II	A	B	right liver (or hepatic) ischemia	Signs of liver ischemia	C	E	B,C	C	C	B,C,D,E	E	E	E	C,D	Mirizzi syndrome	C	E	possible answers, clip, staple, stitch, suture)	Duodenal perforation	Gallstone Ileus or Gallstone	B	Endoclose	A,B,C
14	JDR	V/V	IV/IV	I/III	II/II	E/A																												
46	JDR	V/V	IV/IV	I/I	II/II	D/A																												
39	JDR	V	IV	I	II	E/A	B/B	II/II	III/II I	I/I	III/III	B/B																						
21	JDR	V/V	IV/IV	I/I	II/II	B/A	A/A	I/II	III/I	IV/III	I/IV	A	C/C	cant see/bleeding, hepatic infarct	cant see/revascularise	C	C/B	A/B	C	B/B	D/D	C/C	C/C	B/B	A,C / A,C	place a stitch before resection/ same	B/D	B/B	unsure	bleeding	obstruction	A/C	bleeding	A
26	JDR	V/V	IV/IV	I/I	II/II	C/C	D/D	I/II	III/II I	III/II	II/I	A	B	affect blood supply to liver	have a look	C/E	C/C	A,B / A,B	A/A	B/B	A,C / A,C	A / A	F / F	D/D	A / A	Don't know / don't know	D / A	D / A	clip + repair	complication -bleeding	psudeobstruction	E / E	clip	C
40	JDR	V/V	IV/IV	I/I	II/II	A/A	A/A	III/II I	II/II	IV/IV	I/I	E/D	B/A	bleeding/ bleed	stop bleeding / not sure	D/A	E/E	A,B,E / B,E	C	C/A	A,C / C	D / C	F / F	B / D	A / A	Not sure / not sure	C	E	washout	bleeding	obstruction	E / A	not sure	B
13	SR1	V/V	IV/IV	I/II	II/II	E/A	A/B	I/I	III/II I	II/I	II/II	A/B	B	ischaemic liver	unsure	A/E	E/E	D/C	B/A	C/B	B,C,D,E/B,C,D,E	D/B	D/F	D/C	D/D,E	unsure/unsure	B/A	E	clip	duodenal injury	gallstone ileus	F/E	unsyure	C
22	SR1	V	IV	I	II	E	C/E	I/I	III/II I	II/I	II/II	A/D	B/D	hepatocyte necrosis	Adequate dissection of Calot's prior to ligation of vessels/ducts	C	E	B,C	C	C/B	B,C,E/B,C,E	E/C	A/D	E	B,C,D/C, D,E	Hartmanns pouch/ Mirrizi's syndrome	C/A	E	suture and drain	duodenal injury	gallstone ileus	B	endoclose	B,D
24	SR1	V	IV	I	II	E	B/B	I/I	III/II I	II/I	II/II	A/D	A/D	Liver ischaemia	If you have not transected the artery then remove the clip, of not call HPB	C	E	B,C	C	A/D	B,C,E/B,C,E	B/B	H/H	E	A,D/A,D	sorry/sorry	c	E	Washout, drain, ERCP and stent	perforation	gallstone ileus	B	needle	A,B,D
29	SR1	V	IV	I	II	E	B/B	I/I	I/I	III/III	I/I																							
35	SR1	V	IV	I	II	E	A	I	III	IV	II	D/B	B	Liver necrosis	If identified at teh time of the operation, repair by HPB surgeon may be an option	C	E	B,C	C	C/A	B,C,D/B,C	E/E	H/D	E	C,D	don't know	C	E	attempt to apply clip	duodenal injury	gallstone ileus	B/C	spindle needle	A,C,D
36	SR1	V	IV	I	II	E	A	I	III	IV	II	D/B																						
37	SR1	V	IV	I	II	E	B/B	I/I	IV/I V	IV/IV	IV/IV	A/B	B	Necrosis right hepatic lobe	possible cyanosis of right lobe of liver. Try to repair	C	E/D	B,C/B,C,E	A/B	B/A	B,C,E/B,C,E	A/D	E	E	C,D	don't know	C	E	CLIP	duodenal ? CBD INJURY	gallstone ileus	F/E	endoclose	A,B,C
38	SR1	v/v	IV/IV	I/I	II/II	E/A	A	I	III	IV	II	A	B	liver ischaemia	Arterial reconstruction	C	E/E	B,C,E/B,C, E	C	B/B	B,C/B,C	C/C	G	E	C,D,E/D	..../...	C	E	CLIP	.....	gallstone ileus	B/C	endocatch	A,B,C
47	SR1	V	IV	I	II	e	A	I	III	IV	II	A	B/E	right liver necrosis/ hepatic infarction	change in liver colour and removal of clips/ obtaining a critical view prior to any transection	c	E/D	B,C/B,C,E	C	B/D	B,C/B,C	B/C	H/D	E	C,D/B,C, D	dilated cystic duct/ dilated cystic duct	C/B	E	CLIP/ligation	enterotomy/bile leak	gallstone ileus	B	needle	B
1	SR2	V	IV	I	II	e	a/b	I/I	III/II I	IV/IV	II/II	a	c/e	Liver ischemia	Acheive the critical view	c	e/d	b,c/B,C	c	c	b.c/b,c,d	e/E	e	e	c/d	hkdflahsfdk/ Same	c/b	e	clip and drain	iatrogenic bowel perforation	gallstone ileus	b	endotie	b,c
4	SR2	V	IV	I	II	e	a	I	III	IV	II	a	b	Liver ischaemia, avulsion of artery	Packing for bleeding, and will need HPB for ischaemic liver	e/d	e/E	a,b,c/A,B, C	c	d/D	b,c,d,e	e	h/H	e/B	b,d/B.D	no idea/no idea	c	e	clip	perforation	gallstone ileus	b	needle holder	a,b,c
17	SR2	II/II	IV/IV	I/I	III/II I	E/E	b/B	I/I	III/II I	IV/IV	II/II	A/B	b	liver ischemia	Identification of structures before clipping	c	e	b,c	c	c/d	b,c,e	e	e	e/d	d,e/e	don't know/ don't know	C	e	suture closed	duodenal perforation	gallstone ileus	c/f	endoclose	a,c
18	SR2	V	IV	I	II	e	a	I	III	IV	II	A/B	C/D	cystic artery originated from common hepatic artery/Right liver lobe ischemia	mutiple small branches of cystic artery/ Remove the clip	C	E/E	B/A	E/B	D/A	B/B	C/A	H/D	C/B	D/D	Mirizzi's syndrome/Mirizzi's Syndrome	C	E	suturing	perforation of duodenum	gallstone ileus	E/D	endocatch	A,C
19	SR2	V	IV	I	II	e	a	I	III	IV	II	A/A	B/B	Hepatic ischaemia/Hepatic ischaemia	Identify and remove clips/ Critical view prior to clipping, make sure artery going into gallbladder	C/C	E/E	B,C/B,C	C/A/ A	C/A/ A	B,C,E/B,E/B,E	E/E/ E	E/D /D	E/E/ B	C,D/C/D	Mirrizi/phrygian cap/ phrygian cap	C/C	E	Clip and drain	duodenal perforation	gallstone ileus	F/E	endocatch	A,B,C, D
27	SR2	V	IV	I	II	e	A/B	I/I	III/II I	IV/IV	II/II	A	D/E	Hepatic ischaemia	Right lobe pallor/hypoperfusion, do not transsect. Attempt clip removal	C	E	B,C	B/A	C/D	B,C,E/B,C	E/E	E/F	E	C,D/B,C, D	don't know/ don't know	C/B	E	ERCP and stent	Bile duct injury	Gallstone ileus	B	port closure needle	B,C
30	SR2	V	IV	I	II	e	A	I	III	IV	II	B/B	C/A	Right lobe of liver ischaemia - sequelae depend on premorbid liver function	dusky liver. remove clip with care. refer to HPB if artery cut	C	E/D	B,C/B,C	C/A	C	B,C,E/B,C,D,E	E/E	H/D	B/B	D,E/E	unknown/unknown	c	e	clip. lavage.drain	duodenal injury	gallstone ileus	B	tie catcher	A,B
32	SR2	V	IV	I	II	e	A/B	I/I	III/II I	IV/IV	II/II	A	C/D	hepatic ischemia/necrosis of liver	Chnage of color of two lobes and removal of clip/ by obtaining critical view of safety and avoiding any cliping or cutting before this.	C	E	B,C	C/A	B/A	B,E/B,D,E	E/E	F/B	E	C,D/B,C, D	absent of cyctic duct/ mirizzi's	c	e	Clipping the duct and ERCP with sphincterotomy	duodenal perforation	Gallstone ileus	E/D	endoclose	A,B,C, D
33	SR2	V	IV	I	II	e	A	I	III	IV	II	A	B	segmental hepatic necrosis	gain critical view before transecting vessel, remove ligaclips	C/D	E/E	A,B,C/A,B, C	C/A	C	B,C,E/B,C	E/E	F/A	E	C,D/D	UNSURE/UNSURE	C/B	E	clip it	iatrogenics duodenal perforation	gallstone ileus	B	endoclose	A,B,C
34	SR2	V	IV	I	II	e	A	I	III	IV	II	A/D	D/C	liver ischaemia	don't know	A/A	E	B,C	C	B/B	E/E	E/E	B/B											
43	SR2	V	IV	I	II	e	A/A	II/II	III/II I	IV/IV	I/I																							
44	SR2	V/V	IV/IV	I/II	II/II	E/E	A	I/I	III/II I	IV/IV	II/I	E/C	B	ischaemia and eventual infarction and necrosis/ Right hepatic ischaemia/ infarction dependent on presence of accessory vessels. Sequelae of infarction- abscess, necrosis, insuffiency	Demarcation of the liver through colour and size change although Cantile's line./ artery divided in this example. Can proceed to arterial anastomosis if experience in centre.	C	E	B,C	C	B/A	A,B,C,D,E/A,B,C, D,E	E/E	E	E/B	D/D	don't know/ don't know	C	E	Suture it close and leave a drain	Duodenal? Can't really see where fluid coming from	gallstone ileus	A/E	cant remember	A,B

Table 7: Online module answers colour-marked with blue for correct answers and red for wrong answers.

		Q1a	Q1b	Q1c	Q1d	Q2	Q3	Q4a	Q4b	Q4c	Q4d	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27
		V	IV	I	II	E	A	I	III	IV	II	A	B	right liver (or hepatic) ischemia	Signs of liver ischemia	C	E	B,C	C	C	B,C,D,E	E	E	E	C,D	Mirizzi syndrome	C	E	possible answers, clip, staple, stitch, suture)	Duodenal perforation	Gallstone Ileus or Gallstone	B	Endoclose	A,B,C
2	SG	V/V	IV/IV	I/V	II/II	E/E	A/B	I/I	III/III	IV/IV	II/II	A	B/A	necrosis of rt lobe of liver	dissecting the triangles of safety before dividing anything	C	E/E	A,B,C / A,B,C	C	D/A	E/B	E/E	H/D	E/B	D/D	ENDOLOOP/partial cholecystectomy	C	E	ligaclip	avulsion of cystic duct	enterotomy	B	endocatch	B
15	SG	V/II	IV/IV	I/I	II/II	E/A	C/C	I/I	III/III	IV/IV	II/II	B/E	D/A	liver has got a rich blood supply so it will recover. take advise from HPB	Understanding of the clear anatomy , Stay close to the gall bladder to clip the artery, if identidied during operation remove clips.																			
20	SG	V/V	IV/IV	I/I	II/II	A/A																												
23	SG	V/V	IV/IV	I/I	II/II	E/A	D/B	I/I	III/III	IV/IV	II/II	A	D/D	liver ischaemia	correct anatomical identification of CA	C	E	B,C	C	A/D	B,C,D,E/B,C,D,E	E/E	E/D	E/B	D/D,E	subtotal cholecydtectomy/ subtotal cholecystectomy	C	E	clip and ERCP	iatrogenic injury	gallstone ileus	B	loops	A,B,C
45	SG	V/V	IV/IV	I/I	II/III	E/E	A/B	I/I	III/III	IV/IV	II/II	A	B/D	liver ischaemia/ Liver necrosis of right lobe / transient derrangement of liver enzymes/ liver abscess/CBD stricture	remove clips/ deal with the consequences	E/D	E	B,C	A/B	C/D	B,C,D/B,C	E/E	E/D	E/B	B,D,E/D	no clue/no clue	c/b	e	stitch	doudenal injury	gallstone ileus	B	knot retrieval	B,C
3	CON	V	IV	I	II	E	A/B	I/I	III/III	IV/IV	II/II	A/E	E/D	CBD injury	OTC	C	E	B,C	C	A/B	B,C,D,E/B,C,D,E	E/E	E	E	D/D	unknown/miritzi	C	E	drians, attempt clip may need ERCP	iatrogenic duodenal injury	gallstone ileus	E/F	endocatch	A,C
5	CON	V	IV	I	II	E	B/B	I/I	III/III	IV/IV	II/II	A	B	abscess/liver ischaemia	remove clip/ remove clip or leave alone	C	E	B,C	A/B	B/B	B,C,D,E/B,C,D,E	E/E	B/H	A/B	D.E/E	mirrizzi/mirrizzi	C	E	clip					
6	CON	V	IV	I	II	E	B/B	I/I	III/III	IV/IV	II/II	D/D	D/D	ischaemia or infarction of the right lobe and/or biliary tree/ ischaemia of right lobe of liver and biliary tree	observe colour change in right lobe - remove clips / careful dissection of all structures as close as possible to gallbladder	C	E	B,C	C	C/A	B,E/B	E/E	G/F	E	C,D/C,D,E	mirizzi syndrome/ mirizzi syndrome	c	e	clip or endoloop ligation	laceration of duodenum	gallstone ileus	E/F	endoclose	A,B,C
7	CON	V	IV	I	II	E	C/B	I/I	III/III	IV/IV	II/II	A	B	A degree of right liver lobe ischaemia. Possible damage to the CBD due to false recognition	Dissect Calot's triangle and the critical view clearly before dividing any structure.	B/D	E	B,C	C	C/D	B,C,D,E/B,C,D,E	E/E	E	E	C,D	short cystic duct	c	e	Clip or suture if possible. Drain and ERCP if continues to leak.	Iatrogenic injury to duodenum, not a cholo-duodenal fistula.	gallstone ileus	F/E	suture passer	A,B
8	CON	V	IV	I	II	E	A/D	I/I	III/III	IV/IV	II/II	A	B/D	Underperfusion of the right lobe of liver; hepatic abscess. Bile duct stricture	See a hump or caterpillar artery in Calot's triangle. Remove clip or reconstruct the blood vessel	C/D	E	B,C	C	A/D	B,C,D,E/B,C,D,E	E/E	E	E	C,D/C	nk.../nk...	C	E	Intra-op cholangiogram to define anatomy	Duodenal injury or chole-cysto duodenal fistula	Gallstone ileus	B/C	Endoclose	A,B,C
9	CON	V	IV	I	II	E	B/B	I/I	III/III	IV/IV	II/II	A	B	liver abscess, bleeding biliary stricture	critical view dissection and remove clip	C	E	B,C	A/B	B/A	B,C,D,E/B,C,D,E	E/E	E	C/A	C,D/B,C,D	short cystic duct stump/short cystic duct stump	C	E	drain and ERCP	cholecystoduodenal fistula	gallstone ileus	B	endoclose device	A,C,D
10	CON	V	IV	I	II	E	A	I	III	IV	II	B/B	B	liver infarction although it can survive on the portal vein. i have have seen cystic degeneration of the right lobe of liver	remove clips	C	E/E	C/C	C	C	B,C,D,E/B,C,D,E	E/E	E	B/B	D/D	UNKNOWN/ UNKNOWN	C	E	suture	iatrogenic duodenal injury	gallstone ileus	B	endoclose	A,B
11	CON	V/II	IV/I	I/IV	II/III	E/E	B/B	I/I	III/III	IV/IV	IV/II	A	B	Ischaemic liver/ ischaemic liver	colour change in liver. remove clip/Liver changes colour. Take clip off	D/D	E	B,C	A/A	A/A	B,C,D,E/B,C,D,E	E/E	G/G	E	D/D	Mirizzi/mirizzi	c	E	clip it if seen	fistula	gallstone ileus	F/F	endocatch	A,B
12	CON	V/V	IV/IV	I/I	II/II	A/A	A	I	III	IV	II	A	B/B	Necrosis of the right side of the liver	observe hepatic discolouration adn remove the clip																			
16	CON	V	IV	I	II	E	A	I	III	IV	II	A	B	Ischaemia of the right lobe of the liver	Observe the colour of the liver and release the clips	C	E	B,C	E/A	D/A	B,C,D,E/B,C,D,E	E/E	B/H	B/A	C,D	short cystic duct	C	E	clip the duct	Duodenal injury	Gall stone ileus	B/C	endocatch	a,b
25	CON	V	IV	I	II	E	A/B	I/I	III/III	IV/IV	IV/II																							
28	CON	V	IV	I	II	E	A	I	III	IV	II	B/B	B	ischaemic right liver/ ischaemic liver injury	take clips off, look for pale right lobe/ pale right lobe of liver, reconstruction if possible	C/D	E	B,C	C	C	E/B	E/E	F/G	E	C/D	caroli's disease/ caroli's disease	C	E	drain	duodenal injury	gallstone ileus	E/C	tervit's needle	B
31	CON	V	IV	I	II	E	A/B	I/I	III/III	IV/IV	IV/II	A	B	Liver ischaemia	trace the vessel to gall bladder																			
41	CON	V/V	IV/IV	I/I	II/II	E/A	A/B	I/I	III/III	IV/IV	IV/II	A	B	Death. Liver failure. SIRS and MOFS.	d/w HPB team. Likely no reconstruction though. HDU. Organ support. Duty of candour.	C	E/D	B,C/B,C	C/B	C	B,C,E/A,B,C,D,E	E/E	B/C	E/B	B,D	large hartmann pouch/ large hartmann pouch	C/B	E/C	CLIP OFF	perforation	gallstone ileus	B/A	J shaped needle	B
42	CON	V	IV	I	II	E	A	I	III	IV	II	E/B	B/A	Possible ischaemia and atrophy of right lobe	Identify the critical view and be aware of the anatomical variations	C	E	B,C	C	C/B	B,C,E	E	E	E	D/D	wide cystic duct/wide cystic duct	C/B	E	washout and drain. clip if feasible	Duodenal injury	gallstone ileus	B		

Table 7: Online module answers colour-marked with blue for correct answers and red for wrong answers.

6.4 Junior doctors' results (Foundation doctors)

Of the six candidates starting the online assessment, two dropped out after the first screen (question 2 out of 27) and the third candidate dropped out at the third screen (question 5 out of 27). Three candidates finished the online assessment and two candidates, both females, were interviewed. The first interview was with an F2 and the second was with an F1. Figure 4 summarise the emerging themes from analysing junior doctors' interviews. As the aim of the feasibility study was to evaluate the new designs, themes reflect the main points to support the study aim.

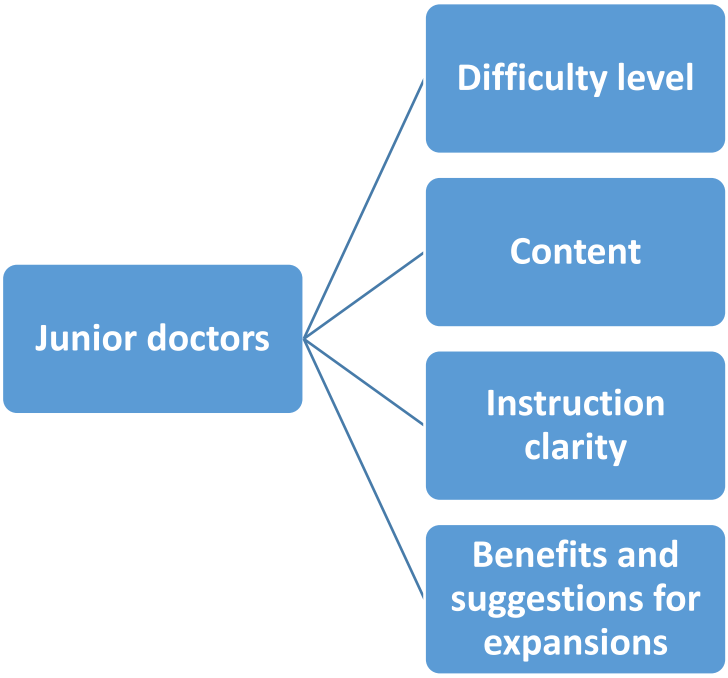


Figure 4: Junior doctors' interview themes.

6.4.1 Difficulty level

The first question in the online module was about the clinical presentation of various diseases included in the cholecystitis differential diagnosis. The main idea of that question was to check candidates' orientation to the operation indications. As this question held some relevance to the junior doctors' daily job it was the only question where they did well.

Looking at the six candidates submitted results, a clear pattern emerges. Regardless of how many questions they had completed, after this first question, they struggled to answer the remaining questions. Even with the use of the two permitted attempts they only managed to get a handful of questions right.

Their struggle to answer the questions was also highlighted in their interview results with the module difficulty rated seven or eight out of ten by one doctor, and nine out of ten by the other.

> *''I found that some it was very unfamiliar to me, especially in terms of anatomy because I haven't studied anatomy to that level.''* (Junior 1, MCQ interview)

> *''I've never heard of half the stuff in it. Some of them I recognized but I knew very few. I found it very difficult.''* (Junior 2, MCQ interview)

6.4.2 Instruction clarity

During some of the initial interviews with other candidates (piloting phase), they raised concerns about the clarity of the instructions, especially for the questions where more than one option was to be chosen from the option list. The data showed that all three junior doctors had spotted the need to submit more than one option in the relevant questions although they did not choose the correct ones.

As the two junior doctors' interviews took place at a later stage of the research, I specifically asked about the clarity of the multi-choice questions to further investigate the initial concern raised. The two junior doctors were very happy with the instruction clarity although one suggested shortening the instructions.

> *''Yeah, I think it was clear enough…I think the shortest instructions is better for what you want, is the best, I mean some of them were quite long, possibly that was what they mean.''* (Junior 2, MCQ interview)

6.4.3 Content

Both candidates expressed satisfaction with the content organization and comprehensive cover although they agreed it was not aimed at their level.

> *''The content was really good, I think it covered all the complications quite thoroughly, I hadn't necessarily heard of all of them, or didn't necessarily know how to treat all of them but it seemed very logical, seemed cover it quite comprehensively''* (Junior 1, MCQ interview)

''I think it was quite good, but it's for STRs, for our level something more simple, would be better, but I'm sure it's fine for them.'' (Junior 2, MCQ interview)

6.4.4 Overall benefit and suggestion for expansion

Despite the module's clear difficulty for their level, candidates were happy with the potential benefit of such a module. They anticipated the value of such a module for SPR level and they even anticipated the relevance of the module to their own practice in the form of suggestions for future expansion.

''I think it gave a very comprehensive snapshot of all the complications in quite a short amount of time actually, for such a commonly done operation. So, if I was an SPR I think it would be a really worthwhile time investment. It didn't take that long for the amount of information in it …by the end I felt like I'd learned something about complications in Lap Choly.'' (Junior 1, MCQ interview)

''We had someone with a ureteric injury from a Hartman procedure a couple of weeks ago, and if we'd had something like that we could have seen, and recognized straightaway what happened.'' (Junior 2, MCQ interview)

6.4.5 Conclusion about junior doctors' results

As previously explained, junior doctors were recruited to support the aim to target the materials at SPR level. The data from both the MCQs and interviews indicates, as intended, that the module was too difficult for junior doctors.

However, junior doctors expressed interest in the concept and communicated their preference for future online modules aimed at their level. They clearly followed the instruction and provided multi-choice answers where needed although they frequently failed to get the correct answer.

6.5 Higher trainees' (SPR level) and consultants' results

I carried out 25 interviews at this level. Those interviews were analysed along with the online MCQ submitted results (Table 7) and the results will be presented in the coming sections.

As explained earlier, I started the research with the expectation that SPRs' training level would affect their results. This assumption was the reasoning behind dividing SPR into three sub-groups: SPR1, SPR2 and staff grades. However, the results from the online module, shown in tables 8 and 9, did not really match such expectations. There was no major difference between SPR1 (ST3-4) and SPR2 (ST5-8) sub-groups, in terms of the results. I would even add, that their results were also not much different to the consultants' results (as explained later in this chapter).

Some questions proved to be challenging to all groups especially the bile duct classification (Question 13), the Mirizzi question (Question 19) and the final management question (Question 27). Surprisingly, no candidate managed to get all the correct answers at first attempt.

Free text questions proved to be a challenge as well. They caused frustration due to the rigid auto-marking that was explained in Chapter Four. They were marked wrong by the website unless the exact wording was used in the written answers and there was limited scope for alternatives. This problem was anticipated to a certain degree and was the main reason behind restricting the number of attempts to one rather than the two attempts in the rest of the module. Along with this frustration the results suggested some confusion amongst candidates, with some candidates jumping the direct answer to predict the future consequences of the injury as was the case with candidate 41 Question 7 (Table 7). This might require further investigation to ensure wording and instruction were clearly set out.

I would like to return to my earlier statement; that the validation of individual questions was beyond the scope of this research as the online module in my research was a cognitive hazard training resource rather than a real assessment. However, I recognise the limitations of this approach and will return to this in the coming discussion in this chapter.

Figure 5 provides a visual summary of the higher trainees' and consultants interviews' themes.

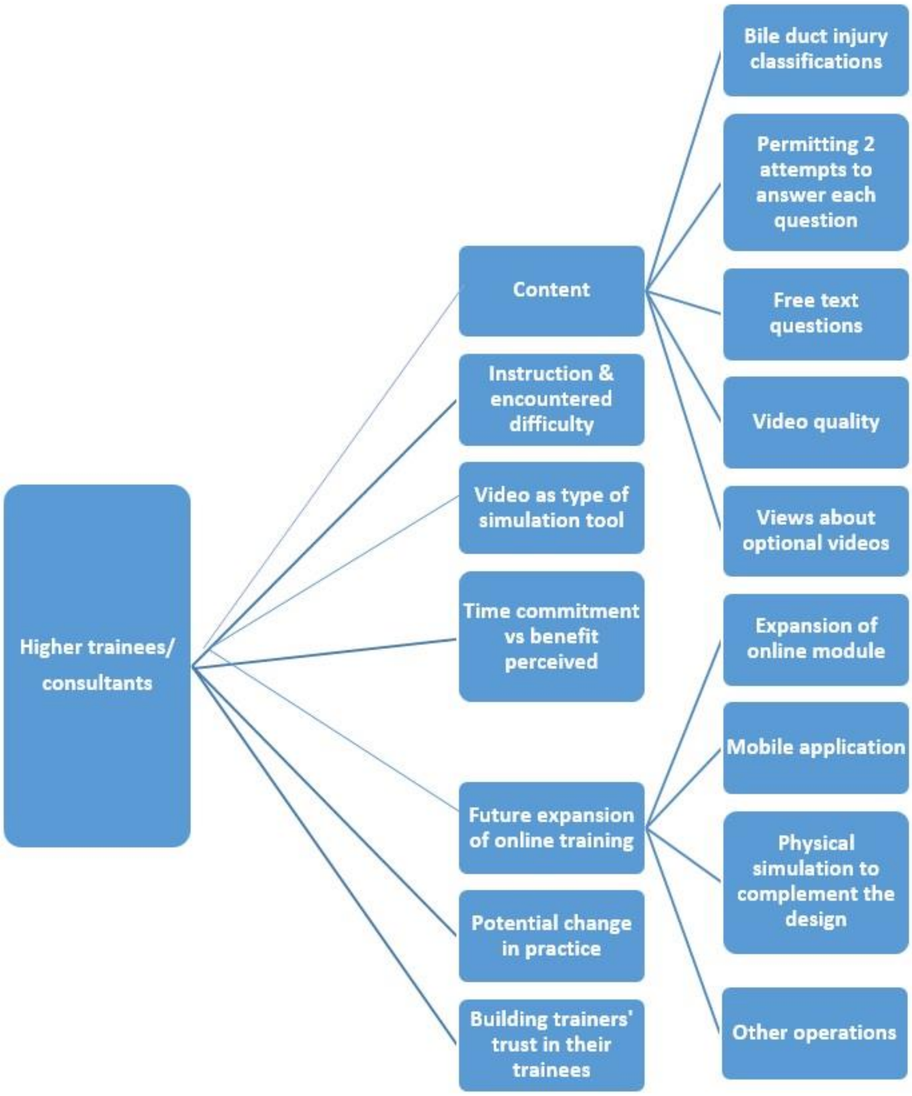


Figure 5. Themes from interviews with higher trainees' and consultants on their views of the Cognitive Hazard Training overall value.

6.5.1 SPR experience level

Before presenting the interview findings, I was keen to share some points raised by candidates which might explain the lack of differences between seniors in the results of the online module.

The first question in my SPR interview schedule (Appendix 70) was about the candidate's level of experience. The question wording was "how many years of surgical experience do you have?" This specific wording revealed an unexpected mismatch between training level and experience level for some candidates.

In this research SPR level 1, was used to describe trainees in the first three years of their training. The assumption here was that they were less experienced than candidates in the last three years of training (SPR2). However, interview answers revealed much more of a mixed picture. Some candidates held previous, but uncounted experience, either abroad or through clinical research posts or in non-training posts before gaining their training number. Such experience complicated the picture and due to the anonymity of data collection (which pooled all responses), linking years of training to grade and re-ranking was not an option.

This finding did help to explain some of the sub-group anomalies between the SPR1 and SPR2s. However, the minor differences between the three SPR sub-groups and the consultant group could not be solely explained by this factor. The explanation seems to be more complicated than a straightforward fixed relationship between surgical experiences measured in years and the achieved competence level.

One candidate came up with some insightful suggestions about the difference in individual training ability and hinted at the fact that training progress depends on the individual and their ability not about time served.

''Trainees are very variable there are some people, it doesn't matter how much you train them they seem not to get awareness, and operative skills so easily, and there are other people who do quite well, quite early on, and I think it comes down to the individual.'' (Consultant 4, MCQ interview)

I don't think the candidate was suggesting that some trainees are literally not trainable. I think the quote simply referred to trainees' variable skill acquisition speed or varying slopes in individual training curves.

Interview analysis also hinted at the effect of previous experience types in the form of previous hepatobiliary surgical posts and anatomical dissection experience.

''It has to be a combination of different things including your own reading, your experience, your anatomical training, your topical experience, and your actual operative experience specific to Lap Choly…some would have done additional anatomical studies by dissecting in medical school, and so on, professional dissector jobs, and things like that…a registrar that's done transplant, done retrieval, they're going to know about these Anatomical Variations in a lot more detail than somebody that hasn't." (Consultant 4, MCQ interview)

So, in summary, experience level is quite complex and difficult to define. However, as the aim of my research was to prove the effect of the online cognitive hazard training module rather than validating an assessment, this finding, although of interest, was not the main focus of the research

The findings are of interest for several reasons: they helped me to ensure the online programme was appropriately targeted at SPRs, they suggest the module findings could be used by trainers' to increases their trust in their trainees' knowledge and risk awareness, this finding also informs the competency based curriculum debate (discussion in Chapter 9), and lastly it would be useful to others conducting similar.

6.5.2 The participants views of the module's overall value

This section focuses on all those that completed the online module and all 27 questions and excludes those who dropped out. It became clear from the analysis of the interview data that SPRs had different approaches to the online module, and were motived to participate for one of two main reasons.

One group were motivated by future career interest: whether they would or would not have future involvement in Laparoscopic cholecystectomy operations as part of their future consultant jobs.

> *''It would be very useful for people that are going to be doing upper G I Surgery and have an interest in doing Gallbladders. I think you'll get less interest obviously from people that are heading down different routes and maybe see their time in doing Gallbladder Surgery a bit 'yes we are doing it, but I am going to be a Breast Surgeon so', they are not*

really that interested and 'as soon as I can stop doing it I will'. So those two very different characters are going to have two different approaches.'' (Consultant 4, MCQ interview)

''I am not an Upper GI Trainee and I have no interest in doing Lap Cholys in my subsequent career, so I want consultant job where I do not do any Lap Cholys.'' (SPR 13, MCQ interview)

The second group were motivated by the learning benefit. Some candidates approached the module with an expectation to learn from the resource.

''I think at my level it was definitely very useful. I'm not experienced yet in Cholys and I've not done many on my own. So, to be able to know exactly what to look for, and then see a video live, you know, an actual recording of how it's done and what can go wrong is very useful.'' (SPR 15, MCQ interview)

Other candidates, especially some senior trainees and consultants, started the task with the expectation that they were checking the module to help the researcher, with no personal learning benefit.

Despite those variations, the overall feedback was overwhelmingly positive. All candidates reported encouraging feedback and some expressed the shift in their expectations as they progressed through the module.

''I'm quite pleased. Initially I felt that this was just a waste, not a waste of time, no, I shouldn't say that, like unnecessary time, forty minutes to do a small assessment, but then when I was into it I found it all quite interesting. I found it is also slightly difficult because initially I said this is quite a boring anatomy about the Gall Bladder, but it wasn't and I must praise you for this, it's very high level so it works for registrars of all levels, it is quite high level.'' (SPR12, MCQ interview)

"It was actually quite good. It actually covered a lot more than I expected it would do. It was a very comprehensive online module." (SPR1, MCQ interview)

"Most people know the steps and how to do it but it's the complications and the Anatomical variations that is what you need to be aware of." (SPR 5, MCQ interview)

Even the candidate who stated no future interest in laparoscopic cholecystectomy operations reported some benefit and expressed the desire to have a shorter version of the materials for a quick revision before starting the procedure.

"Actually, I thought it was probably quite long. I'd rather you do it in smaller component sections so you do the Cystic Artery bit, and then you leave that alone, and then you do something else and leave that bit alone…If it was something that I could do over a shorter time, say fifteen

minutes before a case, like I would watch a YouTube video, or a website video." (SPR13, MCQ interview)

To my surprise even consultants reported a good personal learning value from the online module.

> *"Even as a surgeon with some experience I would say there was some things there I did not encounter or encountered a long time previously and it was useful to be reminded about them."* (Consultant 6, MCQ interview)

> *"It was good, it was educational, and I learnt stuff."* (Consultant 3, MCQ interview)

In fact, the last candidate in the quote above recommended deleting the warning message about the 45 minutes, required to finish the module. He was worried that that message did put one of his colleagues off, before that colleague could see the material benefit and he was keen for every consultant to share the benefit.

> *"One of my colleagues was about to do it and was surprised at the length of time it might took. It is difficult to say if you put that at the start of the assessment, if that would put people off. Stop them from doing it, if a person goes, 'it took forty minutes', forget that, I am going for lunch'. So, I don't know, no it was fine."* (Consultant 3, MCQ interview)

6.5.3 Content

Overall, candidates were happy with the online module organization, content and unique approach.

> *"The content was excellent. There was no doubt, by the end of that I had improved my knowledge, I can tell you this now, I improved my knowledge on the Anatomy in the various Anatomical Variants, or the Calot Triangle structures. So that was very good. It felt pretty much like a driving hazards tests, which was very useful."* (SPR 14, MCQ interview)

> *"It was probably even more specific and detailed than we would teach in a course almost."* (Consultant 9, MCQ interview)

> *"I felt really good about it, I think it is well organized and very comprehensive…It's given me lots of information I have never heard, I have never seen."* (SPR 10, MCQ interview)

> *"There's really good illustrations, the video clips were appropriate as well, and I could see that as being a very useful training tool, cause once you have digested that information you have got the strategy of what you are trying to do during the operation and all the pitfalls there are available as well."* (Consultant 2, MCQ interview)

The majority of the interviewed candidates thought all the components were relevant and should be kept. Only two candidates reported the desire to reduce the material length but did not specifically label any component as irrelevant or unnecessary.

> *"I think making people aware of variations in anatomy, and some examples I think would get that point across. Whereas I felt I got that in the first couple and then really wasn't paying too much attention afterwards to be honest. We've got a lot of demands on our time, I think you could have less, I think you just need some pertinent examples."*
> (SPR 16, MCQ interview)

In fact, the majority of the suggestions from the participants were about expanding the materials, as will be discussed later (Section 6.5.7).

6.5.3.1 Bile duct injury classifications

As I explained earlier, many candidates struggled with the bile duct injury classification question and I had a mixed response about its value. The SPRs in general did not complain about the question and some found it informative.

> *"I thought it was beneficial and I actually learned some things, particularly regards to classification of complications. So, I thought it was useful, I think the time that it takes is reasonable for what it gives you."* (SPR 4, MCQ interview)

However, consultants struggled with this part, including comments asking me to double check that I had got the correct classifications for bile duct injury and for Mirizzi Syndrome. Consultants argued that knowing the exact classification is not essential to safely conduct the operation and it could even distract from the main point of understanding the reason behind the injury. They also argued that this classification was already tested in the FRCS exam and it would be more useful to explain about management, such as adding a section about a gastrojejunostomy operation to treat the injury.

> *"I wouldn't necessarily expect a trainee to describe multiple classifications of biliary injury as part of an assessment. That's kind of what you get up to in the FRCS isn't it. As I say it's relevant because it's a descriptor of how you reconstruct and the management of a complication. It isn't necessarily what you want to be driving at when you're teaching, you want someone to understand where the potential pitfalls are as in why is this potentially wrong rather than necessarily what's the classification. You might as well be asking somebody to describe how you do a gastrojejunostomy that's the logical next step."*
> (Consultant 1, MCQ interview)

Although I accept the fact that knowing the classification was not essential to conduct the operation safely, I would argue that without such knowledge it would be difficult to explain the indications for various injury repair options including gastrojejunostomy. Such classification and treatment options would hopefully stress the awareness about the injury's serious consequences. As the material was set for SPR level I would argue that the classification was an essential part of the material.

However, I would understand that consultants might not have used this classification for a while and the information would have started to gradually fade. Information fading might help explain the limited difference in the online MCQ results between SPRs and consultants, without raising doubts about the consultants' safe knowledge level or the online training material' value.

6.5.3.2 Permitting two attempts to answer each question

As was explained at the material design phase described in Chapter Four, the majority of questions, except the free text questions, allowed two attempts or two mistakes to be specific before providing the feedback. This option left room for self-correction before the system provided the answer. This design was specifically praised by some candidates.

> "*Yeah, I thought it was good, I thought it was clear. The questions were clear and it was good when you were given an opportunity if you didn't get the answer right first time to then amend that."* (SPR 3, MCQ interview)

6.5.3.3 Free text questions

Free text questions were used to get the candidates to generate the answer and as there were few reasonable alternative MCQ options. This reduced guesswork, as previously some options may not have been an acceptable possibility, and candidates could select the correct answer by ruling out irrelevant options, even if they did not know the answer. However, as explained earlier, a limitation here was the auto-marking, which required specific wording with limited alternatives so answers were restricted to one attempt only.

Free text questions had a mixed reaction as well. They were praised by some candidates, who perceived the online module as training material. However, they still expressed the desire to correct the auto-marking problem.

> *"I like the idea that you have these free text boxes so it's not just a best matching answer. Obviously, there are some problems there."*
> (Consultant 1, MCQ interview)

They caused frustration to other candidates, who saw the online material as an assessment, with a clear desire to replace it with an MCQ style question.

> *"The only thing that was not ideal was the free text boxes and unless you put the exact words in, even though the answer was correct, it obviously didn't score you. If this was then potentially going to led onto a summative assessment rather than it just being formative the free text this would have to be improved. "* (SPR 3, MCQ interview)

6.5.3.4 Video quality

As mentioned earlier, two of the video-clips used in the assessment were of lower quality. Most candidates expressed their annoyance with the image quality of these videos.

> *"I thought mostly they were quite good. However, there were two that were very poor quality, which were difficult to see what, I thought it was difficult to answer the questions based on the poor quality of the videos."* (SPR4, MCQ interview)

However, surprisingly all candidates, including the two asking for material to be shortened, rejected the idea of removing those clips. They valued the importance of the lesson learned from the injury presented in the videos and expressed the desire to replace the videos with better quality alternatives if such replacements became available.

> *"I think that's difficult because some of those videos actually had some really interesting complications that you probably wouldn't recognize, or wouldn't have seen and so I think they add great value, I think it's just a shame that their quality isn't more."* (SPR 13, MCQ interview)

Some candidates thought the poor video quality, had in fact contributed to the injury observed rather than recognising the hazard. The data fell short from providing an answer to the remaining candidates' perspective in terms of recognising such link between hazards and poor video quality.

This missed hazard communication could be due to the current revolution in laparoscopic instrument technology which makes the high quality laparoscopic equipment standards these days, and candidates would not even entertain the idea of having less than ideal equipment. Poor image quality hazard message might need to be further stressed in any future development of the material, as equipment might sometimes fail and it is important for trainees to recognise the hazard and stop the operation to replace the laparoscopic stack.

> *"I think it's useful to keep them in because without decent vision when you're operating you can end up in that situation and I think it's useful for surgeons to know sometimes if it's difficult to get a good picture rather than changing the camera people will be happy just to carry on, but if you know the consequences could be disastrous, like injury to a vital structure then I think you need make sure that everything is as clear as possible for your patients' sake."* (SPR 9, MCQ interview)

> *"I mean the quality wasn't always great but I think sometimes that, that was the point. Again, trainees need to be aware that the equipment sometimes lets you down and you might have to do something about it."* (Consultant 4, MCQ interview)

6.5.3.5 Views about the optional videos

Seven SPRs and five consultants reported watching the optional videos. Some of the candidates who had watched the optional videos recommended making it essential.

> *"I watched everything, because I did enjoy it and I found it very interesting... I personally would put it as an essential because I wouldn't allow the candidate to proceed without seeing that because it's really important."* (SPR 10, MCQ interview)

However, stated above (Chapter Four), I could not get the permissions to download the videos. Given the additional time burden (double the time) versus benefit I would still hesitate to make these videos essential. Also streaming the videos online was more challenging.

The icon to email the optional videos to the candidate's own email address was noticed and used by seven SPRs, some of whom had also watched the optional videos. Only one consultant reported seeing the icon. This suggest improving the clarity of this option in any future revisions.

6.5.4 Instruction and encountered difficulty

The piloting phase highlighted the importance of instruction clarity for the MCQ questions with more than one correct answer. When reviewing the MCQ results (Table 7) it was clear the problem was solved; however shortening the instructions would improve on this further.

Unfortunately, trusts' internet security blocked any YouTube streaming while viewing on hospital premises. Therefore, I sent emails to candidates recommending they access the material off site, however some candidates still used a mixture of hospital computer and mobile phones. This is another area for future improvements.

The University website updates caused the module to crash twice, rendering the video clips invisible, but after notification this was corrected. Dedicated IT support, would be helpful for any future module developments.

During the design phase (Chapter Four), I deleted the audio additions from the downloaded videos. This was to reduce distraction and prevent revealing the answers. However, I could not edit this out for the streaming videos. Although the majority of those videos were assigned to the optional sections, the right hepatic artery clipping video was too important to be left out and it was used as feedback for Questions 7 and 8. A couple of candidates reported music distraction in that particular video.

> *"If you could change some of the audio so some of them, I don't know if you have the choice but they play a song which is quite distracting. Other than that, no."* (SPR 4, MCQ interview)

> *"The music was a little bit distracting, you could hear the music however you can always turn the noise down."* (SPR 5, MCQ interview)

In the above, I have focused on the module components and the functionalities. I will expand the discussion now to the wider module evaluation and candidates' recommendation.

6.5.5 Video as a type of simulation tool

Video clips were used to mentally train candidates to pick up hazard clues and avoid mistakes which would cause injury to patients. Although I did not specifically ask, respondents compared the module with a type of simulation.

> *"That's what you want, you want, to see a video that has commentary, essentially, it would simulate if you were doing that operation and your Consultant was telling you at the same time, and I think, yes, that's a good substitute for it."* (SPR 6, MCQ interview)

> *"We don't have an opportunity to see other people operate as much so this one helps to look through other people's difficulties and learn. So that's how it is useful. You learn by, I think for visual learners, this is a very good tool."* (Consultant 5, MCQ interview)

One consultant explained that he had an operation video bank from his old operation recordings and he would sometimes refer to that bank to get the message across to his trainee. It served as a demonstration tool in a calm place away from the heat of the operation.

"If I'm doing certain operations sometimes I find it useful to go back and just, because it's sometimes difficult while you're operating to try and make a point because it may not be the appropriate case to make that point, but you can come back and say 'ok, this is what I'm trying to show you'." (Consultant 7, MCQ interview)

Another consultant went further to compare this mental training with aviation pilot simulation training. He argued the importance of such training to prepare candidates to deal with those rare but dangerous hazards and injuries.

"You have the same comfort the airline pilot has in a simulator... This is a rapid take through a lot of things that could go wrong, problems that you could face, injuries you could face in laparoscopic cholecystectomy. It would take a lifetime to cover all these complications in your practice because they don't happen all the time. This is the same reason airline pilots train in simulators. They probably never have two engines fail on a four-engine aircraft but they have to be trained just in case, so you don't wait for it to happen." (Consultant 6, MCQ interview)

Of course simulation can be close to, but cannot completely replace reality. This deviation from reality was commented on by some senior trainees and consultants. They reported missing the haptic feedback through the laparoscopic instrument and the ability to handle and manipulate the anatomical structures.

"I found some of the videos a little bit difficult to follow, I think it's the same with any video when one's not actually there holding it, looking at

the structure, and knows exactly what's what can be more difficult than in a real life situation. In general, there were some good images." (SPR 11, MCQ interview)

"I personally found I got some of these questions wrong just because the image I was seeing on the video… and what I thought I was looking at was completely different. I think in real life you'd actually use your own eyes, and you'd be looking again and I think that'd be easier." (Consultant 8, MCQ interview)

"It made me think a couple of times about different things, so I probably got one or two wrong but it made me think carefully about them…and be sure before I answered them, but I actually enjoyed doing it and I thought it was nice." (Consultant 9, MCQ interview)

It is possible that senior trainees and consultants became used to one way of operating and operate on auto or semi-autopilot. They are used to picking up the anatomy and hazards clues as they progress through the operation and find it difficult to follow a different approach. System One had already been programmed in one way and it is hard to change, so System Two is required to think more deeply and to judge the situation. This might explain the need to replay the videos, and the thinking reported by those candidates. This System Two involvement is the main step in cognitive training and signs of such engagement are signs of a good cognitive training design.

The other possible explanation for this reported difficulty, might be the result of the rapid presentation of hazards. The module condensed many hazards in a limited time, which requires deep thinking.

However, the effort the seniors put in to progress through the material was enjoyed by the candidates and possibly contributed to the educational value reported by them.

> *"Initially I said this is quite a boring anatomy about the Gall Bladder, but it wasn't and I must praise you for this, it's very high level so it works for registrars of all levels, it is quite high level.''* (SPR12, MCQ interview)

> *"You can always replay the clip if it's fifteen seconds. Which I did a couple of timesbut that's more user friendly rather than having to go through several minutes of video waiting for the critical point for me"* (Consultant 2, MCQ interview)

6.5.6 Time commitment versus benefit received

Although the above discussion has already provided evidence to support the value of the Cognitive Hazard training online module, I was keen to investigate the benefit versus time demands. Trainees are under pressure timewise and the module could not be justified unless it produced benefits worthy of the time investment. This question was included in the interview schedule and the answers were very positive.

All candidates with the exception of two SPRs (13 and 16) were very happy with the relative time/benefit value.

> *"I thought it was much more informative than say sitting there and reading a book for half an hour, forty minutes. So yeah, I think the time investment is valid."* (SPR 3, MCQ interview)

> *"I think for the trainees it's a no-brainer. You're hopefully not going to see very many complications. So only through thinking about it and this type of thing... and reduce your level of complications."* (Consultant 1, MCQ interview)

> *"It only takes them an hour to go through that quantity of information…They have got a much deeper appreciation of what they're trying to avoid …to hopefully avoid those pitfalls."* (Consultant 2, MCQ interview)

> *"So, if that means it takes an hour you've learnt a lot,.. You can look at various videos and you have put them all together in one place which I think is a great thing."* (Consultant 8, MCQ interview)

6.5.7 The future expansion of online training

In this section I will discuss the suggestion to expand the material which was raised by 23 out of the 25 interviewed candidates.

When I asked the candidates about the material contents I asked two specific questions. The first question was: Do you want to delete any materials? and the answer was unanimously no. The second question was: Do you want to add any material? Twenty-three candidates recommended material expansion. Some suggested adding a section about normal steps in laparoscopic cholecystectomy. The feeling was to make the online module a comprehensive start to finish teaching tool, taking novice candidates from very simple operation steps to the tricky hazards and mistakes within the operation. Although I did appreciate the candidates' intention to expand the module scope I would argue that such expansion would serve a different purpose and be counterproductive to my aim (see below).

By creating this module I aimed to mentally train candidates to pick up hazard clues and formulate a recovery plans. Such training requires some basic knowledge about the operation steps and understanding of its principles. This Hazard training was aimed at SPR and would be too advanced for novice trainees requiring step-by-step instructions. Such novice trainees would struggle with the hazard training as was the case with the foundation doctors recruited in this research. A basic step-by-step module would not suit more experienced doctors (SPRs) and would stop them from taking the module before engaging with the Hazard training part. Therefore, I would argue that the two training levels should be kept separate.

Currently, in the UK, junior doctors commit to the surgical pathway by first joining the core surgical training. They start their exposure by assisting consultants and SPRs. They start acquiring basic skills and they build up their knowledge level by preparing for and passing the MRCS exam. I don't know if there is a need for a basic module at that level as such modules are already available in various platforms such as the WebSurg website. (118)

Other candidates suggested expanding the mental training resource to include other hazardous operations. The online resource included the generally encountered hazards in Laparoscopic cholecystectomy and the suggestion was to add extra specific examples. Those examples will be listed in the sub-sections below.

6.5.7.1 Online module's: suggested expansion

Currently the online module had four sections: indications, cystic artery, bile duct, and complications. Two candidates suggested expanding the bile duct section with cystic duct anatomical variations in a similar way to the cystic artery variation part. I am not aware of any available materials in this regard and this idea could be entertained if those materials could be identified in the future.

Some candidates suggested adding a section about hot gallbladder surgery. The term hot gallbladder is used to describe cholecystectomy at the early stage of an acute inflammation attack, or what is known medically as acute cholecystitis. The argument was that the tissue would be more swollen and the anatomy would be difficult to identify. I accept the fact that different dissection techniques might be needed and the operation would be more difficult, but inflammation would not change the anatomy, it would only make it harder to identify.

The experts from the piloting phase by suggesting adding a section about heavy bleeding and its management. Duodenal fistula, cholangiogram and gallbladder cancer were also suggested as possible expansion sections.

> *"It's a case of maybe a picture of what a Gall Bladder Cancer looks like."* (Consultant 8, MCQ interview)

All the above recommendations would be a valid addition and would require careful consideration in the light of available audio-visual materials in the future.

6.5.7.2 Mobile application

A couple of consultants argued for the need to repeat the online assessment at regular intervals to overcome memory fading. They stressed the value of repetition in consolidating the knowledge and achieving an improved awareness level and making it easier to access via a mobile device.

> *"If they're going to be in Upper G I Surgery and if they're going to be doing this then it's probably worth doing it more than once to make sure that the messages are in there. But I suspect, given that knowledge has a half-life, but if you recall something at intervals, well, it's probably*

ingrained, you probably know it and the half-life for that will then be very long in training." (Consultant 4, MCQ interview)

"It's probably something that should be repeated maybe every 50 gall bladders that you log through your logbook you do it again and see if you've improved. Just because it's about that repetitiveness to grasp it." (Consultant 1, MCQ interview)

Other consultants and SPRs suggested a shorter version (SPR 13) as a revision resource to be used as a refresher before starting an operation.

"What might be quite good is to have access to it …maybe on tablets, or phones or elsewhere then you could do it, maybe when you're in the coffee room beforehand (before the operation) just a quick refresher but I think it was useful." (SPR 5, MCQ interview)

6.5.7.3 Physical simulation to complement the design

One candidate took the simulation principle a step further by suggesting printing a three-dimensional physical model of anatomical variation to complement the online resource. This would be a physical printed elastic model to be used in laparoscopic simulation boxes.

"It might be worth thinking about simulating …an anatomical anomaly and 3D print it on polymer, and then clipping it… then using it on, so it's reinforcing the knowledge." (Consultant 5, MCQ interview)

However, I doubt such a physical simulation would add extra value to the mental training. The main problem behind most mistakes and injuries were misidentification of anatomical landmarks rather than the physical steps to deal with them. The module would lack reality even more as the printed structure would have a different character to human tissue and would not bleed.

I would argue, based on the evidence, that the best way to reduce injuries would be through cognitive mental training to overcome anatomy misidentification and missing hazard clues. Without dealing with such issues, mistakes will occur due to mental error justification. Initial misidentification would prevail and reduce the value of any extra steps to enhance safety, like the use of cholangiograms during surgery. This entails contrast dye injection in the cystic duct as an attempt to further clarify the anatomy in a difficult gallbladder operation. However as the candidates below argued such test would be difficult to interpret by a surgeon who rarely use it. In this case there such test interpretation might be affected by the mental error justification leading to false assurance rather than preventing an injury.

"If you look at the literature on Bile Duct injuries, it's quite common to find that patients who have suffered Bile Duct injury, about a third to half of them have had a Cholangiography, in which case the Cholangiography has been misinterpreted. So, it doesn't necessarily

prevent Bile Duct injury. So once the Duct's been misidentified that's the problem, and that belief will tend to persist regardless of the Cholangiography. Cholangiography tend to be difficult, and it'll tend to not show what it wanted to show, because it won't be going up because you've transacted the duct and you've put it down, so you'll only see part of it, and the Surgeon will go 'Why's it not going up' 'well let us carry on', so that's what happens in reality." (Consultant 4, MCQ interview)

6.5.7.4 Expansion of online module: other operations

When asked about the possibility of expanding the online hazard training approach to other operations all candidates agreed on such expansion. The suggestion included all laparoscopic operations including appendectomy and laparoscopic colorectal procedures. Even open procedures were suggested but candidates questioned the possibility of finding video recordings of this type of procedure in the absence of the laparoscopic camera involvement.

6.5.8 Potential change in practice

As a surgical trainee myself, I appreciate the difficulty of claiming a clinical effect for any educational intervention. However, I was happy to report candidates' comments about the increase in knowledge and awareness across all SPR levels.

"As I said I'm quite inexperienced so I don't really have an approach, as such. It is only after watching your videos that I've actually started to do them on my own. I think it gave me a good base to start from so yes, it

was very useful. So, the earlier you can get to see these videos, and learn these basic steps, the more useful it will be. For you change your practice after you've already established your technique it's going to be slightly difficult." (SPR 15, MCQ interview)

"I don't say it would change my approach to operate, but it makes, it firmly establishes the rationale behind it, more than it changes it cause we following the main steps, but you kind of know why you're doing that and what you might come across." (SPR 7, MCQ interview)

"Not that much, but yes if there were any doubt in my mind, they just refreshed my previous memories and previous understanding. It's just more visualization which is more helpful. Usually these were the things we are normally seeing through a Laparoscope, they are more relevant and they can make a difference, especially they can strike you when you are doing Lap Choly after seeing the video." (SPR 8, MCQ interview)

"These are mistakes that are very easy to happen unless you are careful…I think it's a wakeup call at least if you don't see so many injuries, I've never seen a major injury yet, so for me it is a wakeup call to look for things and it was quite insightful because you're looking at something you shouldn't be doing." (SPR 2, MCQ interview)

Surprisingly the reported module's educational value, targeted at SPRs, also seemed to have benefits at the consultant level. Consultants commented that they benefited.

> *"I learnt stuff"* (Consultant 3)

There was delay between the trainees' recorded operation and my interview with them. This delay permitted the candidates to share changes in their practice following the Cognitive Hazard Training. In fact, five of the sixteen interviewed SPRs explicitly mentioned a change in their operating approach following the online training and two more candidates hinted at such a change. This was a self-reported behavioural change.

> *"Probably watching over the complications last night, I had become a bit more hesitant today."* (SPR 4, MCQ interview)

> *"I think I will bear things in mind because some things you might not have taken so much more notice until things go wrong but I think use the scenario where you said 'actually, if we do that this potentially might have happened' so you won't try and do that actually in reality rather than actually, you know, maybe you'll dissect them too close over there and this might happen and this stopped you from doing it."* (SPR 6, MCQ interview)

> *"It's given me more awareness, I'm being more cautious about what I'm doing next time in the Lap Choly, immediately after I've seen the videos,*

> *not immediately but in a day or so, and it's felt much different really. In a way being more aware of what could go wrong."* (SPR 10, MCQ interview)

> *"So when I did the online assessment it helped me when I was in the operation, I was aware of certain mistakes, or if certain things went wrong on the online assessment. So I think the online assessment has corrected me indirectly to do things in a standard way, double window techniques etc."* (SPR 12, MCQ interview)

> *"Undoubtedly, undoubtedly. I am now much more conscious of making sure that the critical view of safety is there, right in front of me, before I do anything. I mean I was aware of the concept, I used to apply it but in a very ad hoc way in the past, nowadays I try and dissect everything out thinly, you know, I see the Calot Triangle right in front of me, I make sure there's two structures going through that view of safety, I take a photo of it as well, before I even apply any clips. So it has definitely changed my approach to Lap chole."* (SPR 14, MCQ interview)

In this sense, the Cognitive Hazard Training module did not only increase awareness, it possibly induced a behavioural change. Trainees reported implementing the learned principles and such implementation should ultimately lead to better clinical outcomes for their patients. Those trainees are still under supervision and their supervisor would act as a safety net. However, having enhanced awareness should help to accelerate training and reduce the chance of unintended injuries.

6.5.9 Building trainers' trust in their trainees

As was discussed in the first chapter, the current UK training system has lost the old apprentice style training and consultants these days need to continuously assess trainee competency level.

> *"One of the problems with the current training programme is I don't have a named trainee who is with me for a long period of time, I get somebody on my list and sometimes picking up from scratch takes time."*
> (Consultant 4, MCQ interview)

Such problems reduced trainers' ability to assign a safe and appropriate training opportunity in the absence of an established trust in trainees' knowledge and capability. Therefore, any steps to help in establishing such trust would result in better training opportunity allocation. Such enhanced training access would eventually accelerate training further.

I asked the consultants whether trainees' exposure to the online assessment would help establish or build more trust. Some consultants rejected the idea completely and referred to the early discussion about trainees' different training speeds.

"I would disregard the Module completely it would depend on the individual." (Consultant 4, MCQ interview)

Other consultants were happy to entertain the enhanced trust idea as they would be further assured that their trainees had the basic hazard awareness and they would share a common ground to discuss such topics if needed.

"Yes, I would prefer someone to have done it because it does open you up a little bit and make you think, and if they had done it, and I knew they had done it, then that would give me some common ground to talk about things and to understand what they knew a little bit more. So, I definitely think it's a positive thing." (Consultant 9, MCQ interview)

"I would feel happier knowing the SPR done this, I think discovering potential traps, in real time in an actual patient is very useful, but possibly dangerous. There might not be substitute for going hands on and doing the procedure but each time you go in you have already built up theoretical knowledge and virtual experience from this teaching package that strengthen things. You have to learn your own lessons but they would have been further improved by learning the lessons of others." (Consultant 6, MCQ interview)

If such trust were translated into more training opportunity allocation, the training curve would steepen. If we add that to the reported practical shift in trainees' approach, the online module would serve a double effect in enhancing training and reducing the time to reach competency.

6.6 Chapter summary

One of the aims of this research was to investigate and test the value of the new design by examining each of its components. In this chapter, I concentrated on the Cognitive Hazard Training Module. The overall feedback from the feasibility study was positive. Results supported the value of this online resource in enhancing knowledge and awareness. Interview data also suggested the module’s potential to change practice in trainees’ approach by being more cautious and adhering to the safety steps of dissection. I also explored the idea that such training might enhance the trust between trainers and trainees. If this occurred, it might translate into more future training opportunities being offered to the trainee. I also discussed the various difficulties with the material and listed the suggestions for further development in the future.

The next chapter will complete the assessment of the feasibility study by presenting the results of the second component: The Reflective Formative Assessment (Video-review). I will also discuss the design’s overall value when both components were used together.

Chapter Seven: Results of the reflective formative assessment (video review) and the assessment of the overall design

7.1 Introduction

In the previous chapter I presented the feasibility study of implementing the first component of the design: Cognitive Hazard Training. I established the practical benefits of using such a component and the possible future steps to enhance the design further.

In this chapter I will describe the feasibility study of the second component: Reflective Formative Assessment (Video-review). This will be followed by discussing the value of the design as a whole when both components were used together. This would hopefully fulfil the first aim of the design based research by testing the value of the design as a vehicle to generate further theoretical understanding in the field. In Chapter Eight I will present the theatre observation study, conducted during the recorded operation. This study was planned, in light of the design-based research aims, to capture the complicated surgical training environment and to further inform and enrich the research findings. Chapter Nine will revisit the aims and objectives, and discuss the results alongside the theoretical understanding and set the recommendation for future research.

7.2 Recruitment and candidates' distribution

As described in the methodology chapter, SPRs were invited to the second component of the design after they had finished the Cognitive Hazard Training Module. Once the SPRs completed the online module, I planned to approach them to check their next theatre list with laparoscopic cholecystectomy operations. In reality the majority of SPRs were very active in approaching me first to let me know the operation date and were enthusiastic about the study.

In the first recruitment phase, for the Cognitive Hazard Training Module, one SPR consented to take part in the online module only, declining any involvement in the video recording and review session. This wish was respected and no further arrangements was made after finishing the online module and no interview was conducted.

The plan was to record the operations of ten SPRs on a first come first served basis. I managed to plan all theatre recording sessions.

As I was keen to test the SMOTs system in Gateshead Trust, I recorded a test case which was not used for a review session due to the lack of any eligible SPR candidates within the study period. As a result the total number of recordings was eleven cases but the number of the video-review sessions was ten.

The ten recruited SPRs for video recording included three female candidates and seven males, while the supervising consultants were two females and eight males. Consultants' speciality interests were a mix of benign upper gastrointestinal, bariatric, colorectal and breast surgery.

Patients were approached after being identified as potential cases by the supervising consultants. The consultant or the SPR introduced the researcher to the patient and the patient received an explanation about the research along with an information sheet and consent form. They were told that participation was voluntary and that they could change their mind at any time by contacting the researcher or the research supervising professor to request the deletion of their operation video recording. None of the approached patients declined taking part in the research or withdrew participation. Three cases were found unsuitable for training, therefore the overall number of approached and consented patients was 14: ten for the review sessions, one for the SMOTs recording, and the three unrecorded cases.

7.3 Setting

The main aim of surgical training is to prepare the trainees to become consultants and be capable of operating independently. To achieve this aim, supervising consultants usually assess their trainees' competency and alter their supervision style accordingly. Supervisors scrub and hold the camera for some candidates, providing close instruction and guidance. They might also be present un-scrubbed in theatre to observe part of the operation or they might leave trainees to operate alone or come into the theatre later, if help was needed.

As I was keen to test the design in real life and to check the design's ability to address various training levels, I left the approach to the video–review open for supervisors to adapt to their own style. I did not specify how the review of the video recording should be conducted as long as the consultant was happy to review it with his/her trainee and completed a PBA form after the operation and another one after the video review session (described in Chapter Five). Although I did not target any supervision style, five consultants scrubbed with their trainees and five opted not to join the trainee, with various degrees of in-theatre presence.

Video review sessions were conducted in the consultant's office after processing the video recording using the steps mentioned in Chapter Four. The video review sessions were audio-recorded along with the consultant and SPR interviews after the review session. Those audio-recordings were professionally transcribed and thematically analysed, and the results will be reported in the coming sections of this chapter.

7.4 Procedure Based Assessment: results

The majority of the Procedure Based Assessments (PBA), both post operations and post video review sessions, were conducted on paper, provided by the researcher. However, three SPRs completed the assessment online ,as part of their training portfolio using the Intercollegiate Surgical Curriculum Program (ISCP) website (20). Two of these candidates later emailed a copy of the PBA. However the third of these three, did not provide a post operation PBA (case 5). Also a post operation PBA assessment was not feasible in case 8 due to the consultant's busy schedule on the review day and annual leave in the days following the procedure. The post video review PBA form was also missed for case 6. As a result, the number of paired assessments was reduced to seven.

	PBA global summary level of competency		Consultant scrubbed
	Post operation	Post video-review	
Case 1	3	4	Yes
Case 2	4	4	No
Case 3	3	3	Yes
Case 4	3	3	No
Case 5	-	3	Yes
Case 6	3	-	Yes
Case 7	2	3	Yes
Case 8	-	3	No
Case 9	4	4	No
Case 10	4	4	No

Table 8. PBA global summary post operation and post video-review session.

As described earlier (Chapter One), PBA has six general assessment domains and a global assessment part (Appendix 1). Each domain contains multiple elements which could be marked with 'N' for not assessed, 'D' for needing development and 'S' for satisfactory. There are also feedback spaces for consultants to give constructive feedback to their trainees. The global assessment has four competency levels, which range from 'novice' to a fully 'competent surgeon' (23).

Table 8 shows the changes in the PBA global summary in between the post operation and post the video-review session (case 1&7). There were also some changes in the marking of the items in the six domains, however I focussed on the global summary as it represents the consultant's assessment of their trainee's competency level. Such changes in the global summary reflects the consultant's degree of confidence in the trainee's competency and the rating on these two cases was increased. This enhanced confidence was also obvious in the comments and praise given during the video-review sessions, which were audio-recorded as explained earlier.

If we take into account the fact that three post operation PBA global assessments were already graded the maximum competency 4 (cases 2, 9, 10), only four out of the seven paired cases had potential for improvement after the video review session and two of these four did show such a result.

Interestingly, none of the seven paired PBA grades were reduced in the post-operative global summary. This might indicate a level of caution on the part of the consultant, preferring to underestimate rather than overestimate their trainees' competency. However, the sample size was very small and there needs to be a level of caution in interpreting these results.

The majority of the post-operative PBA paper forms were handed back to the researcher straight away, with missing or very minimal feedback in the comment section (8/9). This was in line with the Sheffield research group findings (27).

The consultants and trainees varied in the way they conducted the video review some went straight to watching the video while others asked their SPRs to comment on the procedure before the video review. Some watched the whole video while others skipped parts of the procedure. Such variability revealed an important finding which will be discussed in the coming results section.

7.5. Reflective Formative Assessment (Video-review): Results

The figure below illustrates the themes identified from the Reflective Formative Assessment (video-review) and shows their relationship to each other.

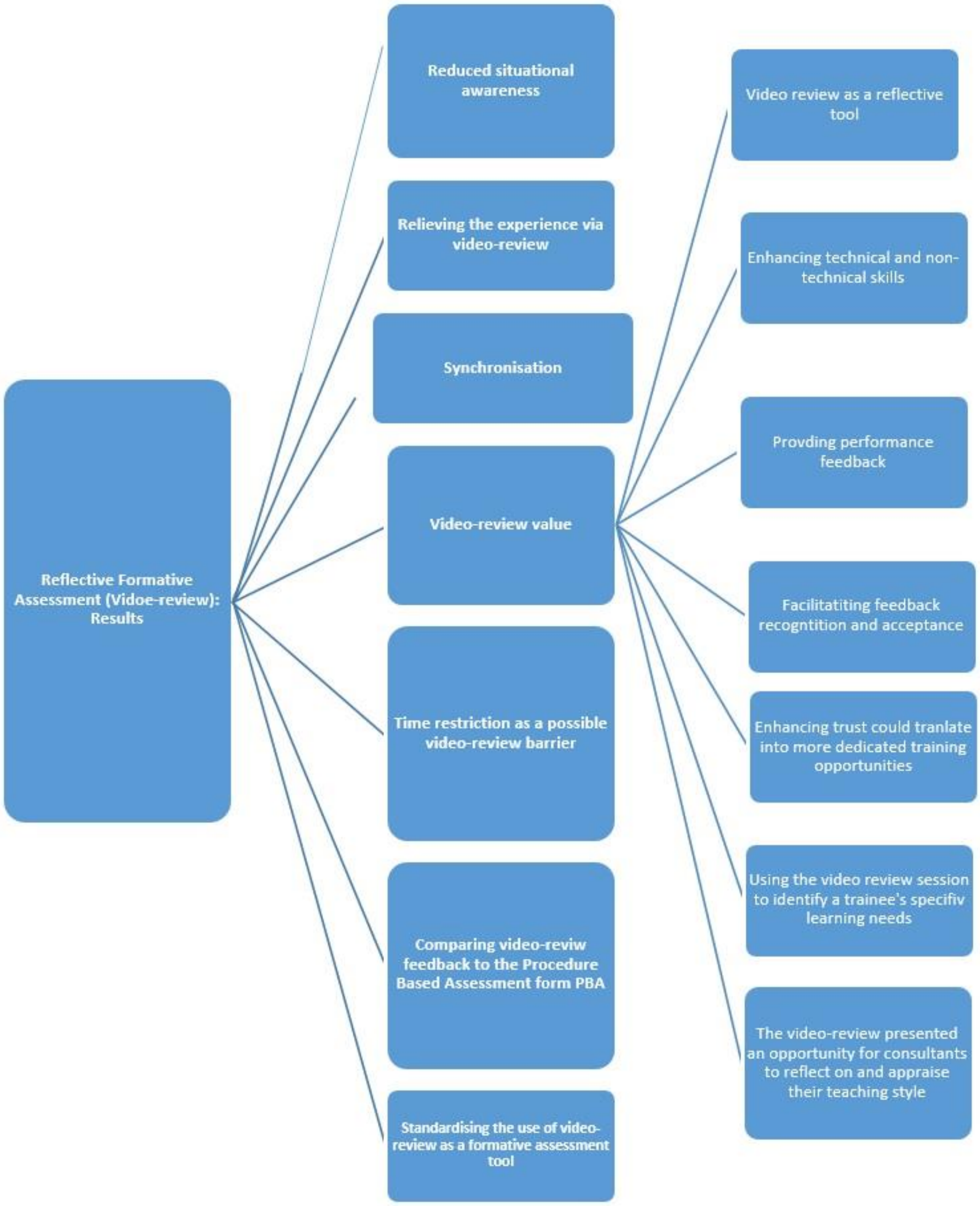


Figure 6: Reflective Formative Assessment (video review) themes.

7.5.1 Reduced situational awareness

Operation video recording usually took place by pressing a button on the laparoscopic stack. I also video recorded the external view, as well as the intra-abdominal view, I placed a normal video camera opposite the operating surgeon. This camera was clearly visible and although I tried to stay away from the camera most of the time and observe from the back of the operative room, I had occasionally moved to check the camera.

I noticed that SPRs were aware of my presence initially and noticed when I approached the camera, but once the operation started they were focused on the procedure and my presence, and the camera seemed to be forgotten. It seemed, due to mental overloading, surgeons become tunnel visioned on the task in hand and lose peripheral awareness.

> *"No, I think I forgot, after the initial, you're aware of someone filming you, you then just get into the operation, you forget."* (SPR, case 3video-review)

7.5.2 Reliving the experience via video-review

It was really interesting to see the consultants' and SPRs' reactions during the video-review session. The session started usually with a couple of comments as a warm up, then the consultant started to give feedback on the progress, the SPR movements and the decision making behind these movements. Up to this point things progressed as expected. It was at the critical steps in the procedure where complete silence took over. This was followed by more comments about the action.

To my surprise some trainee's shared their concern that they thought they had done some damage at that critical point. This was odd given that they were the operating surgeons/assistant and they knew the outcome. The patient was already discharged and the trainees had had a sufficient period of time to know for certain that there were no complications. Yet the video consumed them completely at the critical point. This silent period at the critical points was repeated in all review sessions and was commented on the interviews that followed.

> Consultant: *"couldn't keep my eyes off this one, because it's almost like you're..."*
>
> SPR: *"in Theatre, yeah."*
>
> Consultant: *"So yeah, once you're concentrating on…."* (Case 6 video-review session's audio recording)

These quotes also suggest the power of the video. That they were taken back to the action, and it seemed so real, that they forgot it was a recording. This may explain why trainees seemed to forgot that the operation was successful and the patient had already been discharged.

7.5.3 Synchronisation

In my design, I opted to process the recording as a synchronised split screen of the intra-abdominal view and the outside theatre view. The idea was to show the surgeon's hand movement and the corresponding action intra-abdominally. This synchronised view also captured the surgeon's interaction with the assistant and the verbal and non-verbal communication in theatre.

Most candidates saw some added value in the synchronised view. Some were very impressed by its potential to capture technical skills and movement ergonomics.

> *" It's useful to see both what you're doing on the inside and what you're doing on the outside in terms of hand movements, and ergonomics"*
> (SPR, case 1 video-review interview)

Others commented on the technical and non-technical aspects of the feedback provided by such synchronisation.

> *"Actually, it was very useful to be able to see my movements with my hands, you know, I wasn't fumbling around, my communication with the Anaesthetist, with the Scrub Staff. So, actually I thought it was useful, but yes, you end up watching the operation, but it's nice to have that."* (SPR, case 6 video-review interview)

> *"I like the fact that you can see the Trainee and the Trainer standing and how they interact, human factors and all that sort of stuff, body language. Interaction with other staff that you don't necessarily hear, for example, if it was just audio, or if you were just looking at the Laparoscopic image you wouldn't see any of that."* (Consultant, case 7 video-review interview)

Some even argued that the synchronised video was the only difference in this research, as the non-synchronised intra-abdominal view was the standard recording option which is easily obtained by the press of a button in laparoscopic surgical instrument if needed.

> *"The outside was more important, what's going on across the room, how are you reacting and how are you doing outside. This is very important that way otherwise you can record your own video"* (SPR, case 7 video-review interview)

A few candidates reported that they had not concentrated much on the outside view as they felt they had concentrated more on the inside view. Two possible explanations could explain this. One is mental overloading, in the sense that it was only feasible as a human to focus on one aspect per time. The other explanation was that the main action capturing attention was in the intra-abdominal view most of the time as it was showing the real operation hazards while the outside view was showing hand movement and team interactions.

"Yeah, it's good. You'd only ever looked at one screen at any one time, but the split screen was good, because it was other things, with regards to some of the communication skills within theatre as well." (Consultant, case 2 video-review interview)

"That was brilliant. It clearly helps us look at your perception, and your emotion and whatever is happening, your hand movements, your eye movements, how you're using the team, everything along with what's happening inside the abdomen, it's brilliant. That was great." (SPR, case 2 video-review interview)

In the quote below, the consultant comments of where most of the learning is, but does in fact acknowledge the benefit of the external view.

"I mean the key learning point is obviously the internal Laparoscopic view, the external view adds something but perhaps ten to twenty per cent over the internal view which is eighty, ninety per cent of what you're going to learn." (Consultant, case 4 video-review interview)

"I think it's useful, potentially useful to see generally speaking how your body language is when you're operating" (SPR, case 4 video-review interview)

In these quotes the SPRs seemed to have a higher appreciation to the non-technical skills of communication, body language and team interaction than their supervisors. This may reflect the sample size or indicated trainees have more interest in learning nontechnical skills, given the increased attention given to those skills in the new surgical curriculums.

One consultant suggested that the outside screen might be better served as a small window within the screen.

> *"I didn't look much at that one sorry, just the outside is not very interesting. So, you are drawn to what's more interesting. I saw some videos of people recording both the inside and the outside and normally they use a much smaller screen, much smaller window for the outside."* (Consultant, case 3 video-review interview)

> *"I think, for me I was looking mostly at the operation, but you notice that the consultant notices my odd angles and things, but that's useful as well."* (SPR, case 3 video-review interview)

The suggestion to treat the outside view almost like a side or back mirror in a car was interesting and will be discussed further later (7.5.4.2)

Finally, one consultant felt the external screen was not helpful once the laparoscopic access was established, but this view was not shared by any other candidate.

"I don't know, once your ports are in, if you necessarily need to have the other picture, to be honest. But I didn't find it particularly distracting, I don't know whether you looked at that, I didn't really look at that." (Consultant, case 8 video-review interview)

7.5.4 Video-review value

There was unanimous agreement about the value of the video-review in enhancing feedback and learning from the training opportunity. This quote below highlights the power of video for feedback, even for consultants.

"So that was useful for me, and seeing yourself on the video, as you well know, is very, very powerful. It's one of the most powerful things you can do in terms of feedback, how you behave, how you interact, how you sound, how you look and all that, it's very, very powerful." (Consultant, case 7 video-review interview)

7.5.4.1 Video review as a reflective tool

As mentioned above (Section 2.5), Schon (66) recognized two aspects of reflection: reflection-in-practice and reflection-on-practice. Reflection-in-practice represents the thinking process within the experience, or the operation in the surgical case. It represents the mechanism to make step-by-step decisions while operating. Reflection-on-practice, on the other hand, is the step taken post-procedure, after the initial stress and emotion settles down, to rethink the performed action and plan steps for future improvement.

Video-review provided the opportunity to conduct reflection-on-practice and generate an improvement agenda. In fact, it could be argued that there was so much detail to review, so much reality created by the video, that it almost combined both types of reflection in one. However, it certainly does have the reflection-on-action value of being carried out stress free without the burden of performing the procedure.

> *"The feedback you get on the day, during the operation, is different to the feedback you can have outside as a reflective exercise when it's no longer about operating, it's about actually looking, appraising this, from within it. This was a relatively straightforward case but it was still useful to even pick up minor changes and minor feedback of the positives and the negatives to look at. I think it's very useful to look at, yourself operating, and had feedback from the supervisor."* (SPR, case 1 video-review interview).

The following quote illustrates that at times trainees are not capable of splitting their attention and hearing, responding and doing all at the same time. I have emboldened text in the quote below to illustrate this.

> *"I think the video feedback, that's probably been the most helpful thing out of all, I would say. In order to give feedback, because if you're getting **feedback during the operation** you're **often not listening** to it because you're too busy concentrating on what you're doing to take it on board and act on it. Whereas now, I feel a bit better saying 'you were*

safe with the Hook, you can do this with the hook', 'that's fine', so I think it's worth it." (SPR, case 3 video-review interview)

A stress-free environment to provide feedback, was also appreciated by the supervising consultants. Supervisors have multiple roles in theatre. They have to train the SPR and provide feedback while ensuring patient safety and interacting with various team members in theatre: scrub nurses, circulating nurses and the anaesthetists. Giving feedback during the video-review session removed all other concerns and focussed attention only on feedback to the trainee. Having the opportunity to just give feedback, without other pressures, was felt amongst consultants whether they were scrubbed or not.

> "*I think I gave the SPR some feedback about this procedure at the time when we did the procedure, but having the recording really helps you to look at things again without also being consumed by doing the operation so as in sitting back and looking at what has been done I think it's a very useful for feedback."* (Consultant scrubbed, case 3 video-review interview)

> *"It's very good. So, you have the time to watch again, and you can comment at the same time, without the actual pressure in theatre of having a live patient in front of you."* (Consultant not scrubbed, case 2 video-review interview)

"I think it was good. I mean, I think you probably do see more than you do when you're doing a procedure. I think you're more aware because you're not concentrating on anything else, you're just focusing on the video." (Consultant not scrubbed, case 8 video-review interview)

7.5.4.2 Enhancing technical and non-technical skills

Video-review had a positive input to enhance technical and non-technical skills such as communication as has been discussed in the above sections, especially in the synchronisation section (7.5.3).

"I think it's useful to watch yourself, I've never seen myself operate, actually physically, how I stand and the rest of it with the split screen, and how you interact with others, and the things that you say to the anaesthetist to try and make the ports go in easier by changing the bed position. The sort of stuff you don't really know you're doing but is useful to positively reinforce... You watch yourself as an outsider... I think from the inside out we don't really see how we come across, and if you're rude, or aggressive, in theatre if you're getting stressed, then how they speak to other members of staff sometimes, and communicate may not be ideal." (SPR, case 10 video-review interview)

Referring back to my earlier argument (Section 2.5), I stressed the importance of non-technical skills in surgical safety, also highlighted by Spencer (24). He attributed three quarters of operation skills to decision making and one quarter to surgical dexterity, while Gawande *et al.*'s study (1) linked 43% of surgical errors to communication breakdown. I was really interested in the value of the video review to improve non-technical skills, as SPRs had clearly mentioned their plan to change their practice. This would have an important role in enhancing safety in surgical operations. The quotes below illustrate these points. I have emboldened some text below to highlight the importance of the video review beyond technical skills.

> *"I can definitely see the potential for it as a learning tool, I think it's quite good to look back and reflect on your skills, and I think even the* ***non-technical aspects like communicating*** *with the nurses, managing instruments around the table, some of those behaviours and things I think could be quite useful for doing that."* (SPR, case 9 video-review interview)

> *"I think it would make a big difference, I mean, I can already feel the difference I will be making in my next Lap Choly with having had a chat with the consultant this morning, and had a look at how I was performing. There will be a difference already so I think, not skills wise, it's a* ***whole other holistic thing****. So I think there will be a considerable difference and it will be very useful."* (SPR, case 2 video-review interview)

The main reason I was able to capture the non-technical skills, was that I was able to film the theatre environment, and display it on a synchronised split screen, alongside the internal abdominal view. Without a synchronised outside view, it would not have been possible to show the interaction with the team.

Returning back to the earlier suggestion (Section 7.5.3) of treating the outside view as a back or side mirror in the car and presenting it in a small screen, I would now argue against such a proposal, due to the importance of the non-technical skills in surgical safety. I think the outside screen should be equal to the inside screen to reflect the importance of non-technical human factors in surgical safety and I would also argue that such outside recordings should become a standard addition to the intra-abdominal recording in all laparoscopic stacks in a similar way to the SMOTs system.

7.5.4.3 Providing performance feedback

Video-review also provides trainees with objective feedback on their performance which is hard to dismiss. It projects an objective copy of reality and helps to generate a self-improvement agenda which is more likely to be implemented, rather than colleague feedback which could be ignored and serves both technical and non-technical skills. Some SPRs had previously received feedback about certain skills but they did not feel the need to take any corrective actions until reviewing their videos (bold, again my emphasis).

> *"When you're operating you're not thinking about all the other things that are happening. There is loads of things I picked up from the video review that I would like to change, simple things, like talking to your*

assistant more, keep engaging the team which is around you and not just operating which I thought was very important. ***Bosses have told me*** *to get more involved with the assistant and* ***I was feeling comfortable*** *that I was doing as much as I needed****, but looking at it as a third person****, seeing me do it, I felt I was very quiet which is not the way that I want to be operating, not that I want to be talkative, but I like to keep the team engaged and get their opinions, and work a bit more like that."* (SPR, case 2 video-review interview)

"It was really, really an eye opener, to sum it up. It's an eye opener because you can pick up on a small, minute omissions, things you can do better, for example, small, purposeless movements, you think that you could have done it a different way. So definitely, definitely next time when I do gallbladder surgery I would have done it in a slightly different way. ***I will remember this video all the time****, remember I should have done it this way now. So,* ***this video is really good because you can pick up on your qualities or bad habits****."* (SPR, case 8 video-review interview)

Some SPRs even asked me for a copy of the video recording so they could review their performance again and further critically appraise it. Such request was declined due to the ethical/ legal research requirement. Consultants also recognised the benefit of video-review for trainees with some difficulty.

"I think with more junior trainees, or people you've just met it would be a more useful learning experience, particularly for people who've got issues, and problem trainees, I think it might be more useful on people who are actually reasonably good at the operation, and good at following what you tell them to do, and good for pointing out to people who have come with bad habits to show them as a learning outside the operating Theatre." (Consultant, case 6 video-review interview)

7.5.4.4 Facilitating feedback recognition and acceptance

Verbal feedback is a tool to achieve skills improvement and corrective action. However, for such a tool to work, feedback must be understood and accepted by the trainee. In this section I am discussing the importance of understanding the reasons behind the giving feedback, in order to come up with the necessary corrective action, I am not discussing the difficulty in feedback retention due to mental overload while performing the procedure, or denial.

During the operation in case 4, the consultant was not scrubbed but he visited theatre three or four times and provided feedback in the form of improvement tips. Before starting the video-review session the consultant asked the SPR to recall the tips he gave him. The SPR clearly mentioned the majority of the tips provided by the consultant during the theatre visits. At that point, I thought the video review session became irrelevant and would be of no real value to the SPR. He did not only remember the tips, he clearly stated them.

The video-review started and the SPR was focussed on the video. He started to put those comments into context and critically analyse his action with clear improvement plans for the future. It was as if he memorised the tips and the feedback without managing to link them to a future action plan. It was only after the video-review that he could link those tips to real actions.

> SPR: *"It's actually very interesting looking back at it, it's unbelievable"*.
>
> Consultant: *"In what way?"*
>
> SPR: *"The insight it gives you into things, it's like you're looking at things in a different way, completely different, it's like it's not the same…I think really the most striking point from this exercise is it makes me want to record all my operations. It is very, very revealing in a way that makes you think, sometimes I **adjust my position** just to think that I'll get better tension but actually even **after adjusting** I still haven't got good tension and I dissect. It's probably **better** than before **but** I can see from the picture that it **could have been better** and you don't realise that when you're operating. It's actually unbelievable, I never thought that actually you would have that…I'm quite impressed actually, it's a powerful tool to look at with. I'm just wondering actually, from practical point of view, is it possible to record our operations?"* (Case 4 video-review session's audio recording)

I was interested to get a better insight into this effect. What was it in the video-review that linked the tips to the action? What was the difference between verbal and audio-visual feedback that made such a difference? It must be something beyond the effect of mental overload as the SPR clearly remembered the tips and instructions but failed to link them into the action?

Unfortunately, the only answer I could elicit was it is feedback in a different way, it is a visual way of getting the feedback. This effect deserves further investigation, but it clearly plays a role in the value of audio-visual feedback.

> SPR: *"It's massive, I think it's a very powerful tool to look at a video recording of your own operating, cause it gives you that insight to look at things in the light of day, and reassess, what you've thought when you're relaxed, and unstressed, and see. It's certainly a very powerful tool. As I said before that I'm very tempted now to record all my operations."*
>
> Researcher: *"When the consultant asked you about the points that you got before starting the video review session, it sounded like you had captured a lot of things. So, when you reviewed the video did you capture any more or was it just refinement, or putting things into context? "*
>
> SPR: *"It certainly re-emphasizes things in a different way, in a more visual way and also you always pick up these fine-tuning things that you could have done better. So yeah, there is certainly more that I have picked up after the video than before."* (SPR, case 4 video-review interview)

So, to summarise the benefits of the video-review: it represented an objective, visual and practical way to reflect on practice that helped make the needed links to understand the feedback and generate a self-improvement agenda, which has a higher chance of being translated into action. This was very evident in the SPR comments both for technical aspects of the operation like improving tension and the non-technical aspects such as communication. This should enhance training by making the best use of the available training time while improving operation safety. It would also provide a way to condense training, thus overcoming the reduction in the training time while increasing learning opportunities.

> *"So, with the EWTD restricting the number of hours, [there's] not enough hours to do Lap Choly, that'll be a very useful way of coming up with the competence. We can target certain operations, index procedures. It would be useful."* (Consultant, case 10 video-review interview)

> *"I think it is useful because Trainees' exposure to certain operations is probably limited, and actually, whereas in the past people may have been over trained in terms of numbers, number are now limited, and Training time is limited. ..So I think this is quite useful for looking back at cases and emphasizing the positives."* (Consultant, case 6 video-review interview)

One candidate summarised the reflective value of their own video-review quite well.

> *"The efficiency and competency, is better achieved by watching yourself, and I think the best thing is to reflect on yourself by watching yourself, and you know exactly what happens. I think it should be done in*

every major operation at least once or twice." (SPR, case 8 video-review interview)

7.5.4.5 Enhancing trust could translate into more dedicated training opportunities

Comparing the global assessment section in the paired PBA forms showed an improvement in the SPR skills rating in two of the cases after the video review session (Section 7.4). This change in rating might represent an improvement in the consultant's trust in their trainees, when they are able to observe them without other distractors. Enhanced trust might be translated into providing trainees with more dedicated training opportunities which would in turn enhance and accelerate training.

To understand more about the consultant's change in PBA rating, and any possible links this may have to an increase in trust and any resulting enhanced training opportunities, I needed to identify the factors contributing to consultants' judgement of their SPRs' skills and the factors affecting their ability to trust those trainees.

A consultants' main responsibility is patient safety. They are keen to train the SPRs but they need to establish the safe limits to dedicate training opportunities. As a result, skills rating is a global assessment involving trainees' skills as well as their awareness of their limits of safe practice.

> *"I think it's almost like a holistic type of judgement, as in first of all you need your Registrar to be able to listen to you, and to understand what*

you say, and then attempt to do it. Second thing they need to be able to translate the words which you say to them into an action, and then at one stage they will need to, instead of myself giving them the words before they do the action I need to see what their judgement is without me saying anything, and the last thing possibly is to see how safe they are in terms of when there is a problem, when do they seek help? So, I think I assess trainees overall, in my head, depending on these things." (Consultant, case 3 video-review interview)

However, assessing knowledge, skills, and the safe limits of a trainee's practice is not an easy task and it requires a certain amount of judgement.

"Most of the time by the time you talk to somebody, and watched them operate, things like that, you start of get an idea of how this person will operate. If you start operating with someone who just wanted to go ahead irrespective of the complexity you start to worry because as we start operating with people who assess things carefully and say 'I will need you to be around when I'm doing this', or 'I might need your help', immediately you're thinking of somebody who will be careful, who is safe? Who knows when to call for help" (Consultant, case 9 video-review interview)

This judgement is also affected by other external factors when it comes to filling in the assessment level on the PBA forms.

"I don't think there's any way that you can't let prior experience bleed into the nature of the assessment you make. And there's lots of other things as well, because I know from having gone through the ISCP what they want to demonstrate, more than anything is progress. So, if you're going to mark somebody down at a lower level than they were previously, that's potentially going to cause problems for them, or they may be telling you that they have to achieve a competency four for an appendix. So it's difficult to divorce yourself from that information, that knowledge." (Consultant, case 5 video-review interview)

To complicate the matter further, surgeons operate in different ways and it is difficult for trainees to remember each consultant preference in the current training environment after the loss of the old apprentice training style.

"There are things that we do slightly differently because we all have our own way of doing things and I always feel a bit sorry for trainees when they're working with… seven different Consultants, or eight different consultants." (Consultant, case 1 video-review interview)

As trainees don't have enough time to familiarise themselves with the consultant operating style, they might do things in a different way. As humans, we tend to prefer the familiar approach. In high stakes situations this might result in less dedicated training opportunities, as trainers might take over quicker.

"Everyone's got a different level of when they feel that they need to take over, or reassert control… People might be more inclined to take over

because that then puts you in definitive control." (Consultant, case 5 video-review interview)

"We don't spend as much time with a single registrar, that kind of apprentice trainer type, cause I can remember very clearly what it was like to operate with each consultant and I instinctively knew when they were about to take over, there's all that kind of non-verbal stuff as well, but I guess when you're operating with many more people over many more sites, the opportunity for that nuance to build up is not available." (Consultant, case 5 video-review interview)

As video-review is carried out in a stress-free environment it has the potential to allow the trainers to view the minor details that might be missed during live operations.

"Without having video it is live operating, you just have that one ability, and you probably do miss things, nothing major." (Consultant, case 2 video-review interview)

They might notice the small hints about trainees' ability, even if a different approach was used. This might encourage trust.

"Particular [with this] video … the dissection was slightly different from the way I do things, I don't use as much energy source…,but was it safe? Yes." (Consultant, case 2 video-review interview)

Consultant: *"I was going to say with a few small steps you exposed Calot's really nicely. So, if you look at the other side here this is what you didn't divide, you divided higher up."*

SPR: *"So that would have made that bit easier?"*

Consultant: *"That's right, yes, but it's ok. It's great stuff."*

SPR: *"It's so painful to watch."*

Consultant: *"I'm thinking this is what I would have done, do you know what I mean? I'm thinking that's pleasant, very pleasant watching."* (Case 3 video-review session's audio-recording)

It was evident, in the review session that supervisors were already thinking about dedicating more future training opportunity to their trainees.

"Interesting, based on what I've seen now, he's a good trainee he now has to do this operation… what we need to do with this particular Trainee is just do more difficult ones, more acute one where there's more decision making." (Consultant, case 2 video-review interview)

7.5.4.6 Using the video review session to identify a trainee's specific learning needs

In the previous section I presented the evidence to support the idea that the video-review enhanced the consultants' trust in their SPR abilities, which could translate into extra dedicated training opportunities. However, it seemed consultants were using the videos to address and plan the future training needs of their trainees,

> *"With the video you can actually go back and take a look at the finer points of it, as well. Just to emphasize a particular training need or something that wasn't technically just right."* (Consultant, case 2 video-review interview)

> Consultant: *"Anything you'd do differently?"*
>
> SPR: *"So a bit more, it would have been a nice case to practice the Heel."*
>
> Consultant: *"Perfect place to practice that and to get your confidence up."* (Case 1 video-review session's audio-recording)

Video-review was also suggested as a way of increasing a trainee's confidence when they started to operate independently. It was also suggested that the video permitted the consultant access to check the missed steps or omissions when a trainee operated solo.

> Consultant: *"Sometimes what happens is…Trainees are with you, and they get up to speed, and then you start getting them to go solo and the nurses are reporting back that they are doing really well. But you just go in one day to do an assessment ...and the trainee is sometimes not as good as they were even when you left them and it is because you were there."*

Researcher: *"Another Consultant decided to video record the Trainee solo and then review the recording. So, would that be something that you would be interested in?"*

Consultant: *"I would be interested to do that and I think you could probably learn quite a lot, as to what were the things that tend to slip, so the things that weren't quite embedded yet."* (Consultant, case 1 video-review interview)

Such emphasis on the individual specific training needs might be even more important than numerous training opportunities. It represents a golden opportunity to specify and address weakness. This in turn represents the best way to accelerate training and reduce the time needed to reach competency.

7.5.4.7 The video-review presented an opportunity for consultants to reflect on and appraise their teaching style

The video-review sessions also presented an opportunity for the consultants to reflect on their teaching style. They could see and hear the instructions they had provided to trainees and reflect on it. Two consultants commented on their teaching styles and the things they picked up and wished to improve in future.

"I think possibly I need to give people a bit more structure in terms of what I ask them to do, rather than assume that they knew what they are doing." (Consultant, case 3 video-review interview)

> *"I think maybe I need to be more explicit, or reflect on how explicit I am in my verbal instruction"* (Consultant, case 5 video-review interview)

Candidates also thought that video-review sessions were a good way for educational supervisors to provide evidence about their teaching quality. Such evidence might be required in the future for educational supervisors' teaching/educational appraisals.

> *"I think it's got a lot of opportunities for both reflection and evaluation really, and I think increasingly, if we're going to be Educational Supervisors or Trainers we're going to have to probably provide more and more evidence."* (Consultant, case 1 video-review interview)

In summary, the Reflective Formative Assessment (Video-review) part of the design demonstrated good potential in enhancing training and steepening the learning curve by intervening in the learning process at multiple levels. It worked as a practical tool to facilitate trainees' reflection on the preformed operation. Such reflection was evidenced both in terms of technical and non-technical skills. It provided the objective reality check to overcome memory fading and denial. It also replayed the feedback and action in a stress-free environment away from the mental overload of performing the procedure. It enabled trainees to comprehend the feedback and link it to future corrective actions. It also gave the consultants a better way to check their trainees' competency and identify their learning needs and providing the opportunity to build up rust and tailor future training opportunity to individual trainees' needs. Finally, it gave the consultant a tool to evaluate their own teaching style and provide evidence to support future teaching appraisals.

Such multi-level enhancement should support trainees' to achieve the required competencies in a reduced time frame and improve trainers teaching skills.

7.5.5 Time restriction as a possible video-review barrier

The above discussion, (Section 7.5.4) supported the value of the video review in enhancing surgical training in both technical and non-technical skills, providing a self-improvement agenda, building up trust and addressing individual training needs as well as serving as a teaching evaluation tool. However, such review is time consuming as it would require the consultant to find a time in his/her schedule and review the recording with the trainee. As a result, it was not surprising to find that time was the candidates' main concern when considering the future application of my design.

> *"My only concern with it is it's time consuming. So I think if you could cherry pick things. Record all operations, but then just think 'well, there was a section in that one that I felt wasn't something I'd come across before so let's go back and review that"* (Consultant, case 1 video-review interview)

Despite the consultants' tight schedule, they were overwhelming supportive of future video-reviews as long as they were carried out within a reasonable range of one to two reviews per rotation.

"Time inevitably, for the video playback, but it's something you could do maybe two or three times on a six-month attachment for this particular one key operation." (Consultant, case 4 video-review interview)

"I think once or twice, per rotation's quite reasonable to be honest." (Consultant, case 6 video-review interview)

They argued that it was a powerful feedback tool and should be used selectively to target certain skills and check progress in the rotation.

"I think the biggest issue that you will get is that time has to be dedicated, because when you consider you're doing a whole range of operations it may well be that you have to combine both your traditional assessment, and maybe …one video at the beginning… particularly if someone is not as experienced …say these are the areas to improve and …in the middle you do another …maybe ..another one towards the end." (Consultant, case 9 video-review interview)

This selective use was also supported by the SPRs.

"Very useful, and certainly if it was something that you were good at before you started on the job, certainly do it at the start of the job because then you can iron out some problems, but if it was something you've learnt on the job you could even do it at the end of the job, to

check your competency almost. So, I think that would be useful." (SPR, case 6 video-review interview)

Some consultants rightly said that the time for video-review should be recognised in the educational supervisor job plan and reserved as protected teaching time to conduct such activities.

"It's very time expensive, it's effectively going to absorb half a session. So, it does have to come in my admin on SPA time but I think as long as that's recognized in job planning, and we see it as a quality tool, and I think it is useful to reflect on your own teaching, Training." (Consultant, case 5 video-review interview)

Reflective Formative Assessment (video-review) was created, as the name indicates, to be used as a formative assessment tool. PBA is currently the gold standard for operation assessment and it is one of the WBA used by the Intercollegiate Surgical Curriculum Program (ISCP). ISCP recommend trainees to do forty WBA per year. Selective and limited assessment would be recommended in the new design.

7.5.6 Comparing video-review feedback to the Procedure Based Assessment form PBA

The above discussion established the value of the video review session and its practical, however, as the video review session is meant to work as a reflective formative assessment, it should be compared to the current standard formative assessment: PBA.

Candidates unanimously appreciated the superior feedback value of the video-review session over the PBA. They argued that delayed recall reduced the value of feedback unless the PBA was done directly after the procedure.

> *"I think having the recording is very useful to be able to give proper feedback because unless you do the PBA immediately after the procedure it will be difficult to remember it."* (Consultant, case 3 video-review interview)

> *"I think video recording's a completely different way of doing it with the PBA. With the PBA, you need a very strong Surgical Lead to get the feedback but then you have to remember the bits that you've done, so it's kind of very retrospective as opposed to pointing at the bits you're doing correctly and wrongly."* (SPR, case 1 video-review interview)

Such immediate feedback using the PBA is challenging in the rushed clinical practice. This resulted in the erosion of trust in the PBA feedback value as a learning tool. Some candidates argued that the only remaining role for this form is tick box paperwork for the ARCP.

> *"PBA is meant to be a learning tool but I think it's often used more for proof of competence by deaneries now rather as using them as a*

learning tool for the Trainee. I think we would be perfectly happy doing an operation, talking about it, watching a video, and talking about it without having to do the paperwork. I don't think the paperwork adds to competence, to my learning…but I think reflection amongst ourselves in discussion is how I learn so. It is the paperwork for the ARCP" (SPR, case 10 video-review interview)

The discussion evoked even less favourable reactions towards the PBA. It is clearly stripped of any meaning in the eyes of some candidates. Such lack of any value or consideration regarding the PBA tool was reflected in the tick box comments.

> *"Oh, yeah PBA is rubbish. Well it is. It's just a sheet of paper with tick boxes and it really doesn't help. As far as I'm concerned, the whole learning is involved in the feedback, the actual feedback that you give to the Trainee, the conversation you have about that ok, that's where it all is. The actual PBA, we all know that people sit down and tick the boxes, 'is that alright? Yeah', there you go, tick the boxes it doesn't mean anything. I very much believe in the human factors approach in the feedback approach. That's where the benefit is, and this is quite like that obviously, you know, because you're watching a procedure together and stuff. The PBA doesn't mean anything."* (Consultant, case 7 video-review interview)

This view was not an isolated comment, and it does explain the limited feedback provided, despite direct observation in the Sheffield research group study (27). Unfortunately, the recommendation of that study was to do more PBA's.

> Researcher: *"Would you do this video review or keep the current PBA?"*
>
> SPR: *"I think a bit of both, because the numbers will make you better."*
> (SPR, case 2 video-review interview)

Candidates clearly favoured the video-review feedback over the PBA as a formative assessment tool to enhance learning. However, they argued that the only reason to continue using the current PBA form was to provide the assessment numbers required by the ISCP. This finding highlights the need to re-examine the purpose of the assessment requirement in the ISCP which in turn dictates the assessment modality for future training. Does the curriculum value numbers over detailed targeted feedback? If that is the case then PBA does have the number advantage over video-review feedback. But if the formative assessment should be used for its main purpose, with frequent performance feedback then video-review would clearly out-perform PBA, as described in the above discussion.

7.5.7 Standardising the use of video-review as a formative assessment tool

The consultants who took part in my research showed great enthusiasm for training despite their busy schedule. They were actively engaged in their SPR training and they even spared time to volunteer for educational research activities.

I was amazed by one supervisor's extreme dedication. When I started this project, I was keen to provide a practical example of the possible technology advancement in audio-visual recording, in terms of synchronisation. I developed the synchronised split screen method as a way to display the possible output in new recording systems such as the SMOTs. The purpose was to show the possible advantages of using an audio-visual method in their reflection and feedback. Video synchronization and technology support was not intended to be performed by consultants. I was thinking that trusts should employ someone to look after the technological side of the process as was the case in the Gateshead Trust appointed Simulation and Education Technical Officer.

However, one consultant in my research thought that applying this type of video review meant that he would be in charge of the recording and the time consuming synchronisation process, yet he suggested that he would be able to provide such a task for about 20 percent of his operations. Such dedication deserves extreme admiration and I could not leave the topic without showing my gratitude for such kindness.

"I think the structure is a very good structure…. [however] You will need to have double the time for any operating list. The second thing is ...to do the assessment you need extra equipment which we either don't have or it will be sometimes difficult to make sure it's connected properly, you need a camera on the outside which is not available, as far as I know, and second thing you will need to make sure that you are doing the recording then you will need to synchronize both. So in terms of the operating which I do, possibly I will be able to provide this type of feedback for about twenty to thirty per cent of the operating which I do. I will not be able to do that for a hundred per cent of the patients." (Consultant, case 3 video-review interview)

However, I do accept that due to the voluntary nature of my recruitment, my research would have selected the training and teaching enthusiasts and they might not fully represent the whole consultants' population. This is not meant to be a criticism but people vary in their interest and some consultants will be pro-teaching more than others. As a result, some candidates advised that this assessment would need to be mandatory to guarantee equal application and benefits for all trainees.

"I'm not sure how it is, in a structured world where if this becomes compulsory then it'll be very useful, but if it is ad hoc it depends on who are the bosses." (SPR, case 2 video-review interview)

Some used the term summative which I think meant the compulsory application rather than the real summative nature of the term. At the end of the day the video-review value is in the feedback and that is the most important aspect of formative assessment.

> *"I think the video review session is really valuable, I think it's thrown up lots of things. It is a powerful tool for teaching, learning, and reflection. For SPR's? I think it is enormously valuable and I think it'd be useful to have it as a kind of summative [objective], a minimum of one of these per whatever time period."* (Consultant, case 5 video-review interview)

Such great variation between supervisors willing to go the extra mile for their trainees' benefit, as per the early example in this section, and the ones requiring a compulsory status to take on a new task is another reason to support training oriented supervisors. Such support would be achieved by officially recognising their training role in their job plan with protected educational sessions for training.

7.6 The overall value of the design

My design had two components: the Cognitive Hazard Training online module and the Reflective Formative Assessment (video review session). They were intended to complement each other to enhance surgical skills acquisition and accelerate learning. In this section I will discuss the overall design value when both components apply together. In my discussion, I will pick up on some of the earlier themes discussed in an attempt to summarise and complete this discussion.

Chapter Six presented the practical value of the first component of the design. It showed the benefit of the Cognitive Hazard Training in raising awareness and changing behaviour to be more cautious and to take a safer surgical approach.

In this chapter I illustrated the value of the second component of the design as a reflective tool with the ability to generate a self-improvement agenda. It has the potential to help in building up trust between the supervisor and the trainee, increase the possibility of gaining more dedicated training opportunities as well as focussing training to address the individual trainees' needs.

All of the study participants, even those who were initially sceptical, reported that they could identify the benefits of the overall design.

> *"I think the online assessment shows you images and videos of things which you should be anticipating. So, the content was there and then when you're going onto the practical session it's useful. No, I think it's a great idea. It's going to work out well I think. I was sceptical when I first started off I think but now that I've seen the performance, and reviewed it, I think it will be very useful. It opens your eyes to a lot of things, and yeah, it has."* (SPR, case 2 video-review interview)

Candidates confirmed a positive change in thinking and attitude towards the safety aspects of the procedure after taking the Cognitive Hazards Training online module.

They identified a change in their performance in the recorded procedure, which served as a tool to consolidate what was learnt or refreshed hazard knowledge.

> *"The online assessment concentrated a lot on complications, and potential pitfalls during the procedure and actually it's nice just to get a reminder of that, and it makes you stop and think, and step back and think during an operation 'hang on, am I in the right space? Am I in the right level?' It helped consolidate everything that was in the online assessment really. It's very useful to see the operation back. So, no, I think it is good."* (SPR, case 5 video-review interview)

Such consolidation generated a pre-emptive approach to the possible hazards in the operation. Such an approach is arguably much safer than a standard approach with a mitigation plan to deal with a hazard's consequences when it is encountered.

> *"So, I think they're all useful things and I think doing it formally was good, the online things, I had no complaints with and then doing the operation soon after it, and reviewing it, I think consolidated this and it's been a useful exercise from my point of view…I thought a little bit more about the variations, whereas normally if I was to do a Gallbladder three weeks ago, prior to doing the online thing, I'd dissect Calot's Triangle slowly, and I'd presume things would be where they should be, structures the Cystic Duct, and the Artery, and if there was any variation then I'd start thinking about it and probably I was thinking about it, a bit more pre-emptive cause of the online learning before."* (SPR, case 10 video-review interview)

It also generated a practical change in approach which was documented by the video-recording and commented on by the SPRs. In the example below the SPR explained about his “enthusiastic dissection of the Artery”. This is an important step to ensure safety before clipping the wrong structure and then thinking about the problem in hand or even worse by cutting the structure after clipping it to discover a very hard to rectify mistake.

> *“I think we were much more cautious after the online material, which you can see in my enthusiastic dissection of the Artery, even when we could have said ‘let’s just clip it now’. I think it’s a better way of being assessed than a PBA, because…it’s not just generic it’s down to this individual case, and how I performed on this day and it’s also about technique, and I think it’s useful to have this as a prompt, timewise.”*
> (SPR, case 3 video-review interview)

Furthermore, one consultant hinted at the possibility of the Cognitive Hazards Training online module serving as a common language between junior trainees and consultants. This common language might encourage trust and increase dedicated training opportunities. In this sense, the online module might serve as a vehicle to gain group acceptance by adopting a common language similar to the Alcoholics Anonymous groups discussed in Chapter Two (Section 2.4.2).

> *“I think having the ability to say ‘well, I’ve done the hazard training’, etc., so to say I have actually thought about this, especially for a Junior Trainee that was good, and hopefully that is then reflected in the discussions you’re having inter operatively about forming a critical*

window, and being aware of… I think you probably need to do the hazard training early on, to say I've done it, and I can point to it and then you can go on and do the cases and then go from there."
(Consultant, case 5 video-review interview)

Despite the time-consuming nature of the overall design, which adds up to almost two hours between doing the online module and reviewing the video-recording, candidates still overwhelmingly supported the new design over the established PBA assessment forms.

"I think if you look at it, it's taking about two hours. So, two hours of my time now, I have picked up a few things I could have done differently. So the lack of time is an issue now in our practice, but I think it's worth it and I recommend this to be done in other main operations. I think it should be used as a formal assessment, rather than relying on the PBA."
(SPR, case 8 video-review interview)

They pointed out the difference added by each part of the design that is lacking in the current PBA form.

"I think it's useful. The online system was almost a kind of educational module and a bit of self-assessment on your knowledge of Cholecystectomy management, and different anatomical variations and potential complications. So, it's a good set up, before you operate. You obviously don't get that in a PBA setting, you don't have a need to look at what the potential complications and anatomy can be. I think video-

recording is a completely different way of doing it compared with the PBA. So it's kind of very retrospective, as opposed to pointing at the bits you're doing correctly and wrongly." (SPR, case 1 video-review interview)

The benefits of the design being tested are quite clear even before comparing it with PBA usage. The major concern with PBA is that trainees do not trust in the feedback from the PBA form. It is currently looked at as a tick box for the ISCP and, needless to say, when it is perceived as a burden, it does not then command respect. Candidates pointed to the tick box nature of the form, which seems to be devoid of any practical benefits. However, the PBA does identify the number of procedures and provides the trainers' overall global assessment, which has practical benefit. Despite the restricted advantages of the PBA, in contrast, candidates argued that the new design should be counted, and worth several PBAs.

"I think this is a very valuable thing, however it is absorbing two hours of time. You couldn't have the same number of PBA's reviewed in this way. I think if this was to be written into the structure of the ISCP, because the actual quality and appraisal part was much more valuable than a PBA. We were talking before about people saying just fill the form in and I'll just sign it off or whatever, I think there is some value in that because it shows insight etc… So maybe actually if you had this, it counts for ten PBAs, or you actually if you do a video review section, this would be the summative assessment. So you decide, that now I'm going to clear all those PBA's and do the summative assessment and that's

that, but you only do one of these every couple of years that would seem to me to be a very sensible way of doing it." (Consultant, case 5 video-review interview)

Candidates not only embraced the idea of using the design as an assessment, they started to think ahead about its use. They imagined a progressive curriculum built around such a design. They thought of a spiral curriculum to progressively accommodate trainees' needs for more complex procedures depending on their training level.

"I think for an earlier trainee it's quite useful to do the initial theoretical sessions, look at some of the videos, and then when they operate, they video the procedure. So you can actually use those and then the feedback would be better cause you'd be able to illustrate where they need to improve easily and then you can do a follow up, if you like, to also see whether some of the things you mention have been taken into practice. For an intermediate trainee, you may then need one that's far more difficult, not a typical gallbladder. Then for a more senior trainee you may then have to start looking at things like Acute Gall Bladders, and also maybe exploration by that stage." (Consultant, case 9 video-review interview)

7.7 Chapter summary

This chapter discussed the benefits of the second design component, video-review, in enhancing surgical training at multiple levels. It represents a practical reflection method and allow trainees to learn more from the training opportunity maximising its utility. It helps candidates to overcome self-justification and denial, enhance trust between trainees and trainers and focus training to target the gaps in the learners' skills. It also facilitates teaching evaluation and appraisal adding a benefit to the trainers.

The second design component also supports the benefit reported by the first component in Chapter Six. The raised safety awareness as a result of the first component was emphasised during the operation video-review and trainees showed strict adherence to the safety dissection steps which was reported by trainees and captured by the video-recordings.

Candidates preferred the enhanced hazard awareness and reflective practice of the design over the PBA. They immersed themselves in the analysis of their own operation in a stress-free environment and generated a self-improvement agenda. The review session also helped trainees to understand feedback and link it to practical actions. The research candidates reflected on their views of the PBA as a tick box exercise, to gain the required numbers for the ARCP and the need to officially recognise training in consultants' job plans.

The next chapter will discuss the findings of the observation study conducted in theatre. This study was planned to help support the aim of design-based research to capture the complicated surgical training environment. The findings should enrich the discussion and understanding about surgical safety and surgical training. The final chapter will provide a final overall research summary and the plans for future work to build on the research findings.

Chapter Eight: Results of theatre observation study

8.1 Introduction

The previous two chapters, reported on the findings of the design-based research by testing the feasibility of the design. Design-based research is also interested in capturing the details of the learning environment in all its complexity to help enhance understanding in the field and inform future studies. As a result, the theatre observational study was carried out to include these requirements. In this chapter I will discuss the theatre observation study. Those observations were carried out in theatre while recording the operations for the video-review sessions. This observation study concentrated on aspects of surgical safety and factors affecting training as those two aspects represent this research's broad aims.

8.2 Methodology

This methodology was discussed in Chapter Section 5.4.1. However, I will summarise the methodology again in this section. The observation was carried out at the same time as video-recording the operation, and used hand written notes and short self-audio-recording memos to capture any observations. Audio-recordings memos were used to capture the information needed and reduce the need to use written notes to permit the researcher to blend into the back ground without constantly reminding the theatre staff that they were being observed. Theatre video-recordings were also reviewed (if needed) to check and validate the findings. This was aimed at enriching my understanding of the natural training environment and to complement and maximise the benefits of video-recording. I was looking for any events that interrupted the operation's progress to identify potential safety and training factors.

The figure below illustrates the themes identified in the theatre observation study and how they are related.

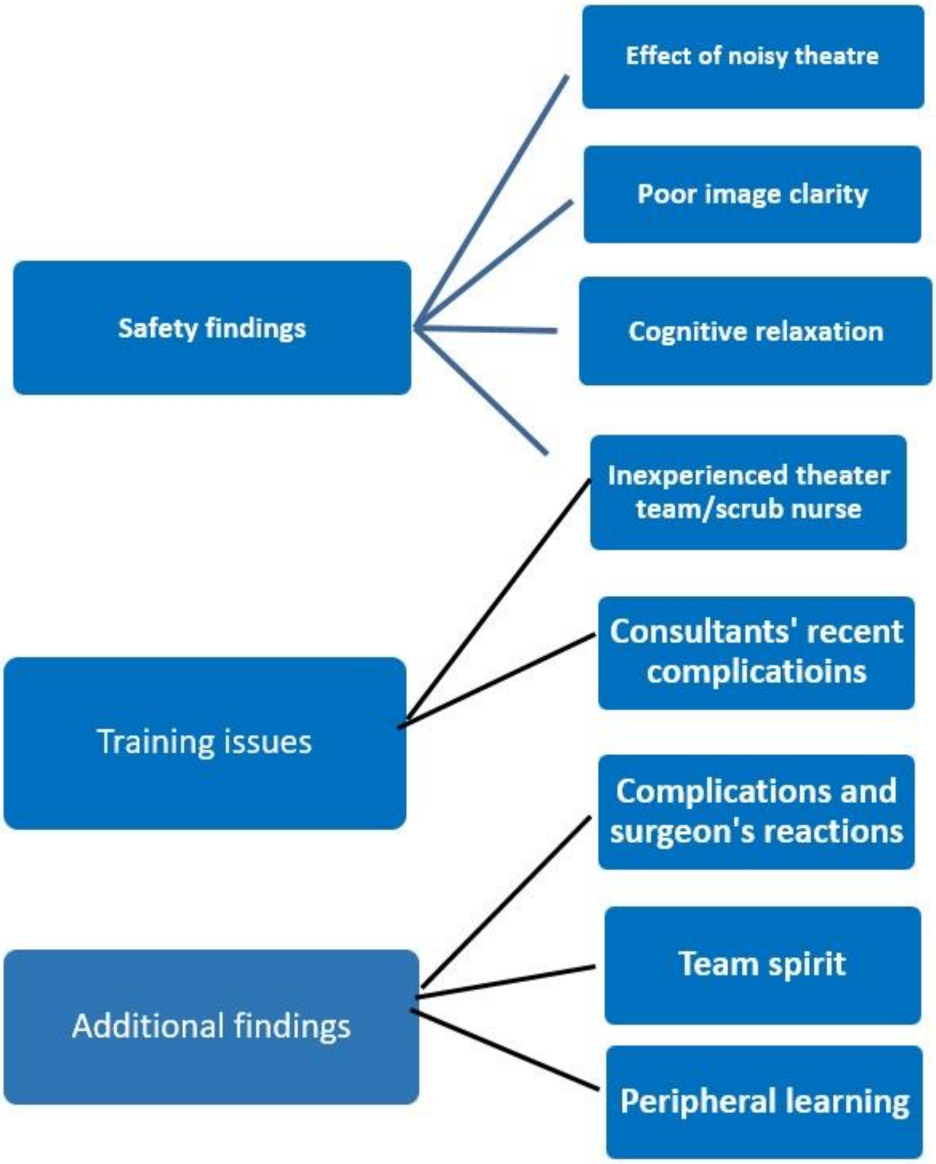


Figure 7: Theatre observation study themes.

8.3 Safety findings

8.3.1 The effect of a noisy theatre on the operation

As explained before, my recordings were a synchronised split screen of the intra-abdominal view and the theatre view. The theatre view was meant to show the surgeons' hand movements and their interaction with the whole team. To capture this view, I used a standard video camera. In the first recorded case I placed the camera on top of the laparoscopic stack beneath the screen. The view was good but the camera was very close to the light source and the laparoscopic stack video recorder. Due to such proximity, the camera picked up noise from the fans in both machines. To my surprise the sound of the fans was very loud and masked the communication between the surgeons and their verbal interactions with the rest of the team. In that first recording the verbal communications were not audible.

To improve the outcome, I placed the camera on a tripod next to the laparoscopic stack. Noise interference was reduced but was still clearly noticeable in all video recordings. As a surgical registrar, I had never noticed such a loud sound in the background. This could have been due to the same focused and narrow visioned effect described in Section 7.5.1, where surgeons forgot about the presence of the camera while operating. It was in fact such a constant sound that after it would be possible for the brain to filter it out. However, such brain activity would lead to quicker fatigue in the long run and it would also affect surgeons' communication with the team, especially the scrub nurse.

The scrub nurse usually stands opposite the surgeon. In fact, they stand very close to the place where the camera was positioned during operation recordings. Such a loud sound captured by the camera would also be heard by the nurse and would interfere with the verbal requests coming from the surgeons. This interference might lead to mistakes in handing the correct instruments or missing key requests, leading to delays and frustrations. It would also increase long term fatigue as well as hearing loss for operation theatre staff.

Such a high noise level, exceeding the noise levels in a busy highway, was recorded within theatre in multiple studies with the same argument about safety and health concerns (119). In the era of technological advances, I would have expected this type of annoyance to have been eradicated. It should not be technically challenging to overcome this and provide a quieter and safer operating theatre environment once this risk was properly highlighted.

High noise level might cause annoyance and risk hearing loss in the long run. It might also cause fatigue, which might in itself become an indirect safety hazard. I also came across other risks that might predispose to complications. Each of those risks might not be sufficient to cause complications in isolation, but it certainly might create a vulnerability in the system. Such vulnerabilities could accumulate and have a combined effect life illustrated in the ‘Swiss cheese model’ when many problems occurred at once (120). In this model mistakes should be prevented from causing harm by the extra protective layers in the system and such harm occurs only if all layers had a weakness in line with the other layers to allow the mistake to penetrate all layers.

8.3.2 Poor image clarity in an old laparoscopic stack

In case 8 the laparoscopic stack had a problem and had to be replaced before the start of the procedure. The replacement stack was of very poor image quality. Visibility was limited and anatomical landmarks were barely visible. Yet the procedure went as planned, although with clear difficulty. The consultant was not scrubbed but was present in theatre and commented on the poor image contrast. As my aim was to capture the usual operative practice I progressed with the video recording and the review session as planned.

After the review session, I asked the consultant about the reason behind keeping such a poor visibility laparoscopic stack in use. The explanation was due to financial pressure and the expanding laparoscopic work in modern surgical practice.

> *"Financial. There's so much demand on the stacks because just about everything is done laparoscopically and there aren't enough stacks. Since we did this we have actually got some new stacks but there is so much demand on them that sometimes we do have to use the old ones."*
> (Consultant, case 8 video-review interview)

I would argue that keeping these old stacks with such a limited view was financially counterproductive. It would increase the complication risk which would cost money in terms of patients' prolonged need for inpatient service and complications management. It would also cause some tension and even competition about stack utility. Such competition would leave trainees with the worst stacks which would hinder their learning and expose them to more complications.

> *"Invariably it is the more senior consultants who get the best stacks. When really, you should argue it should probably be the more junior people who should get the best stacks, and I think the SPRs often feel in a difficult position to kick up. Whereas if it was us, we would say 'look, I can't see a thing here, get me another stack'. I think it is probably fair to say SPRs probably wouldn't, unless they were really struggling they would not have the courage enough to say that."* (Consultant, Case 8 video-review interview)

It might be important to empower SPRs to speak up when the equipment is inadequate and poses a safety risk, but it is certainly more important for managers to eliminate the problem by disposing of the old inadequate stack. As long as such a stack is left in use trouble would inevitably follow. This observational study finding complements my early discussion about the importance of recognising poor image quality as a hazard factor in Chapter Six section 6.5.3.4.

8.3.3 Cognitive relaxation

In case 2 the surgeon encountered one of the risks presented in the Cognitive Hazard Training online module. There was an early division of the cystic artery and the posterior branch was missed leading to minor bleeding. The SPR acknowledged the problem immediately in theatre and referred back to the hazard presented in the online material. The same comment was repeated in the review session and in the post-review interview with a bit of justification, which would be expected as per the mental defence mechanism discussed in Section 2.4.3. However, it is important to note that the mental justification did not cloud the judgement in the presence of objective video evidence and the training online module.

> *"The online assessment shows you images and videos of things which you should be anticipating, but if you haven't seen them, you haven't seen them. So, things like early division of the Cystic Artery to anterior and posterior one. In this case, I did have a proper division which I did not anticipate and that led to a bit of bleeding. So, in retrospect now, I saw the online material early on, I should have been expecting something or I should have been looking for something a bit more during the operation. So it is helpful."* (SPR, Case 2 video-review interview)

In this case, the SPR had learned about the hazard in the online assessment but failed to put that knowledge into practice at least in this example. I was keen to understand the reason behind such a split between knowledge and action, so I asked the SPR if the online assessment changed his approach to the operation. He acknowledged that he was mentally relaxed and was not expecting any possible hazard as the case seemed straightforward and appeared risk free.

> *"I don't think so, this was a straightforward problem elective straight-forward Gallbladder and the anatomy was considered quite straight-*

forward. It was easy to release the Gallbladder, I got the window quite easily, in such a case I would go ahead and do what I normally do, but if it was a stuck Gallbladder, hard Gallbladder, then yes, of course I would have been thinking of all the possibilities which I have seen in the online videos and see if it was present. It does make you think but not in a straight-forward case like that." (SPR, Case 2 video-review interview)

This brings me back to my discussion in the cognitive theory section in Chapter Two (Section 2.4.1). Despite the hazard awareness skills, surgeons can get into trouble in two situations. This could happen if surgeons are completely relaxed, as in the case of a simple straightforward operation or in the complex procedure when System Two becomes over engaged and relaxes its grip on System One. Case 2 was a typical example of the first situation described by the cognitive theory, and Hazard training would not be able to tackle such a problem.

This case represents the need to educate trainees and surgeons about those two hazardous scenarios. It also highlights the importance of having an experienced assistant and empowering all team members to speak up if they suspect any hazards. Unfortunately, both safety nets were absent in this case, leading to the missed hazard and the minor bleeding, which was controlled with no damage due to the trainee's competence.

8.3.4 Inexperienced theatre team

Before presenting this risk, I would like to provide a brief explanation about team roles in theatre to set the scene for the coming scenario. The surgical field is quite narrow and cannot hold all the necessary sterile instruments. Those instruments are maintained, most of the time, at the sterile table. Scrub nurses help the surgeon by keeping the sterile table in order and handing the needed sterile instruments to the operation surgeon in a timely manner. They also tidy up the surgical field by removing unused instruments back to the sterile table. Due to the limited space on the sterile table only the most needed instruments will be opened and organised at the table at the start of the procedure. Circulating nurses supply the scrub nurse with all the extra instruments needed during the procedure. They search for the instruments in the store, bring them to theatre and open the package. This allows the scrub nurse to take the sterile instrument and maintain field sterility.

While preparing for the case 6 video recording I heard the consultant complaining to another colleague about his previous operation. He had a complex case and the scrub nurse was very junior with no experience in such cases. He had to interrupt the operation flow many times to guide the nurse. He was presented with the wrong equipment at some critical points in the procedure and had to wait for other instruments to be brought from other theatres due to lack of preparation and anticipation by the scrub and the circulating nurses. He expressed his frustration as he had to shift his attention from the difficult case to deal with all those issues and he argued that such a problem poses a great safety risk.

This finding is not an isolated incidence and it is clearly common in surgical practice. This theme was repeated in the comments of many candidates.

> *"Scrub Team come in lots of shapes and sizes and we as the operating individuals, it is our responsibility to accommodate the variation in their skill mix. The same applies to the Nurses who come and help you in clinic and the Nurses on the Ward."* (Consultant, Case 5 video-review interview)

However, there is a common agreement that the only way to deal with the matter is through recognition and anticipation. There is an appreciation of the role of the nurses but consultants accept that patient care and team management lie within their responsibility.

> *"A really good Scrub Nurse makes the operation better because they give you the Kit you want before you know you want it, but if they're not giving you the right kit, or you're having to ask for something it's frustration, but actually, ultimately, it's our fault because we are the ones that have created the situation that needs that stuff. We just need to articulate that well and recognize the situation."* (Consultant, Case 5 video-review interview)

Despite such recognition consultants are humans and cannot overcome the feeling of frustration when they encounter such situations. Some candidates used humour to cover the deeply felt frustration in those circumstances, especially at the critical moments in the procedure.

"One of the things I find most frustrating is when you encounter bleeding you send somebody off to go and get a suction irrigation kit and they just disappear, and you're like 'where have they gone?', 'have they gone to a different Hospital to get the kit?', it's because they don't know where to look, they haven't thought to ask somebody, they don't appreciate that this is quite urgent." (Consultant, Case 5 video-review interview)

But the main reason behind this frustration is a deep concern about patients' safety. It is the recognition that accumulating risk factors will eventually lead to mistakes and patient harm.

"So, there are a set number of variables you can change, but what you don't want to do is to do a difficult case, with crap equipment, a crap Scrub Team, a poor anaesthetic because suddenly it's just going to get out of hand really quickly. So, allow yourself one variable to change, but not more than that" (Consultant, Case 5 video-review interview)

In fact, one candidate took my argument in (Section 2.2.3) this thesis about the similarity between surgeons and drivers onto a new level. He compared the theatre situational awareness mentioned above to the speed awareness course. The speed awareness course is a course set to be attended by drivers caught breaking the speed limit for the first time. It is meant to educate drivers about the potential harm in accumulating risk factors.

"In the speed awareness course they do these things, they show you a slide and the road is wet. There's a sign there telling you something is

coming up. The road surface looks in poor quality', actually when you start to think about it you can suddenly realise that there are lots of potential things which are going to affect the likelihood of a problem. It's the same sort of things, it's trying to take a global attitude towards the potential risk, and recognizing that they are multi factorial and some of them you've got control over, and some of them you don't. Anaesthetic Scrub Team, the kit you are using." (Consultant, Case 5 video-review interview)

He expanded further by providing a practical example about a recent injury resulting from the use of a new piece of equipment with different tactical feedback. He rightly argued that the only way to avoid such a problem is to be aware, to slow down and think. In other words, to switch from using System One to using System Two as per the cognitive theory described in Chapter Two Section 2.4.1.

> *"The time of the Trocar injury to the vessel, that was with a new Trocar. It is so obvious, you give somebody a new piece of kit they're not familiar with, the feedback is different, and suddenly you've got a problem. So anytime I'm given something that is different I'm much, much more switched on 'Is this safe?', 'am I doing this right?'."*
> (Consultant, Case 5 video-review interview)

I asked the consultant in case 6 after the review session about the possible ways to overcome such a problem in staff experience, especially in difficult cases. I was thinking staff selection might be the answer to tackle such risk but the answer brought me back to the cold reality. Staff shortage is the norm these days and consultants have to choose between proceeding with difficult cases or cancelling the case and delaying the needed patient treatment. It is a hard choice and compromise is needed in many cases.

> Researcher: *"Before the operation I saw that you were frustrated with the junior assistant, or junior scrub nurse who were helping you in the operation. Is there a way for the consultant, these days, to decide if this operation is suitable for a trainee nurse, or is that something that had to be dealt with?"*
>
> Consultant: *"It's hard to deal with in reality due staffing numbers. We try to get people doing major cases who actually have seen them, and have formed an idea of what's going on but the cold reality of staffing these days into push rotas sometimes you have to put up with who you get, which is not ideal, and probably isn't ideal for patient safety but the other option is to not proceed with cases. So, it's a difficult balance."* (Consultant, Case 6 video-review interview)

One candidate proposed the use of the video review session as a way to overcome staff skill shortages. He suggested using the video review as a simulation training to help in training scrub and circulating nurses outside theatre.

> *"We try to but it doesn't happen all the time. Sometimes the person that's scrubbed are not to standard. It stops your flow of the operation, so Scrub Nurses do play an important part. Actually, it may be also useful for Scrub Nurses to watch the operation video recording, as a*

team in fact they would understand, so it can be useful for them."
(Consultant, Case 10 video-review interview)

So far, I have identified three risk factors that hold the potential of causing complication if they are linked with other risk factors. Those risk factors might also play a role in hindering training. Poor image contrast unnecessarily increases the operation's difficulty and hinders trainee confidence. Awareness of the possible slips in cognitive power would certainly enhance trainee safety by avoiding complication. This would help in building trust and increase training opportunities as discussed in the previous chapter.

Experience staff turned out to be another factor to help in training opportunities. This was clear in one consultant's comments.

> *"The first question that I asked was who the Scrub Nurse is? Because that was going to have a big effect on how much I was going to let you proceed, because I knew that X would keep you right in the time it took me to get changed and get in there."* (Consultant, Case 5 video-review interview)

There is a sense of trust between the consultant and the experienced scrub nurse. This trust comes with a sort of empowerment for the scrub nurse to look after trainees in the consultant's absence.

The effect of this and other factors affecting training will be discussed further in the next section.

8.4 Factors affecting training

During the observation study and the discussion raised in the post video review interviews, I became aware of some factors affecting training opportunities. Those factors, discussed here, are not related to the trainees' experience or attitude. They are simple independent factors outside trainees' control.

8.4.1 Inexperienced scrub nurse

As discussed in the previous section, surgeons have the ultimate responsibility for patient care and team management. They coordinate the team effort to provide safe patient care as well as serving their other role as trainers. In such a complex job description, other members of the team, especially scrub and circulating nurses in theatre, play a vital role in allowing smooth progress in consultant training duties.

The absence of proper support from other members of the team would force the consultant to shift his/her attention from training to cover the gap created by the lack of experience in the team.

> *"It means that not only are you concentrating on your own operation, you're also trying to teach other people what you are doing, and what they are supposed to be doing which obviously takes a little bit of your time and attention to do that, and suddenly if you then put in the fact that*

you're also teaching somebody to operate, observing, that kind of complicates your life a little bit. So certainly, I think if we had somebody senior looking after the Scrub Nurse and leave the Surgeon to look after the Trainee that would make life a little bit easier for people when you need to be able to have an overview of the whole environment." (Consultant, Case 9 video-review interview)

Patients' safety remains the consultant's main concern and in such situations with a difficult operation and inexperienced team consultants might feel the need to terminate the training opportunity by taking over and operating themselves. Consultants however differ in their ability to tolerate risk before feeling obliged to reassert control and perform the remaining parts of the procedure.

"Well I think everyone's got a different level of when they feel that they need to take over, or reassert control. The potential is people might be more inclined to take over because that then puts you in definitive control." (Case 5 video-review interview)

Such reassertion of control however has an impact on trainees' learning opportunities. Consultants are aware of such impact and they understand trainees' frustration as they were trainees themselves at some point in the past. Consultants also struggle to balance the desire to operate with the duty to teach. As one consultant put it clearly, he became a surgeon because he loves to operate and, although he enjoys training, surgery remains his first passion.

“Well I remember what it feels like, so I try to wherever possible. So, I can think of trainers whose way of re-establishing control was just to take over. The other thing I know is that as soon as I touch those instruments I can’t help myself. I’ll say ‘I’ll just do this bit’, and before I know it three quarters of the operation has happened, and it’s really hard once you’ve wrestled the controls off somebody to then give them up again. You’ve got no idea how difficult it is letting somebody else operate because I know that I can do it faster and better than you can, and I’m a Surgeon because I love to operate. So, letting you guys operate is just pain, it pains me on so many levels and whilst I enjoy training I don’t enjoy it as much as I enjoy operating.” (Case 5 video-review interview)

This last point highlights the struggle trainers have and the difficult balance between the passion to operate and the duty to teach. In this sense, good trainers are the ones who managed to strike the right balance by practising self-control and tolerating some calculated risk to allow training to take place. Such dedication should be acknowledged and supported in every possible way. It should be included in the consultant’s job plan as an official activity with the necessary protected time.

It is really strange to see the difference between surgical training and endoscopy training. Surgical training is expected to take place at the normal theatre list time and within the complex normal clinical working environment, while endoscopy training takes a more relaxed approach. Endoscopy leads in each trust have the power to reduce the number of cases in certain endoscopy lists to allow training. They call the reduced lists training lists and those lists are booked in advance by trainees. In this way trainees and trainers have a more relaxed time to concentrate on learning and skill acquisition.

It might be reasonable to argue that in the current squeeze on NHS resources it would be almost impossible to apply the same endoscopy approach to theatre lists. However, it should be reasonable to support the recognition of training as a separate activity and provide the proper protected time slots along with the experienced theatre team, to ensure the optimum support of such activity.

8.4.2 Consultants' recent complications

As explained earlier, consultants take the holistic responsibility for patient care and safety. They play a team manager role and dedicate responsibility to other team members as felt appropriate to ensure such safe patient care.

Mistakes could always happen in surgery despite surgeons' best effort. Those mistakes are called complications and there is a list of common complications for each procedure. Despite the possibility of known complications surgeons are humans and cannot easily overcome the feeling of deep responsibility and sorrow in such events. They are likely to be affected by their emotional status when taking the next decisions to delegate responsibility to others in the team, including trainees. One consultant expressed the deep stress in the next few cases following a bile leak complication.

> *"As a Consultant that was the first time it had happened to me and it's never happened again since, thank goodness and I hope it never does, but every Gall Bladder for the next couple of weeks I was on edge. At one point I stopped the operation, I just stopped as my Registrar cut through and I hadn't noticed he'd actually cut the Liver and there was a drop of Bile and I thought he'd caused a Bile injury. I had to get him to just stop and that was actually because I just needed to get my heart rate to settle down and I needed to assess the situation, ordinarily I wouldn't have had that response to it at all but it's because it happened just after I created a bile leak."* (Consultant and SPR, case 1 video-review interview)

Such severe emotional stress expressed above would understandably affect the consultant's self-confidence for a while and impact on the decision to delegate operating responsibility to a trainee. The clear emotional response raised by remembering previous complications generated further revelation by the candidates, and it highlighted a different use of my design as well as hinting at a different understanding of the denial and mental justification defence mechanism suggested by the cognitive theory.

8.5 Additional findings

8.5.1 Complications and surgeons' reaction to it

The discussion about complication was not intentionally brought up. I did not set plans to investigate such a topic and the matter was simply brought up by one consultant as a suggestion for a future useful role of the video review session. As consultants don't usually have peer review on their operative approach the suggestion started as using the video review to facilitate such reflection in the event of a complication. However, that suggestion was almost immediately dismissed with the understanding that it is a very emotional topic and would generate massive resistance amongst consultants.

> *"I think where it becomes incredibly useful is where there's actually complications, now that's going to make a lot of Surgeons very uncomfortable because then potentially you can be peer reviewed on your operating which actually most of us who are Consultants don't get. So, I would imagine that some would have a degree of hostility towards that"* (Consultant, case 1 video-review interview)

However, this initial suggestion was soon replaced with the suggestion to use the video review as a reflective tool for trainees post complications. Despite the expected emotional reaction to observing the mistake played back to the trainee, the consultant argued about the real learning benefit from such reflection. Video review would provide a holistic view of the problem, as the complication cause would most probably be multifactorial as has been argued in Section 8.3.

> *"We had a trainee a year ago who went through a common bile duct, and I'm sure that actually he's reflected on it a lot, he knows where he went wrong but I think it would be even more powerful for their learning if they could actually go through it. I know it would be horrible, I would hate to have to watch myself doing that, I'd probably find it quite upsetting, if I was going to be very honest about it, but you would then see the various holes in the Swiss cheese that led to that happening, because it's not normally a single thing that led to it."* (Consultant, case 1 video-review interview)

Even if the surgeon knew exactly what caused the complication in the first place such reflection using the video review would help to reinforce the learning point by allowing a critical analysis of the decision making and the event that caused the complication to occur.

> *"Oh, you feel awful. I did have a Bile Duct injury and literally the moment that I did what I did, which was use Diathermy somewhere where I shouldn't, I knew I'd done the wrong thing, even before I saw the Bile welling up, I was aware of what I'd done. I think to actually have seen how I'd actually got into that situation in the first place, what did I do, and what led me into that scenario, and I know what it was, and it's something that now, it was a tiny little bit of bleeding that now I wouldn't even contemplate stopping, but I just think to reinforce that for me would have been very good"* (Consultant, case 1 video-review interview)

The post video review interview took place directly after the session and the SPR and the consultant opted to stay and had the interview together. The same intense emotional reaction was expressed by the SPR listening to the complication discussion. The SPR expressed the dilemma after a complication and the deep desire to have an explanation even if it turned out to be the SPR's own mistake or fault.

> *"On that complication note, I had one Bile leak in a difficult Lap Choly that was presumed to be from liver bed but I was very emotional, and very upset about it for the five, six days that she was in hospital, and the two months that she got to outpatient because it's the first Gall Bladder I did unsupervised, so there was no boss there to tell me, I don't think I did, but had I done something wrong? if there was that video to then go back and see is it something that I've done or it was inevitably because there was no cleanse of the Liver, I would have felt a lot more reassured. Even if it turned out to be a mistake that I made I'd rather know about it, because until this day I didn't know what it was."* (SPR, case 1 video-review interview)

The desire to know the truth, to have an explanation, was really deep and genuine. There was a clear need to know the answer and learn from the mistake if there was something to be learned, but the lack of a trusted reflective tool in the form of a recorded video was the main obstacle. The consultant stepped in to suggest that such a video would have helped the SPR to keep his record clean and manage the consultant's possible mistrust, or even merely to have internal peace and settle the emotional distress.

> *"Absolutely, yeah, and some consultants are difficult to work with and hold a grudge, and then actually if you can then show you didn't do anything wrong and that it was a little Duct of Luschka that you couldn't see or a Gall Bladder Fossa that's dropped a bit, and you haven't caused any harm that's a lot of evidence, apart from anything else to just calm you."* (Consultant, case 1 video-review interview)

Despite agreeing with the above justification, the deep need to reflect and learn from any possible mistake was overwhelmingly clear.

> *"Exactly, so if you find that there's nothing that you have done personally wrong then it relaxes you, and if it is, then I want to know about it to fix it for the next one, because I tell you the next five, six, ten Gall Bladders I did I was."* (SPR, case 1 video-review interview)

Such deep desire to reflect and learn from the mistake, which was still intense a long time after the complication, defies the mental protective justification mechanism suggested by cognitive theory (Section 2.4.1). There might be an initial period of justification to deal with the direct effect of the complication, or it might only be a superficial expression to save someone's face, but deep inside there is a clear desire to know and correct the mistake for future cases. Such a finding is in line with the finding in case 2 discussed in Section 8.3.2. Although the SPR provided a justification at the start of the statement, he had also pointed out the mistake many times and acknowledged the value of the online material and the video review session.

I think the main problem in the mental justification defence mechanism proposal is that it took the superficial expression used to maintain self-respect but missed the deep desire to find the root cause and address it. The main reason for missing such a deep desire was the absence of a vehicle to use in reflection and learning. However, once such trusted evidence is present, the SPR's and the consultant's deep desire to find the cause of the complication.

8.5.2 Team spirit

Case 7 presented almost an opposite scenario to the one described in Section 8.3.3. In this case, the theatre team contained very experienced members. They were watching the laparoscopic stack screen and anticipating the needed instruments before the need arose. I watched the circulating nurse with the tonsil swap package ready in his hand at the right time in the operation. He opened the package for the scrub nurse at the first sign of minor bleed before the consultant and SPR even reacted to the scene. Suction irrigation was set up ready to use in the same pre-emptive way. There was a clear sense of team trust and the nurses initiated the action before the need arose.

Such action clearly freed the consultant's attention to concentrate on the case. However, that was not the main point I wanted to discuss here. The point is that there is a clear atmosphere of trust in theatre. The consultant trusted the team and relied on them to initiate the action before he requested it and the team returned the trust and acted autonomously. Such mutual trust was clearly presented as well in case 5, discussed at the end of Section 8.3.4. In that case, the consultant trusted the experienced scrub nurse to look after the trainee while the consultant returned to the changing room, changed to theatre scrubs and entered the operating room.

The above scenarios highlight the importance of trust between all members of the healthcare team headed by the consultant. Let us imagine a scenario with a dictatorship type of relation between the consultant and the rest of the team. In this scenario, the consultant asserts power by shouting and blaming team members. In this case team members would have definitely reacted in a completely passive way. Even the most senior member of the team would avoid any autonomous action that might lead to any sort of problem, just to avoid being blamed or shouted at. This would strip the benefit of the team experience and the experienced team action would be similar to an unexperienced team. The presence of the knowledge and skills in this scenario would be useless as team members would opt not to act upon that knowledge due to the lack of trust and real team spirit. This hypothetical scenario highlights the importance of the spirit of team-play and the danger of intimidation and bullying within the team.

8.5.3 Peripheral learning

The case of the theatre nurses' team (case 7) is a useful example of peripheral learning. It involved the combination of three very experienced nurses and one very junior nurse. The junior nurse was a clear peripheral participant (Section 2.4.2). She did not understand the preparatory actions for setting up the case and required a lot of explanation. She was standing behind and watching other team members acting autonomously without even being prompted by a surgeon request. She seemed to be intimidated by their competence.

The team leader asked her if she would like to go for her break and was surprised when she said she had had her tea, commenting that he did not see her in the coffee room. It sounded as if she was avoiding the team, despite their clear effort to integrate her, it is possible she was feeling intimidated.

At the end of the procedure she got the courage to step in and help throwing out the scrubs used to cover the patient. Those scrubs had the diathermy cable covered under them. The cable needed to be preserved while the rest of the scrubs got thrown away. She clearly did not know about the cable and was rushing to get rid of the scrubs. The rest of the team tried to warn her but she was still progressing with it. The team leader had to shout just a simple stop. He removed the cable and explained the need to preserve it.

The nurse looked completely shocked and about to cry. The cleaning action progressed and I stayed behind to recover the recording from the laparoscopic stack to the USB memory. The team broke for lunch and I was the only one remaining in theatre. Soon I was joined by the junior nurse; she appeared to be avoiding the team by staying behind and re-stocking the theatre. This type of action is usually carried out at night or at the end of the list. It seems to me that the nurse preferred to skip her lunch to avoid the rest of the team. Coming back to my argument in the section above, there was a clear lack of a team spirit in this case and the junior nurse did not feel part of the team. I don’t think it was anyone’s fault but I would argue that the peripheral participant theory was not only about knowledge or integration, it was also about trust. As the member's knowledge increases he/she feels more empowered or entitled to be part of the team and the team trust him/her more. Such dual action leads to closer team interaction and mutual trust. This hidden spiral progressive trust is manifested in the change from a peripheral to a more central role in the team.

8.6 Chapter summary

In this chapter I presented the main points from the theatre observational study. Those points included safety findings and training related issues. The chapter also contained a brief discussion about the importance of team trust. These findings complement the findings of the design feasibility study presented in the previous two chapters (Chapters 6 and 7).

The final chapter will highlight and further discuss the main findings. It will also contain the recommendations and future research area.

Chapter Nine: Discussion and conclusion

9.1 Discussion

This thesis, and the research behind it, was set up to answer the challenge of the competency based curriculum of accelerating trainees' progress to full competency, while enhancing patient safety. I used design-based research to explore the feasibility of the new approach to enhance surgical training and improving patients' safety. The previous three chapters (Chapters Six to Eight), illustrated the feasibility and possible design value in enhancing surgical training and improving safety via reflection and cognitive hazard training. I also reported additional safety and training themes from the observation study.

In this chapter, I will summarise the overall findings and link them back to the study aims and objectives. This will be followed by a more detailed discussion of some of the research findings with the aim of generating a new understanding about the topics of surgical training and patient safety. This will then be followed by the conclusion, study limitations, recommendations and future research areas.

9.2 Revisiting the aims and objectives

In this section I will revisit the research aims and objectives in the light of the research findings and highlight the original contribution made by this research.

The aim of this research was “To create a new cognitive hazard training and reflective formative assessment design and test its feasibility to enhance and potentially accelerate surgical training” and the objectives of the research were:

1) To critically analyse the relevant literature to inform the design.
2) To create a prototype of the new cognitive hazard training and reflective formative assessment design using the laparoscopic cholecystectomy procedure as a model.
3) To test the feasibility of the new design in the Northern Deanery training environment and conduct an observational study in theatre to capture the complex surgical training environment.
4) To make recommendations for future research and future design modifications in this field.

In the first chapter I addressed the general background, identified the need and set up the aim of the study. This was followed by a wide literature review in Chapter Two. Chapter Three presented the proposed new design to fulfil the first research objective. The steps to create a practical example of my design for laparoscopic cholecystectomy were detailed in Chapter Four to meet the second objective.

As design-based research, a feasibility study was carried out in a real training environment in the Northern Deanery and a theatre observation study was conducted to capture the details of the complex surgical training environment in theatre. The steps and permissions needed for the feasibility study and the theatre observation study were discussed in the Chapter Five).

The research findings along with practical future steps to improve the design were discussed in Chapters Six to Eight. Chapter Six illustrated the benefits of Cognitive Hazard Training. This was the first component in the design and it was a stand-alone online module to deliver cognitive hazard training. It was correctly calibrated and targeted at SPRs as shown by the findings from testing with the Foundation Programme doctors and it was unanimously welcomed by all SPRs and consultants. The data supported a good outcome in increasing hazard awareness and behavioural modification in the form of cautious dissection and strict adherence to safety steps during the procedure. It also served to support a common language between trainees and trainers which increased trust and increased dedicated training opportunities.

Wallace *et al* (121) conducted a literature review of cognitive training and its adaptation to surgical education. The review article established the value of cognitive training and recommended implementing such training in the surgical curriculum. However, they identified multiple gaps in the available literature with two major limitations. Firstly, sample sizes were usually small and the majority of studies were conducted using simulation training rather than in real life. Those factors made it challenging for the authors of the review article to assess the feasibility of delivering cognitive training as a formal training curriculum component. Secondly, most studies used trained instructors to deliver the cognitive training with no clear cost effectiveness evaluation.

The Cognitive Hazard Training module I developed overcame those limitations. It is a dedicated stand-along online module to deliver cognitive training without the need for instructors. The initial steps to create the module were time consuming and required expertise in the planned operation as has been described in Chapter Four. However, once the module was up and running the only support needed was general IT support. This makes the module implementation cost minimal and the website could be hosted at the ISCP or the Royal Colleges' websites.

The second design component was the Reflective Formative Assessment (video-review). Chapter Seven reported the feasibility study findings which supported the benefits of this tool over the current PBA forms. It served as a practical tool to facilitate trainees' reflection on the operation they performed with benefits for both technical and non-technical skills. It provided the objective evidence to overcome memory recall and poor self-assessment (denial) and replayed the operation in a stress free environment away from the mental overload of performing the procedure. This enabled trainees to comprehend the given feedback and link it to future corrective actions. It gave the consultants an improved method to assess their trainees' competency and identify their learnings needs. It provided the opportunity to build up trust and tailor future training opportunities. It also served as a tool to evaluate the trainers' teaching style and provide evidence to support future teaching appraisals.

The two design components complement each other to deliver the intended training benefit as was stated in the overall value of the design (Section 7.6).

Chapter Seven also identified some additional factors that affect surgical training, such as the need for trainers to have trust in their trainees' ability before providing a dedicating training opportunity. This helped to identify the multifaceted elements that affect surgical training and was further enhanced by the theatre observation study findings (Chapter Eight). This chapter reported on the factors that further affect safety and training.

The above discussion highlights how I achieved my aims and objectives. However, before presenting the overall research recommendations and the future research directions, I need to discuss some findings in more details.

9.3 The power of audio-visual feedback

Videos played a major role in both parts of my design, the Cognitive Hazard Training and the Video-review session. In this section I will discuss the role of the video as an educational tool in training and education.

9.3.1 Engagement

As I discussed in Chapter Two (Section 2.5.1), videos represent a very powerful tool in education. This value was demonstrated in both parts of the feasibility study: the Cognitive Hazard Training module and the Reflective Formative Assessment part. Hazard videos allowed concentrated mental training and provided a 'grabbing effect' to maintain candidates' attention. It allowed time to pass without this being realised by the candidates.

It would have been challenging to maintain engagement with such a condensed training module, including most of the hazards in laparoscopic cholecystectomy, without such an effect. This was referred to in the consultant's comment, (Section 6.5.2), about deleting the statement warning how much time was needed to complete the online assessment. He felt that some of his consultant colleagues would have dismissed the online material when they saw the time required. He was genuinely concerned that his colleagues would miss the opportunity to benefit from the online module. He thought his colleagues would have finished the online assessment if they had started it, as it would have grabbed their attention.

The same 'grabbing' effect was replicated in the video-review of the operations. I attended the video review sessions and saw the way consultants and SPRs reacted to the videos. They would be commenting on something and then they would stop, sometimes mid-sentence, at the critical parts in the video. One consultant commented that he was about to try and intervene in a certain moment. It was similar to the spontaneous foot movements a passenger might make towards an invisible brake when sitting next to the driver. However, in the video review this was even more prominent. The consultant and SPR had already completed the operation and they knew the outcome. They might have forgotten about the small hazards they had dealt with within the operation but they knew there had been no major concerns. Despite this knowledge, they reacted as though they were actually dealing with the hazard in real time. This observation was later confirmed by the candidates' comments made during the follow up interview.

9.3.2 Feedback enhancement

Video benefits were not limited to the effect of 'grabbing' a candidate's attention. It extended to feedback enhancement and the identification of corrective action as discussed above (Chapters Six and Seven). The initial argument for using videos in this research design was memory fading and cognitive overload. I argued that as trainees and trainers usually complete the PBA forms days or even weeks after the operation, due to the busy clinical environment, they would forget most of the operation details. This weakness would reduce the quality of feedback provided. Furthermore, the feedback given while operating in theatre was viewed more as coaching or instructions on what to do next rather than feedback on performance. Comments made during surgery were viewed as keeping the operation going, and steering the trainee away from trouble. It seemed that trainees were frequently overwhelmed by the task of operating and would not be in a mental state to process or retain most of those feedback comments. Those arguments were supported and echoed by trainees' themselves in their own comments presented in Chapter Seven.

However, as discussed in Chapter Seven, one case did raise an unexpected finding. Before watching the video-recording the SPR was asked by the consultant, to recall the feedback given during the operation. The SPR recalled almost all the advice before the start of the review session. However, his comments, during the video-review session and in the interview that followed, reflected a deeper understanding of those pieces of feedback. This deeper understanding was only reached following the video-review session. He repeatedly used the construction *"Now I can see what you meant by…"; "Now I understand what you meant by…"*. It sounded as though the SPR recalled the comments given during the procedure but failed to mentally process them, or fully understand them, until he reviewed the video-recording. In this sense the video feedback did more than provide a memory, it provided a mechanism to increased understanding. Identifying what it was that set the video review apart from the verbal feedback, was something I was keen to understand. I asked the SPR about that difference, and the only answer I got was that it provided a different form of feedback, *"it is more visual"*. Hinting at a possible sub-conscious and hard to verbalise benefit in visual feedback.

9.3.3 The difficulty with verbal feedback

Before I explore the value of visual feedback further, I will present some of the candidates' comments that puzzled me in the initial phase of the qualitative data analysis.

As discussed earlier (Chapter Two), learning in surgery is similar to other psycho-motor domains. Trainees observe the skills and practise them until they reach mastery. However, the advantage of current surgical rotations is that they allow exposure to various trainers and various methods of performing the same operation.

Observation and practice however, needs guidance from the expert to correct any mistakes. That guidance or feedback should help resolve trainees' confusion and aid them to reach the mastery level required. This ideal scenario does not always occur in reality and sometimes the feedback itself creates more confusion. One candidate expressed confusion with the feedback received from a senior consultant during the training.

> *"I learned an enormous amount of stuff from one consultant but he's in a different sphere to most people Laparoscopically, and he's just inherently gifted with Laparoscopic Surgery, most of the rest of us have had to learn work to get to a situation that he would just effortlessly create, and so he's not always as good at telling what that work around is, because he doesn't understand how you can't just do it. There were certain bits that I would do when I was operating on his case, if he wasn't in theatre, that would be slightly different to the way I would do it when he was there, because it wouldn't necessarily be as inherent to me, but the outcome would be the same."* (Consultant, case 1 video-review interview)

The candidate here used the term "talent" to explain the ability of the senior consultant to perform the task while the trainee struggles to follow the verbal instructions to do the same. Accepting talent as an explanation means we have to accept that some tasks cannot be performed or replicated without a special physical mental ability which is beyond most or that certain tasks are not easily explained.

If a lack of talent was not the reason for the trainee's difficulty in following the verbal instructions to perform the same task, then there must be a problem with those verbal instructions or the words used despite the consultant's best effort to help his trainees. What was even more interesting were the comments given by the same senior consultant, during the MCQ interview (Chapter Six), about his move to use a personal video collection to explain some steps to his trainee's. So, what was the problem of verbal feedback? Why cannot a consultant verbally guide a trainee and instead resort to a video collection to illustrate the teaching?

Another interesting comment was the inconsistency in the perceived benefit of the feedback. In the post video-review interview, one SPR was very pleased with the detailed feedback given in the review session, marking it as the best feedback. The consultant in the same video-review session, however, expressed concern about the value of the detailed step by step feedback provided during the session. He argued that the feedback should give trainees some form of a summary or an agenda for improvement and that very detailed feedback was more suited to a novice.

> *I think the point by point comment is really suitable for people who are at lower level."* (Consultant, case 3 video-review interview)

So what is the best way to provide feedback: verbal or visual? Is it step by step comments or a summary of an improvement agenda?

To answer those questions we need to understand the way verbal comments are processed and interpreted to correct and enhance our performance.

9.3.4 Biologically compatible training tool

In his book about motivation and action in the corporate world, Simon Sinek (122) referred to the function of the two brain parts: the neocortex and the limbic brain. The neocortex represents the newest part in the human brain. It is the home for rational, analytical thoughts and language. The limbic brain, on the other hand, is responsible for decision making and feelings like trust and loyalty with no capacity to deal with language (122) (page 61).Therefore, to verbalise a performed action or a decision by the limbic brain we have to pass the signals to the neocortex and process the information to verbal comments. The listener then has to interpret the verbal information in the neocortex and pass it to the limbic brain to perform the instructed action. This is due to the inability of the limbic brain to deal with language. This might help to explain the SPR's (case 4) ability to recite the verbal feedback but his apparent inability to process it before the video review, as previously discussed.

The limbic brain actions looks very similar to the System One described by Kahneman (54) (page 105) (discussed in Section 2.4.1). The limbic brain is also called the adaptive unconscious in Gladwell's book (123) (page 11-16). Gladwell argued that the limbic brain, or the adaptive subconscious, constantly scans the environment for clues and initiates action decision in the subconscious level. In Chapters one and two of his book (123) (page 18-71), Gladwell provided many examples of the adaptive subconscious actions and its ability to interpret visual clues from the environment then take active decisions sub-consciously without our awareness of such decisions. One striking example reported by Gladwell (123) was in the hanging robe study performed by Maier. In this study Maier asked candidates to find ways to tie two robes that were hung apart from the ceiling. The distance between the robes did not allow the candidate to reach for the second robe while grabbing the first. As the candidates struggled to solve the quiz Maier walked to the window and deliberately brushed his body against one robe setting it into a swinging action. Candidates came up with the answer after unconsciously picking up the subtle visual clue by the experimenter. However, when questioned about their solution they failed to understand that the visual clue was the reason behind their correct answer as the visual clue was picked up by the adaptive subconscious and candidates were not aware of this process.

Gladwell also highlighted a story telling problem that we all suffer from (123) (page 61-71). As we are not aware of the actions and decisions made by our adaptive subconscious we try to come up with a plausible explanation for our decisions and actions and in most cases those explanations are simply not true. He used two specific examples from sports coaching with very important educational implications. The book mentions the story of a famous baseball player who insisted that he could visually follow the ball till it hit the bat. However, the ball in the last five feet is almost impossible for a human eye to follow. It is too close and moving too fast. When confronted by that result the player simply said I guess it seemed like I could (page 68).

The book also reported the inability of tennis players to verbally analyse their performance. Explanations were contradicting and changed with time (page 67). The most important example was the widely cited instruction by almost every professional tennis player about the importance of using the wrist to roll the racket over the ball when hitting a forehand. However, the use of a digital image recording showed that the wrist is always fixed and does not move until after hitting the ball. The verbal instruction here is completely wrong and it has only resulted in wrist injuries (page 68).

So the problem with verbal instruction is that it does not stop at the need to shift information between two separate brain parts, with all the processing needed. It extends to our inability to comprehend our sub-conscious actions and explain them with an invented story with limited or no reality. This explains the senior consultant's difficulty in providing verbal instructions to guide his trainee, described in the above subsection, with the later switch to using a video recording library.

Gladwell argued that there will always be a problem when we ask people to verbally describe an action performed in the sub-conscious. He argued that this problem is the reason we pay coaches in tennis or sport or any other psychomotor skill to show what they do, not to tell us what they do: *"we learn by example and by direct experience because there are real limits to the adequacy of verbal instruction"* (page 70-71). Furthermore my research exposed a third problem with verbal instructions. Some of the consultants' expressed dissatisfaction with their verbal instructions and the problem of saying one thing when they meant to say another (Section7.5.4.7).

So, in summary, verbal instructions suffer from many shortcomings and it is reasonable to say that they are not the best way to guide learning and provide feedback in surgery. Visual instructions and feedback, on the other hand, bypass the human brain's inability to comprehend the sub-conscious decisions and actions, with the resulting logical story, by reflecting the reality. They also overcome the brain's separation of language and action centres (the neocortex and the limbic brain) by directly communicating with the limbic brain or the adaptive sub-conscious as described by the various studies in Gladwell's book (123). This effect would explain the SPR's (case 4) insight after reviewing the video recording and his use of the word "visual" to describe the change in the feedback after the review session.

Taking all the above discussion into account, along with the feasibility study findings, video instructions and feedback should be the number one method in surgical training. It is the way to overcome our brain limitations in providing and responding to verbal instruction during surgery and instead to provide a visual training tool. Despite the obvious educational benefits of such a tool, surgical and medical education are still lagging behind other industries in utilising videos as a training method. The wide literature review in Chapter Two pointed to the use of video-review in athletic training (82). Recently some of the new surgical text books are adding links to an online video library to enhance the educational value of their traditional paper based written teaching instructions (124). However, it is reasonable to say more efforts should be made to further incorporate the audio-visual into modern medical education training in the current digital era with the wide availability of video platforms in our daily life. This research presented a practical example of such a possible implementation.

9.4 The timing of feedback on performance

In this research it became quite clear that there were two views about the best time to give feedback. The majority of the consultants initially thought that feedback was best provided at the time of the supervised operation. Consultants either scrubbed to assist the trainee by holding the camera or visited the theatre at multiple times during the operation and gave the necessary feedback. As a result they thought another feedback session after the operation was an unnecessary repetition of something they had already done. In this sense they initially considered the video-review session interesting, because it showed their operation recordings, but a burden otherwise.

The timing of feedback might explain the limited value associate with of the PBA forms. It seemed that many supervisors did not see the value of repeating the feedback after the operation in any form, whether written in PBA or verbal in the video-review session.

As PBA forms are formative assessments, their main value is to provide and document the performance enhancing feedback. It is hard to convince users to fill in the feedback in those forms if users themselves do not believe that there is a need for such feedback.

SPRs on the other hand saw the timing of feedback from a completely different angle. Instructions given in the heat of the operation, as some SPRs referred to call it, were hard to comprehend. SPRs were concentrating on progressing the procedure and they viewed the feedbacks as instructions to support them to achieve this task. They were narrow visioned, and mentally occupied by the task to the point that they could not process instructions beyond this point. It was certainly not feedback that they could embrace. Such a narrow vision, during surgery, might change and improve as trainees gained in experience and seniority but the effect of missed feedback was evident in my data.

I do not mean to say here that trainees' perception of reality was right and a consultant's was wrong. I am simply stating the fact that there were two realities, and both had supporting evidence. Both realities co-exist together in the same time and place.

Despite acknowledging the fact that two separate realities can co-exist in the same time and space, we need to understand the way these dual realities occur. Consultants were trainees themselves at some point in the past. They progressed from being junior trainees to senior trainees to consultants. Along with experience and their seniority, their feedback reality changed as well. The question is, how did their reality change? What was the process? Or was this as a result of moving from novice to expert by learning to behave and adopt the expert's language and behaviours? Or could this be about a change in perspective and taking on more responsibility?

My research showed that there was some middle ground and some supervisors did still appreciate the role of post-operative feedback and even used a version of video recording themselves to highlight difficult to teach feedback. However, the consultant who used his own video library was not using it for feedback but as instruction. According to the comments (reported in Section 9.3.3) there was a senior consultant who was a naturally talented laparoscopic surgeon and trainees used to struggle to copy him. He could do a step but he struggled to explain it in words. This senior consultant switched recently to the use of a video recording library to explain certain steps. Such a change in training style might represent a realisation that his trainees' struggled over the years which led him to experiment and find the way to overcome the problem. However the use of a video library as instruction or feedback is still very limited in surgery. This might be due to the lack of understanding about the dual feedback reality and the verbal feedback problems described above.

Furthermore, engagement with, and commitment to, feedback forms has presented a range of challenges which was repeatedly highlighted in the literature, for example the WHO check list and the Sheffield PBA study (27). The recommendation was that each operation form should be done by at least three different consultants. In other words, do more of the same rather than accept the problem and change the approach. Such forms would benefit from further research aiming to identify a solution to improve feedback.

9.5 Non-technical skills

9.5.1 Reduced situational awareness

As discussed in Chapter Two (Section 2.4.1), System Two is responsible for deep thinking and gets engaged after being alerted to a certain difficulty or danger by System One. Cognitive overload results in a narrow vision and reduced situational awareness. This effect was supported by the findings of the feasibility study and the theatre observation study. In Chapter Seven (Section 7.5.1), trainees reported that they were aware of the camera recording their operation in the first few minutes but once they were mentally engaged with the procedure they completely forgot about the video-recording. The same reduced situational awareness was also discussed in Chapter Eight (Section 8.5.2), the senior staff opened the suction and set the irrigation up far before the operating surgeon's request. The suction irrigation was placed in the surgeon's hand ready for action the moment he thought about asking for it. The point here is not the senior staff initiation of action before the request, or the implicit rather than the explicit cooperation in surgery. The point is the loss of situational awareness by the operating consultant and SPR causing them to miss all the activity around them.

More interesting was the absence of any comment about the nurses' action during the video-review session. The outside view in my synchronised video only covers the operating consultant and SPR. So the action of opening and setting the suction irrigation device was not visible in the video recording but the speed with which the device was handed in ready for action did not trigger any comments during the review session. This could be due to the effect of the audio-visual power discussed in

Section 9.3 of this chapter with the resulting mental engagement at that difficult dissection stage during the review session. In other words the consultant and SPR relived the stressful situation while watching the video and suffered the same narrow vision effect from mentally concentrating on the re-played hazard situation. Another possible explanation is the importance of team work and trust in surgery. Such trust in the senior nursing team provided the consultant with a feeling of safety which allowed him to mentally relax and focus on training as was discussed in Chapter Eight, Section 8.3.4 and Section 8.4.1.

It is important for surgeons to understand their limitations and appreciate the need for extra help in those times when they lose situational awareness. Empowering senior staff to speak up might help. Another important safety step would be an early situation analysis to be carried out by the consultant to allow him/her to plan ahead and anticipate possible hazards and judge the seniority of the team. Such planning would enable the surgeon to prepare for the risks and allow a maximum of one or two variables as was discussed by the case 5 consultant in Section 8.3.4. Consultant 5 stressed the importance of limiting the number of variables that can cause complication by early situational awareness and intervention to reduce the future risks in a similar manner to the driving speed awareness course.

9.5.2 The importance of non-technical skills

Despite the importance of non-technical skills in surgical safety, these skills are still under represented in surgical training and assessment. There is not a special focus on such skills in current surgical training programmes and the ISCP website is still awaiting the addition of the NOTTS assessment tool to its list of WBA forms. This might be due to the difficulty in assessing non-technical skills and the need for special training to use the NOTTS assessment system.

This reduced attention to non-technical skills was also evident through the discussion in Chapter Seven, Section 7.5.3. In this section some SPRs and consultants reported limited interest in the outside view of the synchronised video-recording. They did not watch that part of the screen much and focused their interest on the inside technical part of the procedure. However, they acknowledged that the outside view would be important if they were to look for non-technical skills (human factors) during the procedure.

In other words non-technical skills are still undervalued by some surgeons, with a main focus on technical operative skills instead. Such a finding should raise the alarm for further integrating non-technical skills in training and assessment.

9.6 Competency in the era of the competency based curriculum

Current surgical training is organised by the intercollegiate surgical curriculum and monitored through its website (20). This website includes all the assessment forms as well as the educational principles of the surgical curriculum (125). In those principles the curriculum is clearly described as a competency based curriculum. It also states that progress should be competency based rather than time based.

> *"Regulation of progression through training by the achievement of outcomes that are specified within the specialty curricula. These outcomes are competence-based rather than time-based."*

Despite such clear aims and objectives, the results presented in Section 6.5.1 of the feasibility study showed the misalignment between SPR training grades and their previous experience. Some SPRs had previous experience which was not counted towards their training grade. There was also the issue of variability in the SPRs' gained experience, depending on the kind of jobs or placements they had had before. Section 6.5.1 reported a consultant comments about the difference in SPR experience in laparoscopic cholecystectomy hazards depending on their previous exposure to hepatobiliary surgery during their rotation which is an optional placement in the current general surgical training program. He argued that such hepatobiliary placement would make surgical SPRs more aware of such hazards. All those variations made it hard in my research to judge experience in terms of training grades (ST3-ST8) which reflect the trainee's place in the training programme.

It is clear from those results that time rather than competency is still the main focus of the current curriculum. It might be argued that trainees need to prove certain competencies to progress from one year to the next, but it certainly did not place trainees in the right rank according to their competency level. In other words the competency here is used as a progress prohibition, if not achieved, rather than a clear ranking criterion. Trainees' previous experiences were not counted when they joined the training programme and faster progress was not permitted in the current system.

A clear ranking criteria should be the first step to achieve the competency based curriculum. Trainees' should be judged according to their experience not their numerical years in training and should progress in seniority according to their abilities and competence rather than time served. This would focus training on trainees' needs and allow competency rather than time based progress. Such criteria should be the main focus of any effort to accelerate training and achieve competency based progress and enhance research accuracy in surgical skills training.

9.7 Study limitations

Data collection during the feasibility and observation studies was from one geographical training region and limited to the trusts giving R&D permission before the study closing date. It could be argued that the results cannot be generalised due to such a limited geographical representation, however the studied variables of safety and training are not known to be geographically affected.

All efforts were made to target the widest possible sample and include all possible candidates performing laparoscopic cholecystectomy: breast, colorectal and vascular as well as Upper GI surgeons. However, participation was voluntary and enthusiastic training oriented trainees and consultants might have been selected; also hepatobiliary surgeons were represented in the pilot phase but missing from the feasibility study sample.

The second stage of the feasibility study operation video-review sessions was limited to ten cases only. These were chosen on a convenience sampling basis, of first come first served. A full implementation study is still needed to confirm the findings and assess the full potential of the design on surgical training and safety.

As the only researcher in this study I had a dual role in theatre. I had to supervise the recording equipment and conduct the observation theatre study. This dual role might have caused some limitations in the observation study but was compensated for by watching the video-recording during the video-processing and the results analysis.

Despite the above limitations, results were triangulated between the three parts of this research. These were the two feasibility study parts (Knowledge and Hazard assessment and the Video-review session) and the observation study. Data saturation was achieved as a result of such triangulation. Results were also in line with other research findings in the surgical, athletic, military and cognitive fields.

9.8 Conclusion

I conducted a design-based research aiming to create a new cognitive hazard training and reflective formative assessment design and test its feasibility to enhance and potentially accelerate surgical training for the benefits of patients. I presented my two steps design and carried out a feasibility study to explore its value in the real surgical training environment.

Step One of my design included a unique stand-alone online Cognitive Hazard Training module to enhance awareness, reduce possible complications and highlight possible mitigation actions. My Cognitive Hazard Training module overcomes some of the previously reported problems in surgical cognitive training such as the need for expert facilitators and the lack of follow up with real patients (121). My module is a stand-alone online resource which eliminates the needs to recruit expert trainers. The strength of my Cognitive Hazard Training is the low running cost and widespread applicability as it could be hosted on the Royal College or the Intercollegiate Surgical Curriculum Programme websites. The feasibility study supported the module value in enhancing hazard awareness and creating an attitude shift towards a strict adherence to safety steps in dissection during the procedure.

Design Step Two was the Reflective Formative Assessment using a synchronised video-review of the trainee's supervised operation. Synchronization of the external and internal field facilitated the visualization of the team human interactions and linked surgeons hand movement and verbal communication with the assistant/trainer to the resulting intra-abdominal surgical action. The video review feasibility study reported the acceptability of such reflective assessment method and its value in enhancing feedback, identifying trainee's training needs, setting up self-improvement agendas, overcoming the verbal feedback limitations and strengthening the trusting relationship between trainees and trainers. It also provided the consultants with the opportunity to evaluate their teaching and provide educational appraisal evidence.

The two design steps benefits were complementary as been shown in the feasibility study. Such clear benefits support the need for a future full implementation study.

I also carried out an observation study in theatre to capture the contextual factors affecting training and safety. This observational study complemented the feasibility study and provided an overall broader understanding of the complex surgical environment and the numerus factors affecting surgical training opportunities in theatre. I also explored the relevant literature to gain a deeper understanding of the limitations of verbal feedback and the advantages of audio-visual feedback in an attempt to expand current knowledge about such important aspect of surgical training.

9.9 Overall recommendations

1) Incorporate cognitive hazard training into the surgical training curriculum to enhance safety and accelerate training. This could be achieved by hosting cognitive training modules on ISCP website (ISCP, GMC and Royal College).

2) Incorporate operation video-review practice into the ISCP formative assessments by widening the availability of commercial recording system such as SMOTs. There is also the need to tighten the security settings around those recording systems to restrict the access in-line with theatre privacy requirements as was highlighted in the good practice at Gateshead trust (Section 5.6.5). (HEE and Trusts).

3) Identify training oriented consultants with a special training status and acknowledge training as a separate duty in consultant's timetable and contracts (HEE).

4) Further stress the importance of non-technical skills in surgical training and assessment. This could be achieved via incorporating non-technical skills assessment (NOTSS) in the ISCP assessment tools and training the consultants to use this tool effectively (HEE, ISCP).

9.10 Future research areas

- Further implementation study with a larger national sample to test the new design and its effects on surgical training and patient safety. This could be achieved by hosting the Cognitive Hazard Training on the ISCP website and incorporate the Reflective Formative Assessment into the ISCP formative assessment tools.
- Expand the design to incorporate other surgical procedures to test the possible synergistic effect of a full hazard cognitive training and a reflective curriculum.
- Further research should be conducted to explore the current trainees' ranking system (ST3-ST8) with a new system to reflect trainee's experience level rather than their chronological progress in terms of year in training. This would be the first step to achieve a competency based training (HEE, GMC, and ISCP).

- Further research should be carried out to study an enhanced PBA and other WBA forms' human compatibility by applying behavioural economy principles.

9.11 Dissemination

- The initial research idea was published as a leading article in the British Journal of Surgery in 2011 (33) and won the first place in the Bright Ideas in Health Awards under the Training and Education Category.
- Design principles were presented as a poster presentation at the Bright Ideas in Health Awards annual event, Gateshead, 2012 and 2013.
- Design principles and study planning were presented as a poster at the Postgraduate conference, School of Medicine, Pharmacy and Health, Durham University, 2015.
- Early study findings were presented as an oral presentation at the Postgraduate conference, School of Medicine, Pharmacy and Health, Durham University, 2016.
- Early results were also presented as a poster presentation at the ASME Annual Scientific Meeting, Belfast, 2016.

Appendices

Appendix 1

General Surgery (HPB) PBA: Laparoscopic cholecystectomy

APPROVED SURGICAL

TEMPLATE Jun 06

Trainee:	**Assessor:**	**Date:**
Start time:	**End time:**	**Duration:**
Operation more difficult than usual? Yes / No (If yes, state reason)		

The Trainee should explain what he/she intends to do throughout the procedure
The Assessor should provide verbal prompts, if required, and intervene if patient safety is at risk.

Rating: N = Not observed or not appropriate D = Development required
S = Satisfactory standard for CCT (no prompting or intervention required)

	Competencies and Definitions	Rating N/D/S	Comments
I.	**Consent**		
C1	Demonstrates sound knowledge of indications and contraindications including alternatives to surgery		
C2	Demonstrates awareness of sequelae of operative or non operative management		
C3	Demonstrates sound knowledge of complications of surgery		
C4	Explains the perioperative process to the patient and/or relatives or carers and checks understanding		
C5	Explains likely outcome and time to recovery and checks understanding		
II.	**Pre operative planning**		
PL1	Demonstrates recognition of anatomical and pathological abnormalities (and relevant co-morbidities) and selects appropriate operative strategies/techniques to deal with these e.g. nutritional status		
PL2	Demonstrates ability to make reasoned choice of appropriate equipment, materials or devices (if any) taking into account appropriate investigations e.g. x-rays		
PL3	Checks materials, equipment and device requirements with operating room staff		
PL4	Ensures the operation site is marked where applicable		
PL5	Checks patient records, personally reviews investigations		
III.	**Pre operative preparation**		
PR1	Checks in theatre that consent has been obtained		
PR2	Gives effective briefing to theatre team		
PR3	Ensures proper and safe positioning of the patient on the operating table		
PR4	Demonstrates careful skin preparation		
PR5	Demonstrates careful draping of the patient's operative field		
PR6	Ensures general equipment and materials are deployed safely (e.g. catheter, diathermy)		
PR7	Ensures appropriate drugs administered		
PR8	Arranges for and deploys specialist supporting equipment (e.g. image intensifiers) effectively		
IV.	**Exposure and closure**		
E1	Demonstrates knowledge of optimum skin incision / portal / access		
E2	Achieves an adequate exposure through purposeful dissection in correct tissue planes and identifies all structures correctly		
E3	Completes a sound wound repair where appropriate		
E4	Protects the wound with dressings, splints and drains where appropriate		

PBA Assessment: Produced by OCAP, OpComp & the SAC for General Surgery 1/2

Competencies and Definitions		Rating N/D/S	Comments
V.	**Intra operative Technique**		
IT1(G)	Follows an agreed, logical sequence or protocol for the procedure		
IT2(G)	Consistently handles tissue well with minimal damage		
IT3(G)	Controls bleeding promptly by an appropriate method		
IT4(G)	Demonstrates a sound technique of knots and sutures/staples		
IT5(G)	Uses instruments appropriately and safely		
IT6(G)	Proceeds at appropriate pace with economy of movement		
IT7(G)	Anticipates and responds appropriately to variation e.g. anatomy		
IT8(G)	Deals calmly and effectively with unexpected events/complications		
IT9(G)	Uses assistant(s) to the best advantage at all times		
IT10(G)	Communicates clearly and consistently with the scrub team		
IT11(G)	Communicates clearly and consistently with the anaesthetist		
IT12 (T)	Creates a pneumoperitoneum safely		
IT13 (T)	Safely inserts an appropriate number of ports		
IT14 (T)	Dissects cholecystectomy triangle safely		
IT15 (T)	Safely ligates and divides cystic duct		
IT16 (T)	Safely ligates and divides cystic artery		
IT17 (T)	Carefully mobilises gallbladder off the liver		
IT18 (T)	Safely extracts gallbladder from a port site		
I.	**Post operative management**		
PM1	Ensures the patient is transferred safely from the operating table to bed		
PM2	Constructs a clear operation note		
PM3	Records clear and appropriate post operative instructions		
PM4	Deals with specimens. Labels and orientates specimens appropriately		

Global summary

Level at which completed elements of the PBA were performed on this occasion		Tick as appropriate
Level 0	Insufficient evidence observed to support a summary judgement	
Level 1	Unable to perform the procedure, or part observed, under supervision	
Level 2	Able to perform the procedure, or part observed, under supervision	
Level 3	Able to perform the procedure with minimum supervision (needed occasional help)	
Level 4	Competent to perform the procedure unsupervised (could deal with complications that arose)	

Comments by Assessor (including strengths and areas for development):	
Comments by Trainee:	
Trainee Signature:	**Assessor Signature:**

Appendix 2

PBA fields divided into competency topics					
Knowledge	Surgical dexterity	Non-technical skills			
		Situational awareness	Decision making	Communication and teamwork	Leadership
C1,2,3			C4,5	C4,5	
PL1		PL4,5	PL2	PL3,4	PL4
	PR4,5	PR1,2,7,8		PR1,2	PR1,2,6
E1	E2,3,4				
	IT1,2,4,5,6,7, 12-18	IT8,9	IT3,8	IT10,11	IT8
				PM2,3	PM1,4

Table 1: Laparoscopic cholecystectomy procedure based assessment fields with their possible knowledge, surgical dexterity and Non-technical skills assessment values.

Appendix 3

Topics	subtopics
Indications	emergency elective - with colic, cholecystitis, US findings, exclusion of other disease
Anatomy	list of common anomalies : cystic artery variations (double, various different origins) cystic duct variations (short duct, Mirrizzi, tortuosity of CD)
Procedure steps clear plan :	such as assessment of GB and anatomy dissection of Calot's triangle- how (post, ant) indications of intra-operative cholangiogram plan for removal of GB from liver (Endopouch) Finish - haemostasis, wash, aspiration, drain, closure etc
Complications	spillage of gallstones and bile direct bile duct damage classification of injury (Blumgart, others) liver bleeding duodenal / colonic damage post operation bile leak
Management	repeat laparoscopy - low threshold LFTs scan sepsis
Hazard videos - content	Diathermy injury to common bile duct, to duodenum or liver Critical view and hazards due to failure to dissect GB body off liver, above cystic duct Possible use of box simulator to simulate hazard in lap chole - cystic duct and artery applied tightly to each other video of curling right hepatic artery with high cystic branch diathermy set up - yellow pedal and power setting Small perforation of thin walled gallbladder with risk of major stone spillage

Table 3: List of desirable test points to search for suitable content images and videos.

Appendix 4

IgorTFerreira ☑

https://www.youtube.com/watch?v=9zL9bWSDPnw

full retrograde dissection with mini tools, duct tie

https://www.youtube.com/watch?v=xkiViwkezs8

omental adhesions, **anterior and posterior branching artery**, tie the duct

https://www.youtube.com/watch?v=idz0PdDjkQo

adhesion, normal dissection, diathermy the artery and tie the duct

https://www.youtube.com/watch?v=nOVlEZcIIyI

1- **Mirrizi type 2**, sever adhesions, retrograde scissor dissection, prolene endoloop
3:00 to 3:39 expose the CBD and gallbladder 3:39 identify CBD (hepatic duct). Then lateral, medial and retrograde dissection 11:02 artery and neck dissection (T shape) 12:20 neck cleared 13:05 neck tied 14:02 cutting cystic duct 14:29 clip with anatomical drawing

https://www.youtube.com/watch?v=FlQVJNhQI7M

normal dissection tie duct no clear artery

https://www.youtube.com/watch?v=o3NGnsz_4Fg

Stuck u shaped gallbladder close duodenum, long dissection of the duct, critical view 08:30 -10:30, dissect artery, retro dissection, tie the duct

https://www.youtube.com/watch?v=YQX810OrlfM

2- **Artery:** anterior cystic artery branch dissection (written on screen 4:09 with fat and 7:58 clean), **clear double artery view 09:15-09:17 11:30-11:37 bleeding from posterior branch (help to identify but bleeding can still occur, good to know and be prepared)**, duct tie as usual for the surgeon, inguinal hernia identification

https://www.youtube.com/watch?v=1vlqf3rP0PM

3- Close duodenum, **white spot on duodenum ?** ulcer 01:26-1:33, visible anterior branch **1:54-2:20 can work with the artery lap view images (double artery sign)**, retrograde dissection of fundus, Double branched artery **13:19-13:38**

https://www.youtube.com/watch?v=loau5mVNKQM

Retrograde dissection, common and hepatic duct view but unusual due to retrograde dissection

https://www.youtube.com/watch?v=Jbi7otIu3WQ

very close duodenum, thin gallbladder, normal dissection, anterior and posterior artery, milking cystic duct up, clipping

https://www.youtube.com/watch?v=eT1v_MGStds

normal dissection, anterior artery only critical view, tie as usual

https://www.youtube.com/watch?v=ITxh6tM5HZk

adhesion to duodenum,

https://www.youtube.com/watch?v=B9BwjLjIY-k

dissection with anterior artery cauterization, clipping

https://www.youtube.com/watch?v=dIZ1NL1jfbk

acute gallbladder bloody dissection, perforated with pus, blunt dissection,

https://www.youtube.com/watch?v=i4HhtorFN84

Standard technique

https://www.youtube.com/watch?v=T2POcLE8Jmo

long meso-gallbladder retro-dissection,

https://www.youtube.com/watch?v=BPkIDiFNPuk

severe peritonitis, stuck upper abdomen, pus from gallbladder, necrosis of the wall empyema, suction of gallbladder, hydro-dissection, liver diathermy injury, https://www.youtube.com/watch?v=RicwTXSvXFM

normal dissection, slight bleeding from ? anterior branch, burned then clipped the artery stump,

https://www.youtube.com/watch?v=4uT_dlbypWo

very small gallbladder, critical view, long anterior cystic artery, burn artery clip stump

https://www.youtube.com/watch?v=Xsy5cid4Ha0

long meso-gallbladder, retro-dissection, artery and duct together in thin sort of cord

https://www.youtube.com/watch?v=DKaOJcycUfc

stuck omentum, normal dissection

https://www.youtube.com/watch?v=lY0as_ubWNA

long anterior artery not clear away from gallbladder

https://www.youtube.com/watch?v=RVnzwkcw6mY

empyema with sever inflammation

https://www.youtube.com/watch?v=1Rlj3FSTcag

normal dissection

https://www.youtube.com/watch?v=3Jqu37vMBAg

4- flimsy attachment to duodenum, **anterior artery (? Gastroduodenal origin) 1:01-02:00**, clipping

https://www.youtube.com/watch?v=NXnBRT2TxZ8

5- non fatty gallbladder, anterior and posterior arteries far away, sign at 1:26 then 2:48-3:22, posterior 3:52 less important maybe?

https://www.youtube.com/watch?v=MhT0GpR74q8 fatty gallbladder, close duodenum hidden behind fat, **3:48 then duodenum at 3:56**

https://www.youtube.com/watch?v=jVdUYBupKWQ

fatty gallbladder retro dissection,

https://www.youtube.com/watch?v=2F6rYnlnIC8

cut adhesion over liver, post pancreatitis, mobilise fundus/body,

https://www.youtube.com/watch?v=pYmS1ZJHjZU

cut adhesion under liver and to the gallbladder, close stuck duodenum under the adhesions, **hepatic cyst 3:59, identify artery and duct,** cauterize the artery and loop tie the stump and the duct

https://www.youtube.com/watch?v=xsoROLt9yTU

unusual large infundibulum, small bleeding from lateral edge ignored to extend dissection, bleeding close to cystic artery ignored for further dissection, then artery cauterized, after calot dissection retrograde dissection?, duct ligated,

https://www.youtube.com/watch?v=0FBckekcB6g

adhesion dissection, close duodenum, 4:16 ? cyst opened during dissection, anterior artery ?(gastroduodenal origin) **4:20** use 4:20 to 5:00 (written on screen)

https://www.youtube.com/watch?v=oQWKm4AvbJs

small hepatic capsule tear (at the liver edge 4:25 gauze inserted), anterior artery and medial cystic artery

https://www.youtube.com/watch?v=93Rdt8PXO3Q

Adhesions, sever fibrosis, retrograde dissection to avoid common bile duct (not initially exposed), **necrosis of the posterior wall**, bloody dissection loop to ? Base of gallbladder/? Cystic duct

https://www.youtube.com/watch?v=kQYvlN7MQd8

Retrograde dissection then adhesion dissection then infundibulum dissection https://www.youtube.com/watch?v=nItla9cuG-o

Scissor dissection artery bifurcation clear but ? not ideal image

https://www.youtube.com/watch?v=5xgSzoFGAJk

clear dissection small capsular tear treated by pressure

https://www.youtube.com/watch?v=B8T9BU7Twtc

close CBD, clipping the cystic duct after full dissection from the liver

https://www.youtube.com/watch?v=EXzLWDrNM70

standard op

https://www.youtube.com/watch?v=vAnuS5e-6zA

Coagulation dissection and tie

https://www.youtube.com/watch?v=EaRfVsh7mfw

6- anterior cystic artery, Acessorie Biliar Duct - Luschka Duct 1:38 then writing on screen at 1:48 a diagram at 2:13 clipping the duct 5:52

http://www.youtube.com/watch?annotation_id=annotation_247315&feature=iv&src_vid=Di--x6qSk2I&v=kASyAgQuWx4#t=3m6s

7- Biloma 2 Days After Cholecystectomy. CT at 0:09 lap look 0:31

https://www.youtube.com/watch?v=MnC16cOAEhE

clear adhesion with clear duodenal adhesions, small liver tear diathermy treated

https://www.youtube.com/watch?v=hx5pHSISQjk

hepatic cirrhosis,

https://www.youtube.com/watch?v=hmo2Gwg9GwU

standard op

https://www.youtube.com/watch?v=2cbwERFKOkw retrograde dissection, then normal Calot's dissection, tie the duct

https://www.youtube.com/watch?v=bSnJmnkrJ7s

Hepatic abscess, blunt and hydro dissection, necrotic posterior wall 11:35, **drain liver abscess at the end 11:39**

https://www.youtube.com/watch?v=GnhpWJgq0tc

retrograde dissection,

https://www.youtube.com/watch?v=Di--x6qSk2I

8- retro-dissection then normal, anterior artery, Imperceptible Section of an Accessory Bile Duct, cauterized 13:17 and caused bilioma in the next video

https://www.youtube.com/watch?v=kASyAgQuWx4

9- **Biloma management**, post accessory bile duct, ct scan then operation, wash out, **identify the duct 3:05 without writing and suture it** 3:50

https://www.youtube.com/watch?v=HXTNI2CGshI

Severe adhesions, omental and duodenum, anterior cystic artery, close common hepatic duct,

https://www.youtube.com/watch?v=UmHPu5fJ5Sw

https://www.youtube.com/watch?v=np8vsKX3Xw0

Scleroatrofic Gallbladder adhered to Transverse Colon + Primary **Suture of Colon**, very close CBD/ hepatic duct, retrograde dissection,

https://www.youtube.com/watch?v=6sm1r6Hd2U0

some adhesion, start with retro then normal dissection, long cystic artery

https://www.youtube.com/watch?v=zOUIAn8uWAQ

post pancreatitis difficult op, adhesion, anterior artery and close duodenum, very confusing operation to surgeon and observer

https://www.youtube.com/watch?v=Bb_E4uW872g

retro then normal dissection, flimsy adhesions, diathermy the artery

https://www.youtube.com/watch?v=gKz8p6gCBb4

anterior artery diathermy,

https://www.youtube.com/watch?v=QEukfeTsYSE

Cholecystectomy For Cholangitis + Endoscopic retrograde cholangiopancreatography (ERCP)

Adhesions, unusual high tie and cut the gallbladder, loop the remaining end, dissect and leave posterior wall (necrotic),

Ajay Kriplani ☑

https://www.youtube.com/watch?v=YlVXeI458Gc

10- Laparoscopic Cholecystectomy (Gallbladder Surgery) with Anomalous Right Hepatic Artery lateral to cystic duct 2:06, cystic artery clipped at 2:39 the second cystic artery 3:18 anatomy post gallbladder removal 03:54 (not the usual right artery as per images)

Sait Bakır ☑

https://www.youtube.com/watch?v=h8KRKBXOVvg

(CYSTIC ARTER BLEEDING CONTROL) /CHOLECYSTECTOMY 4:08 bleeding start continued clipping and cut the artery 4:45 clear bleeding point 6:42 clipped bleeding posterior branch could be used as example for missing branch but image quality is limited

Dr. Sarder A. Nayeem ☑

http://www.youtube.com/watch?v=-OIunbmdTro

Laparoscopic Cholecystectomy (unedited-2)-Low GB neck with short cystic duct.

Jonathan Carter ☑

http://www.youtube.com/watch?v=UX300cxhdJ4

11- Laparoscopic cholecystectomy complications - UCSF Lawrence Way, **bile duct injury diagram of injury at 0:09 then 0:19 CBD dissection, 0/:34 tenting effect 1:00 CBD clipping 1:19 CBD cut, second CBD clipping 2:17 , cutting 2:40, Duodenal injury 4:19 grasping the duodenum, 4:33 sign of perf, 4:48 perf confirmed,**

https://www.youtube.com/watch?v=UX300cxhdJ4&list=PLEA7780890536821C&index=6

same video

Evangelos Felekouras ☑(**only for the videos I produced myself**)

https://www.youtube.com/watch?v=jKAhF2281mk

12- This link shows injury of the CHD just below the confluence during laparoscopic cholecystectomy with false and true clues written on screen.

Surgeon managed to dissect the CBD and injure the CHD with diathermy then clip it and clip the cystic duct while narrowly avoiding an injury to the right hepatic artery. Please note the following moments in the clip: 0:30 CBD dissection, at 6:16 false duct/artery view, 9:35 right hepatic artery, 9:88 CHD injury, 12:51 cystic duct with CBD view, 13:18 cystic artery, 13:40 cystic artery clipped, 16:42 posterior cystic artery, 17:34 circle CBD injury, 19:00 clipping the injured CHD, 20:23 cystic duct clipped.

Dr. Mark Fraiman ☑

https://www.youtube.com/watch?v=Qv0YcmVnHJI

13- Bile Duct Injury Prevention, lecture , video 2:33 excess fat, 4:38 hratman pouch view, 6:00 **right hepatic artery** view close to dissection, 6:50 the two branching from the artery,

http://liverandpancreassurgeon.com For business enquiries: markfraiman@umm.edu

Dr. Sergey Baydo ☑

https://www.youtube.com/watch?v=IYgJWbYwZvk

14- Iatrogenic injury of left bile duct during laparoscopic gastrectomy with D2 lymph-node dissection. Laparoscopic repair of injury, 0:48 injury of duct, 3:05 tube inserted, suture 5:10,

Dr. Brij B. Agarwal ☑

https://www.youtube.com/watch?v=FXf7pMoCAeQ

15- Stone Ileus - Very Rare Complication of Gallbladder Disease- 0:05 loop retrieved out

Benjamín Jordán ☑

https://www.youtube.com/watch?v=WghE4TfQlFk

16- Tips & Tricks in cholecystectomy. Injury of liver parenchyma adjacent to the falciform ligament 0:11, coagulation 0:28

https://www.youtube.com/watch?v=VaybqAcmjnc

Tips & Tricks in cholecystectomy. Safe dissection of Calot´s Triangle

https://www.youtube.com/watch?v=uMTM4HfhZNE

Tips & Tricks in cholecystectomy. Prevention of duodenal injuries.

https://www.youtube.com/watch?v=mBoe62s67nE

Cholecystectomy Tips & Tricks. Inadequate control of bleeding, atrery bleeding 0:16, 1:02 clipped no control, gauze inserted 1:37 then pressure applied,

https://www.youtube.com/watch?v=IOJ_97H683Y

Cholecystectomy Tips & tricks

https://www.youtube.com/watch?v=Ipsr0OEbFoQ

Cholecystectomy in Mirizzi syndrome type I

https://www.youtube.com/watch?v=kemx762sxpo

17- Cholecystectomy didactic vascular anomaly, cystic artery from left hepatic artery 1:12 written names on screen, 2:00 critical view, packing with gauze for hemostasis 2:56,

https://www.youtube.com/watch?v=mXhHr__HEJc

18- Cholecystectomy Complicated no gallbladder fossa bleeding but can be used to ask for hemostasis with gauze?

https://www.youtube.com/watch?v=AYVdAqFesUE

Gallbladder implanted in the left lobe

https://www.youtube.com/channel/UCA4cRbSetxlbTd7l3SIkzqg/videos

Multiple tips and tricks videos

Narotam Dewan ☑ (inform him)

http://www.youtube.com/watch?v=OrQvh4aB4fM

Laparoscopic cholecystectomy - Bleeding from gall bladder fossa - Dr Narotam Dewan, Dewan Hospital. Dr Narotam-Dewan-Hospital Ludhiana (youtube + hangout + comment+ facebook+ tweet)

http://www.youtube.com/watch?v=bqFU57ztWoQ

Laparoscopic Cholecystectomy cystic artery broke on application of clip diabetic patient part 1. Dr Narotam-Dewan-Hospital Ludhiana (youtube + hangout), 2:15 removing fat adhesion caused liver bleeding,

No permissions

https://www.youtube.com/watch?v=AjB4_fubq0Q

Anomalous rt.hepatic artery encountered in lap chole By Dr.Deba Kumar Choudhury, 0:59 right hepatic artery,

https://www.youtube.com/watch?v=Pl1Mv1OdR40

Ruptured cystic artery aneurysm during lapchole. **Ovidiu Florica** http://www.sydneygastricbanding.com.au

https://www.youtube.com/watch?v=ssTwAyJtRIE

CBD injury in laparoscopic cholecystectomy - Dr. Kuldip Singh. Gurtej Singh (youtube + hangout one video no image and multiple similar names +youtube comment), low dissection, no critical view, clipping and cutting CBD,

http://www.youtube.com/watch?v=CHJcefY4wgo

Detection of accessory bile duct during laparoscopic cholecystectomy. lk kukreja (hangout + you tube + youtube comment)

http://www.youtube.com/watch?v=axm57tYcqig laparoscopic cholecystectomy - rupture of the gallbladder. www.MedTube.eu

MEDtube sp. z o. o.
59 Zlota St.
00-120 Warsaw
T: 0048 22 240 22 34
F: 0048 22 222 46 01

United States
55 Tiemann Place
Suite 29
New York, NY 10027

RocketSpace Suites
180 Sansome St. VI floor
San Francisco, CA 94104

http://www.youtube.com/watch?v=tUeNq-FfTbo

19- clipping Rt.hepatic artery-Dr.Gamal Sakr. (youtube + hangout + youtube comment then email) clipped the RHA then at 2:12 before cutting realized the anatomy, 3:14 liver ischemia, 3:20 removing clips, 4:11 ischemia improved (marking the dead area if clips left in),

http://www.youtube.com/watch?v=mU_V6gyE4SQ

Control of bleeding cystic artery in laparoscopic cholecystectomy. MFaisalMurad (NO massage) last post 4 years ago (dead account) (youtube comment)

http://www.youtube.com/watch?v=LtotN4MeKrw

20- Identification of tangential hepatic vein during laparoscopic cholecystectomy. 김성민 (youtube + hangout + youtube comment) 3:03 diagram of cystic artery from RHA, 5:35 identify the hepatic vein in the gallbladder fossa, article downloaded

http://www.youtube.com/watch?v=s4MOlI2JQDc

Right hepatic artery rupture. www.MedTube.eu (youtube comment)

http://www.youtube.com/watch?v=CZrFkZaRbPs

Unexpected surprise Laparoscopic Cholecystectomy.wmv. G.B is to the left of the falciform ligament ALEXEA Endoscopy (youtue + hangout + youtube comment) Wael Nabil Abdel Salam, Assistant Professor of General & Laparoscopic surgery, Faculty of Medicine, university of Alexandria, Alexandria Egypt.

Tel: Home: 0203/4206048

Cellular: 0123304841

wael.lap.center@gmail.com

http://www.youtube.com/watch?v=7UmNY6oCzbw

A complicated case of laparoscopic cholecystectomy. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) (youtube comment)

http://www.youtube.com/watch?v=j1mGhQ_iRxw

BILE DUCT INJURIES TREATMANT OF LATE COMPLICATIONS Eduardo de Santibanes,MD ARGENTINA. Medicaldtv (youtube comment)

http://www.youtube.com/watch?v=aaMRXulDIHY

21- Video Symposium: Fear During the Routine Lap Chole - The Bile Duct Might Be/Is Injured. Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) 1:45 the tenting effect diagram, mmarohn1@jhmi.edu

associate professor Michael Robert Marohn

- Diathermy injury to common bile duct
- Diathermy injury to duodenum

https://www.youtube.com/watch?v=KNphM8HlY5g

22- Treatment of Duodenal Cautery Burning during Laparoscopic Cholecystectomy, 0:35 stapling injury failed, 3:03 stitching

Shahram Nazari, MD : General Surgeon / Gastrointestinal Hybrid Surgeon

Office : >No. 1, Afarin Medical Building, Afarin Alley, Alvand St., Argentin Sq., Tehran 1516636113, Iran

Phone : (+98 21) 88884610, (+98 21) 88884652

Mobile : (+98) 9121583700

Fax : (+98 21) 88678159

Email : info@shahramnazari.com

https://www.youtube.com/watch?v=VKH9yd5pJWE

23- conducto biliar accesorio-accessory biliary duct alvarez luis fernando (massage, discussion)(last activity 1 year ago) 0:42 accessory duct, 1:12 clipping

https://www.youtube.com/watch?v=LGwiXJmNlQ4

Near miss bile duct injury **John Hagen**, 1:39 right hepatic artery view close to posterior wall

https://www.youtube.com/watch?v=dwul7r3E3K4&list=PLEA7780890536821C

John Thanakumar complication list 0:17 port arterial bleeding, controlled as in the video using port closure needle for both proximal and distal ties on the inferior epigastric artery

Normal anatomy and anatomical variations in the laparoscopic cholecystectomy

https://www.youtube.com/watch?v=5BWUvYA-gnE

Intra Operative Gall stone Spillage at Laparoscopic Cholecystectomy - dr varunraju, spillage on extraction 1:20, collected with grasper

https://www.youtube.com/watch?v=dK_wk_7K_co&list=PLYxWoflrrmxYSPX2e87Bokeb0H0SkiHRR&index=17

Laparoscopic Cholecystectomy in a patient with Situs Inversus Totalis(S.I.T)

https://www.youtube.com/watch?v=JE1NkO0R_xs

24- Gallstone Ileus - A complication due to GALLBLADDER STONE DISEASES, start with CT scan for gallstone ileus, 0:29 open view of bowel with gallstone, 0:50 enterotomy, 0:56 stone size

Appendix 5

From: CLARK R.K.
Sent: Friday, September 04, 2015 3:32 PM
To: ISREB S.
Subject: RE: [3-5916000005345] query

Hi Siddek,

Provided you only use video footage for which you have collected permission from the copyright holder, I am happy that you have done what's legally necessary for this work to go ahead. I am satisfied with the permissions you have collected so far. Please adhere carefully to the boundaries of these permissions, and in the event that the work you intend to do varies significantly from the work you have requested permission to undertake, please go back to the copyright holders to request an expansion of these permissions.

The only final note I must make on this is for you to ensure that no identifiable personal data of information is featured or disclosed via this footage without the express consent of the data subject.

I am happy for you to pass this email to the ethics committee if it is helpful.

Kind regards

Rachel

Rachel Clark
Legal Support Officer

Legal Support
University of Durham,

Mountjoy Centre, Maple Block,

Stockton Road,

Durham,

DH1 3UP

Tel: +44 (0) 191 33 49137

Fax: +44 (0) 191 33 44634

r.k.clark@durham.ac.uk

Appendix 6

Next question

Identifying anatomical variation clues could help predicting and planning to avoid possible risks. Can you identify the possible anatomical variation in the following clips:

https://www.youtube.com/watch?v=YQX810OrlfM
https://www.youtube.com/watch?v=NXnBRT2TxZ8

use 2:38 to 2:50 from the first link and 1:30 to 1:35 from the second (second one is anterior)

1- what is the possible cystic artery anatomical variation

   a- Cystic artery doubling (This is the correct answer)

   b- Cystic artery originating from right hepatic artery

   c- Cystic artery originating from the gastroduodenal artery

   d- Cystic artery originating from the left hepatic artery

   a- Recurrent cystic artery

Artery identification might be easy in the skinny gallbladder (second clip 2:53 to 2:58) but would require further dissection in a fatty gallbladder 10:40 to 11:35

Identifying anatomical clues help predicting and planning to manage possible risks. Those risks might be simple bleeding in this case or it might lead to more serious consequences as it would be shown in the flowing questions (either continue link one clip 11:35-12:48 in first clip) or use the clip below

https://www.youtube.com/watch?v=h8KRKBXOVvg **Use 4:55 to 5:10 control at 6:50 (CYSTIC ARTER BLEEDING CONTROL 4:08 bleeding start continued clipping and cut the artery 4:45 clear bleeding point 6:42 clipped) bleeding posterior branch could be used as example for missing branch but image quality is limited**

Note : artery cauterization is the preferred method for this expert surgeon. We are not recommending any particular method in this assessment. Our focus is on identifying risk clues and planning to mitigate any predicted problem using surgeons experience and preferred techniques.

Next question

https://www.youtube.com/watch?v=Qv0YcmVnHJI

2- what is the possible cystic artery anatomical variation in this clip use 6:00 to 6:50

a- Cystic artery doubling

b- Cystic artery originating from right hepatic artery (This is the correct answer)

c- Cystic artery originating from the gastroduodenal artery

d- Cystic artery originating from the left hepatic artery

b- Recurrent cystic artery

Clear view and clipping 12:06 to 12:36

Extra examples:

https://www.youtube.com/watch?v=LGwiXJmNlQ4

Near miss bile duct injury **John Hagen**, 1:39 right hepatic artery view close to posterior wall, the clue is in 2:10 to 2:19 and at 2:41 to 3: is the artery view after clipping ad cutting the cystic duct **((No permission, streaming only))**

Next question:

3- What would be the possible consequences of missing the anatomical variation and clipping the right hepatic artery:

The answer is: right liver (or hepatic) ischemia

4- How do you identify and recover from such hazard:

The answer is: Signs of liver ischemia

Please watch the link below for the full 6 minutes. It shows a surgeon identifying liver ischemic signs and removing the clips from the right hepatic artery to prevent damage. Please note the color difference between the two liver loops after applying the clips and the improvement post clip removal. Missing the hazard and failing to recover he clips would have resulted in right hepatic abscess and the need for lobectomy.

Note: Unfortunately we could not get a permission to download the video so we have to stream it online

http://www.youtube.com/watch?v=tUeNq-FfTbo clipping Rt.hepatic artery- then at 2:12 before cutting realized the anatomy, 3:14 liver ischemia, 3:20 removing clips, 4:11 ischemia improved (marking the dead area if clips left in), **((No permission, streaming only))**

Next question:

Laparoscopic view clues would help identifying anatomical variation but they would not cover all the possible variations and would not replace the need for careful dissection and establishing the critical view. In the remaining questions in this part we will show more cystic artery anatomical variation

Not sure if to continue with questions or just show the cases

https://www.youtube.com/watch?v=3Jqu37vMBAg Use clip 1:00 to 2:05

5- what is the possible cystic artery anatomical variation

a- branching cystic artery

b- Cystic artery originating from right hepatic artery

c- Cystic artery originating from the gastroduodenal artery (This is the correct answer)

d- Cystic artery originating from the left hepatic artery

c- Recurrent cystic artery

https://www.youtube.com/watch?v=kemx762sxpo use 0:36 to 2:18 then

https://www.youtube.com/watch?v=YlVXeI458Gc Use 1:49 to 2:16 at 2:17-2:24 anatomy written on screen, left hepatic artery 3:00 to 3:10 and then names on screen, post resection 3:57 to 4:10 then names on screen at 4:13 **(not the usual right artery as per images)**

Extra examples:

https://www.youtube.com/watch?v=AjB4_fubq0Q

Anomalous rt.hepatic artery encountered in lap chole By Dr.Deba Kumar Choudhury, 0:59 right hepatic artery, **((No permission, streaming only))**

http://www.youtube.com/watch?v=LtotN4MeKrw

Identification of tangential hepatic vein during laparoscopic cholecystectomy. 김성민 (youtube + hangout + youtube comment) 3:03 diagram of cystic artery from RHA, 5:35 identify the hepatic vein in the gallbladder fossa, article downloaded **((No permission, streaming only))**

Appendix 7

During routine laparoscopic cholecystectomy the surgeon encountered the injury presented in the image below. How do you describe this injury using is Strasberg classification:

https://www.youtube.com/watch?v=jKAhF2281mk

use 6:30 to 7:00 and 7:30 to 7:40 and 8:23 to 8:35 and 9:32 to 10:10 and 10:26 to 10:332 and 13:10 to 13:20 and 14:55 to 15:10 and 15:16 to 15:21 and 16:32 to 16:43 and 17:30 to 18:10 and 18:48 to 19:05 and 20: 20 to 20:31 and 20:50 to 21:16

How do you describe this injury using is Strasberg classification: (ideally image and choices should be in one page)

A- A

B- B

C- C

D- D

E- E1 / E2 (this is the correct answer)

F- E3

G- E4

H- E5

Note: Patient in the above clip had a successful repair in a tertiary Centre 4 months after the injury and recovered well.

Appendix 8

Surgeons Survey

Progress to date ***1. Diagnosis:*** *Not Started,* ***2. Artery:*** *Not Started,* ***3. Bile Duct:*** *Not Started,* ***4. Complications:*** *Not Started.*

siddek,

Thank you for kindly joining our study.
This assessment will allow you to check your knowledge as well as supporting your professional development. It is meant to mentally prepare you to anticipate and avoid possible surgical hazards.

It is divided into four sections, which you should work through in sequence:

1. DIAGNOSIS

Part 1 Start Here

2. ARTERY

Part 1
Part 2
Part 3
Part 4
Part 5
Part 6 (optional)

3. BILE DUCT

Part 1
Part 2
Part 3
Part 4
Part 5
Part 6
Part 7
Part 8 (optional)

4. COMPLICATIONS

Part 1
Part 2
Part 3
Part 4
Part 5 (no questions)
Part 6 (no questions)
Part 7
Part 8
Part 9 (final)

Click a link above to begin. Each part contains questions. You have two attempts to answer each one correctly. After that you will only be shown the answers. You will be asked to watch video clips from a real operation with real risks and complications. There are essential mandatory video clips and some additional optional ones (which you can look at as you go through or have them forwarded to your email address for later review).

Video clip owners have provided the copyright permission on restricted access hence the need for a username and password. Access will expire once you finish the assessment.

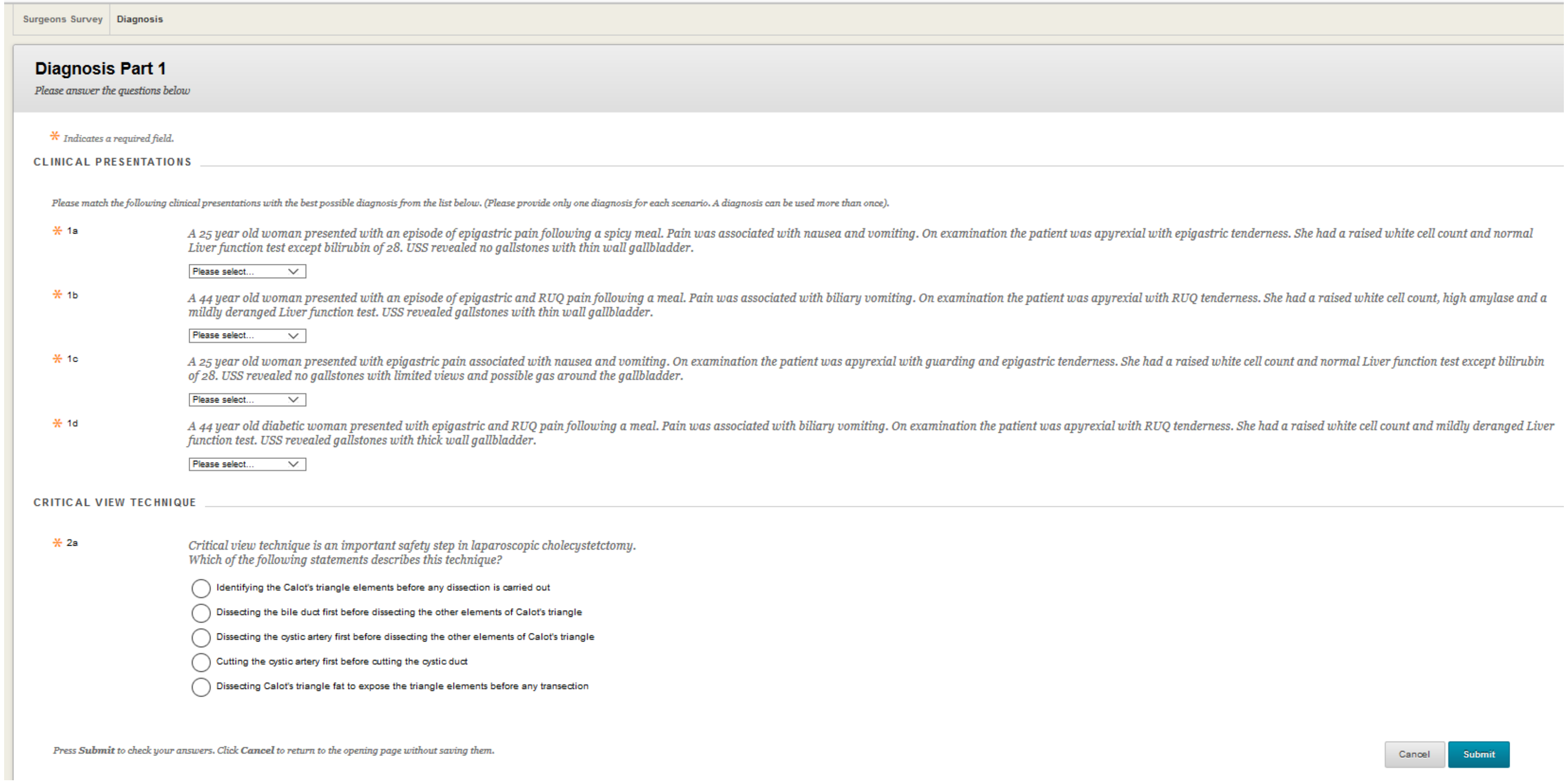
It should take you approximately 40 minutes (additional time might be needed if you opt to watch the optional videos).

Results will be grouped and anonymized so your individual scores will not be accessible.

The assessment will be available for two weeks and I will send you a reminder via email during this period. Many thanks for your kind cooperation.

Siddek Isreb
siddek.isreb@durham.ac.uk

Appendix 9



Surgeons Survey | Diagnosis

Diagnosis Part 1

Please answer the questions below

* *Indicates a required field.*

CLINICAL PRESENTATIONS

Please match the following clinical presentations with the best possible diagnosis from the list below. (Please provide only one diagnosis for each scenario. A diagnosis can be used more than once).

* 1a *A 25 year old woman presented with an episode of epigastric pain following a spicy meal. Pain was associated with nausea and vomiting. On examination the patient was apyrexial with epigastric tenderness. She had a raised white cell count and normal Liver function test except bilirubin of 28. USS revealed no gallstones with thin wall gallbladder.*

Please select...

* 1b *A 44 year old woman presented with an episode of epigastric and RUQ pain following a meal. Pain was associated with biliary vomiting. On examination the patient was apyrexial with RUQ tenderness. She had a raised white cell count, high amylase and a mildly deranged Liver function test. USS revealed gallstones with thin wall gallbladder.*

Please select...

* 1c *A 25 year old woman presented with epigastric pain associated with nausea and vomiting. On examination the patient was apyrexial with guarding and epigastric tenderness. She had a raised white cell count and normal Liver function test except bilirubin of 28. USS revealed no gallstones with limited views and possible gas around the gallbladder.*

Please select...

* 1d *A 44 year old diabetic woman presented with epigastric and RUQ pain following a meal. Pain was associated with biliary vomiting. On examination the patient was apyrexial with RUQ tenderness. She had a raised white cell count and mildly deranged Liver function test. USS revealed gallstones with thick wall gallbladder.*

Please select...

CRITICAL VIEW TECHNIQUE

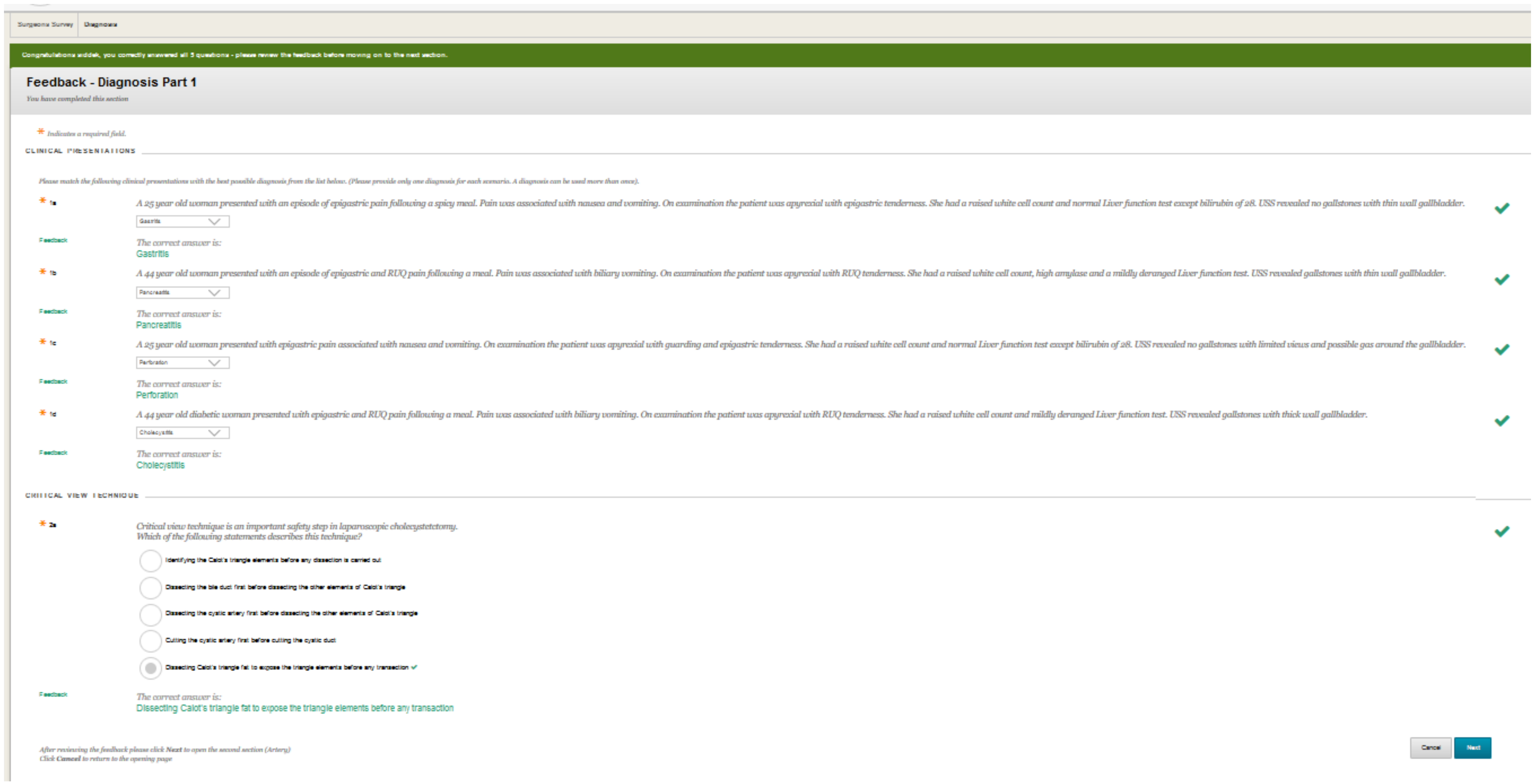
* 2a *Critical view technique is an important safety step in laparoscopic cholecystetctomy. Which of the following statements describes this technique?*

- Identifying the Calot's triangle elements before any dissection is carried out
- Dissecting the bile duct first before dissecting the other elements of Calot's triangle
- Dissecting the cystic artery first before dissecting the other elements of Calot's triangle
- Cutting the cystic artery first before cutting the cystic duct
- Dissecting Calot's triangle fat to expose the triangle elements before any transection

*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

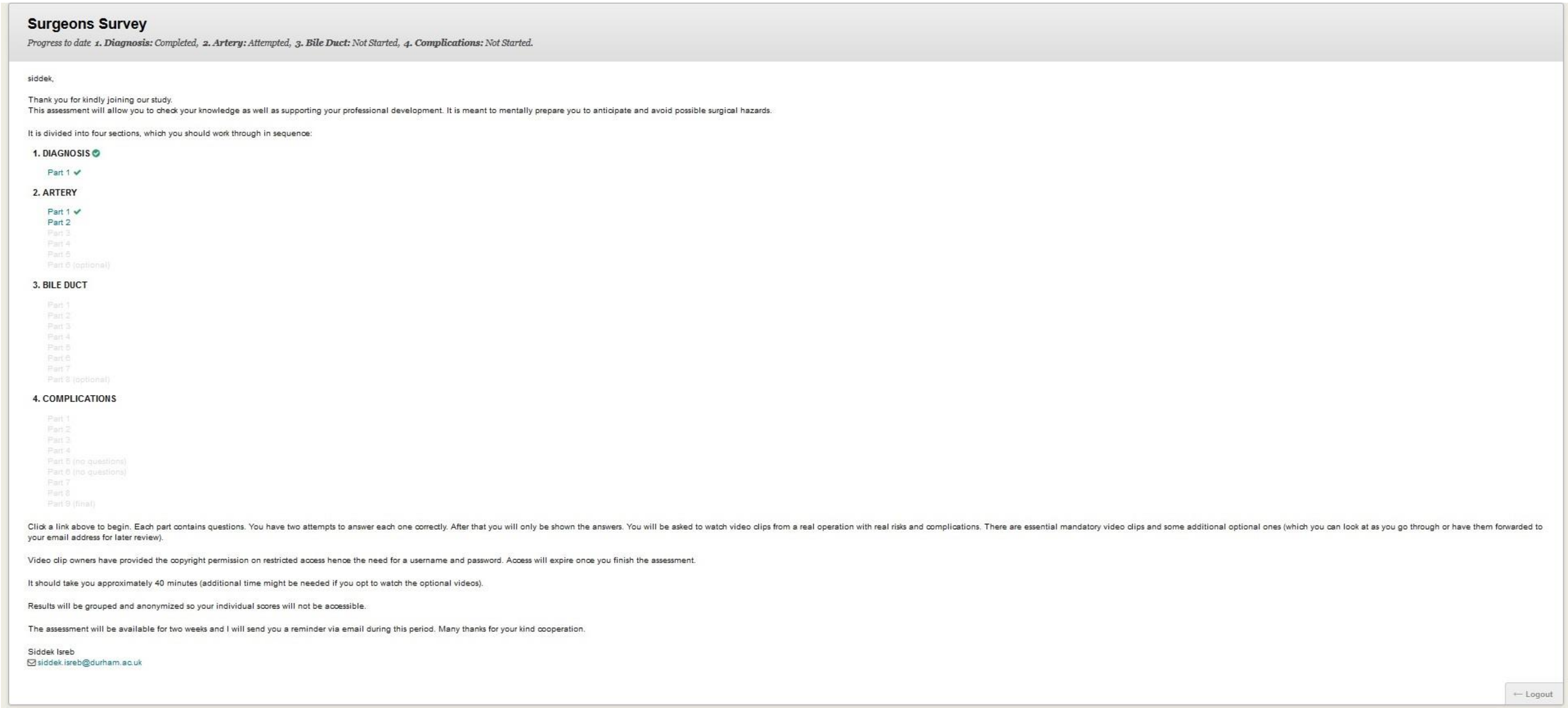
Cancel | Submit

Appendix 10



Surgeons Survey
Diagnosis
Congratulations siddek, you correctly answered all 5 questions - please review the feedback before moving on to the next section.
Feedback - Diagnosis Part 1
You have completed this section
* Indicates a required field.
CLINICAL PRESENTATIONS
Please match the following clinical presentations with the best possible diagnosis from the list below. (Please provide only one diagnosis for each scenario. A diagnosis can be used more than once).
* 1a
A 25 year old woman presented with an episode of epigastric pain following a spicy meal. Pain was associated with nausea and vomiting. On examination the patient was apyrexial with epigastric tenderness. She had a raised white cell count and normal Liver function test except bilirubin of 28. USS revealed no gallstones with thin wall gallbladder.
Gastritis
Feedback
The correct answer is:
Gastritis
* 1b
A 44 year old woman presented with an episode of epigastric and RUQ pain following a meal. Pain was associated with biliary vomiting. On examination the patient was apyrexial with RUQ tenderness. She had a raised white cell count, high amylase and a mildly deranged Liver function test. USS revealed gallstones with thin wall gallbladder.
Pancreatitis
Feedback
The correct answer is:
Pancreatitis
* 1c
A 25 year old woman presented with epigastric pain associated with nausea and vomiting. On examination the patient was apyrexial with guarding and epigastric tenderness. She had a raised white cell count and normal Liver function test except bilirubin of 28. USS revealed no gallstones with limited views and possible gas around the gallbladder.
Perforation
Feedback
The correct answer is:
Perforation
* 1d
A 44 year old diabetic woman presented with epigastric and RUQ pain following a meal. Pain was associated with biliary vomiting. On examination the patient was apyrexial with RUQ tenderness. She had a raised white cell count and mildly deranged Liver function test. USS revealed gallstones with thick wall gallbladder.
Cholecystitis
Feedback
The correct answer is:
Cholecystitis
CRITICAL VIEW TECHNIQUE
* 2a
Critical view technique is an important safety step in laparoscopic cholecystetectomy.
Which of the following statements describes this technique?
Identifying the Calot's triangle elements before any dissection is carried out
Dissecting the bile duct first before dissecting the other elements of Calot's triangle
Dissecting the cystic artery first before dissecting the other elements of Calot's triangle
Cutting the cystic artery first before cutting the cystic duct
Dissecting Calot's triangle fat to expose the triangle elements before any transection
Feedback
The correct answer is:
Dissecting Calot's triangle fat to expose the triangle elements before any transaction
After reviewing the feedback please click Next to open the second section (Artery)
Click Cancel to return to the opening page
Cancel
Next

Appendix 11


Surgeons Survey

Progress to date ***1. Diagnosis:*** *Completed,* ***2. Artery:*** *Attempted,* ***3. Bile Duct:*** *Not Started,* ***4. Complications:*** *Not Started.*

siddek,

Thank you for kindly joining our study.
This assessment will allow you to check your knowledge as well as supporting your professional development. It is meant to mentally prepare you to anticipate and avoid possible surgical hazards.

It is divided into four sections, which you should work through in sequence:

1. DIAGNOSIS

- Part 1 ✔

2. ARTERY

- Part 1 ✔
- Part 2
- Part 3
- Part 4
- Part 5
- Part 6 (optional)

3. BILE DUCT

- Part 1
- Part 2
- Part 3
- Part 4
- Part 5
- Part 6
- Part 7
- Part 8 (optional)

4. COMPLICATIONS

- Part 1
- Part 2
- Part 3
- Part 4
- Part 5 (no questions)
- Part 6 (no questions)
- Part 7
- Part 8
- Part 9 (final)

Click a link above to begin. Each part contains questions. You have two attempts to answer each one correctly. After that you will only be shown the answers. You will be asked to watch video clips from a real operation with real risks and complications. There are essential mandatory video clips and some additional optional ones (which you can look at as you go through or have them forwarded to your email address for later review).

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Results will be grouped and anonymized so your individual scores will not be accessible.

The assessment will be available for two weeks and I will send you a reminder via email during this period. Many thanks for your kind cooperation.

Siddek Isreb
siddek.isreb@durham.ac.uk

← Logout

Appendix 12

Surgeons Survey | Artery

Artery Part 1

The Artery section comprises six parts. This page is the first.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

CYSTIC ARTERY

* 3

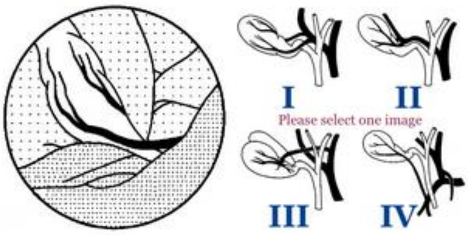
The cystic artery has potential anatomical anomalies
*Which **one** of the following statements represents the most common anatomical anomaly?*

- ○ Cystic artery doubling
- ○ Cystic artery originating from the right hepatic artery
- ○ Cystic artery originating from the gastroduodenal artery
- ○ Cystic artery originating from the left hepatic artery
- ○ Recurrent cystic artery

IMAGE MATCHING

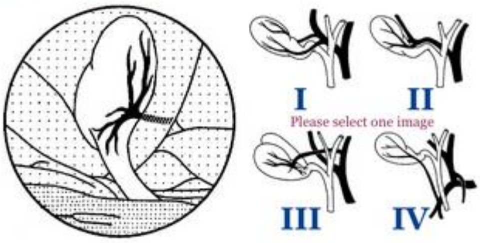
Match the laparoscopic view of the cystic artery shown in each question with the corresponding diagram of the anatomical variety. Use the select control below each image to pick the appropriate diagram

* 4a



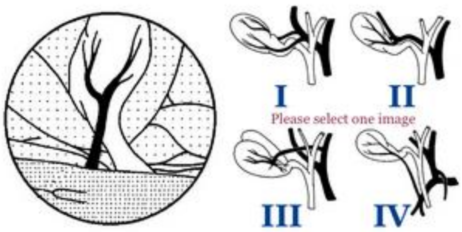
Select a value to change the answer image displayed...

* 4b



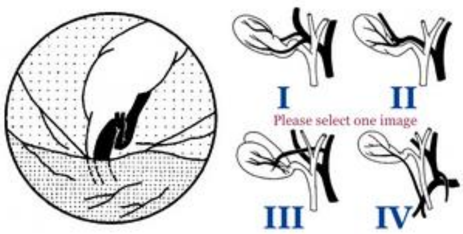
Select a value to change the answer image displayed...

* 4c



Select a value to change the answer image displayed...

* 4d



Select a value to change the answer image displayed...

*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel Submit

Appendix 13

Surgeons Survey | Artery

Artery Part 1

The Artery section comprises six parts. This page is the first.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

CYSTIC ARTERY

* 3

The cystic artery has potential anatomical anomalies
*Which **one** of the following statements represents the most common anatomical anomaly?*

- (●) Cystic artery doubling
- ( ) Cystic artery originating from the right hepatic artery
- ( ) Cystic artery originating from the gastroduodenal artery
- ( ) Cystic artery originating from the left hepatic artery
- ( ) Recurrent cystic artery

IMAGE MATCHING

Match the laparoscopic view of the cystic artery shown in each question with the corresponding diagram of the anatomical variety. Use the select control below each image to pick the appropriate diagram

* 4a

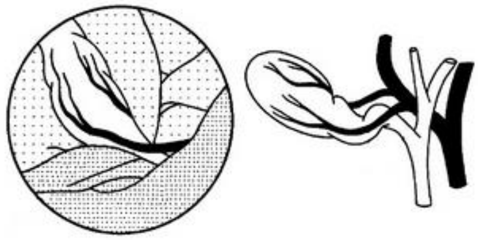


Image - I

* 4b

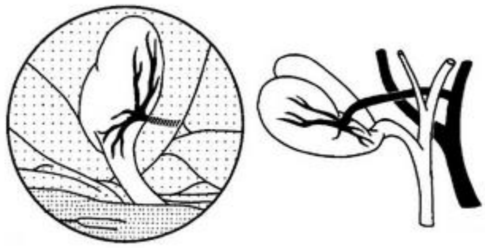


Image - II

* 4c

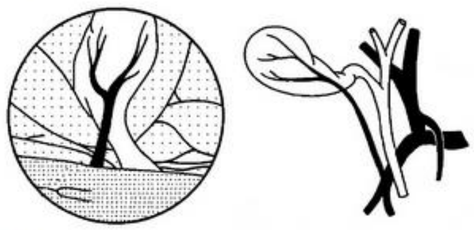


Image - IV

* 4d

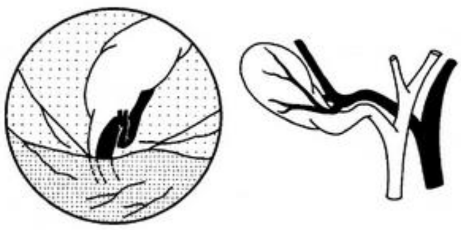
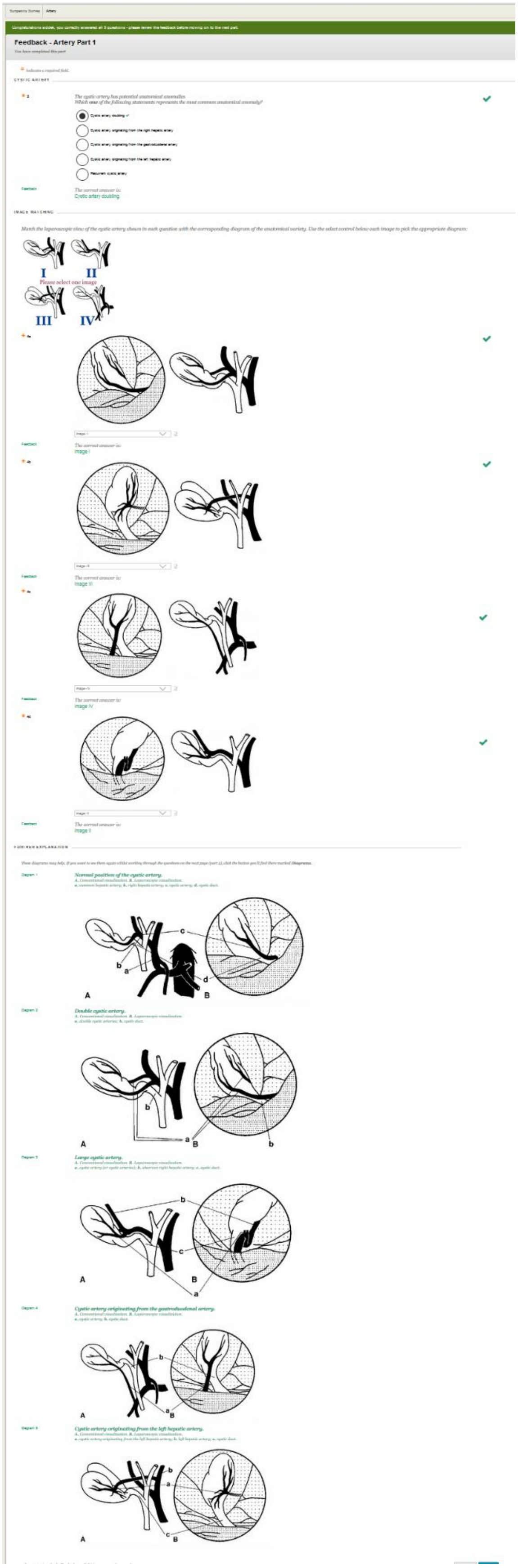


Image - II

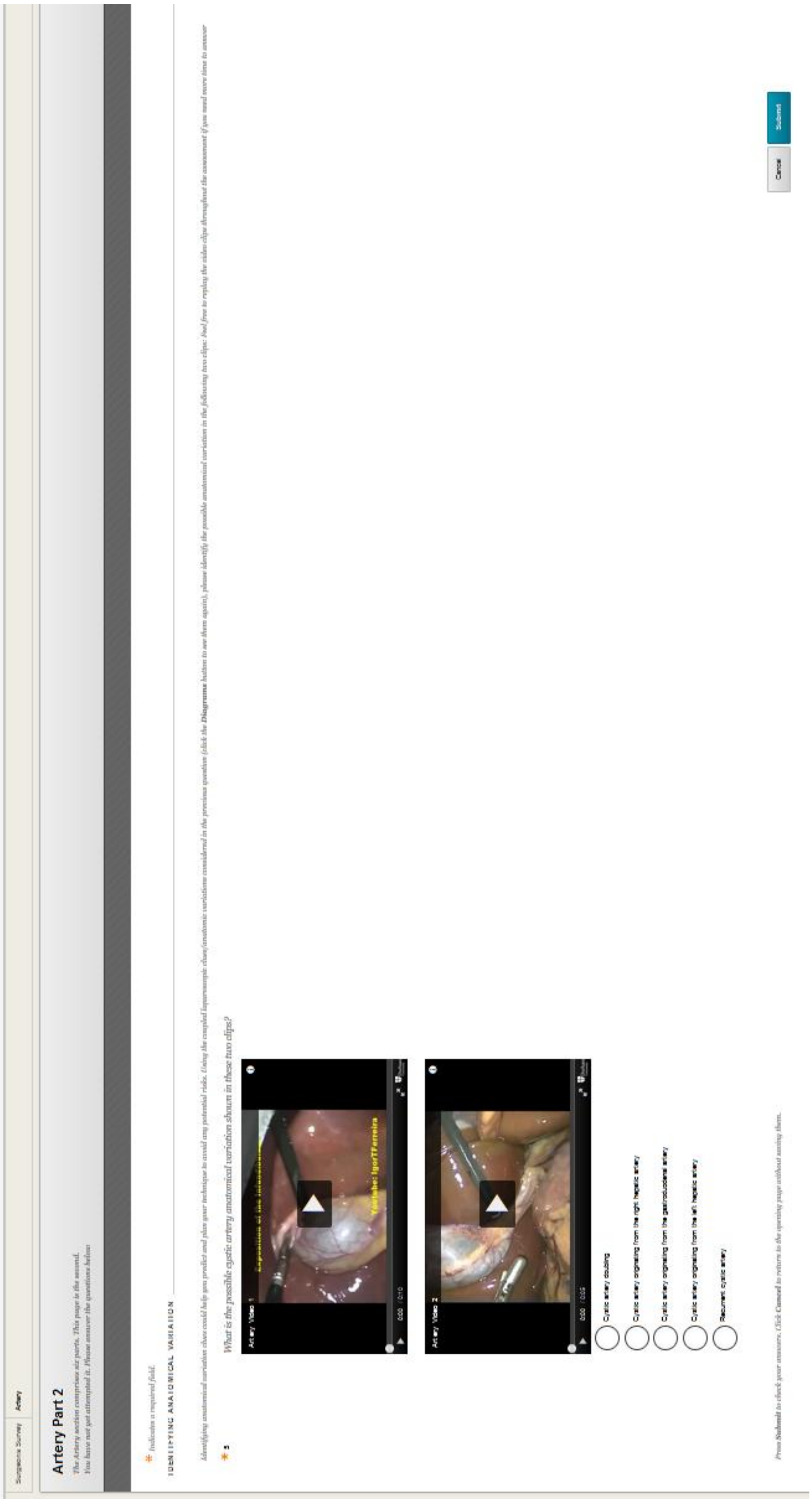
*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel | Submit

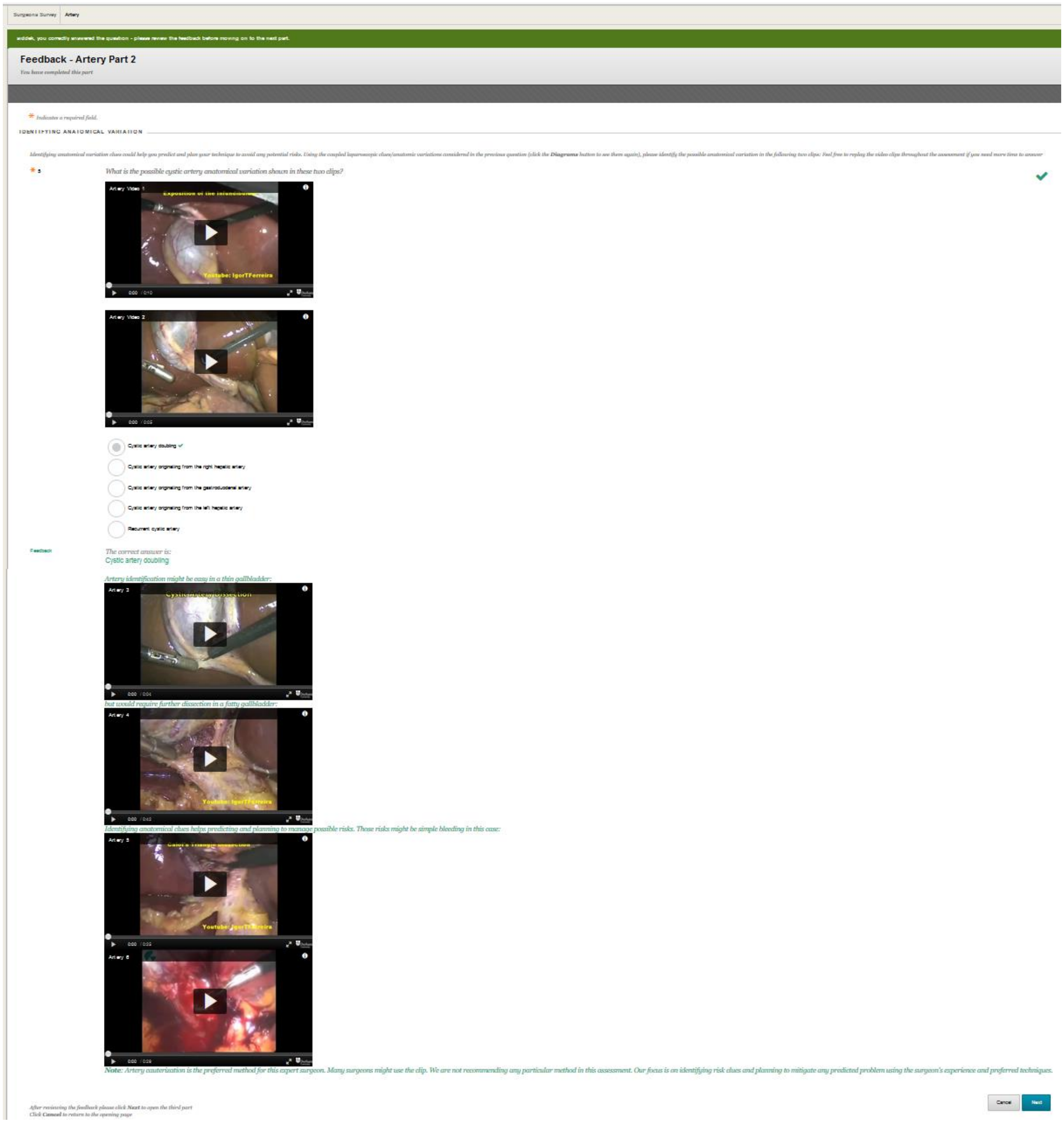
Appendix 14


Feedback - Artery Part 1
The correct answer is:
Cystic artery doubling
I
II
Please select one image
III
IV
The correct answer is:
The correct answer is:
The correct answer is:
The correct answer is:
Normal position of the cystic artery.
c
b
a
d
A
B
Double cystic artery.
b
a
A
B
b
Large cystic artery.
b
c
A
B
a
Cystic artery originating from the gastroduodenal artery.
b
a
A
B
Cystic artery originating from the left hepatic artery.
b
a
c
A
B

Appendix 15

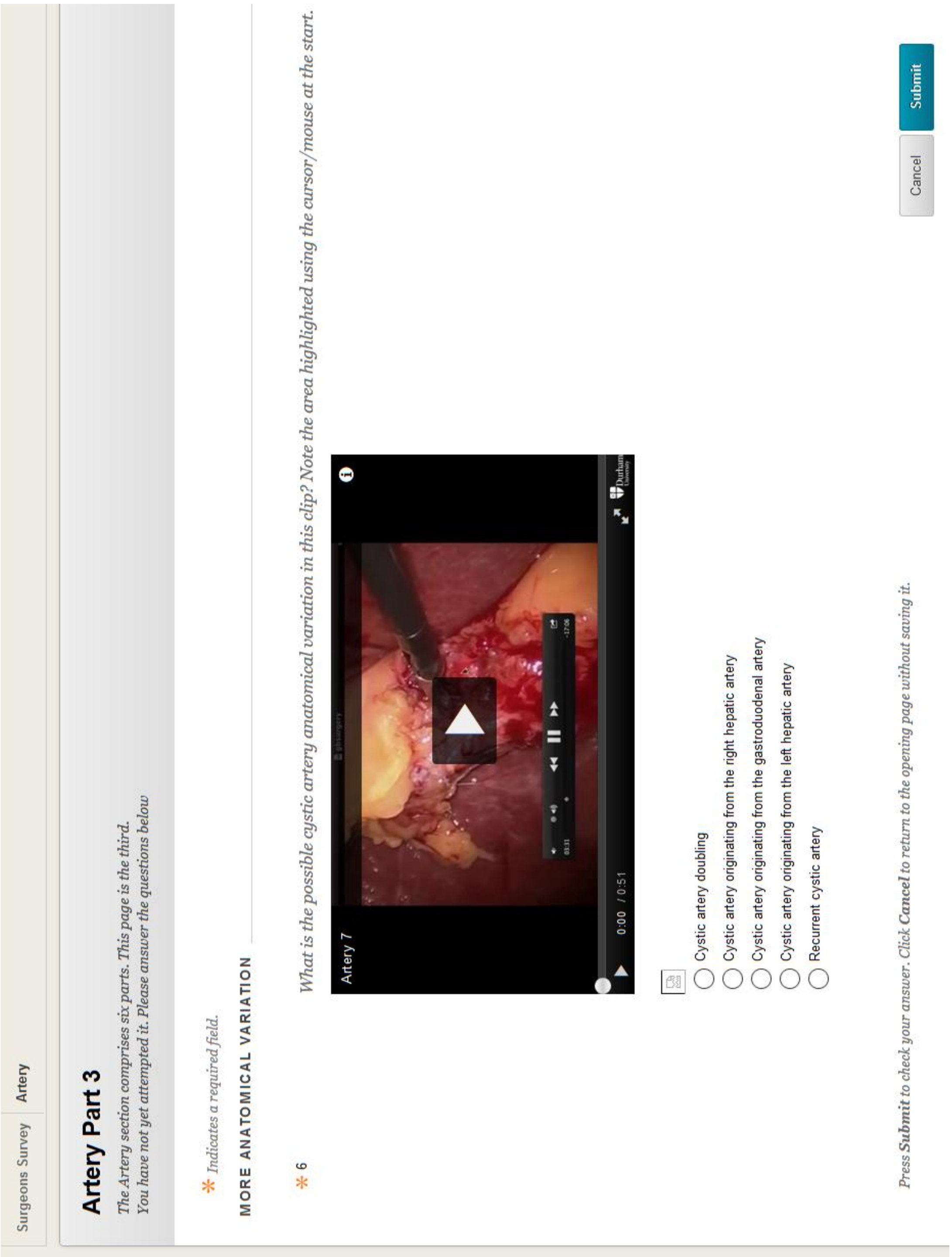

Surgeons Survey
Artery
Artery Part 2
IDENTIFYING ANATOMICAL VARIATION
What is the possible cystic artery anatomical variation shown in these two clips?
Artery Video 1
Artery Video 2
Cystic artery doubling
Cystic artery originating from the right hepatic artery
Cystic artery originating from the gastroduodenal artery
Cystic artery originating from the left hepatic artery
Recurrent cystic artery
Cancel
Submit

Appendix 16



Surgeons Survey
Artery
Feedback - Artery Part 2
You have completed this part
Indicates a required field.
IDENTIFYING ANATOMICAL VARIATION
What is the possible cystic artery anatomical variation shown in these two clips?
Artery Video 1
Youtube: IgorTFerreira
Cystic artery doubling
Cystic artery originating from the right hepatic artery
Cystic artery originating from the gastroduodenal artery
Cystic artery originating from the left hepatic artery
Recurrent cystic artery
Feedback
The correct answer is:
Cystic artery doubling
Artery identification might be easy in a thin gallbladder:
but would require further dissection in a fatty gallbladder:
Identifying anatomical clues helps predicting and planning to manage possible risks. These risks might be simple bleeding in this case:
Note: Artery cauterization is the preferred method for this expert surgeon. Many surgeons might use the clip. We are not recommending any particular method in this assessment. Our focus is on identifying risk clues and planning to mitigate any predicted problem using the surgeon's experience and preferred techniques.
After reviewing the feedback please click Next to open the third part
Click Cancel to return to the opening page
Cancel
Next

Appendix 17



Surgeons Survey | Artery

Artery Part 3

The Artery section comprises six parts. This page is the third.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

MORE ANATOMICAL VARIATION

* 6

What is the possible cystic artery anatomical variation in this clip? Note the area highlighted using the cursor/mouse at the start.

Artery 7

0:00 / 0:51

- Cystic artery doubling
- Cystic artery originating from the right hepatic artery
- Cystic artery originating from the gastroduodenal artery
- Cystic artery originating from the left hepatic artery
- Recurrent cystic artery

*Press **Submit** to check your answer. Click **Cancel** to return to the opening page without saving it.*

Cancel | Submit

Appendix 18

Feedback - Artery Part 3

You have completed this part

* *Indicates a required field.*

MORE ANATOMICAL VARIATION

* 6

What is the possible cystic artery anatomical variation in this clip? Note the area highlighted using the cursor/mouse at the start.

- Cystic artery doubling
- Cystic artery originating from the right hepatic artery ✔
- Cystic artery originating from the gastroduodenal artery
- Cystic artery originating from the left hepatic artery
- Recurrent cystic artery

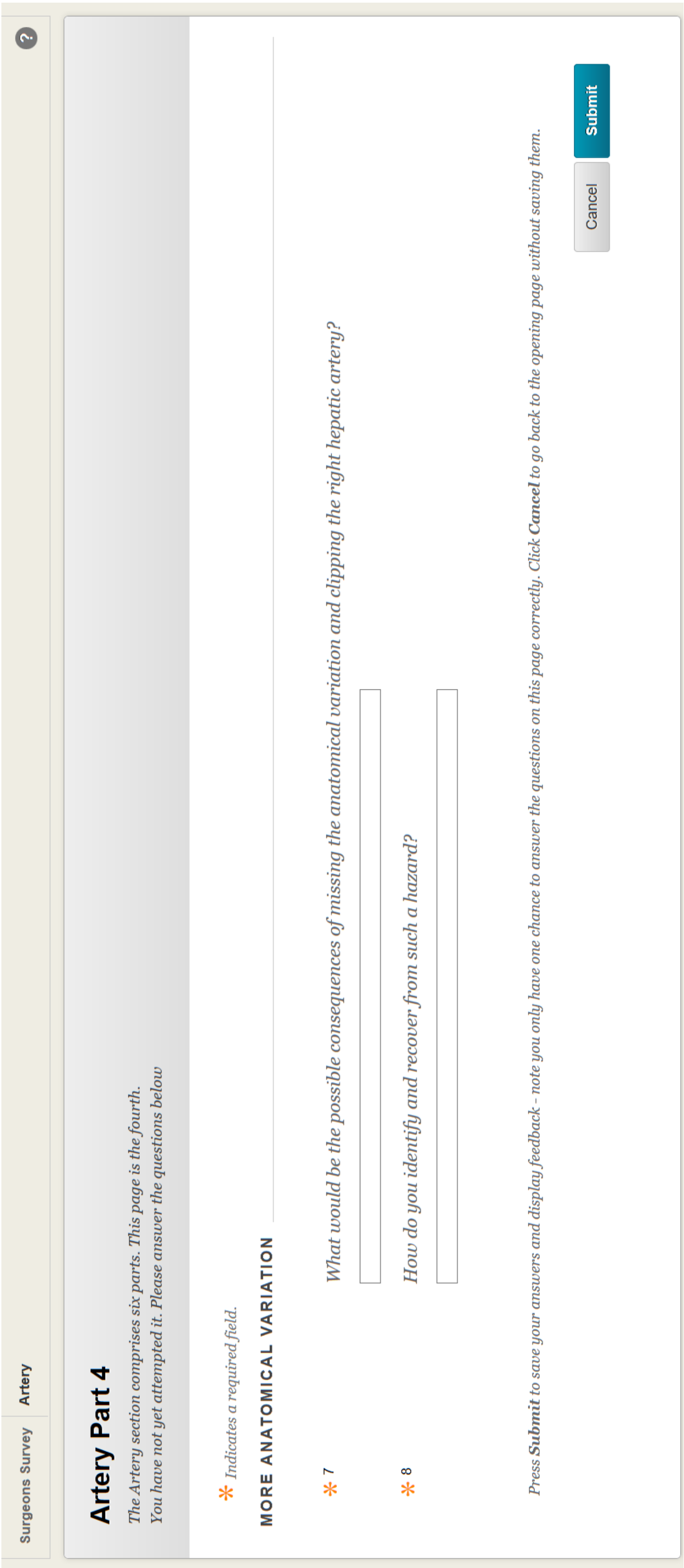
Feedback

The correct answer is:
Cystic artery originating from the right hepatic artery

*After reviewing the feedback please click **Next** to open the fourth part*
*Click **Cancel** to return to the opening page*

Cancel Next

Appendix 19



Surveons Survey | Artery

Artery Part 4

The Artery section comprises six parts. This page is the fourth.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

MORE ANATOMICAL VARIATION

* 7 *What would be the possible consequences of missing the anatomical variation and clipping the right hepatic artery?*

* 8 *How do you identify and recover from such a hazard?*

*Press **Submit** to save your answers and display feedback - note you only have one chance to answer the questions on this page correctly. Click **Cancel** to go back to the opening page without saving them.*

Cancel | Submit

Appendix 20

* 7 What would be the possible consequences of missing the anatomical variation and clipping the right hepatic artery?

cckkk

Feedback *Model answer:* hepatic/liver ischemia

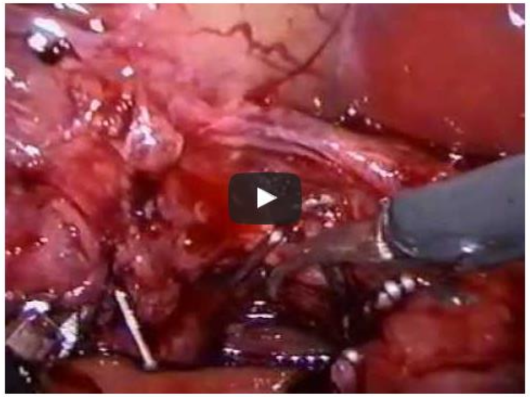
* 8 How do you identify and recover from such a hazard?

mmmlll

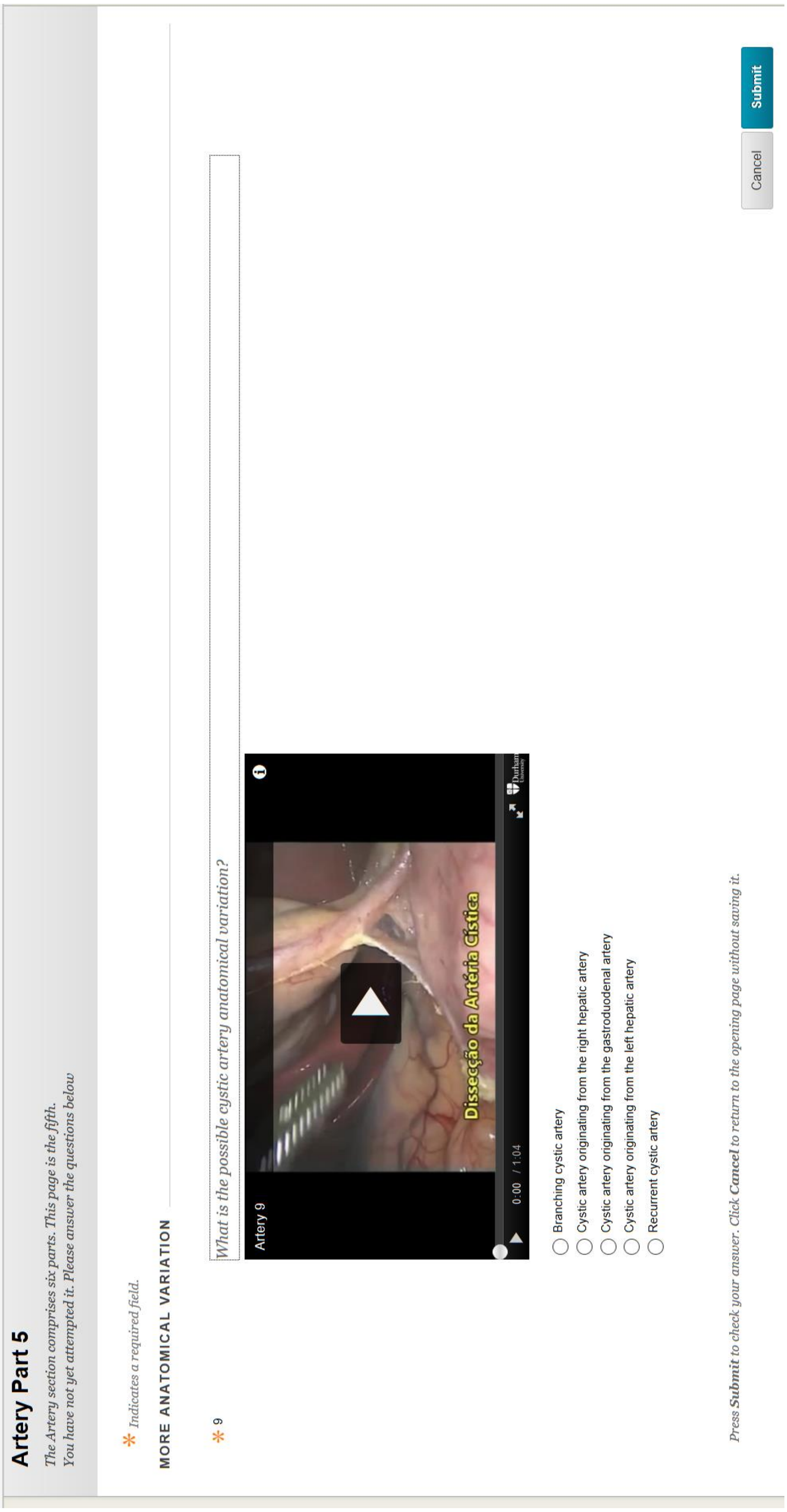
Feedback *Model answer:* signs of hepatic/liver ischemia

ORE INFORMATION

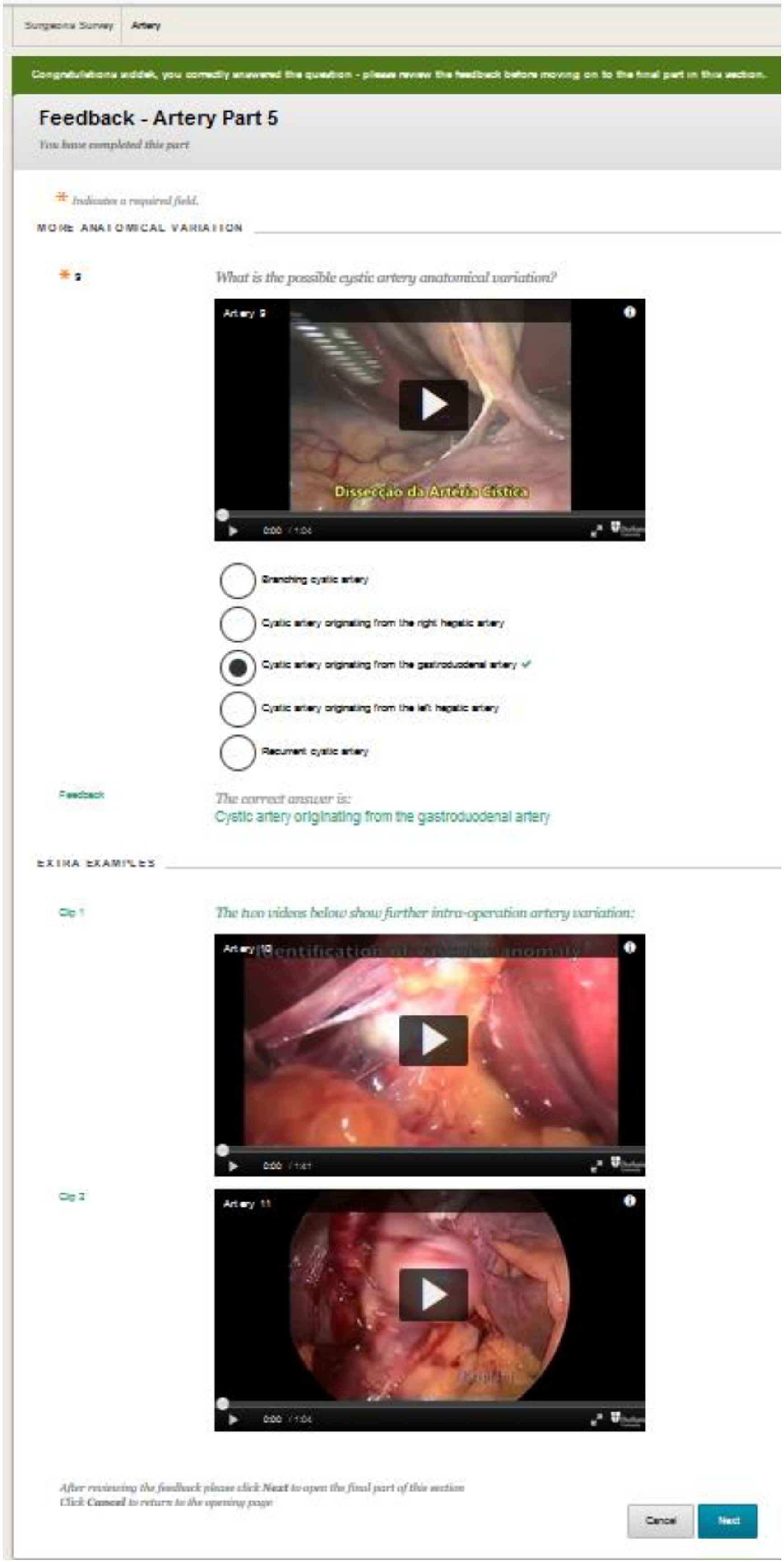
Please watch this YouTube video for the full six minutes. It shows a surgeon identifying liver ischemic signs and removing the clips from the right hepatic artery to prevent damage. Please note:
[3:14] the colour difference between the two liver loops and
[4:11] the improvement post-clip removal.
Missing the hazard and failing to recover after applying the clips would have resulted in right hepatic artery abscess and the need for a lobectomy.



Appendix 21


Artery Part 5
The Artery section comprises six parts. This page is the fifth.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
MORE ANATOMICAL VARIATION
* 9
What is the possible cystic artery anatomical variation?
Artery 9
Dissecção da Artéria Cística
0:00 / 1:04
Branching cystic artery
Cystic artery originating from the right hepatic artery
Cystic artery originating from the gastroduodenal artery
Cystic artery originating from the left hepatic artery
Recurrent cystic artery
Press Submit to check your answer. Click Cancel to return to the opening page without saving it.
Cancel
Submit

Appendix 22



Surgeons Survey | Artery

Congratulations addek, you correctly answered the question - please review the feedback before moving on to the final part in this section.

Feedback - Artery Part 5

You have completed this part

* *Indicates a required field.*

MORE ANATOMICAL VARIATION

* 9 *What is the possible cystic artery anatomical variation?*

- Branching cystic artery
- Cystic artery originating from the right hepatic artery
- Cystic artery originating from the gastroduodenal artery ✓
- Cystic artery originating from the left hepatic artery
- Recurrent cystic artery

Feedback *The correct answer is:*
Cystic artery originating from the gastroduodenal artery

EXTRA EXAMPLES

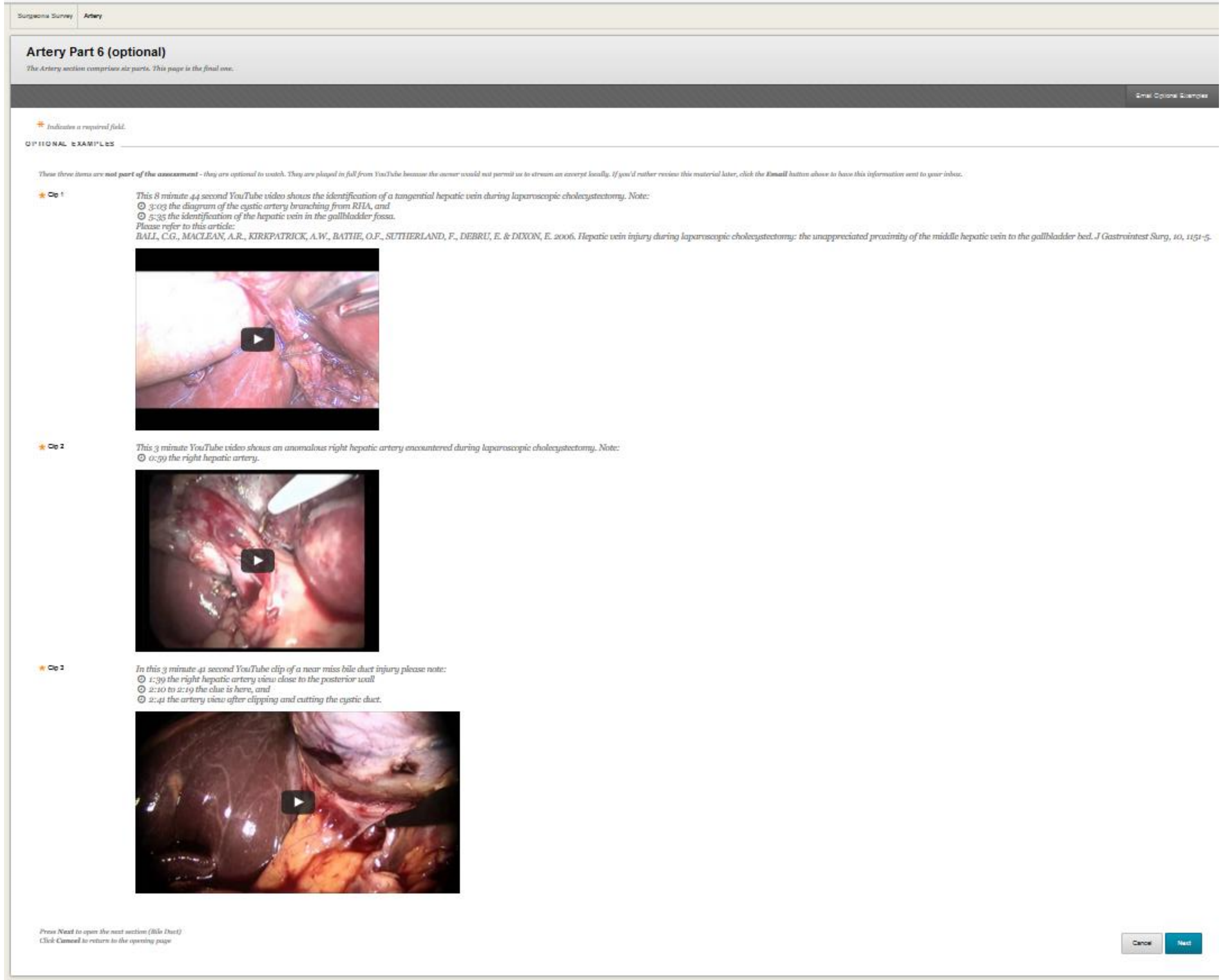
Clip 1 *The two videos below show further intra-operation artery variation:*

Clip 2

After reviewing the feedback please click ***Next*** *to open the final part of this section*
Click ***Cancel*** *to return to the opening page*

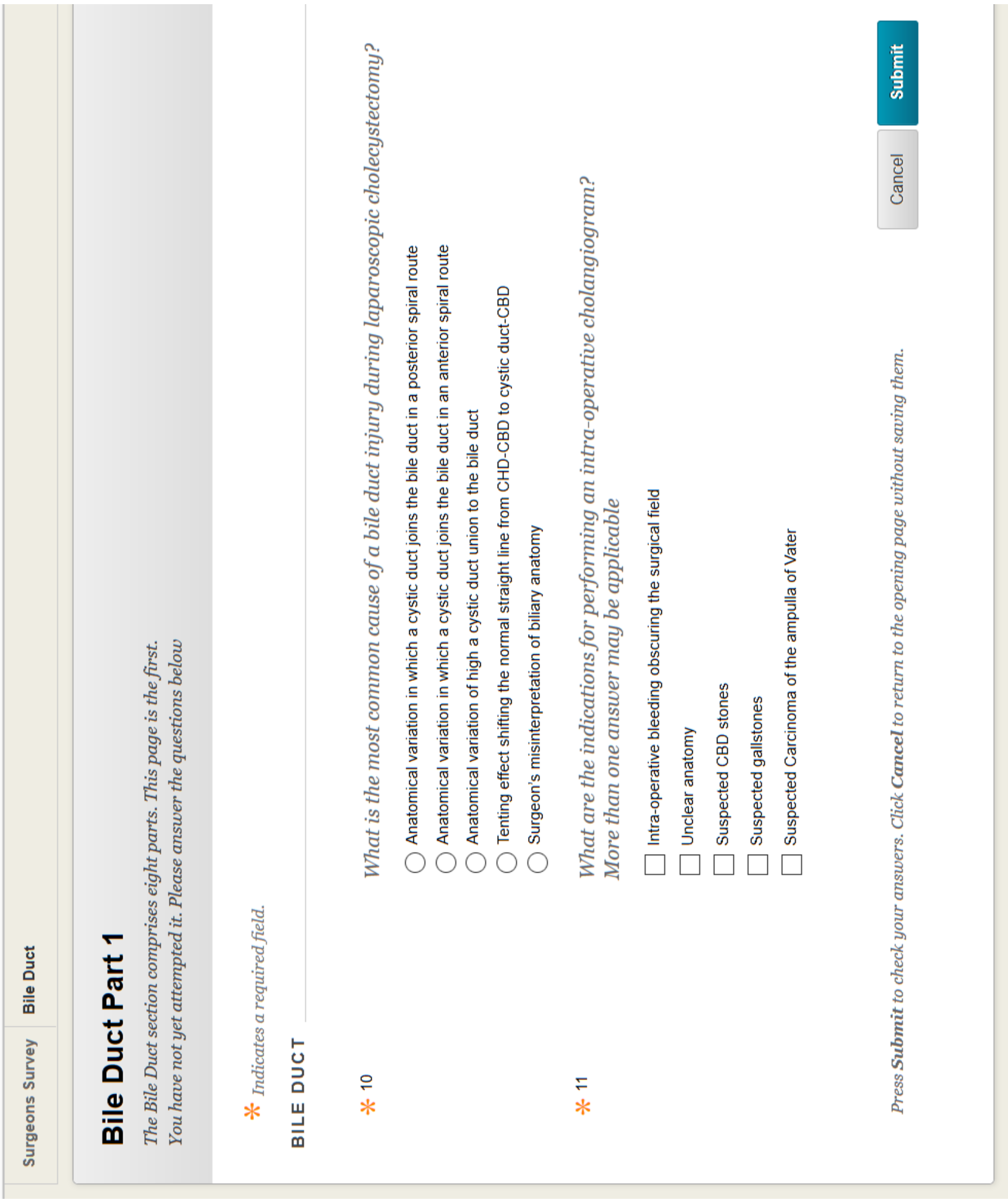
Cancel | Next

Appendix 23



Surgeons Survey
Artery
Artery Part 6 (optional)
The Artery section comprises six parts. This page is the final one.
Email Optional Examples
* Indicates a required field.
OPTIONAL EXAMPLES
These three items are **not part of the assessment** - they are optional to watch. They are played in full from YouTube because the owner would not permit us to stream an excerpt locally. If you'd rather review this material later, click the **Email** button above to have this information sent to your inbox.
* Clip 1
This 8 minute 44 second YouTube video shows the identification of a tangential hepatic vein during laparoscopic cholecystectomy. Note:
3:03 the diagram of the cystic artery branching from RHA, and
5:35 the identification of the hepatic vein in the gallbladder fossa.
Please refer to this article:
BALL, C.G., MACLEAN, A.R., KIRKPATRICK, A.W., BATHE, O.F., SUTHERLAND, F., DEBRU, E. & DIXON, E. 2006. Hepatic vein injury during laparoscopic cholecystectomy: the unappreciated proximity of the middle hepatic vein to the gallbladder bed. J Gastrointest Surg, 10, 1151-5.
* Clip 2
This 3 minute YouTube video shows an anomalous right hepatic artery encountered during laparoscopic cholecystectomy. Note:
0:59 the right hepatic artery.
* Clip 3
In this 3 minute 41 second YouTube clip of a near miss bile duct injury please note:
1:39 the right hepatic artery view close to the posterior wall
2:10 to 2:19 the clue is here, and
2:41 the artery view after clipping and cutting the cystic duct.
Press **Next** to open the next section (Bile Duct)
Click **Cancel** to return to the opening page
Cancel
Next

Appendix 24



Surveys Survey | Bile Duct

Bile Duct Part 1

The Bile Duct section comprises eight parts. This page is the first.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

BILE DUCT

* 10 *What is the most common cause of a bile duct injury during laparoscopic cholecystectomy?*

- ◯ Anatomical variation in which a cystic duct joins the bile duct in a posterior spiral route
- ◯ Anatomical variation in which a cystic duct joins the bile duct in an anterior spiral route
- ◯ Anatomical variation of high a cystic duct union to the bile duct
- ◯ Tenting effect shifting the normal straight line from CHD-CBD to cystic duct-CBD
- ◯ Surgeon's misinterpretation of biliary anatomy

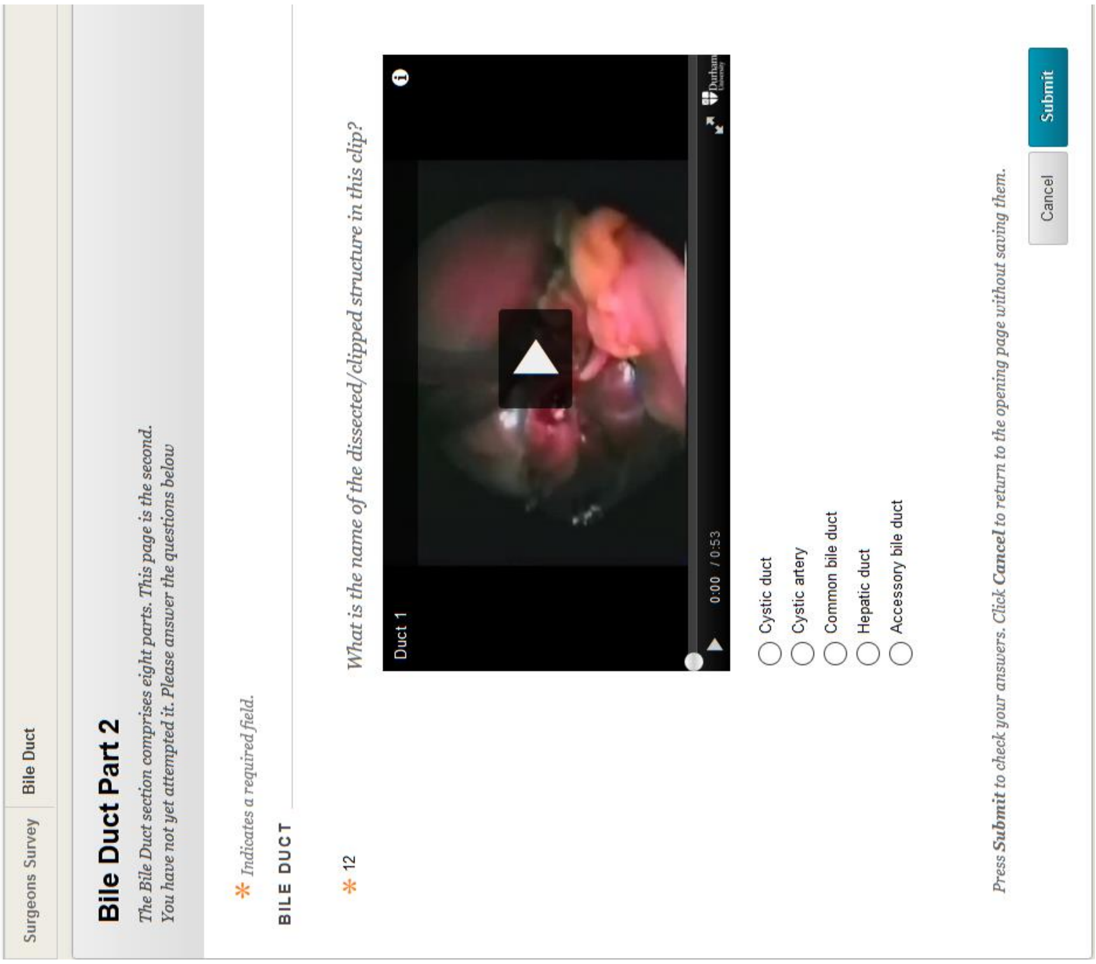
* 11 *What are the indications for performing an intra-operative cholangiogram?*
More than one answer may be applicable

- ☐ Intra-operative bleeding obscuring the surgical field
- ☐ Unclear anatomy
- ☐ Suspected CBD stones
- ☐ Suspected gallstones
- ☐ Suspected Carcinoma of the ampulla of Vater

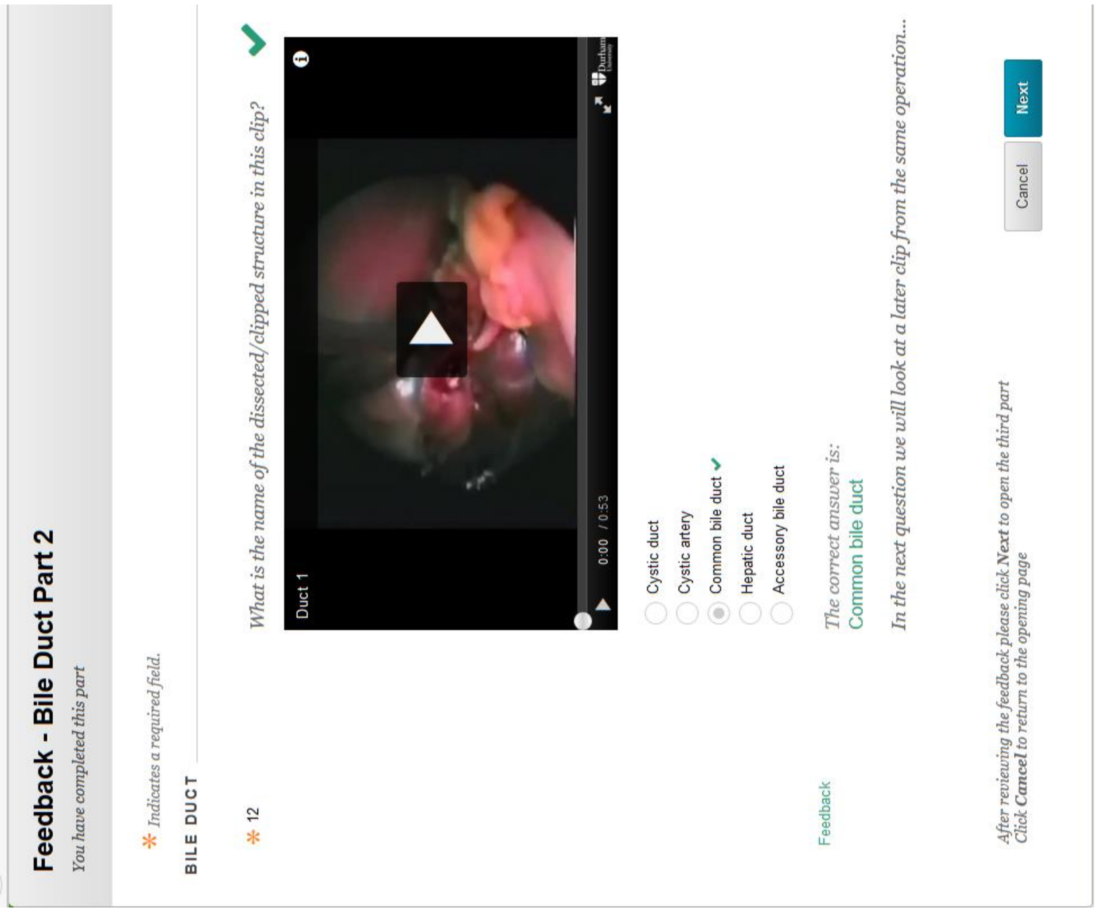
*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel | Submit

Appendix 25


Surgeons Survey
Bile Duct
Bile Duct Part 2
The Bile Duct section comprises eight parts. This page is the second.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
BILE DUCT
* 12
What is the name of the dissected/clipped structure in this clip?
Duct 1
0:00 / 0:53
Cystic duct
Cystic artery
Common bile duct
Hepatic duct
Accessory bile duct
Press Submit to check your answers. Click Cancel to return to the opening page without saving them.
Cancel
Submit

Appendix 26



Feedback - Bile Duct Part 2
You have completed this part
* Indicates a required field.
BILE DUCT
* 12
What is the name of the dissected/clipped structure in this clip?
Duct 1
0:00 / 0:53
Cystic duct
Cystic artery
Common bile duct
Hepatic duct
Accessory bile duct
Feedback
The correct answer is:
Common bile duct
In the next question we will look at a later clip from the same operation...
After reviewing the feedback please click Next to open the third part
Click Cancel to return to the opening page
Cancel
Next

Appendix 27

Surgeons Survey | Bile Duct

Bile Duct Part 3

The Bile Duct section comprises eight parts. This page is the third.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

BILE DUCT

* 13

What is the expected injury on a Bismuth-Corlette classification?

- ◯ Type I
- ◯ Type II
- ◯ Type III
- ◯ Type IV

* Note

In the last two videos the overall image quality was very poor and should be considered a risk in itself. In a modern operating theatre a much clearer image should be achieved.

*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel | Submit

Appendix 28

Surgeons Survey | Bile Duct

siddek, you correctly answered the question - please review the feedback before moving on to the next part.

Feedback - Bile Duct Part 3

You have completed this part

* *Indicates a required field.*

BILE DUCT

* 13

What is the expected injury on a Bismuth-Corlette classification?

- ○ Type I: low injury, CBD stump length more than 2cm
- ○ Type II: mid level injury, CBD stump length less than 2cm
- ◉ Type III: high level injury, without common hepatic duct available, but preserved confluence ✓
- ○ Type IV: loss of hepatic confluence, no communication between left and right ducts

Feedback

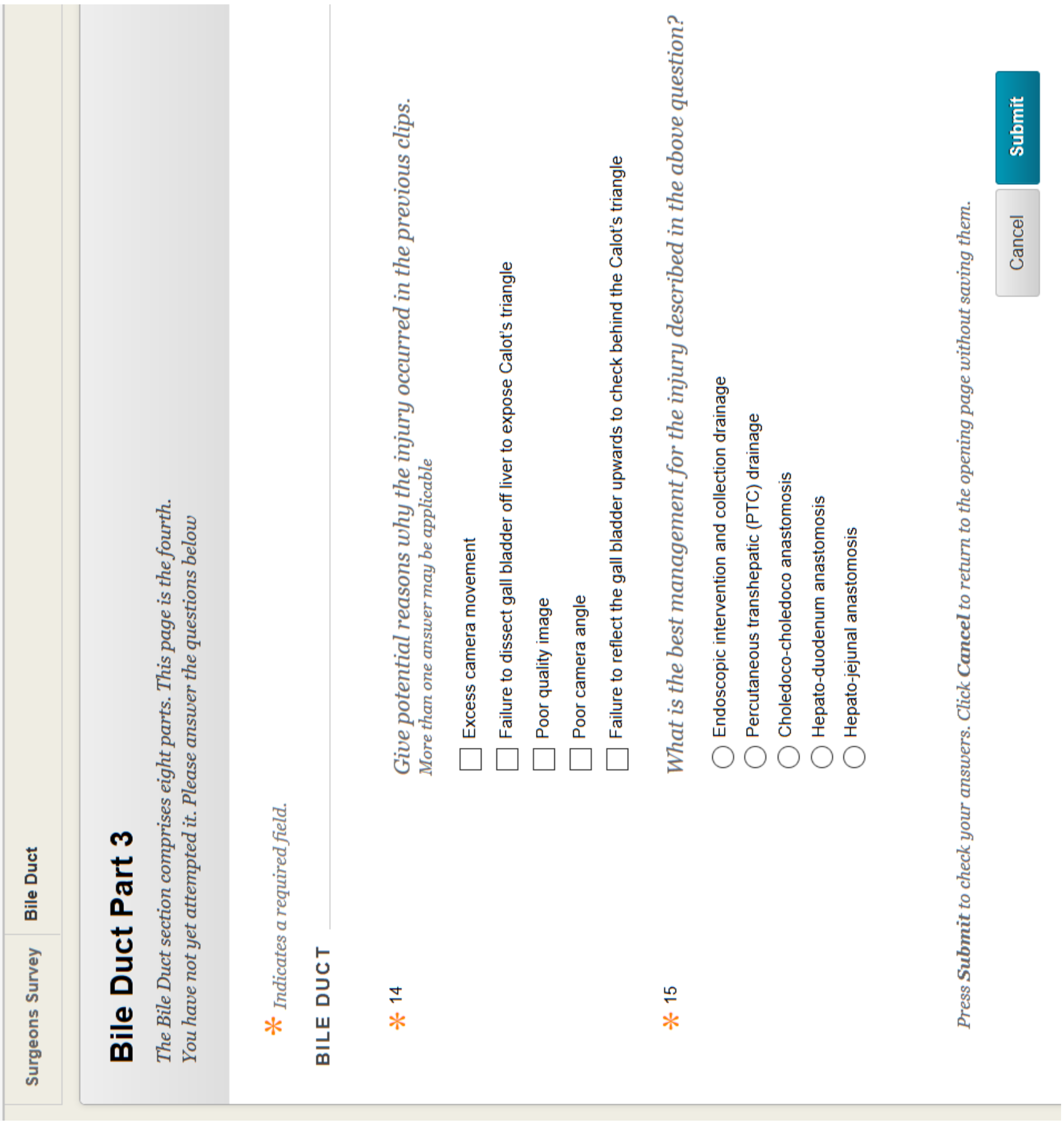
The correct answer is:

Type III

*After reviewing the feedback please click **Next** to open the fourth part*
*Click **Cancel** to return to the opening page*

Cancel | Next

Appendix 29



Surgeons Survey | Bile Duct

Bile Duct Part 3

The Bile Duct section comprises eight parts. This page is the fourth. You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

BILE DUCT

* 14 *Give potential reasons why the injury occurred in the previous clips.*
More than one answer may be applicable

- ☐ Excess camera movement
- ☐ Failure to dissect gall bladder off liver to expose Calot's triangle
- ☐ Poor quality image
- ☐ Poor camera angle
- ☐ Failure to reflect the gall bladder upwards to check behind the Calot's triangle

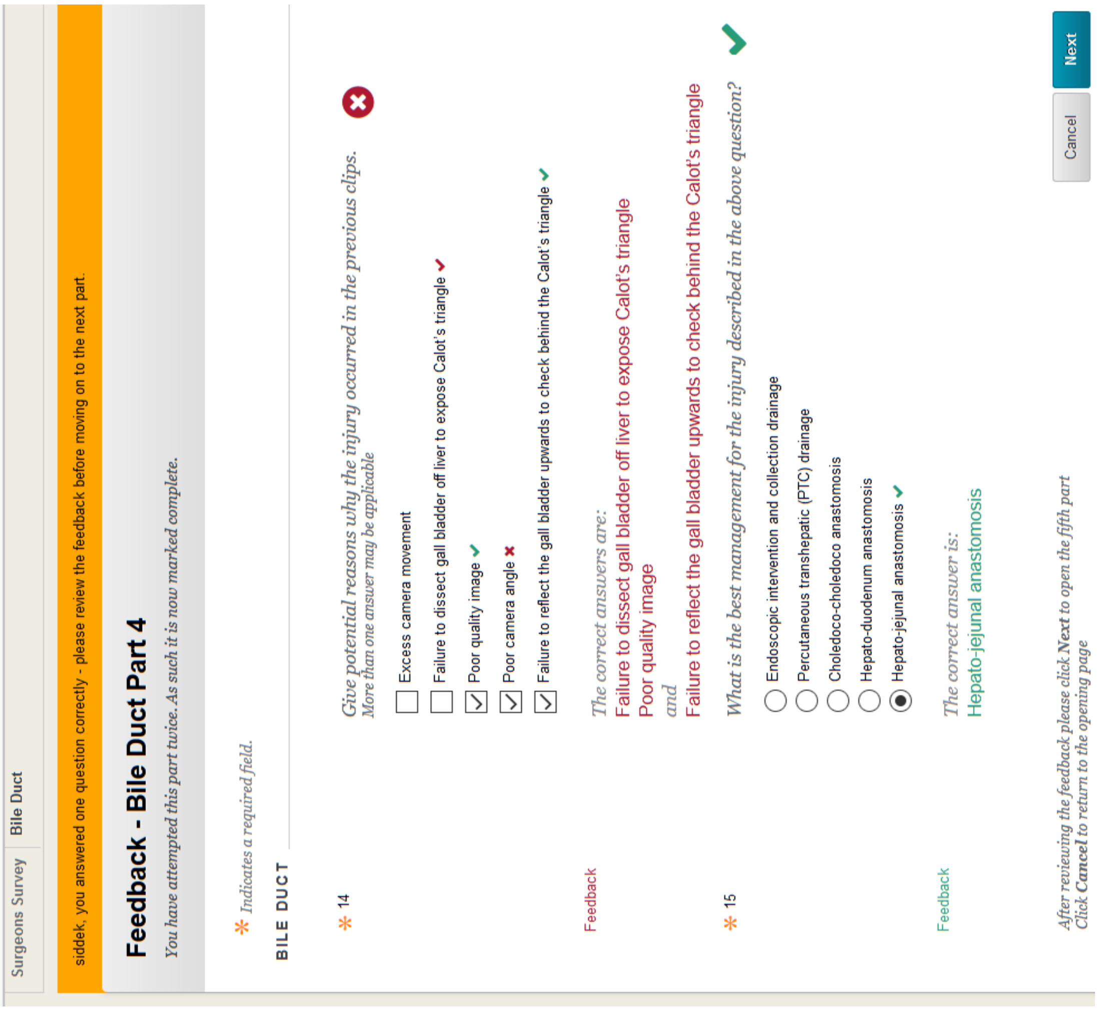
* 15 *What is the best management for the injury described in the above question?*

- ◯ Endoscopic intervention and collection drainage
- ◯ Percutaneous transhepatic (PTC) drainage
- ◯ Choledoco-choledoco anastomosis
- ◯ Hepato-duodenum anastomosis
- ◯ Hepato-jejunal anastomosis

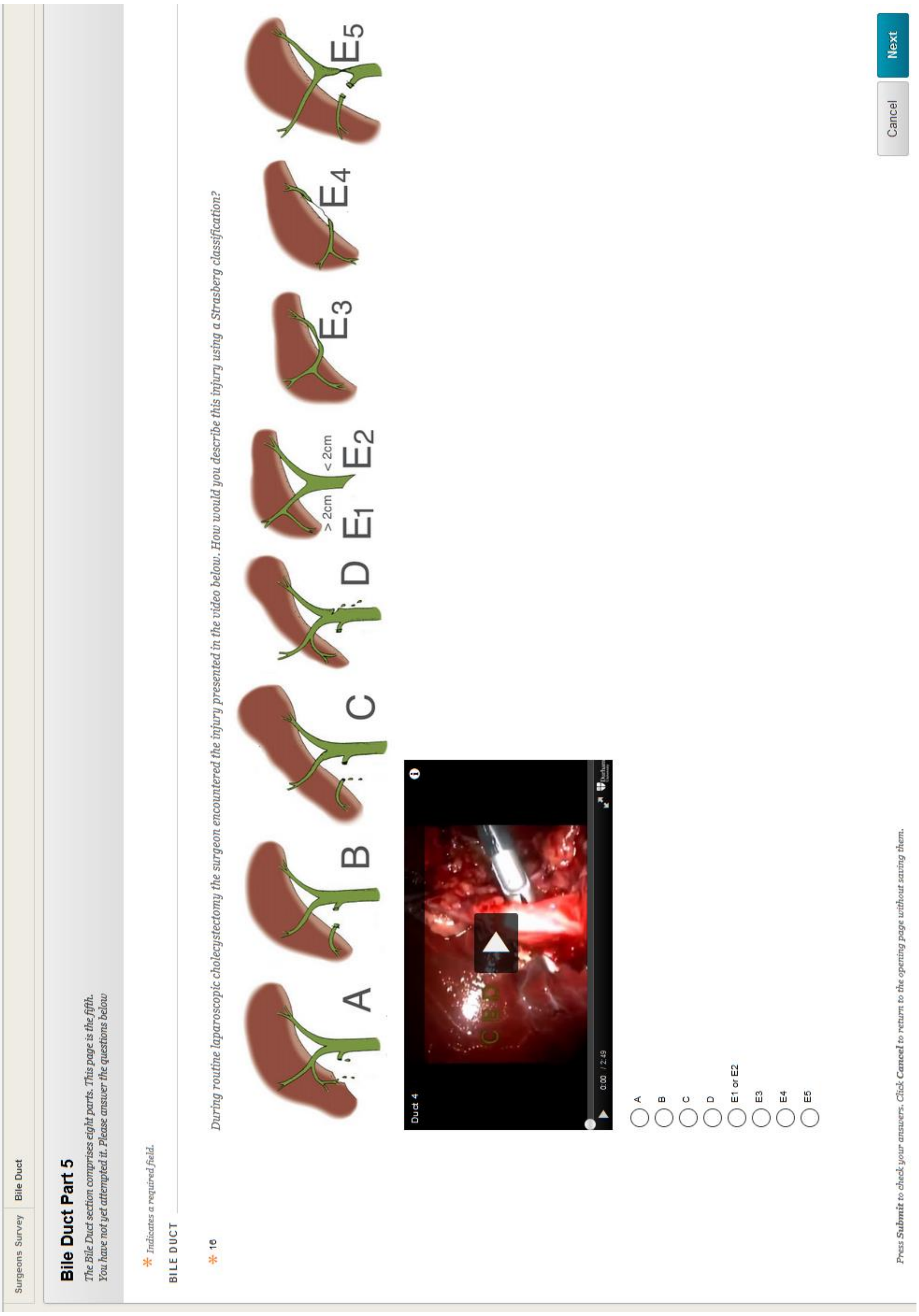
*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel | Submit

Appendix 30

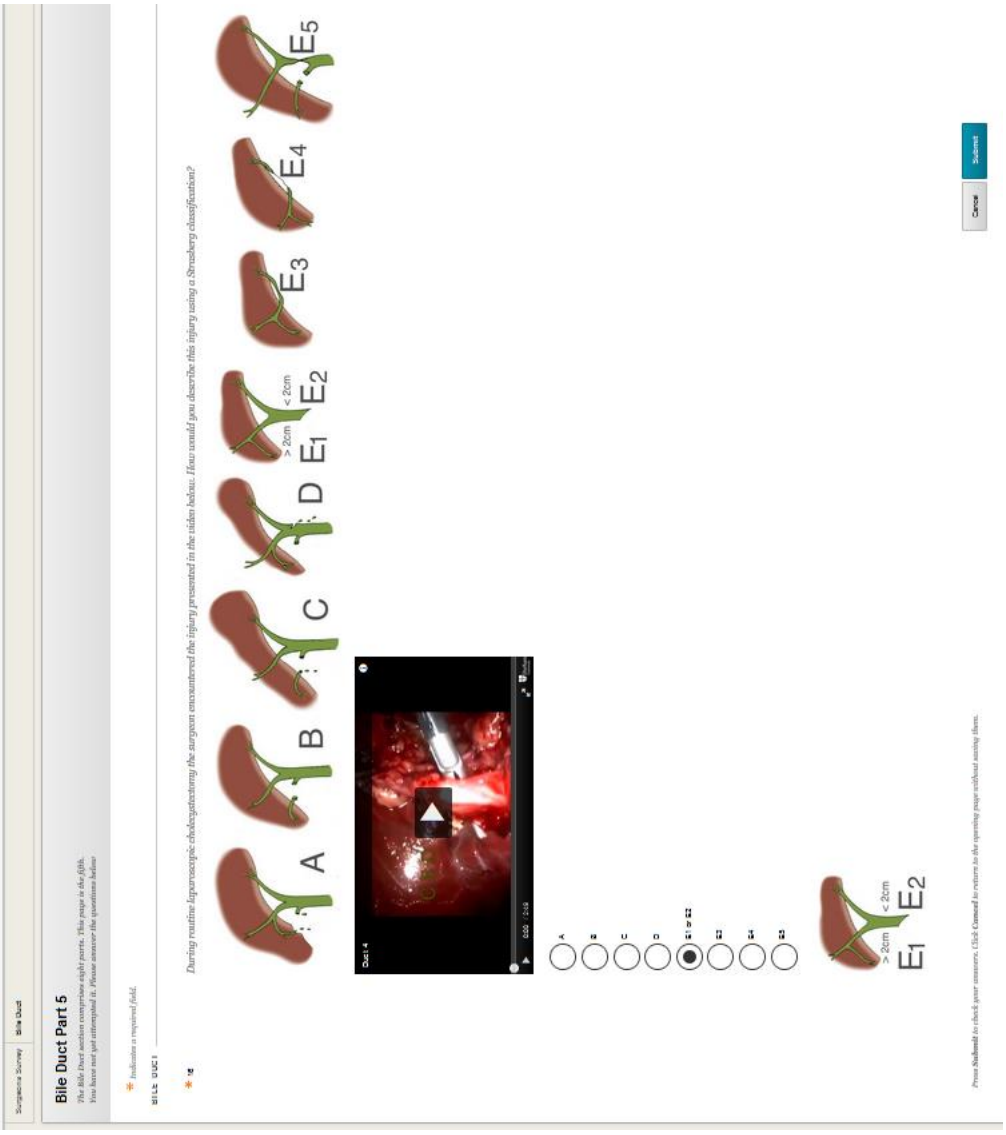

Surgeons Survey
Bile Duct
siddek, you answered one question correctly - please review the feedback before moving on to the next part.
Feedback - Bile Duct Part 4
You have attempted this part twice. As such it is now marked complete.
* Indicates a required field.
BILE DUCT
* 14
Give potential reasons why the injury occurred in the previous clips.
More than one answer may be applicable
Excess camera movement
Failure to dissect gall bladder off liver to expose Calot's triangle
Poor quality image
Poor camera angle
Failure to reflect the gall bladder upwards to check behind the Calot's triangle
Feedback
The correct answers are:
Failure to dissect gall bladder off liver to expose Calot's triangle
Poor quality image
and
Failure to reflect the gall bladder upwards to check behind the Calot's triangle
* 15
What is the best management for the injury described in the above question?
Endoscopic intervention and collection drainage
Percutaneous transhepatic (PTC) drainage
Choledoco-choledoco anastomosis
Hepato-duodenum anastomosis
Hepato-jejunal anastomosis
Feedback
The correct answer is:
Hepato-jejunal anastomosis
After reviewing the feedback please click Next to open the fifth part
Click Cancel to return to the opening page
Cancel
Next

Appendix 31

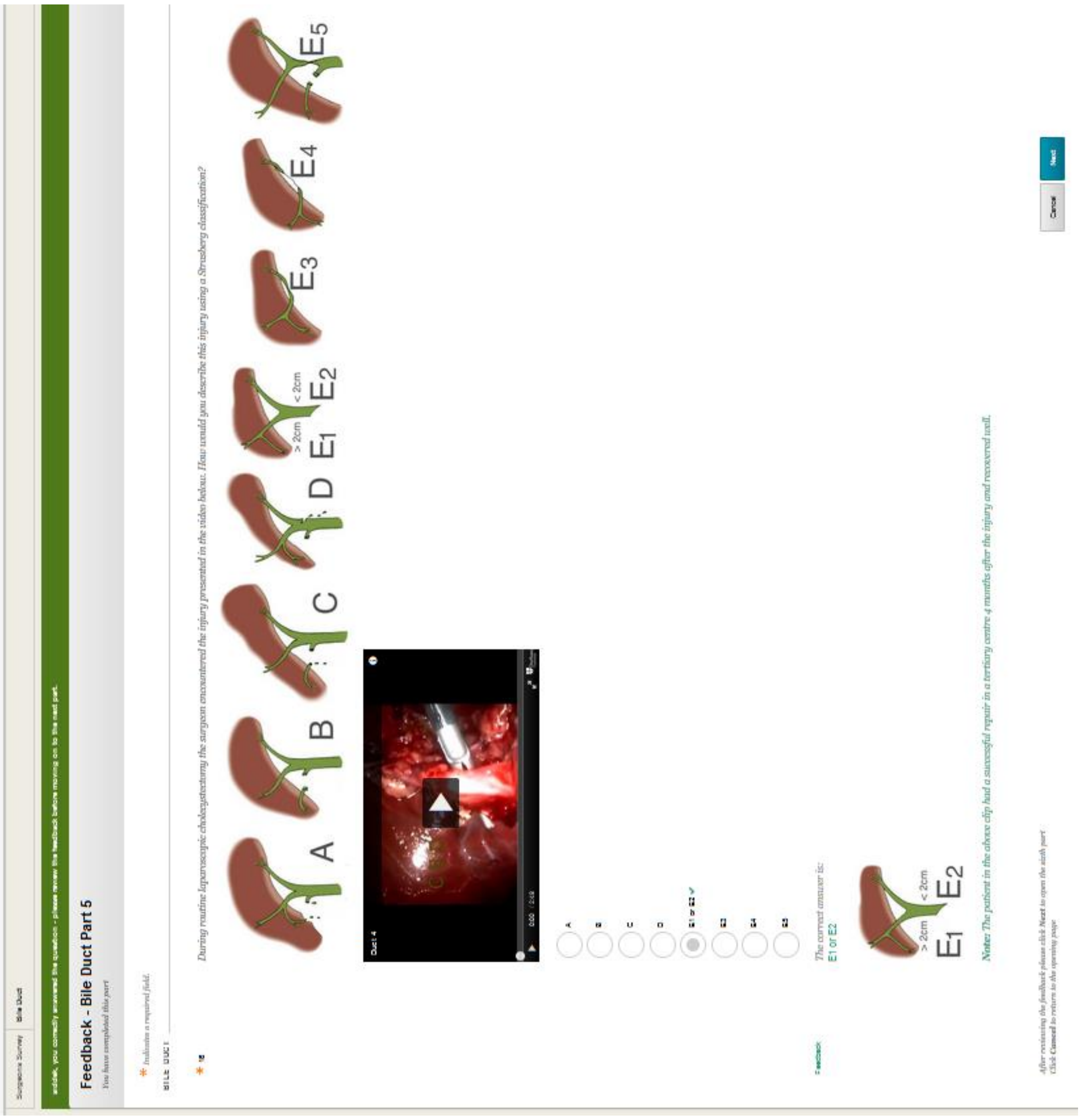


Surgeons Survey
Bile Duct
Bile Duct Part 5
The Bile Duct section comprises eight parts. This page is the fifth.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
BILE DUCT
* 16
During routine laparoscopic cholecystectomy the surgeon encountered the injury presented in the video below. How would you describe this injury using a Strasberg classification?
A
B
C
D
> 2cm
< 2cm
E1
E2
E3
E4
E5
Duct 4
0:00 / 2:49
A
B
C
D
E1 or E2
E3
E4
E5
Press Submit to check your answers. Click Cancel to return to the opening page without saving them.
Cancel
Next

Appendix 32

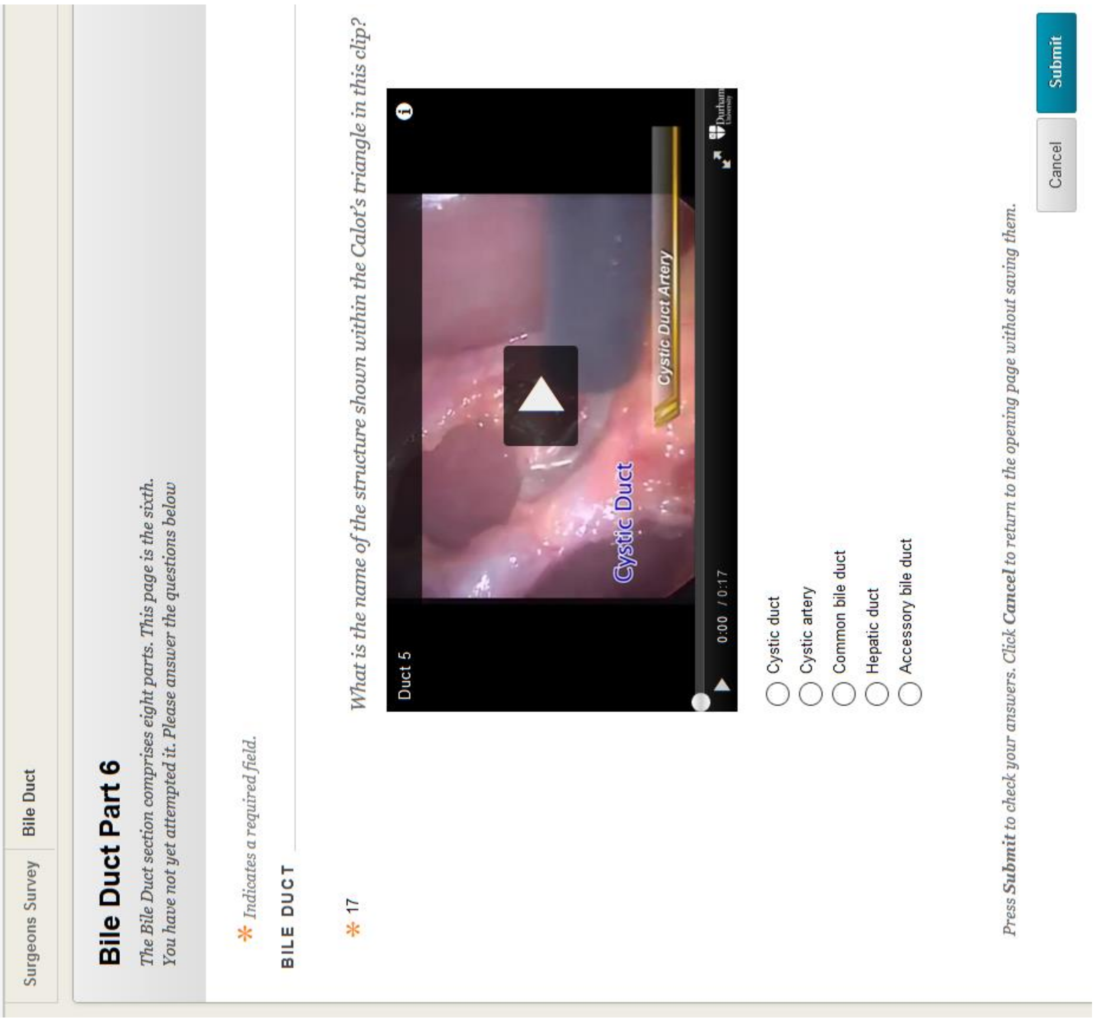


Appendix 33



Feedback - Bile Duct Part 5
During routine laparoscopic cholecystectomy the surgeon encountered the injury presented in the video below. How would you describe this injury using a Strasberg classification?
A
B
C
D
> 2cm
< 2cm
E1
E2
E3
E4
E5
The correct answer is:
E1 or E2
Note: The patient in the above clip had a successful repair in a tertiary centre 4 months after the injury and recovered well.
Cancel
Next

Appendix 34


Surgeons Survey
Bile Duct
Bile Duct Part 6
The Bile Duct section comprises eight parts. This page is the sixth.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
BILE DUCT
* 17
What is the name of the structure shown within the Calot's triangle in this clip?
Duct 5
Cystic Duct
Cystic Duct Artery
0:00 / 0:17
Cystic duct
Cystic artery
Common bile duct
Hepatic duct
Accessory bile duct
Press Submit to check your answers. Click Cancel to return to the opening page without saving them.
Cancel
Submit

Appendix 35

Surgeons Survey | Bile Duct

Bile Duct Part 7

The Bile Duct section comprises eight parts. This page is the seventh.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

BILE DUCT

During laparoscopic cholecystectomy the surgeon encountered some difficulty in isolating the cyctic duct, forcing him to undertake retrograde dissection. The gallbladder attachment to the common bile duct is very wide (1.5 cm):

* 18 *How would you proceed to remove this gallbladder?*
More than one answer may be applicable

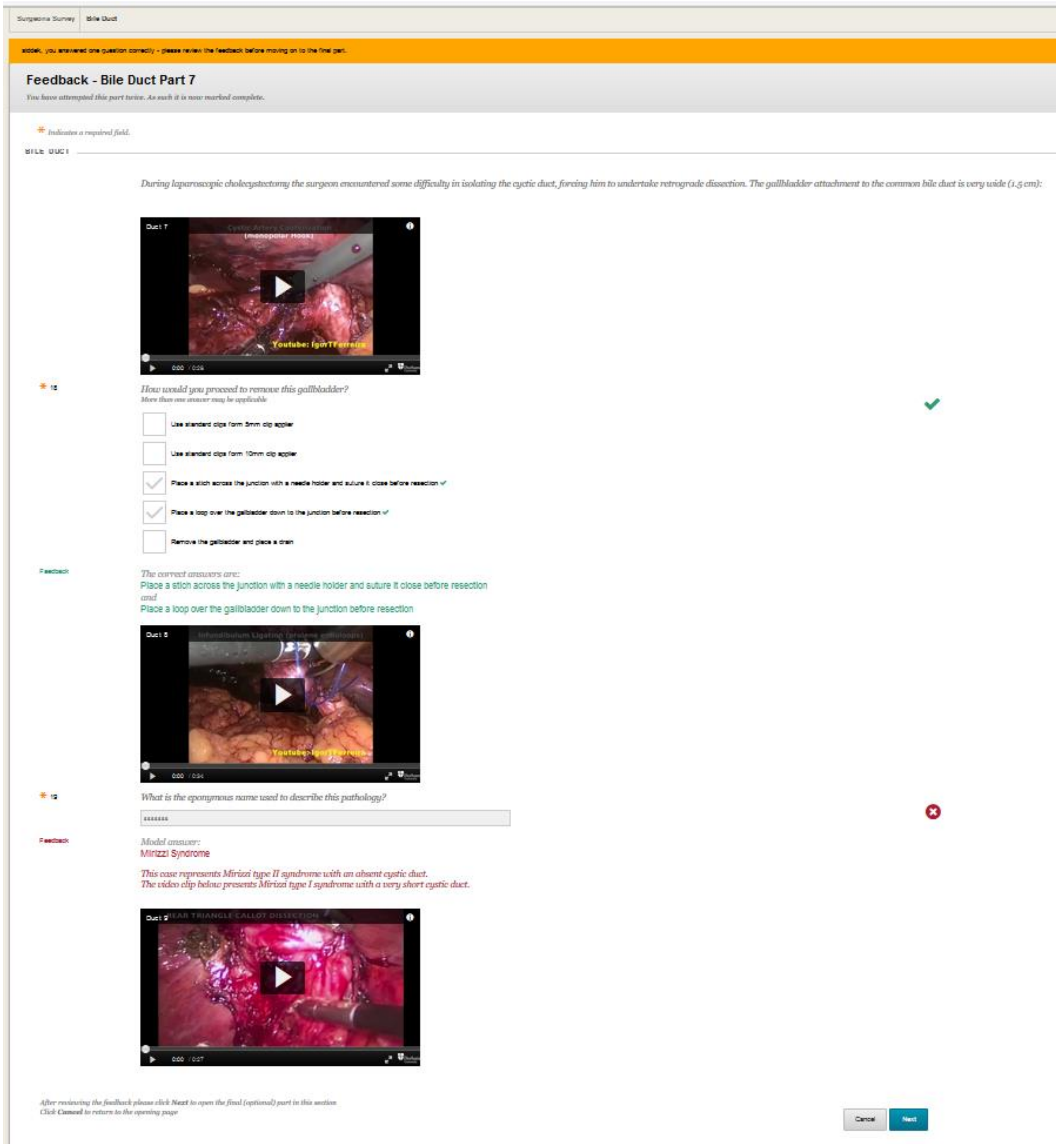
- [ ] Use standard clips form 5mm clip applier
- [ ] Use standard clips form 10mm clip applier
- [ ] Place a stich across the junction with a needle holder and suture it close before resection
- [ ] Place a loop over the gallbladder down to the junction before resection
- [ ] Remove the gallbladder and place a drain

* 19 *What is the eponymous name used to describe this pathology?*

*Press **Submit** to check your answers. Click **Cancel** to return to the opening page without saving them.*

Cancel | Submit

Appendix 36



Surgeons Survey | Bile Duct

siddek, you answered one question correctly - please review the feedback before moving on to the final part.

Feedback - Bile Duct Part 7

You have attempted this part twice. As such it is now marked complete.

* *Indicates a required field.*

BILE DUCT

During laparoscopic cholecystectomy the surgeon encountered some difficulty in isolating the cystic duct, forcing him to undertake retrograde dissection. The gallbladder attachment to the common bile duct is very wide (1.5 cm):

* 18 *How would you proceed to remove this gallbladder?*
More than one answer may be applicable

- [ ] Use standard clips form 5mm clip applier
- [ ] Use standard clips form 10mm clip applier
- [x] Place a stich across the junction with a needle holder and suture it close before resection ✓
- [x] Place a loop over the gallbladder down to the junction before resection ✓
- [ ] Remove the gallbladder and place a drain

Feedback

The correct answers are:
Place a stich across the junction with a needle holder and suture it close before resection
and
Place a loop over the gallbladder down to the junction before resection

* 19 *What is the eponymous name used to describe this pathology?*

****

Feedback

Model answer:
Mirizzi Syndrome

This case represents Mirizzi type II syndrome with an absent cystic duct.
The video clip below presents Mirizzi type I syndrome with a very short cystic duct.

After reviewing the feedback please click ***Next*** *to open the final (optional) part in this section*
Click ***Cancel*** *to return to the opening page*

Cancel | Next

Appendix 37

Surgeons Survey | Bile Duct

Bile Duct Part 8 (optional)

The Bile Duct section comprises eight parts. This page is the final one.

* *Indicates a required field.*

BILE DUCT INJURY

*These five items are **not part of the assessment** - they are optional to watch. The videos are played in full from YouTube because the owner would not permit us to stream an excerpt locally. If you'd rather review this material later, click the **Email** button above to have this information sent to your inbox.*

Clip 1

This (7 mins 45 secs) YouTube video shows bile duct injury, possible clues to spot and avoid such danger and best injury repair approaches. It is really worth watching especially the following moments:
- *1:40 the tenting effect*
- *2:40 the common double duct injury*
- *2:46 onwards intraoperative danger clues explained.*

Clip 2

This YouTube video shows the detection of bile duct iatrogenic injury, during laparoscopic gastrectomy with D2 lymph-node dissection, with a primary repair. Please note the following moments:
- *0:48 injury of duct*
- *3:05 tube inserted*
- *5:10 suture.*

Clip 3

This 5 minute YouTube video shows a CBD injury, during laparoscopic cholecystectomy due to low dissection and the omitting of the critical view technique.

ACCESSORY BILE DUCT DETECTION

Clip 4

This short YouTube video (1 min 45 secs) shows:
- *0:42 detection of an accessory duct*
- *1:12 clipping the accessory duct*

Clip 5

Note the following moments in this YouTube video:
- *1:50 accessory bile duct detection*
- *3:23 to 4:10 stitching*

*Press **Next** to open the next section (Complications)*
*Click **Cancel** to return to the opening page*

Cancel | Next

Appendix 38

Surgeons Survey | Complications

Complications Part 1

The Complications section comprises nine parts. This page is the first.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

MANAGEMENT

* 20

A patient continues to complain of nausea and abdominal/shoulder pain 48 hours following uncomplicated laparoscopic cholecystectomy. Observations were stable except mild tachycardia, bloods showed a normal liver function test and an abdominal examination showed mild epigastric and RUQ tenderness.
What is the best management action?

- ○ Pain relief and mobilization to improve post operation ileus
- ○ Pain relief and repeat liver function test
- ○ Pain relief and perform a CT scan
- ○ Pain relief and upper GI endoscopy to rule out a stress ulcer

Press ***Submit*** *to check your answer.*
Click ***Cancel*** *to return to the opening page without saving it.*

Cancel | Submit

Appendix 39

siddek, you correctly answered the question - please review the feedback before moving on to the next part.

Feedback - Complications Part 1

You have completed this part

* *Indicates a required field.*

MANAGEMENT

* 20

A patient continues to complain of nausea and abdominal/shoulder pain 48 hours following uncomplicated laparoscopic cholecystectomy. Observations were stable except mild tachycardia, bloods showed a normal liver function test and an abdominal examination showed mild epigastric and RUQ tenderness.
What is the best management action?

- Pain relief and mobilization to improve post operation ileus
- Pain relief and repeat liver function test
- Pain relief and perform a CT scan ✔
- Pain relief and upper GI endoscopy to rule out a stress ulcer

Feedback

The correct answer is:
Pain relief and perform a CT scan

*After reviewing the feedback please click **Next** to open the second part*
*Click **Cancel** to return to the opening page*

Cancel Next

Appendix 40

Surgeons Survey | Complications

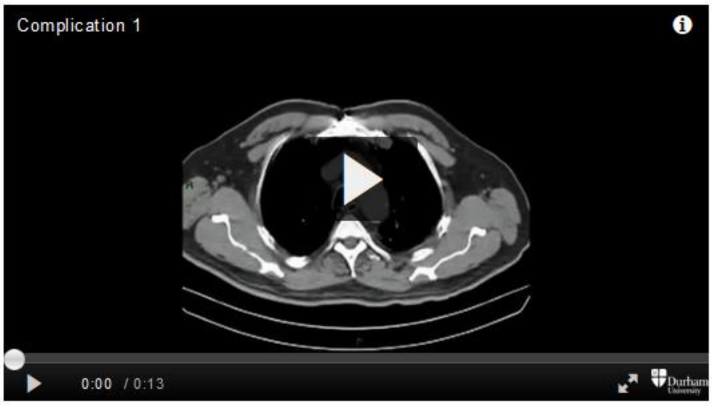
Complications Part 2

The Complications section comprises nine parts. This page is the second.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

MANAGEMENT

The patient had a CT scan with the following result



* 21

What is the best management for this patient?

- ○ Pain relief and mobilization to improve post operation ileus
- ○ Pain relief and repeat the liver function test
- ○ Pain relief and repeat the CT scan in a couple of days
- ○ Pain relief and upper GI endoscopy to rule out a stress ulcer
- ○ Pain relief and laparoscopic exploration

*Press **Submit** to check your answer.*
*Click **Cancel** to return to the opening page without saving it.*

Cancel | Submit

Appendix 41

Surgeons Survey | **Complications**

siddek, you correctly answered the question - please review the feedback before moving on to the next part.

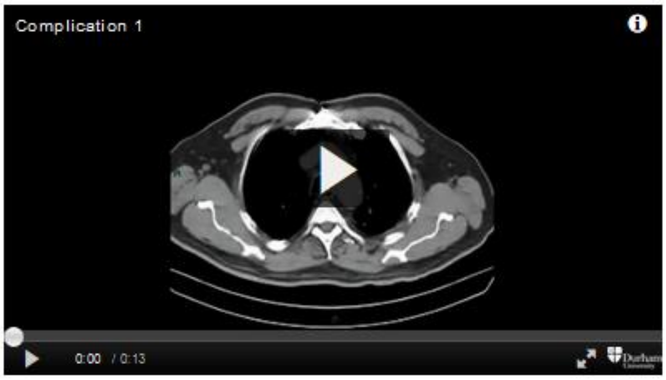
Feedback - Complications Part 2

You have completed this part

* *Indicates a required field.*

MANAGEMENT

The patient had a CT scan with the following result



* 21

What is the best management for this patient?

- Pain relief and mobilization to improve post operation ileus
- Pain relief and repeat the liver function test
- Pain relief and repeat the CT scan in a couple of days
- Pain relief and upper GI endoscopy to rule out a stress ulcer
- Pain relief and laparoscopic exploration ✔

Feedback

The correct answer is:
Pain relief and laparoscopic exploration

After reviewing the feedback please click ***Next*** *to open the third part*
Click ***Cancel*** *to return to the opening page*

Cancel | Next

Appendix 42

Surgeons Survey | Complications

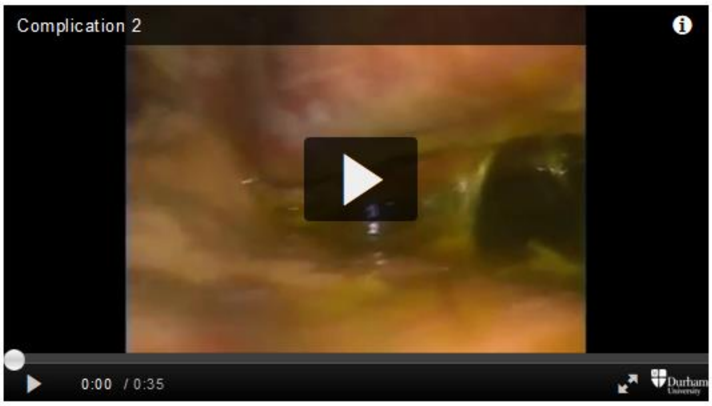
Complications Part 3

The Complications section comprises nine parts. This page is the third.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

MANAGEMENT

Laparoscopic exploration was carried out as per the video below:

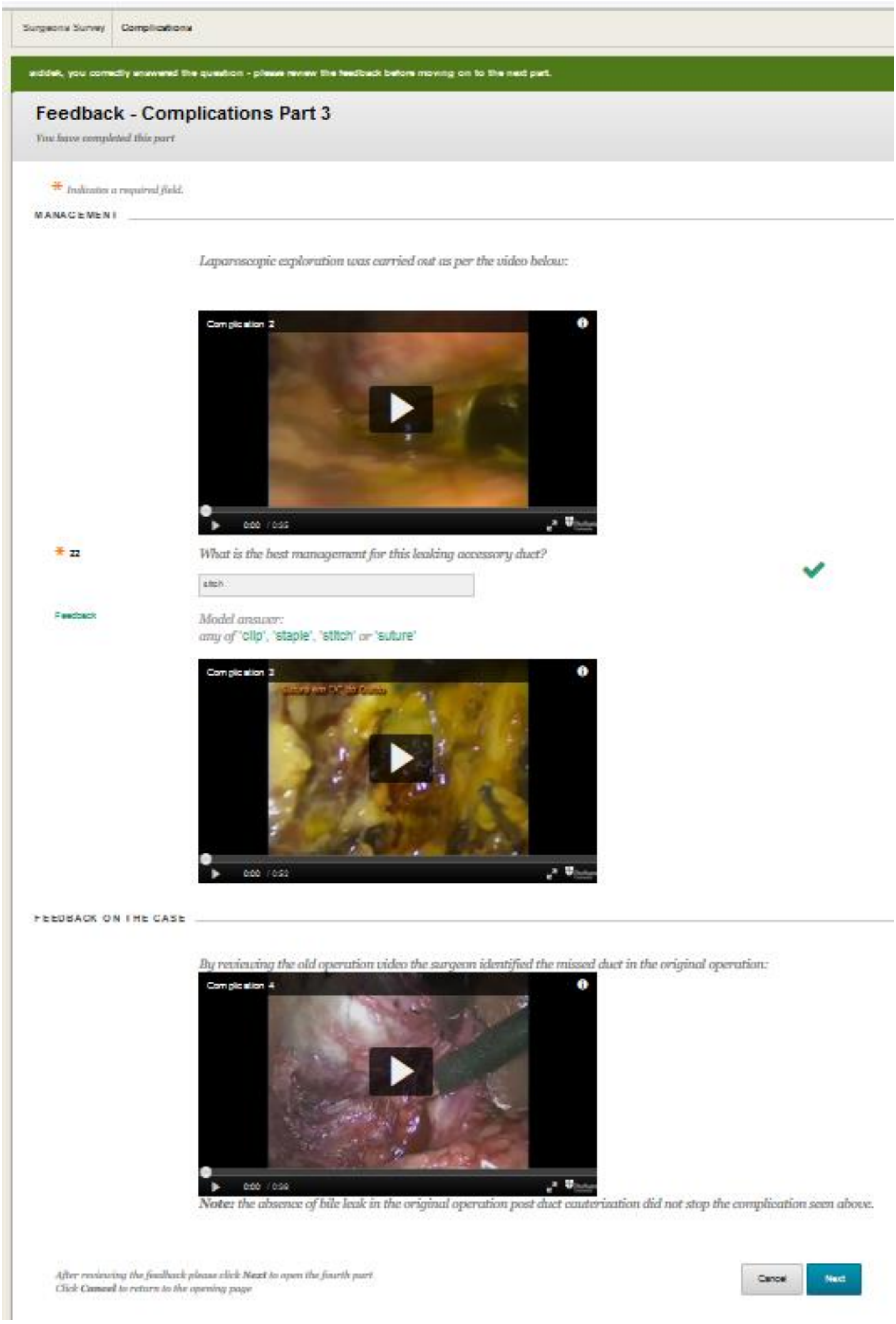


* 22 *What is the best management for this leaking accessory duct?*

*Press **Submit** to check your answer and display feedback.*
*Click **Cancel** to return to the opening page without saving it.*

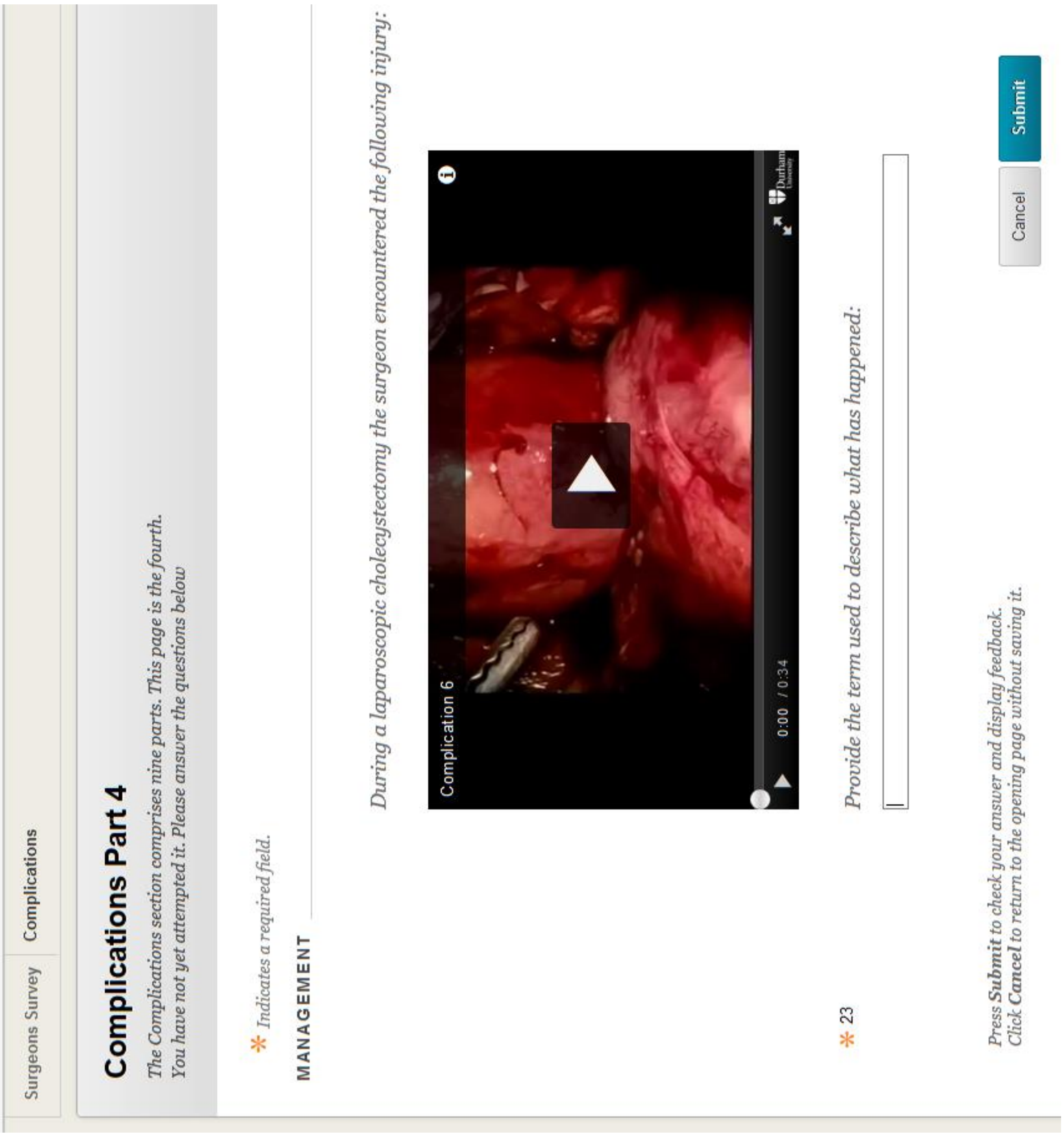
Cancel Submit

Appendix 43



Surgeons Survey
Complications
siddek, you correctly answered the question - please review the feedback before moving on to the next part.
Feedback - Complications Part 3
You have completed this part
* Indicates a required field.
MANAGEMENT
Laparoscopic exploration was carried out as per the video below:
Complication 2
0:00 / 0:55
* 22
What is the best management for this leaking accessory duct?
stich
Feedback
Model answer:
any of 'clip', 'staple', 'stitch' or 'suture'
Complication 3
0:00 / 0:52
FEEDBACK ON THE CASE
By reviewing the old operation video the surgeon identified the missed duct in the original operation:
Complication 4
0:00 / 0:39
Note: the absence of bile leak in the original operation post duct cauterization did not stop the complication seen above.
After reviewing the feedback please click Next to open the fourth part
Click Cancel to return to the opening page
Cancel
Next

Appendix 44



Surgeons Survey
Complications
Complications Part 4
The Complications section comprises nine parts. This page is the fourth.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
MANAGEMENT
* 23
During a laparoscopic cholecystectomy the surgeon encountered the following injury:
Complication 6
0:00 / 0:34
Provide the term used to describe what has happened:
Press Submit to check your answer and display feedback.
Click Cancel to return to the opening page without saving it.
Cancel
Submit

Appendix 45

Surgeons Survey | Complications

siddek, you did not answer the question correctly - please review the feedback before moving on to the next part.

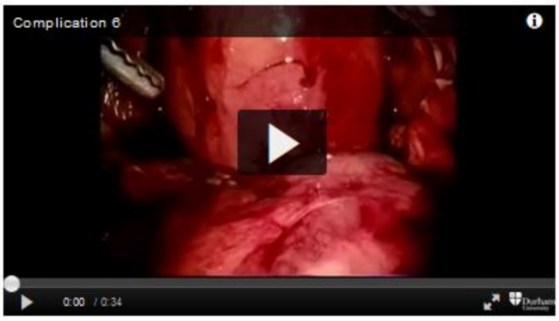
Feedback - Complications Part 4

You have attempted this part twice. As such it is now marked complete.

* *Indicates a required field.*

MANAGEMENT

During a laparoscopic cholecystectomy the surgeon encountered the following injury:



* 23

Provide the term used to describe what has happened:

perforation

Feedback

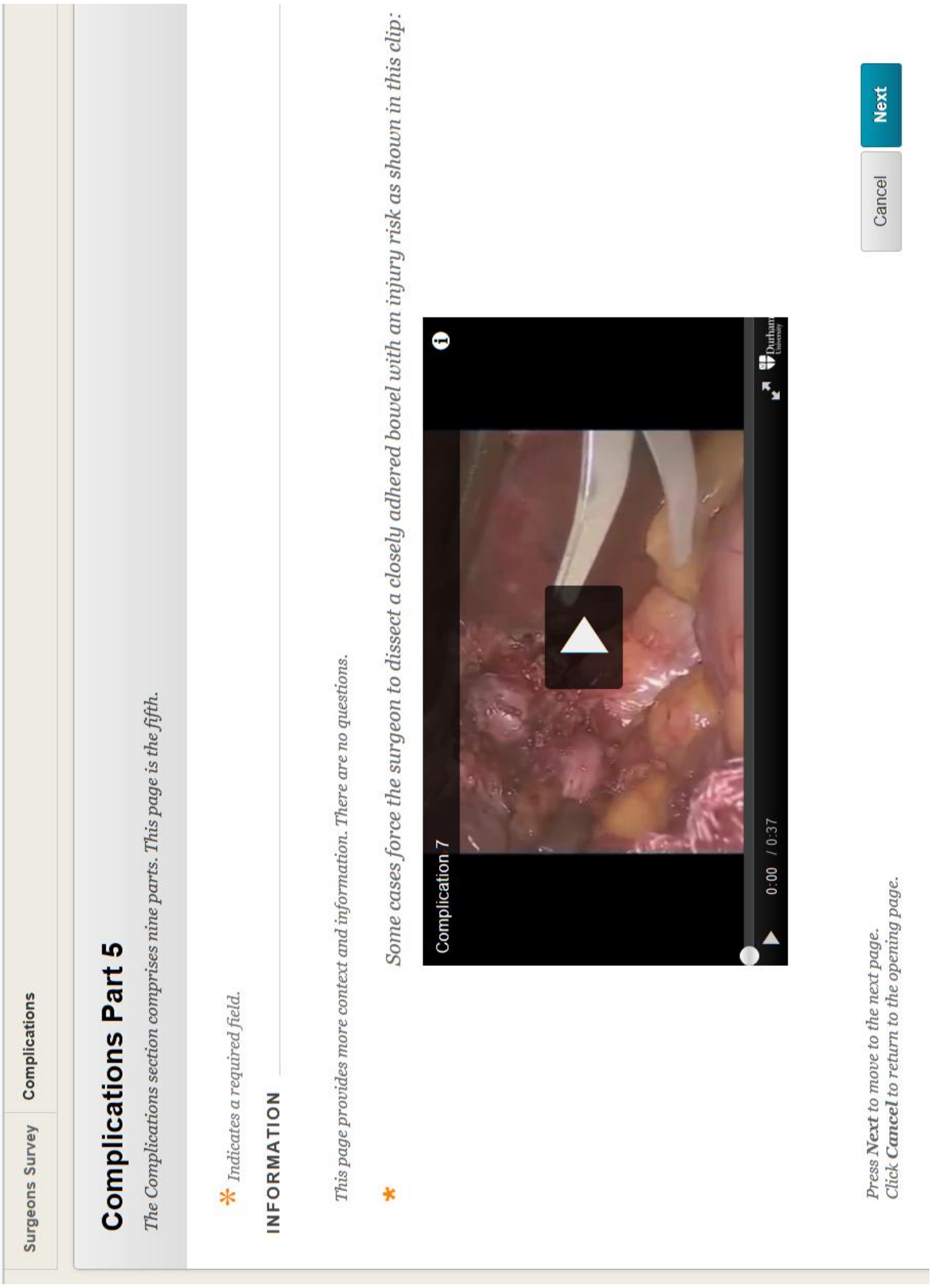
Model answer:

Enterotomy, Duodenal perforation, or Duodenotomy

*After reviewing the feedback please click **Next** to open the fifth part*
*Click **Cancel** to return to the opening page*

Cancel | Next

Appendix 46


Surgeons Survey
Complications

Complications Part 5

The Complications section comprises nine parts. This page is the fifth.

* *Indicates a required field.*

INFORMATION

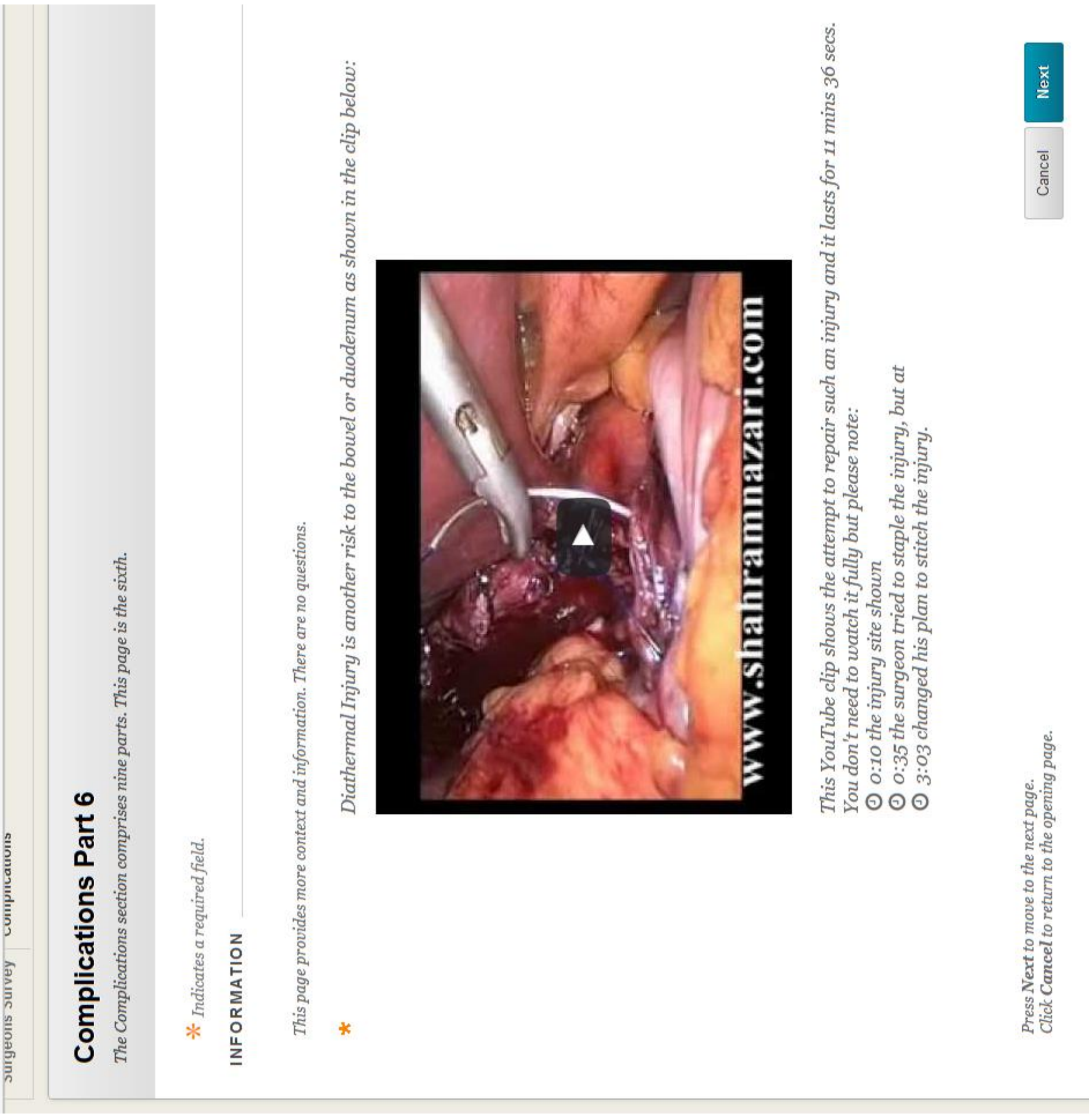
This page provides more context and information. There are no questions.

* *Some cases force the surgeon to dissect a closely adhered bowel with an injury risk as shown in this clip:*

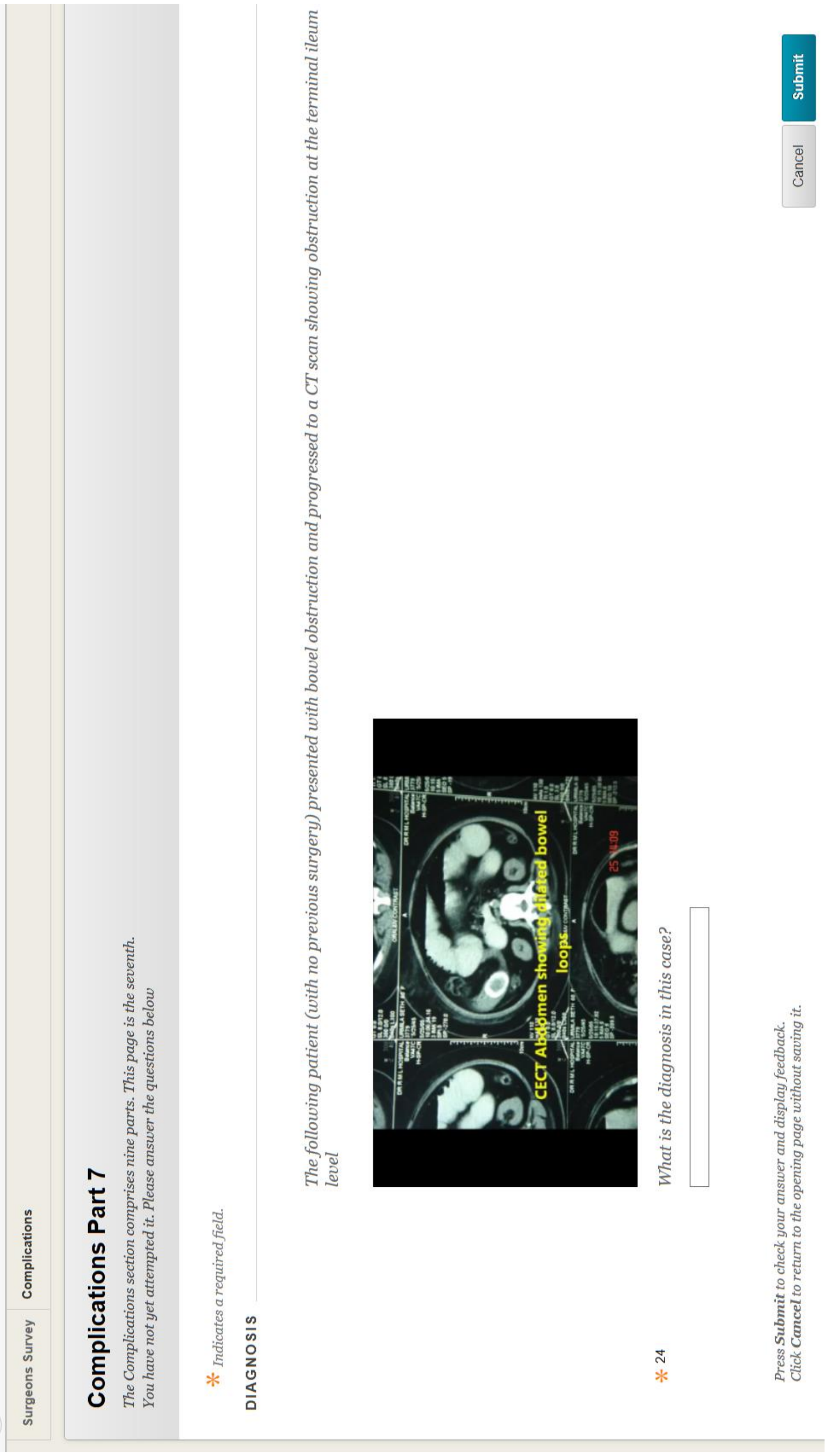
*Press **Next** to move to the next page.*
*Click **Cancel** to return to the opening page.*

Cancel
Next

Appendix 47


Surgeons Survey
Complications
Complications Part 6
The Complications section comprises nine parts. This page is the sixth.
* Indicates a required field.
INFORMATION
This page provides more context and information. There are no questions.
* Diathermal Injury is another risk to the bowel or duodenum as shown in the clip below:
www.shahramnazari.com
This YouTube clip shows the attempt to repair such an injury and it lasts for 11 mins 36 secs.
You don't need to watch it fully but please note:
0:10 the injury site shown
0:35 the surgeon tried to staple the injury, but at
3:03 changed his plan to stitch the injury.
Press Next to move to the next page.
Click Cancel to return to the opening page.
Cancel
Next

Appendix 48


Surveyors Survey | Complications

Complications Part 7

The Complications section comprises nine parts. This page is the seventh. You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

DIAGNOSIS

* 24

The following patient (with no previous surgery) presented with bowel obstruction and progressed to a CT scan showing obstruction at the terminal ileum level

What is the diagnosis in this case?

*Press **Submit** to check your answer and display feedback.*
*Click **Cancel** to return to the opening page without saving it.*

Cancel | Submit

Appendix 49

Surgeons Survey | Complications

addek, you correctly answered the question - please review the feedback before moving on to the next part.

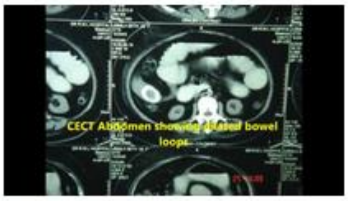
Feedback - Complications Part 7

You have completed this part

* *Indicates a required field.*

DIAGNOSIS

The following patient (with no previous surgery) presented with bowel obstruction and progressed to a CT scan showing obstruction at the terminal ileum level



* 24

What is the diagnosis in this case?

gallstone ileus

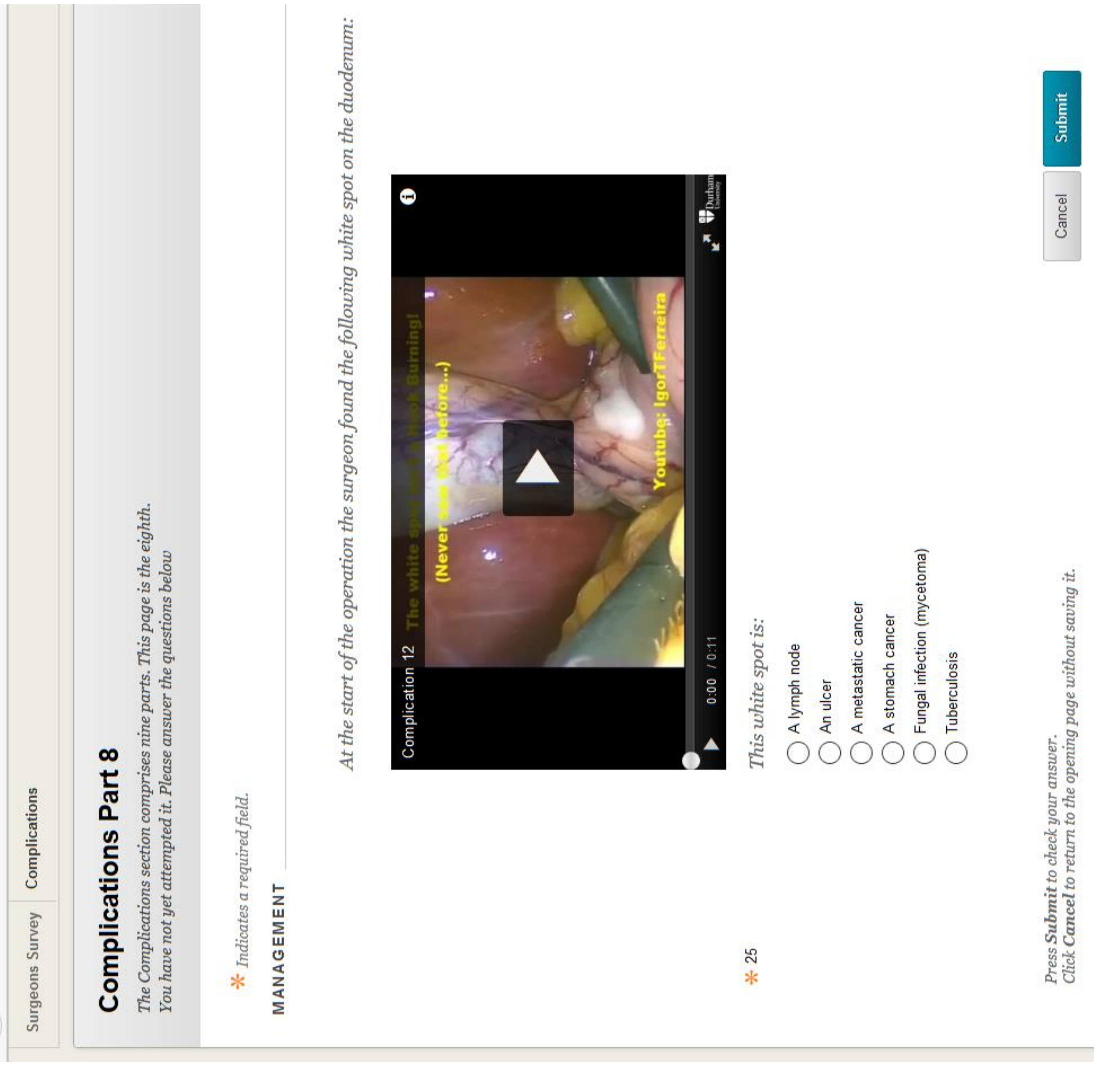
Feedback

Model answer:
Gallstone Ileus

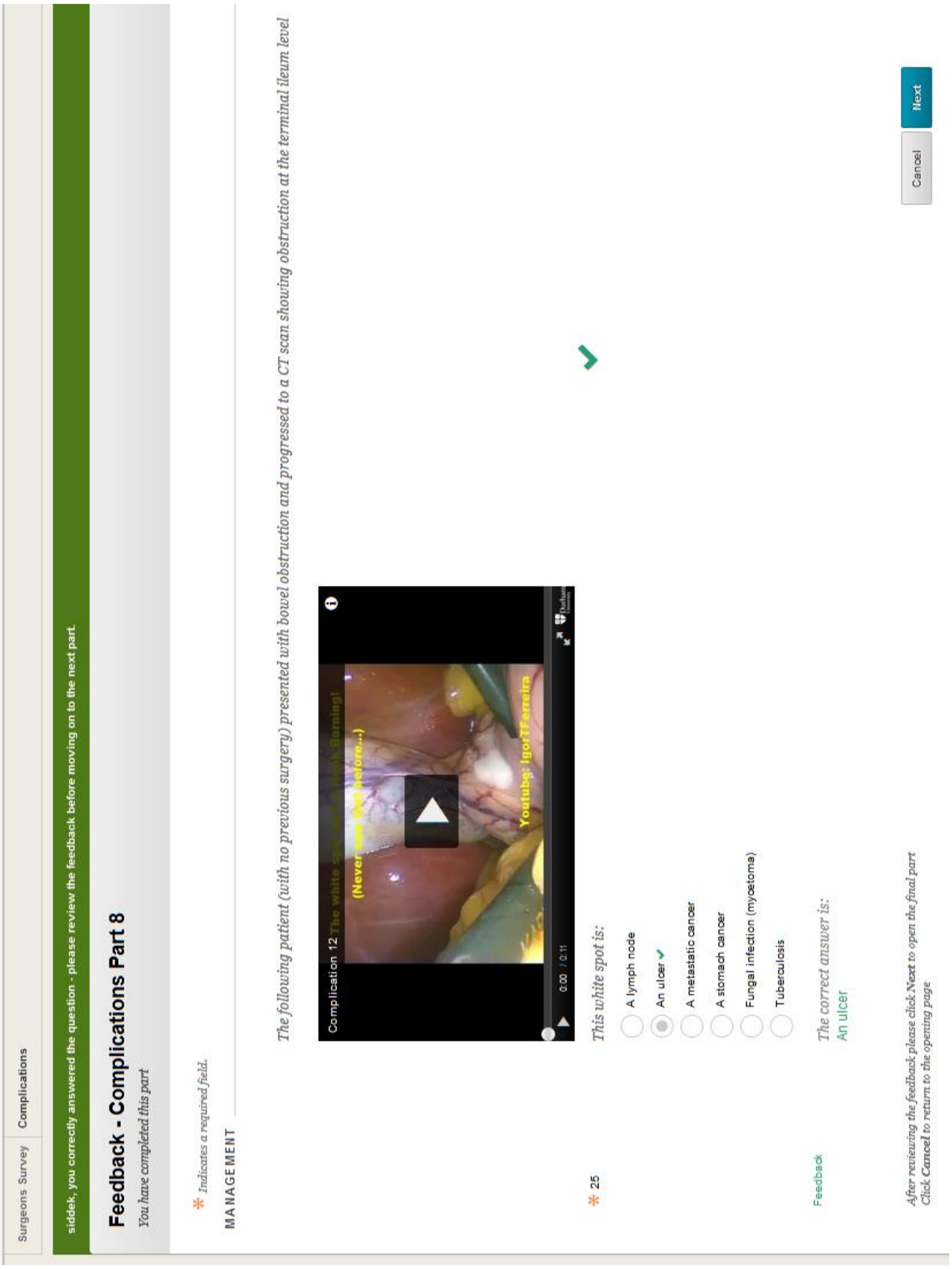
*After reviewing the feedback please click **Next** to open the fifth part*
*Click **Cancel** to return to the opening page*

Cancel | Next

Appendix 50

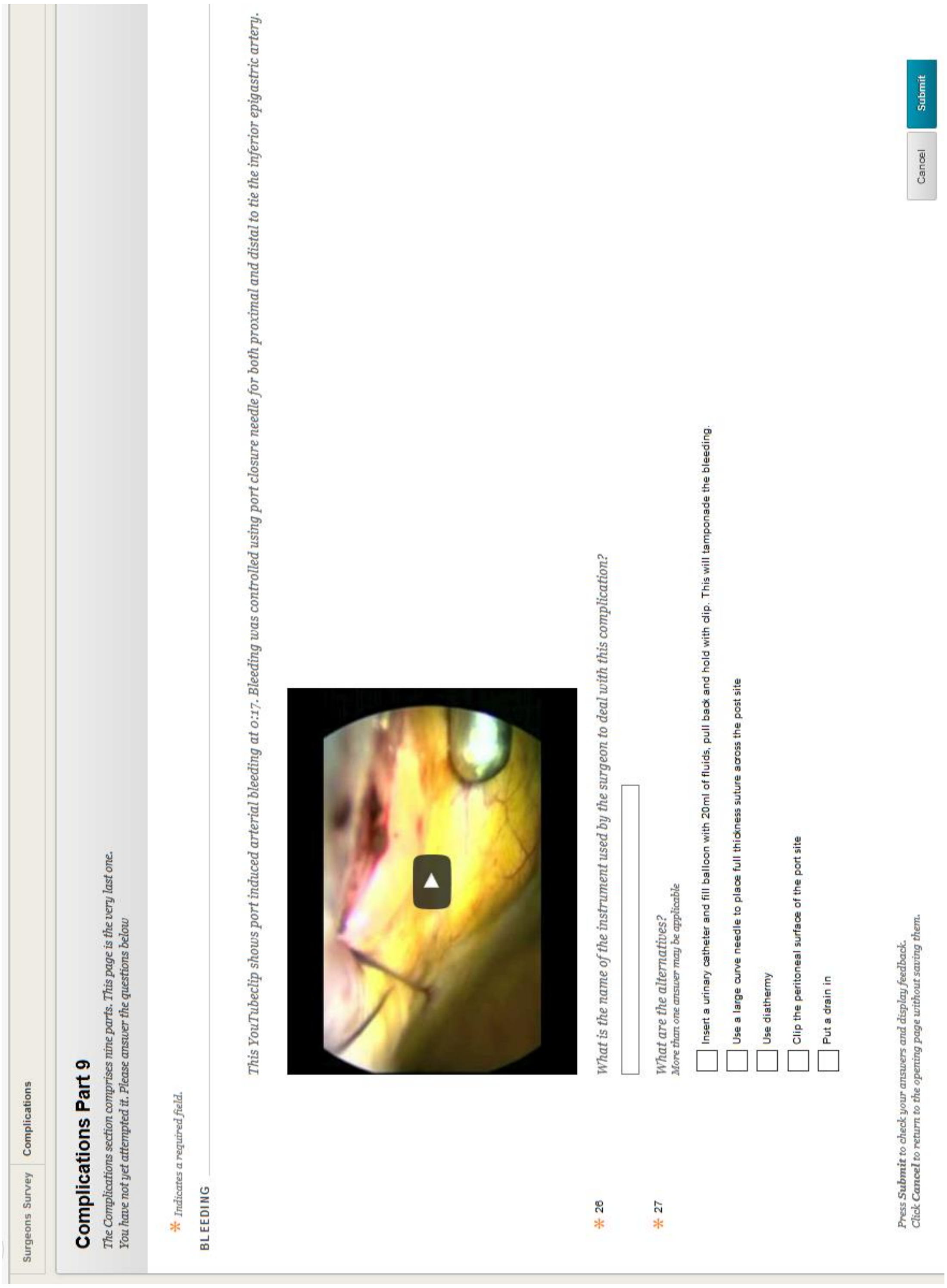

Surgeons Survey
Complications
Complications Part 8
The Complications section comprises nine parts. This page is the eighth.
You have not yet attempted it. Please answer the questions below
* Indicates a required field.
MANAGEMENT
* 25
At the start of the operation the surgeon found the following white spot on the duodenum:
Complication 12
(Never seen that before...)
Youtube: IgorTFerreira
0:00 / 0:11
This white spot is:
A lymph node
An ulcer
A metastatic cancer
A stomach cancer
Fungal infection (mycetoma)
Tuberculosis
Press Submit to check your answer.
Click Cancel to return to the opening page without saving it.
Cancel
Submit

Appendix 51



Surgeons Survey
Complications
siddek, you correctly answered the question - please review the feedback before moving on to the next part.
Feedback - Complications Part 8
You have completed this part
* Indicates a required field.
MANAGEMENT
The following patient (with no previous surgery) presented with bowel obstruction and progressed to a CT scan showing obstruction at the terminal ileum level
Complication 12
Youtube: IgorTFerreira
0:00 / 0:11
* 25
This white spot is:
A lymph node
An ulcer
A metastatic cancer
A stomach cancer
Fungal infection (mycetoma)
Tuberculosis
Feedback
The correct answer is:
An ulcer
After reviewing the feedback please click Next to open the final part
Click Cancel to return to the opening page
Cancel
Next

Appendix 52


Surveys Survey Complications

Complications Part 9

The Complications section comprises nine parts. This page is the very last one.
You have not yet attempted it. Please answer the questions below

* *Indicates a required field.*

BLEEDING

This YouTubeclip shows port induced arterial bleeding at 0:17. Bleeding was controlled using port closure needle for both proximal and distal to tie the inferior epigastric artery.

* 26 *What is the name of the instrument used by the surgeon to deal with this complication?*

* 27 *What are the alternatives?*
More than one answer may be applicable

- [ ] Insert a urinary catheter and fill balloon with 20ml of fluids, pull back and hold with clip. This will tamponade the bleeding.
- [ ] Use a large curve needle to place full thickness suture across the post site
- [ ] Use diathermy
- [ ] Clip the peritoneal surface of the port site
- [ ] Put a drain in

*Press **Submit** to check your answers and display feedback.*
*Click **Cancel** to return to the opening page without saving them.*

Cancel Submit

Appendix 53

siddek, you correctly answered both questions - please review this final feedback.

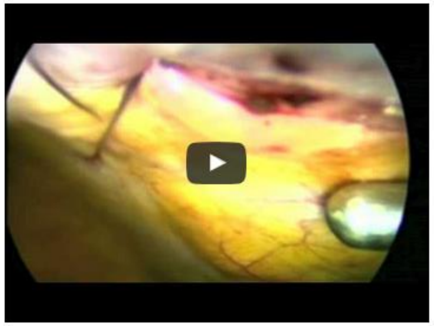
Feedback - Complications Part 0

You have completed this part

* *Indicates a required field.*

BLEEDING

This YouTubeclip shows port induced arterial bleeding at 0:17. Bleeding was controlled using port closure needle for both proximal and distal to tie the inferior epigastric artery.



* 26 *What is the name of the instrument used by the surgeon to deal with this complication?*

endocloser

Feedback *Model answer:*
Endoclose

* 27 *What are the alternatives?*
More than one answer may be applicable

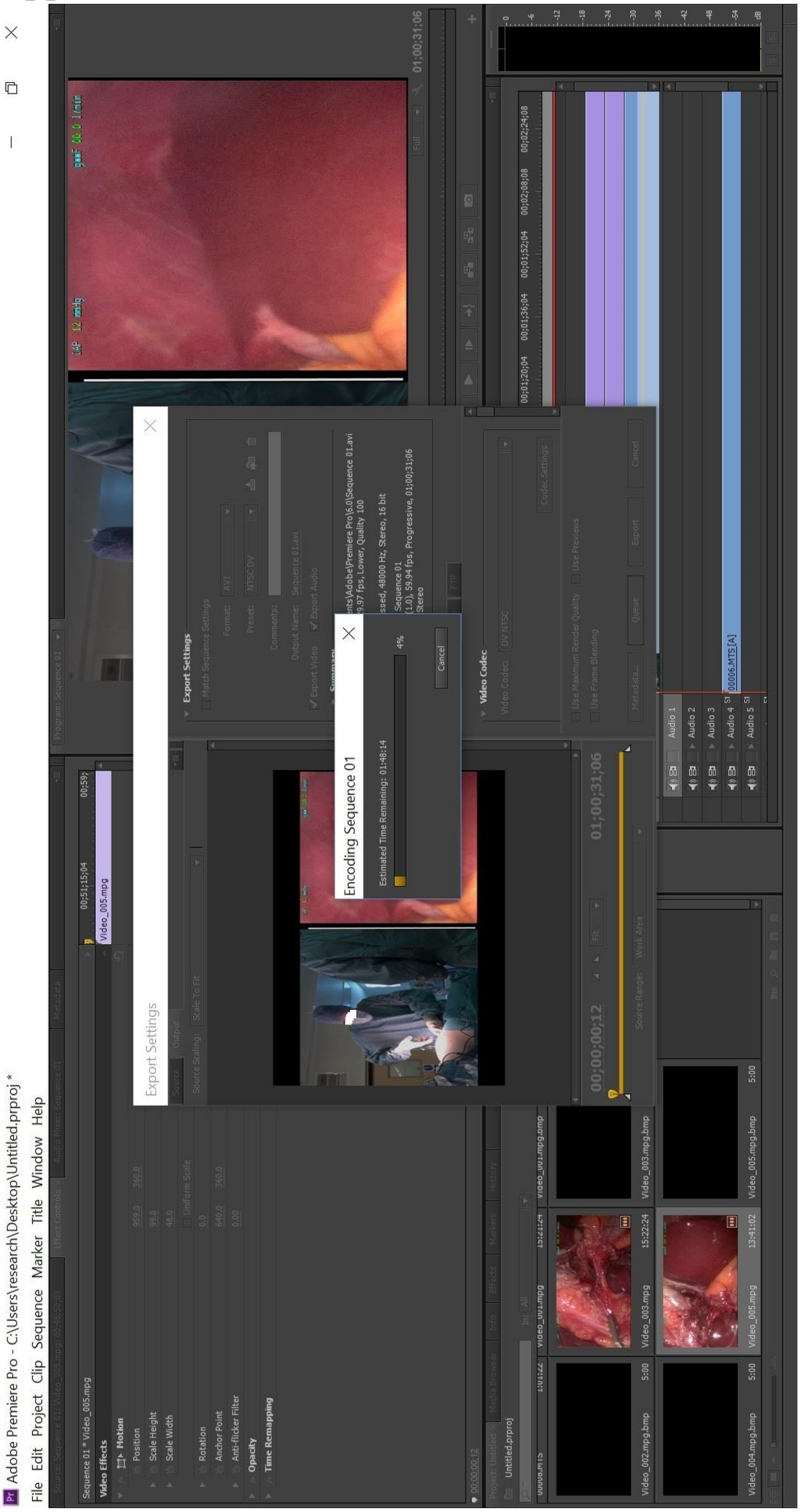
- [ ] Insert a urinary catheter and fill balloon with 20ml of fluids, pull back and hold with clip. This will tamponade the bleeding. ✔
- [ ] Use a large curve needle to place full thickness suture across the post site ✔
- [ ] Use diathermy
- [ ] Clip the peritoneal surface of the port site
- [ ] Put a drain in

Feedback *The correct answers are:*
Insert a urinary catheter and fill balloon with 20ml of fluids, pull back and hold with clip. This will tamponade the bleec
and
Use a large curve needle to place full thickness suture across the post site

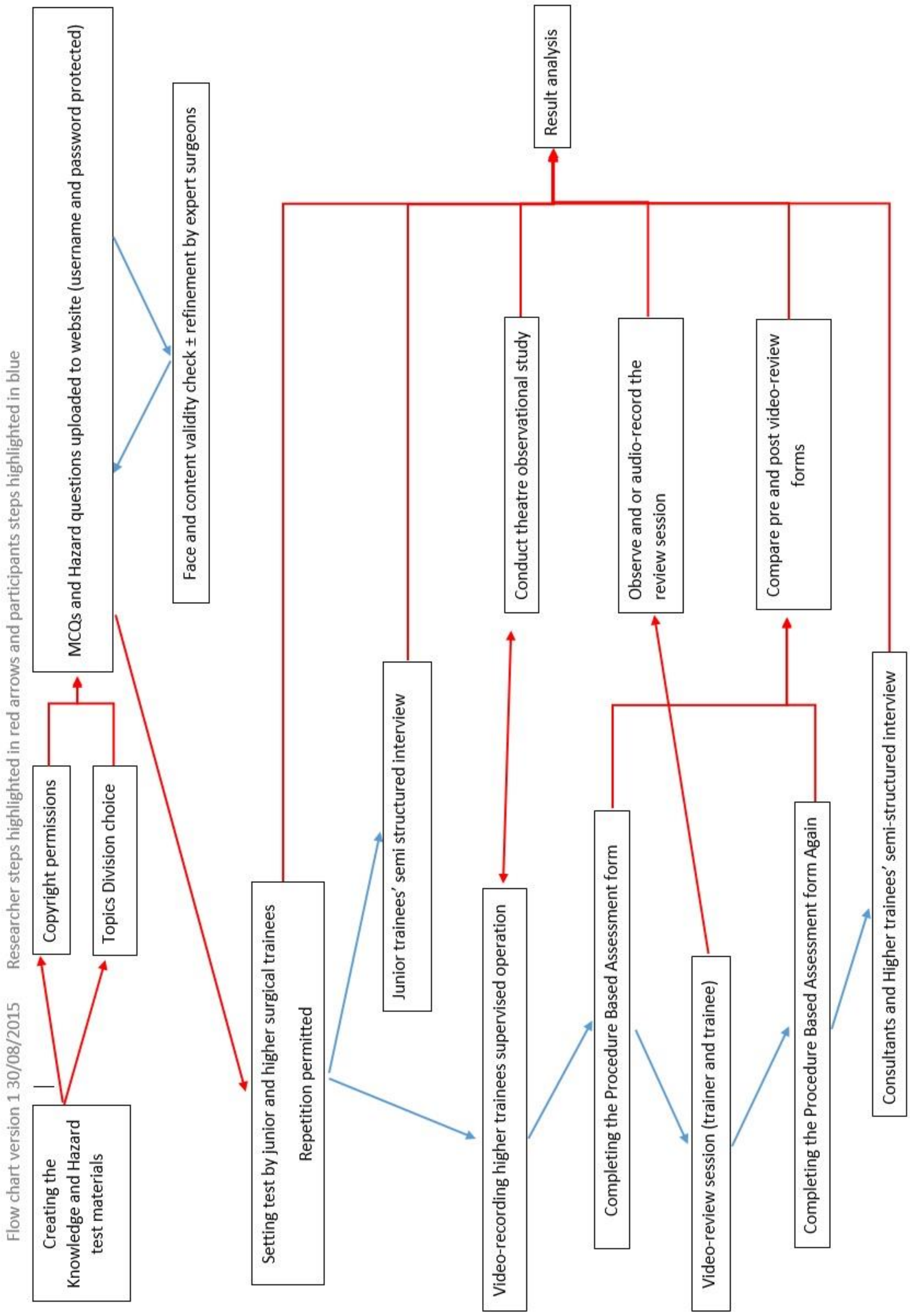
*After reviewing this final feedback please click **Finish** button*

Finish

Appendix 54


Adobe Premiere Pro - C:\Users\research\Desktop\Untitled.prproj *
File Edit Project Clip Sequence Marker Title Window Help
Export Settings
Encoding Sequence 01
Estimated Time Remaining: 01:48:14
4%
Cancel

Appendix 55



Flow chart version 1 30/08/2015
Researcher steps highlighted in red arrows and participants steps highlighted in blue
Creating the Knowledge and Hazard test materials
Copyright permissions
Topics Division choice
MCQs and Hazard questions uploaded to website (username and password protected)
Face and content validity check ± refinement by expert surgeons
Setting test by junior and higher surgical trainees
Repetition permitted
Junior trainees' semi structured interview
Video-recording higher trainees supervised operation
Completing the Procedure Based Assessment form
Video-review session (trainer and trainee)
Completing the Procedure Based Assessment form Again
Consultants and Higher trainees' semi-structured interview
Conduct theatre observational study
Observe and or audio-record the review session
Compare pre and post video-review forms
Result analysis

Appendix 56

Semi structured interview themes

Junior trainees interview question themes (post Knowledge and Hazard assessment)

1- rate the new assessment materials:

Not useful			very useful
1	2	3	4

2- what did you like about the new assessment

3- what do you want to change in the new assessment

4- do you have any suggestions to improve surgical training and assessment

Higher surgical trainees interview question themes (after they finish the full assessment framework)

1- rate the Knowledge and Hazard assessment materials:

Not useful			very useful
1	2	3	4

2- Rate the video review session

Not useful			very useful
1	2	3	4

3- what did you like about the new assessment

4- did you discover areas to improve in your technical skills after reviewing your own operation recording.do you mind sharing couple of them with me please

5- what do you want to change in the new assessment

6- do you have any suggestions to improve surgical training and assessment

7- do you have any suggestions to improve theatre safety or smooth operation progress in theatre

Consultants interview question themes (exposed only to the video review part of the assessment framework)

1- Rate the video review session

Not useful			very useful
1	2	3	4

2- what did you like about the new assessment

3- what do you want to change in the new assessment

4- do you have any suggestions to improve surgical training and assessment

5- do you have any suggestions to improve theatre safety or smooth operation progress in theatre

Appendix 57

Northumbria Healthcare NHS
NHS Trust

PATIENT CONSENT TO MEDICAL IMAGE RECORDING

The operation you have consented to will be carried out in a dedicated laparoscopic theatre which has closed circuit video recording both of the general views of the theatre and of the planned operation. Video images of all or part of the operation are routinely collected and will form part of your patient record if they are stored. Video clips and still photographs may be taken for educational purposes. No video recording will be taken without your permission and you can be reassured that strenuous attempts will be made to conceal your identify if the images are used for publications.

Stick patient label here Name DOB Hospital No.

I confirm that I give consent for video recording and video stills to be taken during my operation. I understand the material has both clinical and educational value and I consent to the material being shown to appropriate professional staff and used in educational applications.

To be completed by patient or parent/guardian (if patient under 16)

I agree with the above statement .... Date ....
(Signature patient or parent/guardian)

I also give permission that all or part of the material may be used in conjunction with other photographs, drawings, video images, sound recordings and other form of illustration and may be published in medical journals. As far as it is possible to do so any images will be completely anonymous.

Once released I realise that recovery of the material may not be possible and may be seen by the general public. I understand that no fee is payable to me by the Northumbria Health Care NHS Trust or any other person in respect of the material either now or at any time in the future. I confirm that the purpose for which the material would be used has been explained to me in terms which I have understood. Refusal to consent will in no way affect my medical care.

To be completed by patient or parent/guardian (if patient under 16)

I agree with the above statement .... Date ....
(Signature patient or parent/guardian)

I confirm that I have obtained the above consent from my patient.

Name – Doctor/Surgeon/Dentist.. Date ....

This consent to be kept with patient consent for operation and filed in the notes

---

Theatre use: Material Recorded – Pictures/Images/Video

Description of Material...

Video images were/were not stored on disc/server

Images are stored on a computer server and will normally be deleted after 8 years (25 years for children under the age of 16) unless there has been a request by the patient or consultant to store the material for longer.

LP20577

Appendix 58

Durham University
School of Medicine, Pharmacy and Health

Shaped by the past, creating the future

Dr Shelina Visram
Lecturer, Centre for Public Policy and Health
Deputy Chair, School of Medicine, Pharmacy and Health Ethics Sub-Committee

Siddek Isreb
School of Medicine, Pharmacy and Health
Durham University
12th October 2015

Dear Siddek,

Re: Ethics Application ESC2/2015/15
Comprehensive framework to support & assess surgical training progress.

Thank you for sending the above application to the School of Medicine, Pharmacy and Health Ethics Committee for ethical review. The project was reviewed at a committee meeting on 16th September 2015. The committee requested some changes to the application, and these have now been reviewed by myself as Deputy Chair. I am satisfied that all of the comments made by the committee at the meeting have been adequately addressed and I can therefore confirm Durham University ethical approval for the study.

Approval is given subject to the following:

- That you gain all relevant NHS REC, governance and Caldicott Guardian approvals prior to starting the research.
- That data generated for this study is maintained and destroyed as outlined in this proposal and in keeping with the Data Protection Act.
- If you make any amendments to your study, these must be approved by the School committee prior to implementation.
- At the end of the study, please submit a short end of study report (ESC3 form) to the School ethics committee.

Please do not hesitate to contact me should you have any questions.

Kind regards,

Shelina Visram

Appendix 59

North East - York Research Ethics Committee

Jarrow Business Centre
Viking Business Park
Rolling Mill Road
Jarrow, Tyne & Wear
NE32 3DT

Telephone: 0191 4283563

07 December 2015

Mr Siddek Isreb

Research Student Administrator office at School of Medicine

Pharmacy and Health

Room A101, Holliday Building, Queen's Campus

Stockton-on-Tees

TS17 6BH

Dear Mr Isreb

Study title:	**Comprehensive framework to support and assess surgical training progress**
REC reference:	**15/NE/0367**
IRAS project ID:	**142194**

Thank you for your letter received 1 December 2015, responding to the Committee's request for further information on the above research [and submitting revised documentation].

The further information has been considered on behalf of the Committee by the Chair.

We plan to publish your research summary wording for the above study on the HRA website, together with your contact details. Publication will be no earlier than three months from the date of this opinion letter. Should you wish to provide a substitute contact point, require further information, or wish to make a request to postpone publication, please contact the REC Manager, Mrs Helen Wilson, nrescommittee.northeast-york@nhs.net.

Confirmation of ethical opinion

On behalf of the Committee, I am pleased to confirm a **favourable ethical opinion** for the above research on the basis described in the application form, protocol and supporting documentation [as revised], subject to the conditions specified below.

Conditions of the favourable opinion

The REC favourable opinion is subject to the following conditions being met prior to the start of

the study.

Management permission must be obtained from each host organisation prior to the start of the study at the site concerned.

Management permission should be sought from all NHS organisations involved in the study in accordance with NHS research governance arrangements. Each NHS organisation must confirm through the signing of agreements and/or other documents that it has given permission for the research to proceed (except where explicitly specified otherwise).

Guidance on applying for NHS permission for research is available in the Integrated Research Application System, www.hra.nhs.uk or at http://www.rdforum.nhs.uk.

Where a NHS organisation's role in the study is limited to identifying and referring potential participants to research sites ("participant identification centre"), guidance should be sought from the R&D office on the information it requires to give permission for this activity.

For non-NHS sites, site management permission should be obtained in accordance with the procedures of the relevant host organisation.

Sponsors are not required to notify the Committee of management permissions from host organisations

Registration of Clinical Trials

All clinical trials (defined as the first four categories on the IRAS filter page) must be registered on a publically accessible database within 6 weeks of recruitment of the first participant (for medical device studies, within the timeline determined by the current registration and publication trees).

There is no requirement to separately notify the REC but you should do so at the earliest opportunity e.g. when submitting an amendment. We will audit the registration details as part of the annual progress reporting process.

To ensure transparency in research, we strongly recommend that all research is registered but for non-clinical trials this is not currently mandatory.

If a sponsor wishes to contest the need for registration they should contact Catherine Blewett (catherineblewett@nhs.net), the HRA does not, however, expect exceptions to be made. Guidance on where to register is provided within IRAS.

It is the responsibility of the sponsor to ensure that all the conditions are complied with before the start of the study or its initiation at a particular site (as applicable).

Ethical review of research sites

NHS sites

The favourable opinion applies to all NHS sites taking part in the study, subject to management permission being obtained from the NHS/HSC R&D office prior to the start of the study (see "Conditions of the favourable opinion" below).

Approved documents

The final list of documents reviewed and approved by the Committee is as follows:

Document	*Version*	*Date*
Evidence of Sponsor insurance or indemnity (non NHS Sponsors only) [Durham Insurance]	v1	20 July 2015
Interview schedules or topic guides for participants [semistructured interview themes]	v1	30 August 2015
IRAS Checklist XML [Checklist_01122015]		01 December 2015
Letter from sponsor [FullCommittee_NHS REC_approval]	v1	12 October 2015
Letter from statistician [Supervisor review letter]		03 September 2015
Non-validated questionnaire [semistructured interview themes]	v1	30 August 2015
Other [Supervisor Stephen Attwood CV]	V1	30 August 2015

Other [Supervisor Hannah Hesselgreaves CV]	V1	30 August 2015
Other [Supervisor Jam Illing CV]	V1	30 August 2015
Other [Ethical approval feedback response]	1	30 November 2015
Participant consent form [consent form Northumbria medical image recording]	LP20577	30 August 2015
Participant consent form [consent form consultant]	V3	02 October 2015
Participant consent form [consent form higher trainees]	v1	30 August 2015
Participant consent form [consent form patient]	v1	30 August 2015
Participant consent form [consent form trainees]	v1	30 August 2015
Participant information sheet (PIS) [Information sheet consultant V4]	V4	30 November 2015
Participant information sheet (PIS) [Information sheet Higher Trainee V4]	V4	30 November 2015
Participant information sheet (PIS) [Information sheet Patient V4]	V4	30 November 2015
Participant information sheet (PIS) [Information sheet Trainee V3]	V3	30 November 2015
REC Application Form [REC_Form_20102015]		20 October 2015
Referee's report or other scientific critique report [Supervisor review letter]		03 September 2015
Research protocol or project proposal [Research Protocl V3]	V3	02 October 2015
Summary CV for Chief Investigator (CI) [Principal investigator CV]	v1	30 August 2015
Summary CV for student [Principal investigator CV]	v1	30 August 2015
Summary CV for supervisor (student research) [Supervisor John McLachlan CV]	V1	30 August 2015
Summary, synopsis or diagram (flowchart) of protocol in non- technical language [study flow chart]	1	30 August 2015
Validated questionnaire [PBA_GS_HPB_Lap_cholecyst]	V2	30 August 2015

Statement of compliance

The Committee is constituted in accordance with the Governance Arrangements for Research

Ethics Committees and complies fully with the Standard Operating Procedures for Research Ethics Committees in the UK.

After ethical review

<u>Reporting requirements</u>

The attached document *"After ethical review – guidance for researchers"* gives detailed guidance on reporting requirements for studies with a favourable opinion, including:

- Notifying substantial amendments
- Adding new sites and investigators
- Notification of serious breaches of the protocol
- Progress and safety reports
- Notifying the end of the study

The HRA website also provides guidance on these topics, which is updated in the light of changes in reporting requirements or procedures.

User Feedback

The Health Research Authority is continually striving to provide a high quality service to all applicants and sponsors. You are invited to give your view of the service you have received and the application procedure. If you wish to make your views known please use the feedback form available on the HRA website:

http://www.hra.nhs.uk/about-the-hra/governance/quality-assurance/

HRA Training

We are pleased to welcome researchers and R&D staff at our training days – see details at http://www.hra.nhs.uk/hra-training/

15/NE/0367	**Please quote this number on all correspondence**

With the Committee's best wishes for the success of this project.

Yours sincerely

pp

Mr Steve Chandler Chair

Email: nrescommittee.northeast-york@nhs.net

Enclosures: "After ethical review – guidance for researchers"

Copy to: Professor John McLachlan

Caroline Potts, Northumbria Health Care NHS Trust

Appendix 60

Durham University
School of Medicine, Pharmacy and Health

Patient consent form

Principal Investigator: Dr Siddek Isreb

Centre number: Case Number:

Participant Identification Number:

Comprehensive framework to support & assess surgical training progress

Please initial box

1- I confirm that I have read the information sheet dated30/11/2015 version V4 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my medical care or legal rights being affected.	
3- I confirm that I signed Northumbria Healthcare NHS Trust Medical Image Recording form (LP20577)	
4- I agree that my surgical operation may be video-recorded and observed by the researcher taking field notes. I understand that recording will be confidentially transcribed and analysed by the researcher.	
5- I agree that still pictures or short video clips from the operation may be used in academic presentation, publications or for education of other health professionals and I have signed the relevant part in Northumbria Healthcare NHS Trust Medical Image Recording form (LP20577) to confirm such permission.	
6- I agree to take part in the above study.	

Name of Participant Date Signature

Name of Person taking consent Date Signature

Patient's consent form v1 30/08/2015

Appendix 61

Durham University
School of Medicine, Pharmacy and Health

Consultant consent form

Principal Investigator: Dr Siddek Isreb

Centre number: Case Number:

Participant Identification Number:

Comprehensive framework to support & assess surgical training progress

Please initial box

1- I confirm that I have read the information sheet dated 30/11/2015 version V4 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my legal rights being affected.	
3- I agree that my supervised surgical operation may be video-recorded and observed by the researcher taking field notes.	
4- I agree that a copy of the operation recording will be confidentially transcribed and analysed by the researcher.	
5- I agree that the video-review session may be Audio-recorded and confidentially transcribed and analysed by the researcher.	
6- I agree that the video-review session may be observed by the researcher and field notes may be taken.	
7- I agree to share the pre and post video-review session Procedure Based Assessment (PBA) forms with the researcher.	
8- I agree to take part in a short research interview and I understand the interview will be audio-recorded, confidentially transcribed and analysed by the researcher.	
9- I agree that anonymised quotes may be used in reports and publications.	
10- I agree that still pictures of me or short video clips may be used in academic presentation, publications or for education of other health professionals using identity concealment techniques (face blurring / pixelation and voice alteration).	
11- I agree to the researcher contacting me to request any additional permissions and these are my contact details:	
12- I agree to take part in the above study.	

Name of Participant_________________ Date________________ Signature___________________

Name of Person taking consent______________ Date________________ Signature___________________

Consultant's consent form v3 02/10/2015

Appendix 62

Durham University
School of Medicine, Pharmacy and Health

Higher trainee consent form

Principal Investigator: Dr Siddek Isreb

Centre number: Case Number:

Participant Identification Number:

Comprehensive framework to support & assess surgical training progress

Please initial box

1- I confirm that I have read the information sheet dated 30/11/2015 version V4 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my training or legal rights being affected.	
3- I agree to take the Knowledge and Hazard Test of this study and for the researcher to analyse my results.	
4- I agree that my supervised surgical operation may be video-recorded and observed by the researcher taking field notes. I understand that recording will be confidentially transcribed and analysed by the researcher.	
5- I agree that the video-review session may be Audio-recorded and confidentially transcribed and analysed by the researcher.	
6- I agree that the video-review session may be observed by the researcher and field notes may be taken.	
7- I agree to share the pre and post video-review session Procedure Based Assessment (PBA) forms with the researcher.	
8- I agree to take part in a short research interview and I understand the interview will be audio-recorded, confidentially transcribed and analysed by the researcher.	
9- I agree that anonymised quotes may be used in reports and publications.	
10- I agree that still pictures of me or short video clips may be used in academic presentation, publications or for education of other health professionals using identity concealment techniques (face blurring / pixelation and voice alteration).	
11- I agree to the researcher contacting me to request any additional permissions and these are my contact details:	
12- I agree to take part in the above study.	

Name of Participant Date Signature

Name of Person taking consent Date Signature

Higher trainees' consent form v1 30/08/2015

Appendix 63

Durham University
School of Medicine, Pharmacy and Health

Trainee consent form

Principal Investigator: Dr Siddek Isreb

Centre number: Case Number:

Participant Identification Number:

Comprehensive framework to support & assess surgical training progress

Please initial box

1- I confirm that I have read the information sheet dated 30/11/2015version V3 for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.	
2- I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason, without my training or legal rights being affected.	
3- I agree to take the Knowledge and Hazard Test of this study and for the researcher to analyse my results.	
4- I agree to take part in a short research interview and I understand the interview will be audio-recorded, confidentially transcribed and analysed by the researcher.	
5- I agree that anonymised quotes may be used in reports and publications.	
6- I agree to take part in the above study.	

______________ ______________ ______________

Name of Participant Date Signature

______________ ______________ ______________

Name of Person taking consent Date Signature

Appendix 64

Durham University

School of Medicine, Pharmacy and Health

Patient information sheet

Principal Investigator: Dr Siddek Isreb

Comprehensive framework to support & assess surgical training progress

This involves a new way to test surgeons' skills. You are being invited to take part in a research study. Before you decide whether or not you would like to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

Thank you for reading this information sheet.

What is the purpose of the study?

This research is being carried out as part of a PhD at Durham University. We have created a new surgical skills assessment framework to enhance surgical training by improving reflection and feedback with the ultimate aim of reducing risks to patients undergoing surgical operations. The framework is designed for laparoscopic cholecystectomy (removing the gallbladder by keyhole surgery).

We think it is important to put this new assessment in practice to find out if it will deliver the intended benefit and improvement. We also want to conduct an observational study in theatre (this involves observing checking what happens in theatre to support better understanding to identify any possible opportunities to enhance surgical training and improve patient safety.

Why have I been invited?

The framework is designed for laparoscopic cholecystectomy (removing the gallbladder by keyhole surgery) and you are listed for this procedure. As a result you have been identified as a potential participant.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and you will be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. You can do so by contacting myself or my supervisor anytime and ask for your operation recording not to be included in the study. A decision towithdraw at any time, or a decision not to take part, will not affect your treatment in any way.

What will happen to me if I take part?

Your operation will progress as planned with no changes. I would like to carry out observations during your surgical operation. I am a qualified doctor but not involved in your care. If I observe your operation this means that I might be looking at the operation progress and the interaction between the healthcare professionals involved in your operation. I will not interfere, interrupt or change the operation progress.

I would also like to make recordings. There are two types of recordings that will be made: field notes and video-recordings.

- Field notes are the notes which I will write down in a notebook while I observe your operation.
- Video-recordings capture how the healthcare professionals operate and interact with each other during the operation as well as recording what is said. Your operation is carried out in a laparoscopic theatre which has video recording. I will capture the general views of theatre and the operation inside

your abdomen (tummy). The two images will be synchronised (put alongside each other on one screen) to show the surgical action and the way the instruments are manipulated, as well as staff interactions.

Will people be able to recognise me from the recordings?

No, you will not be recognizable. Recordings will start after you have been put asleep and covered by the surgical drapes. Recording will be stopped at the end of the procedure before the drapes are removed so your face and body (except your abdomen (tummy)) will always be covered in the recording. The video recordings will include images from inside your abdomen but no-one will be able to recognise you from these. This means they are anonymised. Any recordings of you will be kept securely on NHS secure drives that are only accessible to the researcher and your consultant.

I will want to present my research at medical and academic conferences or in written papers in research journals and I would anonymise all data. I might want to show a short video clip at a conference or a still picture in a journal paper, these may be viewed by people outside of the research team. Any videos or still pictures will not be copied or given to anyone else and will be used for the sole purpose of educational training or to illustrate my research findings.

If you agree to your operation being observed and recordings are made today, you are still free to change your mind at any time. If this is the case, please contact me and any recordings that I have made featuring you would be destroyed.

What do I have to do?

There is nothing you need to do. I am interested in the work that the doctors and nurses are doing in the surgical theatre as the operation progresses. I will not intervene in the operation progress or with your healthcare in any way.

What are the possible disadvantages and risks of taking part?

There are no real disadvantages. However it is possible that you may feel uncomfortable with another person being present during your operation. Your operation is carried out under general anaesthesia so you will be asleep. The researcher will not start the video recording till you are covered with surgical drapes. Any field notes or recordings about you will remain carefully protected through encryption of the data and storage on NHS secure drives.

What are the possible benefits of taking part?

The primary benefits from this research study are for the advancement of surgical skills training and assessment. The availability of these data may lead to improvements in patient care as well as improvements in clinical educational practice, here at the hospital where you are being operated on and elsewhere.

What happens when the research study stops?

As this is a non-interventionist research project, termination of the study does not affect you in any way.

How is the research quality assured?

Before any research study can start it must have various approvals in place including review by an independent research ethics committee. The research department at the hospital has to ensure that all permissions have been granted before the study opens at that site, and that it is appropriate to conduct the research within the Trust. For more information visit the **National Institute for Health Research** website http://www.nihr.ac.uk/**.** If you wish to complain about the study conduct, or have any concerns about any aspect of the research study then you should immediately inform me or my research supervisor (Contact details below). Your participation is always voluntary and you are able to withdraw from the research study at any time, without giving a reason, and without it affecting your normal treatment.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. I will not collect personal information such as your name or date of birth. Procedures for handling, processing, storage and destruction of data are compliant with the Data Protection Act 1998. In cases of litigation we may be legally obliged to disclose any recordings.

What will happen to the results of the research study?

This research is being carried out as part of a PhD degree. Study results will inform the degree thesis and will be presented at conferences and published in journals focused on surgical/medical education, quality and safety in healthcare and work-based learning. Information arising from this study may be presented in the context of scholarly publications, academic symposia, university classes, and professional training activities. Your individual level of consent will be respected so that if you do not wish to allow anonymised pictures or videos of yourself to be shown at conferences or published in journals, you can still take part in the study. I will use pseudonyms to conceal your identity.

What will happen if I don't want to carry on with the study or am unable to?

Once the operation is completed, you will not be expected to have anything more to do with the study.

The operating team would be reviewing the operation recording for their education benefit and the research team might use the recording to help the observational study analysis.

Who is organising and funding the research?

This research is being carried out as part of a PhD at Durham University School of Health, Pharmacy and Medicine. It is self-funded by the researcher.

Who has reviewed the study?

This research has been reviewed within the Durham University School of Health, Pharmacy and Medicine ethics committee and was given a favourable ethical opinion for conduct in the NHS by North East – York Research Ethics Committee Ref. number 15/NE/0367.

What do I need to do if I would like to participate?

If you would like to participate in the study, please sign the attached consent form and return it to the researcher. You may keep this copy of the patient participant information sheet and can have a copy of the signed informed consent form to keep in case you wish to refer back to it afterwards.

Contact for Further Information

Please email the researcher: Dr. Siddek Isreb for further information at siddek.isreb@durham.ac.uk or the research supervisor: Professor John McLachlan at j.c.mclachlan@durham.ac.uk.

Appendix 65

Durham University

School of Medicine, Pharmacy and Health

Consultant information sheet

Principal Investigator: Dr Siddek Isre**b**

Comprehensive framework to support & assess surgical training progress

You are being invited to take part in a research study. Before you decide whether or not you would like to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

Thank you for reading this information sheet.

What is the purpose of the study?

This research is being carried out as part of a PhD at Durham University. We have created a new surgical skills assessment framework to enhance surgical training by improving reflection and feedback with the ultimate aim of reducing risks to patients undergoing surgical operations. The framework is designed for laparoscopic cholecystectomy.

We think it is important to put this new assessment framework in practice to find out if it will deliver the intended benefit and improvement. We also want to conduct an observational study in theatre to identify any possible opportunities to enhance surgical training and improve patient safety.

Why have I been invited?

All general surgical trainees and trainers (consultants) in the Northern Deanery hospitals are being invited to take part in my research. I am conducting an educational study aiming to improve surgical training and patient safety and you have been identified as a potential candidate to join the research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect your work in any way.

What will happen to me if I take part?

I would like to test the new surgical skills assessment and conduct an observational study in theatre so if you kindly join our study the following steps will take place:

1- I would like to video-record and conduct an observational study during your supervised surgical operation. I am a qualified doctor but I am not involved in Hospital management, Deanery assessment or the patient's care. Recordings will be used to assist the observation and to serve the educational purpose explained in step 3 below. If you are willing to be video-recorded and observed as part of this study, your trainee and the patient you are operating on would also have to agree to be video-recorded and observed. If I observe your operation this means that I will be looking at the operation progress and the interaction between the healthcare professionals involved in the operation. I will not interfere, interrupt or change the operation progress.

   I would also like to make recordings. There are two types of recordings I would like to make: field notes and video-recordings.

- Field notes are the notes which I write down in a notebook while I observe your operation.
- Video-recordings capture how your trainee operates and interacts with the team during the operation as well as voice recording of what is said. The operation is carried out in a laparoscopic theatre which already has video recording. I will capture the general views of theatre and the operation inside the abdomen. The two images will be synchronised to show the surgical action and the way the instruments are manipulated, as well as staff interactions. The operation video-recording will be stored in a secure folder in the trust intranet drive, accessible only to yourself and the researcher for the review session (step 3). A copy of the operation recording will be transported securely on an NHS encrypted hard drive to the Northumbria Trust intranet secure folder during the PhD analysis period. This folder will only be accessible by the researcher.

2- Completing the procedure based assessment form (PBA): After performing the surgical procedure you will be asked to fill the PBA form as you would usually do with your trainee. This part will be repeated later as explained in number 3. I will not share those forms with anyone outside the research team.

3- Video-review: you and your trainee will be asked to review the video-recording from your supervised procedure and complete the PBA form again. Video review will serve as a reflective time for your trainee to review his/her performance in a stress free environment outside theatre and receive your feedback. Both you and your trainee will have the opportunity to skip parts of the recordings as you wish.
I would like, with your permission to observe, the video-review session and / or audio-record it. I would like also to compare the PBA form before and after the video-review session to check for any variations post-intervention (video-review).

4- Following the video-review session, I would like to conduct a short (10 minutes) semi-structured interview with you, at a time convenient for yourself, to check your impression about the new assessment framework and share any insight you have on ways to improve surgical training and patient safety . This would be audio-recorded and transcribed for analysis.

Will the data be anonymised?

Audio recordings will be transcribed and the written transcripts then analysed, so no-one will be able to recognise you from these. If your name or another's name is used we will remove these and use pseudonyms.

One of the things I am interested in is communication during the operation which may be non-verbal for example through gaze, facial expression or gesture. The video recordings may capture this information and will only be viewed by the research team (in non-anonymised form). Any recordings about you will remain carefully protected and stored on the Trust intranet in a secure folder. It will only be accessible to yourself and the researcher (SI). Your supervised video-recordings will be observed by yourself and your trainee during the review session.

I will want to present my research at medical and academic conferences or in written papers in journals. I might want to show video recordings at medical and academic conferences, or use a still picture in a journal paper. These will be anonymised by blurring or pixelating your face and by changing your voice on the audio recording or by using a transcript of the conversation as subtitles.

What do I have to do?

You need to allow the researcher to observe and video-record your operation. This is an educational study. I am interested in training and I will not intervene with your work or your decisions in any way.

What are the possible disadvantages and risks of taking part?

There are no real disadvantages to this educational research. However it is possible that you may feel uncomfortable with another person observing your operation. If this happens you are welcome to ask the researcher to leave and you may withdraw from the study at any time.

What are the possible benefits of taking part?

The primary benefits from this research study are for the advancement of surgical skills training and assessment. The availability of these data may lead to improvements in patient care as well as improvements in clinical education.

What happens when the research study stops?

As this is a non-interventionist research project, termination of the study does not affect you in any way.

How is the research quality assured?

Before any research study can start it must have various approvals in place including review by an independent research ethics committee. The research department at the hospital has to ensure that all permissions have been granted before the study opens at that site, and that it is appropriate to conduct the research within the Trust. For more information visit the **National Institute for Health Research** website http://www.nihr.ac.uk/**.** If you wish to complain about the study conduct, or have any concerns about any aspect of the research study then you should immediately inform me or my research supervisor (contact details below). Your participation is always voluntary and you are able to withdraw from the research study at any time, without giving a reason, and without it affecting your normal work.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. I will not collect personal information such as your name or date of birth. Procedures for handling, processing, storage and destruction of data are compliant with the Data Protection Act 1998. In cases of litigation we may be legally obliged to disclose any recordings.

What will happen to the results of the research study?

This research is being carried out as part of a PhD degree. Study results will inform the degree thesis and will be presented at conferences and published in journals focused on surgical/medical education, quality and safety in healthcare and work-based learning.

What will happen if I don't want to carry on with the study or am unable to?

Once the above five steps are completed, you will not be expected to have anything more to do with the study.

If you are unable to continue on with the study any data collected up to that point will be retained.

Who is organising and funding the research?

This research is being carried out as part of a PhD at Durham University School of Health, Pharmacy and Medicine. It is self-funded by the researcher.

Who has reviewed the study?

This research has been reviewed within the Durham University School of Health, Pharmacy and Medicine ethics committee and was given a favourable ethical opinion for conduct in the NHS by North East – York Research Ethics Committee Ref. number 15/NE/0367.

What do I need to do if I would like to participate?

If you would like to participate in the study, please sign the attached consent form and return it to the researcher. You may keep this copy of the patient participant information sheet and can have a copy of the signed informed consent form to keep in case you wish to refer back to it afterwards.

Contact for Further Information

Please email the researcher: Dr Siddek Isreb for further information at siddek.isreb@durham.ac.uk or the research supervisor: Professor John McLachlan at j.c.mclachlan@durham.ac.uk.

Appendix 66

Higher trainee information sheet

Principal Investigator: Dr Siddek Isreb

Comprehensive framework to support & assess surgical training progress

You are being invited to take part in a research study. Before you decide whether or not you would like to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

Thank you for reading this information sheet.

What is the purpose of the study?

This research is being carried out as part of a PhD at Durham University. We have created a new surgical skills assessment framework to enhance surgical training by improving reflection and feedback with the ultimate aim of reducing risks to patients undergoing surgical operations. The framework is designed for laparoscopic cholecystectomy.

We think it is important to put this new assessment framework in practice to find out if it will deliver the intended benefit and improvement. We also want to conduct an observational study in theatre to identify any possible opportunities to enhance surgical training and improve patient safety.

Why have I been invited?

All general surgical trainees and trainers (consultants) in the Northern Deanery hospitals are being invited to take part in my research. I am conducting an educational study aiming to improve surgical training and patient safety and you have been identified as a potential candidate to join this research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect your training in any way.

What will happen to me if I take part?

I would like to test the new surgical skills assessment and conduct an observational study in theatre so if you kindly join our study the following steps will take place:

5- You will be asked to take the Knowledge and hazard test: You will be given a username and password to take the test online. It should take you 40-75 minutes and includes multiple choice questions and surgical operation videos selected to present common hazardous moments during laparoscopic cholecystectomy. You will be asked about possible solutions to avoid or manage those situations. Your identity and test score will remain confidential and will not be shared with your trainer (consultant) or the deanery. You are welcome to repeat the test if you wish. Once you have completed the test your username and password will expire.

6- I would like to video-record and conduct an observational study during your supervised surgical operation. I am a qualified doctor but I am not involved in your Deanery assessment or the patient’s care. Recordings will be used to assist the observation and to serve the educational purpose, explained in step 4 below. If you are willing to be video-recorded and observed as part of this study, your supervising consultant and the patient you are operating on would also have to agree to be video-recorded and observed. If I observe your operation this means that I will be looking at the operation progress and the interaction between the healthcare professionals involved in the operation. I will not interfere, interrupt or change the operation progress.

I would also like to make recordings. There are two types of recordings I would like to make: field notes and video-recordings.

- Field notes are the notes which I write down in a notebook while I observe your operation.
- Video-recordings capture how you operate and interact with the team during the operation as well as voice recording what is said. Your operation is carried out in a laparoscopic theatre which has video recording. I will capture the general views of theatre and the operation inside the abdomen. The two images will be synchronised to show the surgical action and the way the instruments are manipulated, as well as staff interactions. The operation video-recording will be stored in a secure folder in the trust intranet drive, accessible only to your consultant and the researcher for the review session (step 4). A copy of the operation recording will be transported securely on an NHS encrypted hard drive to the Northumbria trust intranet secure folder during the PhD analysis period. This folder will only be accessible by the researcher.

7- Completing the procedure based assessment form (PBA): After performing the surgical procedure you will be asked to fill the PBA form as you would usually do with your supervisor. This part will be repeated later as explained in number 4. You don't have to submit either form for the deanery assessment and I will not share those forms with anyone outside the research team.

8- Video review: you and your supervisor will be asked to review the video-recording from your supervised procedure and complete the PBA form again. Video review will serve as a reflective time to review your performance in a stress free environment outside theatre and receive feedback from your supervisor. Both you and your supervisor will have the opportunity to skip parts of the recordings as you wish.

I would like, with your permission to observe, the video-review session and / or audio-record it. I would like also to compare the PBA form before and after the video-review session to check for any variations post-intervention (video-review).

9- Following the video-review session, I would like to conduct a short (10 minutes) semi-structured interview with you, at a time convenient for yourself, to check your impression about the new assessment framework and share any insight you have on ways to improve surgical training and patient safety . This would be audio-recorded and transcribed for analysis.

Will the data be anonymised?

Audio recordings will be transcribed and the written transcripts then analysed, so no-one will be able to recognise you from these. If your name or another's name is used we will remove these and use pseudonyms.

One of the things I am interested in is communication during the operation which may be non-verbal for example through gaze, facial expression or gesture. The video recordings may capture this information and will only be viewed by the research team (in non-anonymised form). Any recordings about you will remain carefully protected and stored on the trust intranet in a secure folder. It will only be accessible to your supervising consultant and the researcher (SI). Your supervised video-recordings will be observed by yourself and your supervisor during the review session.

The research may be presented at medical and academic conferences or in written papers in journals. I might want to show video recordings at medical and academic conferences, or use a still picture in a journal paper. These will be anonymised by blurring or pixelating your face and by changing your voice on the audio recording or by using a transcript of the conversation as subtitles.

What do I have to do?

You need to take the knowledge test and allow the researcher to observe and video-record your operation. This is an educational study. I am interested in training and I will not intervene with your work or your decisions in any way.

What are the possible disadvantages and risks of taking part?

There is no real disadvantages to this educational research. However it is possible that you may feel uncomfortable with another person observing your operation. If this happens you are welcome to ask the researcher to leave and you may withdraw from the study at any time.

What are the possible benefits of taking part?

The primary benefits from this research study are for the advancement of surgical skills training and assessment. The availability of these data may lead to improvements in patient care as well as improvements in clinical education.

What happens when the research study stops?

As this is a non-interventionist research project, termination of the study does not affect you in any way.

How is the research quality assured?

Before any research study can start it must have various approvals in place including review by an independent research ethics committee. The research department at the hospital has to ensure that all permissions have been granted before the study opens at that site, and that it is appropriate to conduct the research within the Trust. For more information visit the **National Institute for Health Research** website http://www.nihr.ac.uk/**.** If you wish to complain about the study conduct, or have any concerns about any aspect of the research study then you should immediately inform myself or my research supervisor (contact details below). Your participation is always voluntary and you are able to withdraw from the research study at any time, without giving a reason, and without it affecting your training.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. I will not collect personal information such as your name or date of birth. Procedures for handling, processing, storage and destruction of data are compliant with the Data Protection Act 1998. In cases of litigation we may be legally obliged to disclose any recordings.

What will happen to the results of the research study?

This research is being carried out as part of a PhD degree. Study results will inform the degree thesis and will be presented at conferences and published in journals focused on surgical/medical education, quality and safety in healthcare and work-based learning.

What will happen if I don't want to carry on with the study or am unable to?

Once the above five steps are completed, you will not be expected to have anything more to do with the study. If you are unable to continue on with the study any data collected up to that point will be retained.

Who is organising and funding the research?

This research is being carried out as part of a PhD at Durham University School of Health, Pharmacy and Medicine Pharmacy. It is self-funded by the researcher.

Who has reviewed the study?

This research has been reviewed within the Durham University School of Health Pharmacy and Medicine ethics committee and was given a favourable ethical opinion for conduct in the NHS by North East – York Research Ethics Committee Ref. number 15/NE/0367.

What do I need to do if I would like to participate?

If you would like to participate in the study, please sign the attached consent form and return it to the researcher. You may keep this copy of the patient participant information sheet and can have a copy of the signed informed consent form to keep in case you wish to refer back to it afterwards.

Contact for Further Information

Please email the researcher: Dr. Siddek Isreb for further information at siddek.isreb@durham.ac.uk or the research supervisor: Professor John McLachlan at j.c.mclachlan@durham.ac.uk.

Appendix 67

Durham University
School of Medicine, Pharmacy and Health

Trainee information sheet

Principal Investigator: Dr Siddek Isreb

Comprehensive framework to support & assess surgical training progress

You are being invited to take part in a research study. Before you decide whether or not you would like to take part, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Ask me if there is anything that is not clear or if you would like more information.

Thank you for reading this information sheet.

What is the purpose of the study?

This research is being carried out as part of a PhD at Durham University. We have created a new surgical skills assessment framework to enhance surgical training by improving reflection and feedback with the ultimate aim of reducing risks to patients undergoing surgical operations. The framework is designed for laparoscopic cholecystectomy.

We think it is important to put this new assessment framework in practice to find out if it will deliver the intended benefit and improvement. We also want to conduct an observational study in theatre to identify any possible opportunities to enhance surgical training and improve patient safety.

Why have I been invited?

All general surgical trainees and trainers (consultants) in the Northern Deanery hospitals are being invited to take part in my research. I am conducting an educational study aiming to improve surgical training and patient safety and you have been identified as a potential candidate to join our research.

Do I have to take part?

It is up to you to decide whether or not to take part. If you do decide to take part you will be given this information sheet to keep and be asked to sign a consent form. If you decide to take part you are still free to withdraw at any time and without giving a reason. A decision to withdraw at any time, or a decision not to take part, will not affect your training in any way.

What will happen to me if I take part?

I would like to test the new surgical skills assessment so if you kindly join our study the following steps will take place:

1- You will be asked to take the Knowledge and hazard test: You will be given a username and password to take the test online. It should take you 40-75 minutes and include multiple choice questions and surgical operation videos selected to present common hazardous moments during laparoscopic cholecystectomy. You will be asked about possible solutions to avoid or manage those situations. Your identity and test score will remain confidential and will not be shared with your trainer (consultant) or the deanery. You are welcome to repeat the test if you wish. Once you have completed the test your username and password will expire.

2- Semi-structured interview: Following the Knowledge and Hazard test I would like to conduct a short (10 minutes) semi-structured interview with you, at a time convenient for yourself, to check your impression about the new assessment framework and share any insight you have on ways to improve surgical training and patient safety. This would be audio-recorded and transcribed for analysis.

How will the Data be protected?

The recording will be confidentially transcribed, and will be erased following transcription. In addition all identifiable data will be removed during the transcribing of the data. The interview transcript notes will be stored on password protected computers kept in secure offices. In addition all data will be aggregated during the reporting and dissemination of the findings making identification of participants even more secure.

What are the possible disadvantages and risks of taking part?

There are no real disadvantages to this educational research. However it is possible that you may feel uncomfortable with the Knowledge and Hazard test level. Please remember that you are kindly helping the researcher to set the test at the right level. It is not a pass/fail test. It serves as an educational and training tool as well as being an assessment. However if you are still not happy to take or continue the test, you may withdraw at any time.

What are the possible benefits of taking part?

The primary benefits from this research study are for the advancement of surgical skills training and assessment. The availability of these data may lead to improvements in patient care as well as improvements in clinical education.

What happens when the research study stops?

As this is a non-interventionist research project, termination of the study does not affect you in any way.

How is the research quality assured?

Before any research study can start it must have various approvals in place including review by an independent research ethics committee. The research department at the hospital has to ensure that all permissions have been granted before the study opens at that site, and that it is appropriate to conduct the research within the Trust. For more information visit the **National Institute for Health Research** website http://www.nihr.ac.uk/**.**

If you wish to complain about the study conduct, or have any concerns about any aspect of the research study then you should immediately inform me or my research supervisor (contact details below). Your participation is always voluntary and you are able to withdraw from the research study at any time, without giving a reason, and without it affecting your training.

Will my taking part in this study be kept confidential?

All information which is collected about you during the course of the research will be kept strictly confidential. I will not collect personal information such as your name or date of birth. Procedures for handling, processing, storage and destruction of data are compliant with the Data Protection Act 1998.

What will happen to the results of the research study?

This research is being carried out as part of a PhD degree. Study results will inform the degree thesis and will be presented at conferences and published in journals focused on surgical/medical education, quality and safety in healthcare and work-based learning.

What will happen if I don't want to carry on with the study or am unable to?

Once the above two steps are completed, you will not be expected to have anything more to do with the study.

Who is organising and funding the research?

This research is being carried out as part of a PhD at Durham University School of Health, Pharmacy and Medicine. It is self-funded by the researcher.

Who has reviewed the study?

This research has been reviewed within the Durham University School of Health, Pharmacy and Medicine ethics committee and was given a favourable ethical opinion for conduct in the NHS by North East – York Research Ethics Committee Ref. number 15/NE/0367.

What do I need to do if I would like to participate?

If you would like to participate in the study, please sign the attached consent form and return it to the researcher. You may keep this copy of this information sheet and can have a copy of the signed informed consent form to keep in case you wish to refer back to it afterwards.

Contact for Further Information

Please email the researcher: Dr Siddek Isreb for further information at siddek.isreb@durham.ac.uk or the research supervisor: Professor John McLachlan at j.c.mclachlan@durham.ac.uk.

Appendix 68

Audio-visual Simulation: User Agreement, Confidentiality, and Consent.

As a patron of the **Gateshead Health NHS Foundation Trust Clinical Skills Simulation Centre**, I understand the significance of confidentiality with respect to information concerning simulated patients and fellow students. I agree to report any breech of confidentiality that I become aware of to the course facilitator or instructor.

I agree to adhere to the following guidelines:

- All information is confidential and any inappropriate viewing, discussion, or disclosure of this information is a violation of Gateshead Health NHS Foundation Trust policy.
- This information is privileged and confidential regardless of format: electronic, written, overheard or observed.
- I may view, use, disclose, or copy information only as it relates to the performance of my educational duties. Any inappropriate viewing, discussion, or disclosure of this information is a violation of hospital policy.
- The Clinical Skills Simulation Centre is a learning environment. All scenarios, regardless of their outcome, should be treated in a professional manner. The student running the scenario should have everyone's respect and attention.
- The simulation mannequins are to be used with respect and as fit for purpose, no Betadine, or ink pens will be used near the mannequins. If cannulations is required then 22g IV or smaller will be used.
- I grant permission to Gateshead Health NHS Foundation Trust to take and use visual/audio images of me. I agree that Gateshead Health NHS Foundation Trust owns the images and all rights related to them, however the images will not be used in any manner or media without notifying me and requesting my written consent.

I have read this release before signing, I understand its contents, meaning and impact and I freely accept the terms.

Printed Name………………………………… Date………………..

Signature …………………………………. E-mail address……………..……………….

Appendix 69

Junior interview schedule

Many thanks for taking the time to review the material online. These materials are aimed at SPR level so I asked you to look at the material and I would like you to tell me how you found it.

I am interested in establishing the role of this assessment material in Lap Chole training. I will ask you about the strength and weaknesses of the topics, contents and videos used in the assessment. I am interested to know if there is anything you would like to change, remove or add to the assessment and finally I will ask you about the assessment benefit/time consuming value if that is ok.

So let start by establishing your training level first please. How much surgical experience do you have? Are you interested in surgery as a career?

1-Tell me how did you found this assessment?

So if ten is the most difficult how would you rate it on a scale of one to ten? 1-10

2-How did you find the instructions?   How could they be made clearer?

3-Tell me how you found the video?   Was the quality OK?

4- Currently the assessment is divided into four parts: Indication, Cystic artery, Bile duct and complication scenarios. Those are then divided into multi-screens. Tell me what you think about the content and the way it is presented?

5-Tell me what you thought about the assessment content and organisation?

Tell me what you liked about the content?   Anything you would like to add to it?

Anything you would change or remove?

6-This assessment takes about 40-45 minutes to go through, what is your impression about benefit versus time investment by a surgical trainee (SPR)?

7-Would you recommend expanding this research to include other operation or procedures? What do you suggest as the next procedure to be chosen?

8-Is there anything else you would like to say that I have not asked you about?

Appendix 70

SPR post MCQs interview schedule

Many thanks for taking the time to review the material online. These materials are aimed at SPR level and it was developed to either complement the current PBA assessment by using these materials alongside the PBA or to use the material with the operation review session with your trainer, which I hope you will be happy for me to record.

I am interested in establishing the role of this assessment material in Lap Chole training. I will ask you about the strength and weaknesses of the topics, contents and videos used in the assessment. I am interested to know if there is anything you would like to change, remove or add to the assessment and finally I will ask you about the assessment benefit/time consuming value if that is ok.

So let start by establishing your training level first please. How many years of surgical experience do you have?

1-Currently the assessment is divided into four parts: Indication, Cystic artery, Bile duct and complication scenarios. Those are then divided into multi-screens. Tell me what you think about the content and the way it is presented?

PROBES: Is there another way you would prefer to organise the materials.

What was helpful? What was unhelpful?

Did you watch the optional videos? Did you email them to your email?

2- Tell me what you thought about the content, did the material cover the main points you would expect in Lap Chole?

PROBES: Did the material cover the main points you would expect in Lap Chole

Is there anything you would like to add to the content?

Is there anything you would change or remove?

3-Now let us talk about the images and videos used in the materials. Tell me what you thought about these.

PROBES: Was there anything you liked about it? Anything you would change or remove?

4-Tell me what you thought about the video quality?

PROBES: Was it good enough to be used in the assessment?

How did you find the instructions provided for each question? Clear/ unclear

5-This assessment takes about 40-45 minutes to go through, what is your impression about benefit versus time investment by yourself?

6-Would you recommend expanding this research to include other operations or procedures?

What do you suggest as the next procedure to be chosen?

7-Is there anything else you would like to say that I have not asked you about?

Appendix 71

Consultants post MCQs interview schedule

Many thanks for taking the time to review the material online. These materials are aimed at SPR level and it was developed to either complement the current PBA assessment by using these materials alongside the PBA or to use the material with the operation review session with your trainee, which I hope you will be happy for me to record.

I am interested in establishing the role of this assessment material in Lap Chole training. I will ask you about the strength and weaknesses of the topics, contents and videos used in the assessment. I am interested to know if there is anything you would like to change, remove or add to the assessment and finally I will ask you about the assessment benefit/time consuming value if that is ok.

Just for the record. You are a consultant Upper GI/ HPB/Colorectal surgeon is that right?

1- Currently the assessment is divided into four parts: Indication, Cystic artery, Bile duct and complication scenarios. Those are then divided into multi-screens. Tell me what you think about the content and the way it is presented?

PROBES: Is there another way you would prefer to organise the materials.

What was helpful? What was unhelpful?

Did you watch the optional videos? Did you email them to your email?

2-Tell me what you thought about the content, did the material cover the main points you would expect in Lap Chole?

PROBES: Did the material cover the main points you would expect in Lap Chole

Is there anything you would like to add to the content?

Is there anything you would change or remove?

3-Now let us talk about the images and videos used in the materials. Tell me what you thought about these.

PROBES: Was there anything you liked about it? Anything you would change or remove?

4-Tell me what you thought about the video quality?

PROBES: Was it good enough to be used in the assessment?

How did you find the instructions provided for each question? Clear/ unclear

5-This assessment takes about 40-45 minutes to go through, what is your impression about benefit versus time investment by yours trainee?

Would you have more confident knowing your trainee knew all this? Would it result in more case allocation?

6-would you feel happier knowing that your trainee have been exposed to all the online materials/complications?

7- Would you recommend expanding this research to include other operations or procedures?

What do you suggest as the next procedure to be chosen?

7-Is there anything else you would like to say that I have not asked you about?

Appendix 72

SPR post Video review interview schedule

Many thanks for taking the time to review the operation video recording with your trainer. This assessment is aimed at SPR level and it was developed using simulation in the form of the online assessment and reflection in this review session to complement the current PBA assessment.

I am interested in establishing the role of this assessment in Lap Chole training. I will ask you about the strength and weaknesses of using the video review session. I am interested to know if there is anything you would like to change in the assessment and finally I will ask you about the assessment benefit/time consuming value if that is ok.

So let start by establishing your training level first please. How many years of surgical experience do you have?

1-Currently the assessment starts by the online part and progress to video recording theatre training and review it as a reflection and feedback practice. Tell me what you think about the structure of the assessment?

PROBES: Is there another way you would prefer to organise it.

What was helpful? What was unhelpful?

2-What is your thoughts about the effect of video review on your judgment of your own competence level?

Would it change your rating for your own skills? Anything you would like to change?

3-As well as playing back the operation, the video played back your communications and instruction of your assistant, tell me your thoughts about it?

4-What was your thoughts about the synchronized split screen presentation?

What was helpful? What was unhelpful?

5- Did the online assessment change your approach to the operation?

6- The video review session vary according to procedure but it takes roughly 40 minutes, tell me your impression about benefit versus time investment by yourself?

7-Would you recommend using this assessment (online MCQ and video review) over current assessment or would you prefer to keep the current PBA forms in practice?

8-Is there anything else you would like to say that I have not asked you about?

Appendix 73

Consultants post Video review interview schedule

Many thanks for taking the time to review the operation video recording with your trainee. This assessment is aimed at SPR level and it was developed using simulation in the form of the online assessment and reflection in this review session to complement the current PBA assessment.

I am interested in establishing the role of this assessment in Lap Chole training. I will ask you about the strength and weaknesses of using the video review session. I am interested to know if there is anything you would like to change in the assessment and finally I will ask you about the assessment benefit/time consuming value if that is ok.

Just for the record. You are a consultant Upper GI/ HPB/Colorectal surgeon is that right

1-Currently the assessment starts by the online part and progress to video recording theatre training and review it as a reflection and feedback practice. Tell me what you think about the structure of the assessment?

PROBES

Is there another way you would prefer to organise it.

What was helpful? What was unhelpful?

2-What is your thoughts about the effect of video review on your judgment of your SPR competence level?

Would it change your rating for your SPR skills?

3-As well as playing back the operation, the video played back your teaching and instruction for your trainee, tell me your thoughts about it?

4-What was your thoughts about the synchronized split screen presentation?

What was helpful? What was unhelpful?

5-The online assessment takes about 40-45 minutes to go through, and the video review session vary according to procedure but it takes roughly 40 minutes, tell me your impression about benefit versus time investment by yourself?

And what about the same benefit versus time investment for your trainee?

6-Would you recommend using this assessment (online and video review) over current assessment or would you prefer to keep the current PBA forms in practice?

7-Would you recommend expanding this research to include other operations or procedures?

What do you suggest as the next procedure to be chosen?

8-Is there anything else you would like to say that I have not asked you about?

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