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Tuberculosis: a demographic analysis and social study of admissions to a children's sanatorium (1936-1954) in Stannington, Northumberland

Marie-Catherine Bernard
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Abstract

This study analyses the data from medical records from a former tuberculous sanatorium for children at Stannington, Morpeth, Northumberland. It focuses on the demographic profile of the sanatorium and also examines the changes in therapy that occurred between 1937 and 1953. The objective of the study was to understand the patterning of tuberculosis in the sanatorium by considering the differences between male and female patients, ages affected, and the socio-economic backgrounds of patients from a sample of patient records taken from pre- and post-antibiotic eras, pre- and post-Second World War, and pre- and post-NHS years. 1,897 patient records were utilized in this study, all held at the Northumberland Record Office at Morpeth. This study was followed in accordance to the limitations given by the Medical Ethics Committee which was to ensure that patient confidentiality would be maintained. A limited database is included with this reasearch, but a complete database will be held in the future at the Northumberland Health Authority, in Morpeth. Overall more females than males were admitted to the sanatorium and all patients from various types of tuberculosis. The majority of the children (over 60%) were suffering from pulmonary tuberculosis, but there were a large number also suffering from tuberculosis of the bones and joints (230 cases or 12%). Most of the children came from poor backgrounds and originated from the Newcastle and Gateshead areas. The introduction of chemotherapy, the end of the Second World War and the implementation of the NHS did not have a great effect on who was being treated at the sanatorium. In conclusion these records hold a wealth of information that may help build an epidemiological model of tuberculosis in the North-East of England. Future work on the records is suggested and limitations of the research outlined.

Tuberculosis: a Demographic Analysis and Social Study of Admissions to a Children's Sanatorium (1936-1954) in Stannington, Northumberland

Marie-Catherine Bernard
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Volume 1 of 1

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2003
Department of Archaeology
University of Durham

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Declaration

None of the material included in this work has previously been submitted for a degree in this or any other university. It is a result of my own work.

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Terminological note

The author wishes to note that there is some confusion as to certain terms that are dealt with in this work, especially the United Kingdom and Britain. The United Kingdom represents England, Wales, Scotland and Northern Ireland while Britain refers only to England, Wales (Scotland seems to hold its own records). This will cause some misunderstanding as referenced authors seem to confuse the terms. Both of these terms are used in this work as they are used by the original authors. Please let it be known that in this thesis Britain will refer to England and Wales only.

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Chapter 1

Introduction

Pray, of what disease did Mr. Badman die? For I now perceive we are come up to his death. I cannot so properly say that he died of one disease, for there were many that had consented, and laid their heads together, to bring him to his end. He was dropsical, he was consumptive, he was surfeited, was gouty, and, as some say, he had a tang of the foul distemper in his bowels. Yet the captain of all these men of death that came against him to take him away was the consumption, for it was that that brought him down to the grave.

(John Bunyan: *The life and death of Mr. Badman* in Evans 1998:1)

Tuberculosis in children

Tuberculosis (TB) continues to be a major killer (Walls and Shingadia 2003). Today it remains the greatest infectious disease killer of humans, causing 6.7% of all deaths in the developing world (Bloom and Murray 1992). The World Health Organisation (WHO) declared it a 'global emergency' (Sudre *et al* 1992) and is particularly concerned with the situation in children (WHO 1994): there are 1.3 million infected children under the age of 15 years, of which 450,000 die each year (Styblo and Rouillon, 1981; Kochi 1991). Recent data from the Center for Disease Control (CDC) in the United States showed an increase of nearly 50% in tuberculosis in children of less than 15 years of age from 1988 to 1991 (Lee *et al* 1993, in Hakim and Grossman 1995). These children are a good representation of the prevalence of tuberculosis in adults: an infected child indicates that there is a contagious adult in their surroundings (Expanded Programme on Immunization Update Supplement (1989), in Cremin 1995). Young children also carry the largest burden of disease as they are the most likely to develop disease after infection and are also more likely to develop disseminated or extra-pulmonary cases of the disease (Walls and Shingadia 2003). Tuberculosis in children is very significant, not only because of its associated morbidity and mortality, but also because infected children become a reservoir from which future cases will emerge (Starke *et al* 1992). Chakraborty (1999) has estimated the numbers of individuals with tuberculosis in India and believes that there are about three million sputum-positive cases increasing by about one million new sputum-positive cases each year. Given that each new case could infect another ten people, this would result in 40 million people at risk of being infected by tuberculosis each year. Of these 40 million new cases, 10 million would be children under the age of 12. Five per cent may be expected to develop tuberculosis in the first two years following infection, and another two or three per cent in the following two years. Therefore, based on Chakraborty's (1999) estimates, we can expect 700-800,000 children to develop tuberculosis

in India alone in the next five years. We should also expect around 40 - 50% of these to be of the extra-pulmonary form, and at least 10% to be severe forms (being bone and joint cases, tuberculous induced meningitis and miliary TB). Again, according to Chakraborty's (1999) numbers, 80,000 would die or suffer serious disability from tuberculosis within a five-year period. Children are especially at risk as tuberculous meningitis is a fatal complication if it is not diagnosed rapidly.

Tuberculosis in England: past and present

In the past, tuberculosis was a particular problem in Europe in general and in the UK especially. The evidence of the extent of tuberculosis is seen more commonly in the historical and skeletal record beginning in the later Medieval period in Europe and around AD 1000 in North America (Roberts and Buikstra in press). There is also historical evidence for the eighteenth to twentieth centuries providing information on the socio-cultural context of the disease (Dormandy 1999). However, we must be careful in analysing this historical data because at times, it can be misleading especially when concerning frequency of people affected by TB. The disease could have been misdiagnosed or, as will be discussed later in the section dedicated to the stigma attached to tuberculosis, diagnosis could ruin a person's life if they were notified. Often, therefore, doctors would often turn a blind eye to the disease (Bryder 1988). Lutwick (1995) reported that by the mid 1600s in England, 20% of all deaths were reported to be due to tuberculosis, but as noted before, we should not take this data at face value. Tuberculosis was a very prominent disease in the 1800s in England but numbers decreased in the 1900s. There were optimists who believed that by the mid twentieth century the crusade to end tuberculosis would eliminate it altogether, relegating it to the extinct disease list like smallpox (Roberts and Buikstra in press)...Regrettably, this never materialised and tuberculosis is still remains a problem even today in England and Wales. Although tuberculosis sufferers have gained from the benefit of anti-tuberculous therapy, other factors such as poverty, resistance to drugs and HIV have once again promoted tuberculosis to the league of major killers again by the end of the last century. It is particularly prevalent in impoverished urban regions such as Hackney in London (Roberts and Buikstra in press). Most outbreaks of disease are concentrated predominentely in areas where immigrant congregate, reflecting many social problems such as poverty, socio-economic status and access to healthcare which afflict these communities in addition to being faced with the stigma attached to the disease in these communities.

This research uses medical records of patients from a sanatorium in North-East England to show that tuberculosis was still an important disease in 1950's England. The information from these patient records will hopefully help in building an epidemiological model of

childhood tuberculosis that will be of help to today's clinicians, palaeopathologists and medical historians.

Aims of the research

Stannington sanatorium, in England, was opened specifically for children suffering from all types of TB. It opened its doors in 1907, but the medical records used for this study only survive from 1937 until the sanatorium's closure in 1953. The aim of this research is to consider the demographic profile of the population of Stannington sanatorium and to look at the effect of changes in therapy (medical/surgical treatment) on admissions that occurred between the years of 1937 and 1953, by addressing the following questions:

Were more males or females admitted? In pre-industrial Europe, girls suffered higher mortality rates than boys. Similar parallels exist today in countries where women have low social status. In these scenarios, there is often selective abortions, boys get preferential treatment causing more girls to die from malnourishment, in turn increasing the potential for females to be infected by disease and finally, girls are less likely to receive medical attention than boys (Pollard and Hyatt 1999). In contrast, TB was the greatest single killer for males in the first decade of the 20th century, responsible for approximately 2/1,000 male deaths in England compared to 1.4/1,000 for females whose deaths due to TB were only exceeded by heart disease (Bryder 1988). Are these numbers reflected in the sanatorium records?

Were particular age groups affected? How old were the children when they were admitted to the sanatorium, and how old were they when they were discharged (average length of stay)? Do these figures show any patterns with respect to the age at which children are more susceptible?

Did the children come from rural or urban areas? Where exactly did they come from? Were they local to Stannington or did they travel long distances?

What was their socio-economic status? Were the children admitted from poor or wealthy families? TB was thought to affect mostly the poor or a disease of poverty. Is this reflected in the records at the sanatorium (Does TB lead to poverty or poverty to TB?)?

Did the children contract TB from their relatives? Did most families have a history of TB? Were any other members of the family infected? What occupation did the infected

relatives practice? Some occupations have historically had higher rates of tuberculosis deaths (e.g. tin and copper mining, metal grinding and slate working) (Bryder 1988).

Did any of the children develop bone or joint TB? Although pulmonary forms of TB seem the most prevalent type of the disease (Lincoln and Sewell 1963, Miller 1982), how many children were affected by bone and joint tuberculosis and how many displayed bone lesions?

Were there differences in the patterns of TB in the pre- and post- antibiotic eras? Do the records show any differences in admissions according to type of TB to the sanatorium before and after the introduction of such drugs as streptomycin or PAS? Which drugs were used at the sanatorium and what were their rates of success? Did certain types of TB react better to certain types of drugs?

Is the demographic profile in the sanatorium different before and after the Second World War? As many fathers would have been away fighting the war, were there any changes in the numbers of fathers being named as contacts before and after the end of the Second World War?

Did the implementation of the National Health Service (1948) have an effect on who was being treated and on the methods that were used? The implementation of the NHS meant that free health service was now available to all. Did this have an effect on who was being treated at the sanatorium or on any of the methods that were used to treat the children while at Stannington?

The objective of this study is an understanding of the patterning of tuberculosis in the sanatorium by considering differences between male and female patients, age frequencies, and socio-economic background of patients in a sample of patient records taken from pre- and post- antibiotic, pre- and post- war, and pre- and post- NHS years by comparing the actual data from Stannington sanatorium and contemporary (1930-1950s) and modern literature. Chapter Two will provide an overview of tuberculosis, discussing what it is, how it spreads, how it is diagnosed, and the prognosis for those suffering from TB. This will include a short section on TB today outlining tuberculosis control, the link between TB and the human immunodeficiency virus (HIV) and multi-drug resistance. Chapter Three will look at TB throughout antiquity using an outline of the skeletal evidence for TB in the past and the use of ancient DNA (aDNA) in tuberculosis will be followed by a section on the understanding and

treatment of tuberculosis from the fourth century BC to the 19th century. A further section will explore our understanding of TB in the twentieth century by looking at how TB was prevented and treated. The sanatorium movement will be outlined, in particular relating to Stannington sanatorium, along with the impact of the National Health Service. There will also be a section on tuberculosis statistics for England and Wales from the 1930s and 1950s. Chapter Four will focus on childhood tuberculosis by looking at those types of tuberculosis that specifically affect children. Chapter Five contains a description of the data accessed and methods used which will explain how the information from the medical records were transcribed and entered into a database to permit the analysis of the data. Chapter Six includes the results of this analysis, and Chapter Seven will be a discussion of the results in the context of contemporary and clinical literature. The information provided in this study on the bone and joint cases found at Stannington will be the most helpful to physical anthropologists studying tuberculosis in the past, present and in the future.

This study is important for recognising past trends in the spread of tuberculosis which could help with our present understanding of the epidemiology of tuberculosis (Stead *et al* 1995) by giving us data on a known population suffering from the disease. It is surprising to note that interest in tuberculosis is currently low despite the deaths from the disease being at an all time high (Farmer 1999).

Chapter 2

Tuberculosis

Every man at the end has a little tuberculosis
Osler 1892 in Pesanti 1995:7

This chapter provides background information on tuberculosis – information that will be important throughout the rest of this study. The principal questions to be covered are: what is TB, how does it spread, how is it diagnosed and what is its prognosis? The last section deals with tuberculosis today, and especially established tuberculosis control and the impact of HIV.

2.1 What is tuberculosis?

Tuberculosis is a disease that can be transmitted to humans in two ways: either by ingesting contaminated foodstuffs (especially milk or meat) or by inhaling infected droplets. The first route is mostly associated with the organism *Mycobacterium bovis* (bovine) while the second is closely linked with the organism *Mycobacterium tuberculosis* (human) type.

2.1.1 Mycobacterium bovis

The history of the development of *Mycobacterium bovis* as an organism has still not been absolutely determined (Santos 2000). It is not yet certain how the disease originated in animals and humans or whether they are actually two different species. Some authors such as Grmek (1983) suggest that *Mycobacterium archaicum* is the ancestor of the genus *Mycobacterium* we have today. Manchester (1986 in Santos 2000) believes that *M. bovis* developed from a saprophytic *Mycobacterium* through microevolution. The most popular hypothesis is that tuberculosis was endemic in animals long before it affected humans (Manchester 1983, Steele and Ranney 1958 in Daniel *et al* 1994). The hypothesis that the human disease evolved from the bovine disease by the adaptation of the animal pathogen to its host (Stead *et al* 1995) has been recently disputed. This idea has been superseded by new research by Brosch *et al* (2002) on the history of the genus that shows that *Mycobacterium tuberculosis, Mycobacterium africanum, Mycobacterium canettii, Mycobacterium microti* and *Mycobacterium bovis* all resulted from ancient, irreversible genetic events in common

progenitor strains rather than these polymorphisms occurring independently. They believe that the ancestor of the tubercle bacilli might already have been a human pathogen, as it resembled *M. tuberculosis* or *M. canettii.* They based their hypothesis on the fact that *M. tuberculosis* strains could be divided into ancestral and modern strains according to the presence or absence of an *M. tuberculosis* specific deletion, and that this permitted the identification of an evolutionary lineage represented by *M. africanum*, *M. microti*, and *M. bovis* that diverged from the ancestor of the present *M. tuberculosis* strains before TBD1 (tuberculosis deletion-1) occurred (Brosch *et al* 2002). [Meaning that these evolutionary lineages have descended from *M. tuberculosis* instead of *M. tuberculosis* descending from *M. bovis*]

Mycobacterium bovis is contracted by humans through ingesting contaminated milk or meat from infected animals (usually cattle) (Bates and Stead 1993, Manchester 1984, Manchester 1986, Daniel *et al* 1994, Roberts and Manchester 1995, Haas and Haas 1999, Hershkovitz and Gopher 1999) or from inhaling infected droplets (Manchester 1984, Manchester 1986, Bates and Stead 1993, Daniel *et al* 1994, Roberts and Manchester 1995, Haas and Haas 1999). According to Santos (2000), which is supported by Cave's (1939) conclusions based on the location of tuberculous lesions in ancient Egyptians who consumed cow's milk. Vincent and Gutierrez-Perez (1999:140) suggest that children frequently have extrapulmonary TB of bovine origin owing to the fact that their 'infection comes from inhaling or ingesting infected droplets coupled with their age related susceptibility'. They believe that the respiratory route of infection is more often associated with adults who have occupational contact with animals (for example veterinarians, and zoo-keepers).

It is difficult at the present time to evaluate how much human tuberculous infection is linked to *M. bovis,* as there are only a few laboratories in the world that are specialized enough to evaluate it (Moda *et al* 1996, Monteros *et al* 1998, Vincent and Gutierrez-Perez 1999, all in Santos 2000, Hardie and Watson 1992). *M. tuberculosis* is an acid-fast bacillus with microbial and biochemical characteristics that are nearly identical to *M. bovis* and, although the latter causes disease primarily in cattle, it can also affect humans (Mays *et al* 2001). For physical anthropologists, it is impossible to differentiate between the types of infection (i.e. *M. tuberculosis* or *M. bovis*) by skeletal analysis alone (Ortner 1999).

Sreevatsan *et al* (1997) state that due to restricted allelic diversity the change in host specificity of *M. bovis* can be estimated to have occurred 15,000 to 20,000 years ago (cited in Sola *et al* 1999). According to Ortner (1999:260), tuberculosis probably developed as a

human disease in the Old World toward the end of the Neolithic Period: "A plausible mechanism is that the disease came after the domestication of aurochs and that domesticated cattle were the primary source of infection for many centuries". Stead *et al* (1995) agree with this hypothesis. In contrast, Hershkovitz and Gopher (1999) believe that skeletal evidence of TB postdates the domestication of cattle in the Levant (sixth millennium BC) by at least a thousand years. Stead *et al* (1995) estimate that TB began to spread across Europe around the Middle Ages, reaching the New World by the 16th century, followed by Africa in the 19th century, and only recently arriving in remote regions like Papua-New Guinea (mid 20th century) and the Amazon (last quarter of the 20th century).

Between the 1930s and 1950s tuberculosis could be tentatively identified as being due to the human or bovine strain from the site of infection. Therefore, for example, pulmonary tuberculosis may be more likely due to the human type and abdominal tuberculosis to the bovine type, but this is not always the case. When the human type of bacilli causes a tuberculous infection of the intestinal tract, the clinical picture might be identical to disease caused by the bovine type. When people infected with bovine tuberculosis develop pulmonary tuberculosis and transmit the infection to children via droplet infection, the resulting disease in children will be indistinguishable from disease caused by the human form of the disease (Lincoln and Sewell 1963). As has been noted, few laboratories in the world are able to differentiate between the strains. The bacteriological differences between *M. tuberculosis* and *M. bovis* can be described as follows: typical *M. tuberculosis* strains are eugonic, meaning that they reproduce luxuriant growth on an appropriate medium and form aerial colonies with a characteristic cauliflower appearance, whereas *M. bovis* strains are dysgonic, producing poor growth on media that are otherwise suitable for other mycobacteria and form sparse aerial colonies (Vincent and Gutierrez-Perez 1999).

2.1.2 Mycobacterium tuberculosis

Mycobacterium tuberculosis is transmitted from human to human and is contracted by inhaling infected droplets. The tubercle bacilli cause a tissue reaction in the lungs that affects this organ in two ways. First there is an invasion of the infected region by macrophages (which are large phagocytes that, when free, move between cells to collect at infection sites and remove foreign bodies such as bacteria by scavenging) followed by a walling-off of the lesion by fibrous tissue to form a tubercle. This walling-off process will protect the person from further infection but it is possible for it to break down and cause the return of the disease. This failure occurs in about three per cent of all people who contract tuberculosis (Guyton 1992). If the patient remains untreated the failed walling-off process will permit the

tubercle bacilli to spread throughout the lungs, often causing extreme destruction of lung tissue and the creation of large abscess cavities. Tuberculosis in its late stages causes areas of fibrosis throughout the lungs and will reduce the amount of functional lung tissue dramatically. This will in turn affect the respiratory muscles, which will have to work harder to ventilate the lungs properly, thus reducing vital functions and breathing capacity. There will also be a reduction in the total respiratory membrane surface area and an increase in the thickness of the respiratory membrane, all of which will result in a diminished pulmonary diffusing capacity (Guyton ibid).

The tubercle bacillus, which causes disease in humans, is of the Actinomycetales order. They are usually described as acid-fast bacilli as they do not respond to the usual stains for bacteria, but rather will absorb a carbol-fushin stain (also called Ziehl's stain) when heated. They are also characterized by their ability to resist discolouration by acids or alcohol when stained (meaning they are acid-fast). According to Lincoln and Sewell (1963:11), it is the lipid content of the tubercle bacilli that causes this, a factor that is also related to the ability of the tubercle bacilli to create tubercles. These tuberculoproteins are responsible for the hypersensitive state resulting from infection and they are important in antibody production. When tubercle bacilli are injected into individuals not sensitised to tuberculin they do not show any measurable toxicity. Tubercle bacilli grow best in the presence of oxygen and at body temperature. They can survive in a dried state for long periods of time, but they can be killed by exposure to direct sunlight or ultraviolet rays. When in fluid suspension they can be destroyed by a temperature of 60° C within 20 minutes, or by exposure to 5 per cent phenol for 12 hours (Lincoln and Sewell 1963).

The human tubercle bacilli have been divided into three groups according to immunologic responses that show marked variation in virulence (Johnston 1993). *Type 1* is found in India and is the least virulent of the three. *Type A* is found in Africa, China, Japan, Europe and North America, and *Type B* is found exclusively in Europe and North America. Although this discussion has concentrated on *M. tuberculosis* and *M. bovis*, there are other mycobacteria that can affect humans. Vincent and Gutierrez-Perez (1999) state that *M. africanum* can cause tuberculosis in humans in some African countries. Aufderheide and Rodríguez-Martín (1998) believe that *M. microti* can now be added to this list. All other types of mycobacteria will only cause disease when the person infected has partial immuno-suppression or is compromised by other diseased states. Grange and Yates (1994) state that *M. africanum* is not a true species but rather a heterogeneous group of strains of mycobacterium between *M. tuberculosis* and *M. bovis* that were first isolated in equatorial Africa. *M. avium* was first

identified as the cause of tuberculosis in chickens, but is now seen to produce the disease in humans (Kelley and Lytle-Kelley 1999). There are also a series of non-tubercular mycobacteria that have been associated with bronchiectasis, chronic bronchitis and pneumoconiosis. The most common are of the *M. avium* complex including *M. avium* (an economically important disease in chickens), *M. intracellulare* (the 'Battey bacillus') and *M. scrofulaceum* that rarely causes the disease in humans. A list of the mycobacteria associated with human disease can be seen in **Table 1** (Wolinsky 1992). *M. kansaii* mostly causes chronic pulmonary disease that resembles tuberculosis. The *M. fortuitum /M. chelonae* complex can cause soft tissue and skeletal infections. *M. xenopi* causes disease in the lungs. *M. marinum* causes superficial skin lesions in children swimming in infested waters. *M. leprae* causes leprosy, and *M. ulcerans* causes a potentially severe necrotizing disease restricted to tropical Africa and Australia. *M. haemophilum* causes nodules, which can lead to suppuration and ulceration. *M. simiae, M. szulgai* and *M. malmoense* cause disease predominantly in the lungs. *M. smegmatis, M. fortuitum, M. terrae,* and *M. gordonae* rarely cause disease in humans. Wolinski (1992:3) also adds that that it is not possible to clinically differentiate any one of the non-tuberculous mycobacteria as being the specific etiologic agents of pulmonary disease, as only *M. kansaii* can be identified in smears of sputum. *M. kansaii* has a high incidence in certain coal mining areas in England and Wales (Wolinsky 1992).

2.2 How does tuberculosis spread?

The route of infection, according to Ortner and Putschar (1985), is usually through the respiratory tract, resulting in the formation of a primary focus in the lung, with ensuing single or multiple foci in the regional hilar lymph nodes. The second route of infection, which is less common, is the intestinal pathway. Here the formation of a primary complex occurs in the intestinal wall and mesenteric lymph nodes. Whatever the method of entry, the bacilli multiply and create a small area of inflammatory exudate if the person has never been infected previously. Almost immediately after infection some of the bacilli leave the primary focus and are carried through the lymphatic system to the nearest lymph nodes. The bronchopulmonary nodes are affected when the primary infection is in the lung, except when the primary focus is in the apex, in which case the paratracheal nodes are affected. When the primary focus occurs outside the lungs the location of the portal of entry will determine the site of the lymph node infection in the primary complex.

Table 1 Mycobacteria associated with human disease

Mycobacteria associated with human disease	
***M. tuberculosis* complex**	
	M. tuberculosis
	M. africanum
	M. bovis
	M. microti (Rothschild *et al* 2001)*
***M. avium-intracellulare-scrofulaceum* complex (atypical)**	
	M. avium complex *(M. avium, M. intracellulare), M. scrofulaceum*
M. kansaii	
M. xenopi	
M. szulgai	
M. malmoense	
M. haemophilum	
M. marinum	
M. ulcerans	
M. leprae	
***M. fortuitum* complex**	
	M. fortuitum
	M. chelonae
Usually saprophytic	
	M. gordonae
	M. terrae complex
	M. flavescens
	M. smegmatis

(After Wolinski 1992)
* Rothschild *et al* (2001) add *microti* to the *M. tuberculosis* complex

The later course of the disease will depend on several factors including the size of the inoculum, the virulence of the organisms and the resistance of the host (Ortner and Putschar 1985, Bates 1992, Aufderheide and Rodríguez-Martín 1998). A person's resistance is especially poor during three stages in life: the first three years, the period between puberty and approximately the 25th year, and old age. The reasons for this are not clear, although it could be related to the condition of their immune system at these times in life. During the first period, children are more likely to develop the disease outside the lungs (Bates 1992:8), i.e. extra-pulmonary TB. After entering the body, tubercle bacilli are remarkably durable and persistent and they can remain viable throughout their host's life. They may remain dormant and reactivate when resistance fails (Johnston 1993, Smith and Moss 1994).

There are several ways for the bacilli to spread to children. These include infection of children through their inhaling of infected droplets from an adult with active disease, through contact with another child with a chronic form of pulmonary tuberculosis or through ingesting

or inhaling bacilli from tuberculous animals, usually cattle. Smith and Moss (1994) have demonstrated that a sneeze or cough may contain over a million particles with diameters less than 100μm. These can remain suspended in the air for long periods of time, and a 10μm droplet nucleus can contain 3 to 10 tubercle bacilli. This accounts for most of the initial infections in children and most primary complexes in the lungs. Lincoln and Sewell (1963) state that the source case is usually a member of the family when the children are from poor, crowded homes. Alternatively, the source case might be a lodger. A large number of these infected children, especially the young ones, will show radiographic evidence of pulmonary tuberculosis. They continue by stating that children from higher socio-economic backgrounds are less likely to have developed extensive disease when they are first diagnosed and their source case is more difficult to trace. Another method of spread is from the children themselves. Because children do not expectorate much (they tend to swallow their sputum), they do not spread the disease when they are infected by primary pulmonary disease. However, when they are infected by chronic pulmonary tuberculosis, their contagiousness is similar to that of adults with similar pulmonary disease. Children who are in contact with infected animals (e.g. work on a farm) or who ingest infected meat or milk, are likely to contract the disease (e.g. in unpasteurised school milk in Liverpool in the 1930s and developing countries).

2.3 Diagnostic procedures

The diagnosis of tuberculosis was an important aspect of the disease. There was a certain stigma attached to the disease and to be diagnosed with tuberculosis could be a large burden for family and friends in twentieth century Britain. This will be discussed in a later section but, in summary, adults could lose their jobs, people could be unable to marry, getting insurance would be nearly impossible and diagnosis of tuberculosis in children was especially distressing as the stigma could follow them for the rest of their lives (Bryder 1988, Roberts and Buikstra in press). For these reasons, doctors would have to be sure of their diagnosis. The diagnostic methods in use in England in the twentieth century and at Stannington were observation of the signs and symptoms (overall health) of TB in the child when examined, the Mantoux and Patch test along with sputum analysis for confirmation.

The first diagnostic procedure used was an assessment of signs and symptoms of a person infected with tuberculosis, which were persistent coughing, night sweats, loss of weight, loss of appetite, paleness of skin and even haemoptysis. In addition, there were various mechanical diagnostic procedures that will be studied in more detail in an **appendix (A).** The

diagnostic tests that will be outlined are the Mantoux test, the Patch test, the Heaf test, and the Tine test; diagnostic methods including gastric lavage, bronchial washing, microscopic confirmation, culture and radiography will also be discussed. The diagnosis of tuberculosis in children is dependent on several factors as most children (80%) do not produce positive sputum. In these cases the diagnosis is based on the clinical history and presentation of the disease, a history of an infectious contact and other methods of investigation such as radiographs and tuberculin skin tests (Walls and Shingadia 2003)

There are two varieties of tuberculin that are used for testing tuberculous infection. When tuberculin is injected into a patient who has been immunized, or who has had tuberculosis, a characteristic immune response occurs in the skin. A positive reaction to tuberculin is visible as a characteristic swelling at the site of infection. This occurs when memory helper T cells react to the presence of tuberculin through secreting interleukins, which in turn attract the macrophages and lymphocytes responsible for causing the swelling (Alberts *et al* 1989). There are only a relatively small proportion of people infected with TB who actually go on to develop clinical disease (usually 5 to 10%). The tuberculin test permits differentiation between those infected but who don't suffer from the disease and those who are uninfected (Smith and Moss 1994). Tuberculin is very useful in testing child contacts: a study by Raj Narain *et al* (1966) showed that in India, in children under 15 years of age, 41% of children living with a positive case were infected. They compared this data to 19% of infected children in households where the infector was discovered by radiograph. They also found in their study that 12% of children living with a household free from tuberculosis were actually infected by tuberculosis. Therefore, a child living with a positive case has four times the likelihood of contracting TB compared to a child living in a household free from tuberculosis.

The first variety of tuberculin is termed Old Tuberculin (OT), having been in use since Koch's time and it is made from tubercle bacilli grown on glycerol peptone broth. The second variety is termed Purified Protein Derivative (PPD) and was developed by Seibert in 1934. They are both prepared after heating tubercle bacilli in the medium in which they have grown. PPD has a modified method of production, where a single strain of tubercle bacilli is grown on Long's medium. The entire culture is then heated and filtered to remove dead bacilli. The filtrate is then concentrated by ultrafiltration, and the protein is precipitated with neutral ammonium sulphate. This makes PPD very stable. The WHO adopted PPD as the standard tuberculin in 1952 (Lincoln and Sewell 1963, Hakim and Grossman 1995). There are several tests that use this product to test for tuberculous infection. They do not all have the same reliability or ease of application. Whilst there are many ways to diagnose

tuberculosis in children, prognosis varies according to several factors that will be discussed in the following section.

2.4 Prognosis

There are several factors that will affect the prognosis of a person infected with the tubercle bacillus, and it is important to note, that although there are many studies of this kind, those that have been done on adults do not necessarily apply to children (Lincoln and Sewell 1963). In terms of the **sex** of the person afflicted there is no evidence to suggest that there is a sex difference in the pre- adolescent tuberculosis mortality rate (Lincoln and Sewell 1963, Holmes *et al* 1998, Borgdorff *et al* 2000). In adolescent girls, however, chronic pulmonary tuberculosis occurs more frequently. In addition, before chemotherapy, females aged 15-18 in all countries had higher death rates than the males (Lincoln and Sewell 1963). There are **genetic factors** that affect the degree of resistance between ethnic groups. Statistically, people of the Jewish faith have lower rates of tuberculosis morbidity and mortality than those of Negroid population, who have the highest rates (Lincoln and Sewell 1963, Zias 1998). Recent data indicates that American Indians and Alaskan Natives had tuberculosis rates 4.4 times higher than among whites in 1985 (Hurtado *et al* 2003). Hurtado *et al* (2003) also suggest that these Alaskan Inuit have a 30% risk rate for active disease (three times the rate observed in European populations). Historically, children under the **age** of 6 months, were those most susceptible to tuberculosis as their bodies did not develop the antibodies as quickly as the older children (native resistance is lower) (Lincoln and Sewell 1963). Brailey (1936) studied the difference between the prognosis of children infected by tuberculosis in the first six months and those affected in the second six months of life and found that (also Lincoln and Sewell 1963) children affected in the first six months of life have a poorer prognosis but, with the development of chemotherapy, babies no longer have more serious prognoses than older infants (Lincoln and Sewell 1963, Hakim and Grossman 1995). The extent of the disease was based on the radiographic evidence of children who showed skin reactivity. A study by Lincoln and Sewell (1963) showed that the lowest death rates from tuberculosis occurred between three and nine years of age, which is similar to the often cited age range of five to nine years. Their Bellevue group also showed a rise in the death rate in the pre-adolescent and the adolescent rate from 15 to 20 per cent in those years. A study by Mahadevan *et al* (2002) in Pondicherry India showed that children suffering from tuberculous meningitis at a younger age, papilloedema, focal neurological deficit and the stage at which they were diagnosed were found to adversely affect their prognosis. Kaltenbach *et al* (2001) also conclude in their study of patients in a Strasbourg hospital between 1980 and 1997, that

the age of the patient will affect their prognosis concluding that both younger individuals and older individuals have poorer prognoses when affected by tuberculosis.

The role of **nutrition** is very difficult to measure as it is closely associated with socio-economic factors, and there are few who would contradict the findings that the highest tuberculosis rates come from the lowest socio-economic levels (Lincoln and Sewell 1963, Smith 1988). Roberts and Buikstra (in press) state that poverty will lead to a decrease in the level of living conditions, diet, hygiene and access to health care, and these will all impact upon the immune system and leave it more vulnerable to infection. Khansari et al (1990), Enarson and Rouillon (1994) Mantagni et al (1995), Elender et al (1998), all consider poverty and the access to health care but this will be discussed in more detail in Chapter 7 (section 7.5). However, Davies *et al* (1999a) report that tuberculosis mortality declined at a much faster rate than any indicator of social deprivation, questioning the validity of the theory of improvements of social conditions during the period were responsible for the decrease in the tuberculosis mortality rates. They conclude that natural selection may have a role to play in the decline of tuberculosis mortality in Victorian times. Maltezou *et al* (2000) conclude that patients in their study (children's hospital in Athens between 1982 and 1998) suffering from tuberculous meningitis commonly came from families where poverty, immigration and limited access to medical services affected their prognosis from tuberculosis adversely. Hurtado *et al* (2003) state that tuberculosis is becoming a greater menace especially among the poor but that some ethnic groups are more affected by tuberculosis than others, even accounting for poverty levels. **Intercurrent infections** such as measles used seriously to harm children's resistance to tuberculosis (Miller 1982), but this is no longer the case with the development of anti-tuberculous drugs, although some children have been known to develop tuberculous meningitis while convalescing from a mild attack of measles (Lincoln and Sewell 1963). Finally, **unusual stresses**, such as trauma (e.g. a fall) or mental stresses, have been known to lower resistance to the disease (Lincoln and Sewell 1963, Miller 1982). A local trauma can act as a precipitating factor in the dissemination of tuberculosis. More recently, higher rates of tuberculosis have been observed in spring compared to the summer months in immigrants to England, and this has been attributed to the lack of sunlight during the winter months resulting in a deficiency of vitamin D, which is formed in the skin by the action of ultraviolet rays (Wilkinson *et al* 2000).

There are also certain factors that will affect the prognosis of a child affected specifically in the skeletal system. These are the age of the child (when the disease appears in the first two years of life it is more dangerous), the position of the lesion (lesions in the bones of the skull and spine are unfavourable), the spread of the lesion (if the disease spreads, it demonstrates a

lack of resistance to the infection by the child), abscess formation (precursor of septic infection) and intercurrent infection (a superadded infection such as measles) (Fraser 1914).

2.5 Tuberculosis today

This section aims to provide a review of the recent developments in issues relevant to the study of tuberculosis today, namely tuberculosis control and HIV. However, these themes will only be discussed superficially as they are not pertinent to the period under study in this thesis. The current rise in TB has led to a 'waking up' period for most countries. Although this disease was believed to be conquered in the 1960s it has returned today with a vengeance: the World Health Organisation (Sudre *et al* 1992) estimated that one third of the world's population is infected with *Mycobacterium tuberculosis*. They also estimate that eight million new cases of TB occur each year, with up to three million deaths annually. The WHO's report (www1) on global tuberculosis control state that of the 183 countries that report to the WHO 3.8 million cases were notified (62 per 100,000 population) of which 1.6 million (42%) were sputum smear positive. These 3.8 million cases notified for 2001 represent 45% of the estimated 8.5 million estimated new cases of tuberculosis. Twenty-nine per cent of all estimated cases and 32% of estimated smear-positive cases were detected by DOTS programmes. Tuberculosis is now the most common cause of death in acquired immunodeficiency syndrome (AIDS) patients (www2). According to Watson and Packe (www3), there are several factors contributing to the recent increase in TB. These include an increase in the world's population generally, population density, population movement into urban areas and associated poverty, deterioration in public health infrastructures in both developing and industrialised countries, multidrug resistance and the human immunodeficiency virus (HIV) pandemic. These have all helped to make TB an ever present threat, as it was in the past. Mayer (2000) also identifies many possibilities as to why tuberculosis is re-emerging at this point in time. This may be the result of cross-species transfer, spatial diffusion, pathogenic evolution or change in the structure of earlier pathogens, or pathogens that have been around for a long time but have only been recognised recently and, finally, a change in the relationship between humans and their environment. Other factors such as trade and transportation, contamination of water and food, migration, mobility and climate change are also believed to have affected the re-emergence of tuberculosis. Roberts and Buikstra (in press) have identified many predisposing factors relevant to TB occurrence. They name intrinsic factors (such as age, sex, ethnicity) and extrinsic factors such as poverty (a person with low socio-economic status suffers from poor and/or crowded living conditions and poor diet, both of which would depress their immune status and encourage the transmission of tuberculosis). People who live in crowded conditions would also be more likely to transmit the disease to other family members or those

living with them. Enarson and Rouillon (1998) state that the probability of infection depends on several factors such as the number of open cases in the community, the density of the bacteria in the expectorated sputum, the density of bacteria surrounding a person (this is related to ventilation and habitation space), the number of people present and the duration of the contact with the infected person. These all increase one's chance of contracting TB. Travel and migration, occupation, and close association with infected animals are also factors that they identify as predisposing to contracting the disease. They also state that today there are three groups that have higher frequencies: infants, females between 15 and 30 and people over the age of 60 (Johnston 1995, cited in Roberts and Buikstra in press).

The World Health Organisation estimates that between the years 2000 and 2020, 200 million people will contract tuberculosis and an amazing 70 million people will die from the disease. They have also stated that there can be as many as 20 million cases of active tuberculosis in the world at any one time (www4). Raviglione *et al* (1995) stated that a third of the world's population was infected with tuberculosis in 1990, and that by 1999 there will be 90 million new cases of the disease. They also suggest that 30 million people would die from tuberculosis before the year 2000. Snider *et al* (1994) have noted that 80% of the world's cases are in the 15-59 age group, the most productive years, and that the highest number of cases are from sub Saharan Africa, followed by South-East Asia, North Africa, the Middle East and Central and Latin America. These numbers are cause for concern as it is believed that 5% of those infected will develop primary tuberculosis (but will not be infectious) within five years, and another 5% will develop post-primary tuberculosis and will be infectious (Roberts and Buikstra in press).

2.5.1 Established tuberculosis control

A few strategies for dealing with tuberculosis are already well established (Corbett *et al* 2002). The first of these is the use of BCG vaccination, and its target population are neonates in high burden countries. It offers personal protection from disseminated BCG but does not have an effect on who gets infected from tuberculosis and will also have no effect on tuberculosis transmission. The second strategy used is Directly Observed Therapy (DOT) and the Directly Observed Therapy Short course (DOTS) (WHO 2001), where the target populations are the symptomatic TB patients (those diagnosed using sputum smears). It is a standard treatment regimen that minimises default (those who do not complete treatment) by having a regular supply of those drugs needed. It also permits a monitoring and reporting of treatment outcomes. Its strengths are that it is highly cost effective, widely implemented, can lead to reduced transmission rates by efficient diagnosis and treatment of smear positive

patients, and will maintain drug sensitivity. Its weaknesses are that it does nothing for reactivated HIV/TB and is also ineffective at stopping the increase in TB incidence. Whether patients will follow this type of treatment will be affected by their knowledge of prevention and treatment. Starke (2001) has stated that DOTS, using a combination of bactericidal drugs, has standardised the treatment of tuberculosis. As children are usually found to have low counts of bacteria in their lesions, tuberculosis can usually be successfully treated with three drugs in the initial intensive phase, followed by two drugs in the continuation phase. In the areas of the world with high levels of drug resistance, the first intensive phase has four drugs. Starke (2001) also expresses the opinion that although acquired drug resistance in children is rare, resistance to a primary drug does occur and is likely to increase given the problem in adults. There are 12% of tuberculosis cases (although this is not specified whether in adults, children or both) worldwide in which the bacilli are resistant to one or more of the anti-tuberculosis drugs (Swaminathan 2001).

The third strategy commonly used against TB is the PROtest (Girardi *et al* 2000). This is a new programme implemented by the World Health Organisation and is used in high incidence countries (HIC). Its target cases are the people co-infected with TB and HIV. It strengthens the HIV programme of control already in place but is limited by the fact that it will only help if it is widely implemented and is adhered to. Another established tuberculosis control strategy is household contact tracing (Cruciani *et al* 2001), where the people in a household with someone with TB will all be tested to see whether they are infected or not. This is recommended for use in countries with low TB incidence. It is used on patients that are at high risk of contracting TB due to exposure to positive contacts. Its weaknesses lie in the fact that it consumes a lot of extra resources; its efficacy is limited by high rates of transmission and the fact that most of the transmission will happen in the community, not in the household. It is also hard to apply universally in low-income countries (Nair 2001). Most national programmes in developing countries recommend contact tracing and chemoprophylaxis for infants and children under five years of age in a household with sputum smear-positive patients because these children are at greatest risk of developing severe forms of the disease such as disseminated TB or meningeal TB. Active case finding (Corbett *et al* 2002) is used in high-risk populations such as immigrants or miners. This control strategy uses systematic mass screening for active tuberculosis. The strengths of this approach are that it has high detection rates in endemic settings, reduces transmission by diagnosis of chronic TB cases, and will provide an estimate of TB disease prevalence. The drawbacks of this strategy are that it is quite expensive and needs to be repeated periodically. Finally, mass prevention therapy campaigns (Ferebee 1969) are used in epidemic situations. Here, mass screening is used to identify cases and then treatment given to those with active or presumed latent

tuberculosis. This reduces TB incidence and transmission and reduces the prevalence of latent tuberculosis. However, it is expensive and needs continual intensified control to maintain its effectiveness.

2.5.2 Tuberculosis and human immunodeficiency virus

The first case of HIV was identified in the United States. Since then HIV has been identified as a retrovirus (Jurmain *et al* 2000). A retrovirus is described as any virus in the family *Retrovidae* that has RNA as its nucleic acid and uses the enzyme reverse transcriptase to copy its genome into the DNA of the host cells chromosomes. Many cancers in vertebrates are caused by retroviruses. Roberts and Buikstra (in press) describe the retrovirus as containing RNA instead of DNA and they can convert this RNA to DNA after they have entered a cell. This newly formed viral DNA can them become an integral part of the chromosomal DNA.

2.5.2.1 Tuberculosis and HIV in adults

Tuberculosis and HIV have been called the 'cursed duet' (Rieder 1998). In the United States, there has been an increase in tuberculosis cases since 1986 and a disproportionate increase in the number of non-pulmonary cases, which has been associated with the AIDS (acquired immunodeficiency syndrome) epidemic. The proportion of reported cases of extra-pulmonary TB has risen from 7% in 1963 to 18% in 1987 (Weir and Thornton 1985, Humphries and Lam 1998). This has been associated with the AIDS epidemic as extra-pulmonary TB is particularly common in AIDS patients (46% of all cases of tuberculosis in AIDS patients of which 38% had extra-pulmonary TB only and 8% had both extra-pulmonary and pulmonary TB-Humphries and Lam 1998). Tuberculosis, as has already been explained, is a disease of poverty and many people suffering from HIV are living in conditions that are considered poor and unhealthy. HIV patients, who are malnourished, homeless, immigrants and drug users, have compromised immune systems and this further compounds the problem of co-infection (Rieder 1998). The worldwide incidence of HIV-attributable cases is estimated to increase from 31,500 (4% of total TB cases) in 1990 to 1.4 million cases by the year 2000. Approximately 40% of these cases will be in Sub-Saharan Africa and another 40% in Southeast Asia (Cosivi *et al* 1998). A significant number of adults are co-infected by HIV and *Mycobacterium tuberculosis.* Opravil (1997) suggests that the numbers of people suffering from HIV today can explain the increase in TB, as HIV infected individuals have a 30 times higher probability of contracting tuberculosis (Verschoor and Onyebujo 1999). Although 13.9% of new TB cases are attributed to HIV, there are still many more cases of tuberculosis and it is spreading throughout the world at an alarming rate even though there are low cost treatments available (Hurtado *et al* 2003). This increase in TB has also been linked

to drug resistance (Shuter and Bellin 1997). This is very serious as the forms that people with HIV suffer from are most often the drug resistant forms. People with HIV often die from TB, the clinical course of which will be varied and rapidly progress. According to O'Reilly and Daborn (1995), if AIDS patients do not die of something else first, nearly 100% of those patients infected with *M. tuberculosis* will develop active disease.

Parents who are co-infected with TB will cause additional problems to their children as they show an increased incidence of cavitary disease, higher mortality and strains resistant to multiple drugs. Children living with these adults will then be at very high risk of contracting tuberculosis if they are themselves immunocompromised, being in close proximity to their parents who have TB (Hakim and Grossman 1995).

2.5.2.2 Tuberculosis and HIV in children

Children who have HIV may have poor reactions to tuberculin, and so they have a high risk of developing TB without doctors diagnosing it at an early stage. Infants and young children also develop symptomatic and extra-pulmonary infections rapidly (Hakim and Grossman 1995). The WHO recommends that all HIV-infected children who live in high incidence areas but are asymptomatic should receive the BCG vaccine. On the other hand, patients who are symptomatic (i.e. have developed AIDS) may develop disseminated BCG disease if they are given the vaccine (Special Programme on Aids and Expanded Programme on Immunisation, 1987). Datta and Swaminathan (2001) express that there are less children infected with HIV and tuberculosis than adults although they warn that the numbers are increasing. HIV children are at an even greater risk, on both accounts, of contracting TB or any pulmonary infection (Jones *et al* 1992, Khouri *et al* 1992), however, Walls and Shingadia (2003) state that it is still unclear whether HIV-infected children are more vulnerable to TB infection, or are more likely to progress to disease that HIV-negative children. Husson (1998) estimated that there would be over 56,000 cases of HIV-attributable tuberculosis in children in 2000, and that the risk of infection leading to disease will be five times higher in a child with HIV. Datta and Swaminathan (2001) also discuss several other studies where a link between tuberculosis and HIV infection is shown. These include a study from Mumbai (Merchant and Shroff 1998) where there is an HIV prevalence of 18% in children with miliary tuberculosis. Another study in Southern India by Cherian and Verghese (2000) shows that 14% of children infected with HIV have been found to have tuberculosis. Bornschlegel *et al* (1996) demonstrated that the tuberculosis rate in the first four years of life for children born to HIV mothers is 10 times higher than in non HIV-infected mothers, and 30 times higher in HIV-infected children. Although HIV is more commonly thought of an adult

infection, it can affect children as well and for this reason it is important for us to try and stop the spread of both of these diseases.

2.5.3 Other aspects of tuberculosis today

Tuberculosis today has other aspects to it such as drug resistance and access to health care. This will be covered in this section. Drug resistance occurs when a course of therapy is not followed until the end of the treatment. This also makes it more difficult to treat tuberculosis as a non-drug-resistant case which is much cheaper to treat than a drug-resistant case (Walls and Shingadia 2003). Patients may develop drug resistance in two ways. Primary drug-resistance refers to cases in which a patient has no prior history of tuberculosis or treatment with anti-tuberculous therapy. Secondary drug-resistance refers to patients who were initially infected with an organism that is already susceptible to develop antibiotic resistance (presumably due to erratic administration of medication) (Starke 2001). In children available evidence suggests that most drug-resistant tuberculosis is primary (Schluger *et al* 1996). There is little evidence today to suggest the drug resistant TB is more infectious or more likely to cause disease than drug sensitive TB (Walls and Shingadia 2003). In the UK the rate of isoniazid resistance in paediatric cases is 6.5% and that of MDR TB is 0.5% which is similar to the adult rate (of 6.4 and 1.2 respectively – data from the Public Health Laboratory Service in Walls and Shingadia 2003). In 1990, less than ten countries worldwide had adopted DOTS, but by 1999 at least 127 countries were following this type of tuberculosis control among which were the 22 high burden countries responsible for 80% of global tuberculosis morbidity (Raviglione and Pio 2002). This increased to 148 countries in 2000 but the problem remains that only 27% of the world's tuberculosis cases were detected under this regime (Ahmad 2002). This has again increased to 183 countries detecting 29 to 32% of estimated cases of tuberculosis in 2001 (www1). Ahmad (2002) also states that the obstacles to the expansion of the DOTS control are: non conformity of the private sector with DOTS standards (Indonesia and India); poor access to health service (Ethiopia and Mozambique), acceptance of DOTS restricted to the local rather than the national level in Russia; poor collaboration between tuberculosis and HIV/AIDS services (in some African countries), and finally war (Afghanistan). A six month course of DOTS treatment costs £18 and will prevent transmission to other people in the community. Holme (1997) states that DOTS treatment can costs as little £7 if drugs are bought in bulk and will prevent large parts of the community becoming infected with tuberculosis. In industrialised countries today it can cost up to $2000 to treat a person with tuberculosis, but multi-drug resistant cases can cost up to $250,000 (World Health Organisation website)!

DOT and DOTS treatments still have problems related to them. Firstly, countries do not always ensure that the treatment will be followed as many people are not able to afford the trip to the clinic, especially in developing countries. In the United States there are clinics that will offer free trips in either a bus or a taxi to try and ensure that those that need the treatment are receiving it. Poor compliance with treatment was shown to be the most prevalent risk factor associated with relapse, and numerous studies have shown that at least 30 to 50% of people taking medicines for chronic conditions such as tuberculosis will experience significant non-adherence (Starke 1999). Patients treated with low potency regimens, those with adverse effects to the medication, and patients with a history of alcohol abuse, were all more likely to have recurrent tuberculosis. (Selassie and Dawson 2002). Enarson and Rouillon (1998) have determined that, without chemotherapy, 25% of tuberculosis patients will die within 2 years, 50% will die within 5 years, and 25% will undergo spontaneous remission. An additional 25% will remain a source of infection for the population. They state that 8% of patients will die while following chemotherapy treatment, 84% will be completely cured and a further 2% will still be infected by the end of the treatment. The effectiveness of drug treatment in a community will depend on several variables such as the population's concept of how the disease arrived in the group and the means by which it is prevented and treated (Roberts and Buikstra in press).

Directly observed therapy in children will be affected greatly by the parent's attitude towards tuberculosis. Therefore, Starke (1999) suggests that many questions should be asked of the parent and the child before the treatment starts. When this is done it will help adherence to the programme. As early as the 1980's recommended treatment duration for children with pulmonary tuberculosis was as long as 12 to 18 months; this was effective when introduced properly but had high failure rates because of poor adherence to treatment. Today, treatment regimes as short as six months are successful for most forms of tuberculosis (Starke 2001). The major issues concerning DOT are different in children and adults as children rarely develop secondary resistance and they are generally not contagious. The major reason why DOT is used in children so that they complete the whole therapy, protect them from life-threatening complications of the disease and there is no one regimen that is best for DOT in children (Starke 1999).

Access to health care has also been a major aspect of tuberculosis disease today. This will be covered in more detail in Chapter 7. Briefly, there are male-female differences in access to health care and also issues about the access to health care in developing countries. There are problems related to a patient's sex also in this treatment because in developing countries some women may find it hard to access clinics as they do not earn enough money to pay for the

trip, they may also not have the time to go as they have to take care of domestic responsibilities, and they may not be able/allowed to go on their own. There is also stigma attached to tuberculosis so that, if a patient is seen to enter a tuberculosis treatment centre, males may have to take pay cuts as they will be seen to be less productive, and women might find it hard to find a husband and will be ostracized from their family. Women tend to get diagnosed later than men (studies in Vietnam and Nepal) although the reasons are not specified. Women also tend to go and seek health care in the private sector where cases of tuberculosis are not notified. Women also have less access to health care in some regions because their power is less. On the one hand, women prefer to go and see alternative practitioners and for unknown reasons, there is often a delay in the diagnosis of tuberculosis. Women in some countries also have less money and time to go and seek out health care (they are often left at home caring for the house and family) and have lower decision making power than men. On the other hand, women have such a busy role in society today that the fact that they have economic restrictions, are reluctant to go and seek health care if they are ill (as they could get diagnosed with tuberculosis and then have to face the stigma of having the disease) that DOTS as a strategy is not practical in the case of women (*The Lancet Infectious Diseases* 2002)

2.6 Summary

This chapter has dealt with the basic facts about tuberculosis, such as what the disease is, how it spreads, how we diagnose it, and the prognosis of those who contract it. In summary, tuberculosis is a disease contracted by inhaling or ingesting tubercle bacilli of either the human or bovine form. It spreads from those people infected with the tubercle bacilli to uninfected people when they expectorate, exhale, talk or sneeze. Children under six months of age are especially vulnerable to tuberculosis infection along with people who have compromised immune systems. There are several diagnostic tests for TB and these all have various levels of ease of application and precision. The test that was mostly used for the identification of tuberculosis infection in children in Stannington was the Mantoux test, followed by radiographs if a positive result was found. Finally, the position of tuberculosis today was discussed, albeit briefly, as this period postdates that of this study. The period covered by this study will be more fully discussed in the next section, which deals with the history of tuberculosis, its understanding and treatment.

Chapter 3

Tuberculosis in History

And Dr Krokowski answered his own question, and said: "In the form of illness. Symptoms of disease are nothing but a disguised manifestation of the power of love; and all disease is only love transformed"

(Thomas Mann, *The Magic Mountain* 1927:128)

This chapter deals with the understanding and treatment of tuberculosis in the past, building on the background information provided in the previous chapter, but focusing on the period delimited in this study (1937 to 1953). The first section will deal with the antiquity of tuberculosis by looking at the skeletal evidence in both the New and Old Worlds, demonstrating that tuberculosis has been around for a long time. This is followed by a survey of the understanding and treatment of tuberculosis during antiquity, the Middle Ages, the Age of Enlightenment and the eighteenth to the nineteenth centuries. Historical causes of tuberculosis in the past will also be examined. This will help with our understanding of the treatment regimes that were undertaken at Stannington. Tuberculosis in the early twentieth century will be discussed in more detail, as it is the period defined by this study with particular regard to the understanding of tuberculosis in the 20th century, along with its methods of prevention and treatment.

3.1 How old is tuberculosis? The skeletal evidence for the antiquity of tuberculosis.

3.1.1 Old World

3.1.1.1 Europe

This section is divided into five geographic areas (Mediterranean, Northern, Western, Central and Eastern Europe) to discuss the skeletal evidence for the antiquity of tuberculosis. There are a number of skeletons that have been excavated from archaeological sites in Europe with evidence of tuberculosis. A summary of this evidence follows. In Mediterranean Europe, the earliest evidence for skeletal tuberculosis comes to us from Italy (Formicola *et al* 1987, cited in Ortner 1999). An adolescent from Arene Candide Cave, dated to the first part of the fourth millennium BC, is described as having lesions that occur in the thoracolumbar region of the

spine. Angel (1984) diagnosed tuberculosis in an Iron Age (900BC) juvenile from Greece, and Grmek (1989) states that this is probably the earliest known case of tuberculosis in Greece. According to Roberts and Buikstra (in press) there seems to have been little written on tuberculosis skeletal evidence in Greece except for that of Angel. There is also evidence for tuberculosis in Northern European countries. Denmark boasts many tuberculosis studies, the most comprehensive being Bennike's 1999 review of her 1985 data. Tuberculosis in Denmark was well established by the Iron Age (500 to 1BC). Other Scandinavian countries (Finland, Sweden and Norway) have produced little evidence of skeletal TB.

In Western Europe, the evidence comes from several cases reported in France from the 8th to 19th centuries but they do not cover all of France. Roberts and Buikstra (in press) report that that these pockets tend to reflect the work that has been done in certain regions. There is little evidence for tuberculosis reported from Germany. Templin and Schultz (1994) studied164 children (83% of those interred) from a site on the German side of the Rhine in Basel-Stadt, Switzerland, specifically looking at changes on the endocranial surface of the skulls that could be the result of meningitis, and of tuberculous origin (Schultz 1999). They found that 12 children had a meningeal reaction and report that these children suffered from tuberculous meningitis. There has been some work done on tuberculosis in Portugal but there has yet to be much evidence reported from there. Recently, Santos (2000) provided evidence of tuberculosis by studying the skeletons from the Coimbra Identified Skeletal Collection at the University of Coimbra. Biomolecular analysis was also undertaken in this study. The Netherlands seem to have very little, if any, evidence of skeletal tuberculosis.

Central Europe also displays many cases of skeletal tuberculosis. There is skeletal evidence for tuberculosis as early as the second to fourth centuries AD in Austria although no systematic work has been done (Wiltschke-Schrotta and Berner 1999). The evidence from the Czech Republic comes from Horáčková *et al* (1999) who describe tuberculosis as one of the most frequent infectious disease in Bohemia and Moravia (Czech Republic) in the Middle Ages. They used radiological, histological and biomolecular analyses on identified cases of tuberculosis from the 13-18th centuries, the 1720's and a modern case. They were able to confirm the macroscopic diagnosis and confirm tuberculosis by biomolecular analysis in all three of their samples. In Hungary, tuberculosis has been reported for as many as 1,300 years, but according to Hutás (1999) it only became common along with the rise of industrialisation, especially in Budapest. Pálfi and Marcsik (1999) report that there are 15 individuals with tuberculosis from the 7-8th centuries, none in the 10th, five in the 11th to 13th centuries and eleven cases in the 14th to 17th centuries. There has been extensive molecular

analysis of tuberculous skeletons in Hungary. Again, Switzerland has little evidence of tuberculosis published on skeletal remains.

Tuberculosis has also been reported in Lithuania (Eastern Europe), which has rich skeletal collections. Jankauskas (1998) reports that the oldest case of tuberculosis is a 2nd to 3rd century AD 30-35 year old female who demonstrates Pott's disease of the spine and possible hip and foot involvement. This individual also turned out to be positive for *Mycobacterium tuberculosis* DNA when analysed by Faerman and Jankauskas (1998). Gladykowska-Rzeczycka (1999) has also demonstrated evidence for tuberculosis in Poland. A site from the Neolithic (5000BC) has yielded a skeleton possibly showing signs of tuberculosis (Mierzanowice) with involvement of the spine. There are a few examples in later times, and no cases in the Roman period but Gladykowska-Rzeczycka (1999) states that samples of Roman burials in Poland are poorly preserved. As in most other European countries, tuberculosis became more common in the Later Medieval period. The earliest case of tuberculosis from Russia comes from the site of Issyk-Kul Lake in modern Kirgisia of the former Soviet Union dated to the Iron Age (1st millennium BC to 7th century AD) (Rokhlin 1965 in Roberts and Buikstra in press). Very little has been published from Russia regarding tuberculosis in skeletal remains. Britain, however, holds a rich history of tuberculosis and this is covered below.

3.1.1.2 Britain

The first evidence for tuberculosis in Britain was previously believed to be 200-400 AD (Manchester 1984) while other authors favour the later date of 400 AD (Wells 1982, Stirland and Waldron 1990, both cited in Roberts 2000). Cases have also been found in the post medieval and later medieval periods where they increased as indicated by skeletal (Roberts 1999a) and historical evidence (Crawfurd 1911, Clarkson 1975, both in Roberts 2000). There is now much earlier evidence of tuberculosis in Britain. The skeleton of a man from the Iron Age dated to about 300BC has been found recently to have tuberculosis (Holden 2003). This was proved by osteological examination, revealing a Pott's spine and DNA analysis, which confirmed the presence of TB in the man's spine. Simon Mays and Michael Taylor (Holden 2003) were also able to determine that he was infected by *Mycobacterium tuberculosis* rather than *Mycobacterium bovis*. The skeleton, being from a rural area, would have been considered more likely to be infected by *Mycobacterium bovis*. This discovery is indeed important as this skeleton came from a rural settlement, thus showing the extent of infection from *Mycobacterium tuberculosis* in rural areas even in these early times.

The Roman period has provided a few examples of tuberculosis. Wells (1982) describes a male skeleton from Cirencester, Gloucestershire, aged 17-25 years with spinal involvement of the first lumbar vertebra. Some sites have skeletal remains with changes in the ribs (new bone formation) which could be due to tuberculosis, while suggesting a non-specific pulmonary infection, are not diagnostic of TB. Roberts (1989) reported a site (Kingsholm in Gloucester) where three skeletons (two young adults, one male and one female and one female middle-aged adult) from a total of 50 individuals had new bone formation on the ribs. Boylston and Roberts (1996) also show that there were four male individuals out of 110 with rib changes at Kempston in Bedfordshire.

Roberts and Buikstra (in press) show that there is an increase in cases in the early Medieval period (5th to 11th centuries AD) but concede that these sites do not go further north than Barton-on-Humber. They cite Boyle and colleagues (1998) from Butlers Field, Lechlade, Gloucester, a male (30-35 years old) with spinal tuberculosis. Putnam (in Huggins 1978) reported from Nazeingbury, Essex two individuals with tuberculous spines (one female older adult and one unsexed adult). Powers and Brothwell (1988) report from a site at Alton, Hampshire a male (24-27 years of age) with spinal disease, and Boyle and colleagues (1995) reveal from Berinsfield, Oxfordshire seven individuals with new bone formation on the ribs. Harman (1995) also records from Berinsfield one female adult as having a tuberculous spine. Waldron (1988) records an adult male with spinal TB at Great Chesterford in Cambridgeshire, and Powell (1996) at Raunds (Northamptonshire) describes an adult male (17-25 years) with infection in the knee and spine and a further three individuals with new bone formation on the ribs. At Ipswich, Suffolk, (Mays 1989) two individuals had changes in their skeletons consistent with tuberculosis. Anderson (1996) records several skeletons with changes consistent with tuberculosis at Norwich (Farmer's Avenue, Castle Mall): two females with new bone formation on their ribs, one male with possible spinal involvement, and another young adult with possible changes to the wrist. Boylston and Roberts (1996) report from Addingham, a male with tuberculous disease of the spine and associated bone formation on the ribs, and another two individuals with rib periostitis only. Norton and Boylston (1997) report an adult male from Binchester in county Durham (Anglo-Saxon site) with tuberculous changes in the hip and spine with possible changes on the ribs indicative of tuberculosis.

There are also cases of tuberculosis reported in the literature from later and post-Medieval cemeteries (12th century onwards). Roberts and Buikstra (in press) report that there is a further increase in cases but that it is not as high as the contemporary historical data suggest. Anderson and Andrews (n.d.) describe a 7 to 8 year old child with bone formation on the ribs

from St Gregory's Priory, Canterbury, Kent (Roberts and Buikstra in press). Chundun (1991) reported that 54 individuals from a total of 306 showed rib lesions which might be consistent with tuberculosis and Lee (n.d) declares that eight more could be included. Although some cases have been laid out as possible tuberculosis cases affecting the ribs, hips or knees, the only actual diagnostic tool used is Pott's disease for archaeological skeletal material. Further examination by Roberts (Roberts and Buikstra in press) demonstrate that there appears to be a male adult, a 13-15 year old adolescent and a mature female who have changes in their os coxae which could be the result of TB, a 7-8 year old with changes in the elbow, a mature female with possible tuberculous changes to the skull and three other individuals with spinal changes. Conheeney and Waldron (in prep) show that a site in London (Farringdon Street) two females and one male had changes in the vertebral column, and another (unsexed individual) with changes in the wrist. Several sites in Yorkshire have produced tuberculous individuals from late medieval sites such as St Andrew's Fishergate and Jewbury (both in York), Wharram Percy, St Giles and Newcastle Infirmary. In Cumbria, there is also a site from Blackfriars Street, Carlisle, and also sites in Scotland and Ireland that have produced evidence of skeletal TB. Time and space have limited this section on the skeletal evidence for tuberculosis; for more detailed information on all the sites mentioned see Roberts and Buikstra (in press)

3.1.1.3 Middle East/Africa

Zias (1998) states that there are so few cases of tuberculosis reported to date from the Middle East, that it has been suggested that the Jewish community may have a genetic resistance to mycobacteria when compared to populations living in identical conditions (also in Roberts and Buikstra in press). Another plausible reason for the lower rates of infection in Jewish populations could be the high frequency of Tay Sach's disease in the Jewish population where a gene renders the infected resistant to tuberculosis (Zias 1998 and Roberts and Buikstra in press). The skeletal evidence of TB from the southern Levant is sporadic and cases are mostly speculative of TB (Zias 1998). Again, like Israel, there is little evidence of skeletal tuberculosis in Jordan but Ortner (1979) reports a Jordanian Bronze Age skeleton from 3000 BC to have tuberculosis. El-Najjar *et al* (1997) report a case they believe is tuberculous from a Neolithic site in Jordan (Ain Ghazal) but Hershkovitz and Gopher (1999) contested the evidence as the skeletal changes are in atypical elements and state that no differential diagnoses were offered. There has been no evidence identified in Sub-Saharan Africa and only very late incidences of tuberculosis in South Africa. The majority of the evidence from Africa comes from Egypt and the Sudan, in all probability due to their rich historical and archaeological data. There are several skeletons showing tuberculous disease from Ancient

Egypt and Nubia from the most ancient cases, dated to the 4th millennium BC, to the most recent ones from Cemetery K at Sayala, Nubia and from the Batn el-Hagar area 5th to 11th century AD (Strouhal 1999). There are many other cases of skeletal tuberculosis from Egypt and Nubia. Strouhal (1987, 1989, and 1991) has described a case from the 4th century AD with spinal changes (a 22-24 year old male) and also in a middle-aged male from a Middle Kingdom tomb (2025-1700 BC). Evidence of skeletal tuberculosis has been found in Egyptian mummies dating from 3500 BC (Zimmermann 1979), and a mummy called Nesperehăn from 1000 BC (Morse 1961) not only displayed Pott's disease but also a psoas abscess. More recently, Crubézy *et al* (1998) identified *Mycobacterial* DNA in an Egyptian skeleton 5,400 years old with a hunchback deformity consistent with Pott's disease.

3.1.1.4 Asia

The three oldest cases of skeletal tuberculosis in Asia from archaeological sites in Japan are dated to the Kofun period (4th to 8th century AD). These cases, reported by Suzuki (2000), include one male with lumbar, sacral and hip changes (Suzuki 1985), a mature female with spinal damage and a mature male also with spinal changes. Ortner (1999) believes these to be consistent with tuberculosis. Suzuki (1978) also reports one affected spine from the 3rd to 6th centuries AD from 188 spinal columns dated from the Jomon-Edo period (ranging in date from 12,000 years ago to the 17th to 19th centuries). Even though China is one of the earliest centres of agriculture there is little evidence of tuberculosis, although Kiple (1993) states that tuberculosis was identified in the lungs of a female mummy from the early Han Dynasty (206BC to AD 7).

3.1.2 New World

There is mounting evidence that there was tuberculosis in pre-Columbian times as evidenced by Buikstra (1981, 1999), Allison *et al* (1981), and Salo *et al* (1994). Of course, the evolutionary model of tuberculosis is controversial (Kelley 1989) but it is beyond the scope of this work to bring an end to the discussion. It is clear to palaeopathologists working today that the earliest skeletal evidence for tuberculosis appears in the Old World. Roberts and Buikstra (in press) state that these early cases probably relate to animal domestication and that the increase in frequency which is seen in later the Medieval period in Europe is related to the living environment of these people. This is corroborated by New World evidence. The earliest case of non-human tuberculosis from the New World is reported by Rothschild *et al* (2001) who identified tuberculosis from a 17,000 BP bison. However, they were not able to identify the mycobacteria causing the disease except to say that it came from the *Mycobacterium tuberculosis* complex. The biological evolution of the bacteria in

tuberculosis is as yet unclear and causes difficulty to medical historians and palaeopathologists studying the history of tuberculosis. As Pálfi and Marcsik (1999) suggest that there is a need for an interdisciplinary collaboration between palaeopathologists, medical historians, epidemiologists, immunologists and microbiologists if the history of tuberculosis is to be resolved.

3.1.3 Tuberculosis and Ancient Deoxyribonucleic Acid (aDNA)

3.1.3.1 Ancient DNA Analysis

Sola *et al* (1999) state that DNA fingerprinting shows interesting applications in two fields of mycobacteriology: molecular epidemiology of TB (Small and van Embden 1994) and the evolutionary study of the *M. tuberculosis* genome (Sreevatsan *et al* 1997). Archaeologically, tuberculosis in the past is only identifiable if bone lesions, such as Pott's disease, occur. Ancient DNA analysis however, permits scientists and osteologists to identify or confirm tuberculosis even in the absence of bone lesions. This has been done with some success by Baron *et al* (1996), Braun *et al* (1998), Faerman *et al* (1999), Dutour *et al* (1999), Pap *et al* (1999), Horáčková *et al* (1999), and Spigelman and Donoghue (1999), although there are still major problems with this technique. According to Brown (2000:469) ancient DNA analysis proceeds as follows:

> "The PCR-based system used to detect ancient tuberculosis complex DNA amplifies sequences from a repetitive insertion called IS6110. This sequence occurs 0-20 times per bacterium (depending on type of bacterial strain), and the target within this is 123bp long. Many workers use two rounds of PCR, re-amplifying the 123bp products with primers designed for a 92bp portion. It is important that soil samples from around the burials are also tested by PCR to eliminate the possibility that there is cross-contamination from other remains or soil bacteria; otherwise there may be an element of doubt over positive results from remains showing no bony signs of disease. The detection of ancient tuberculosis DNA in remains which otherwise shows no gross signs of disease means that the true prevalence of this disease in past societies, and hence its impact on local economies, settlements and demography can be assessed in conjunction with other forms of archaeological evidence."

3.1.3.2 Problems with ancient deoxyribonucleic acid and polymerase chain reaction

According to Gernaey *et al* (1999), the biomolecular analysis of archaeological remains for tuberculosis has been restricted to the demonstration of DNA fragments from the insertion element IS6110 (Salo *et al* 1994, Taylor *et al* 1996, Nerlich *et al* 1997). They state that the specificity of using this element has been questioned (Doucet-Populaire *et al* 1996; McHugh *et al* 1997) and the amplification steps required for PCR may not allow the disease state to be distinguished from superficial infection (Gernaey *et al* 1999). It is important to keep in mind that a positive result from aDNA test only refers to infection from tuberculosis in the specimen and does not refer to the activity of the disease (Nuorala 1999). Although aDNA analysis seems to be the path for the future there are still many problems with it, as DNA probes and PCR techniques remain subject to problems of contamination, background noise and the lack of survival of ancient tuberculous DNA (Aufderheide *et al* 1994, Rom and Garay 1996 both cited in Kelley and Lytle-Kelley 1999). The work with ancient DNA according to Zink *et al* (2002) also has problems with the stability of ancient DNA. Normally DNA will degrade quickly after death and several factors will accelerate this process, such as high temperatures, UV radiation, humidity and a low pH. However, factors such as a cool dry climate or rapid desiccation of an organism due to natural or artificial mummification may slow down degradation and increase the chances of ancient DNA retrieval. Most often aDNA is significantly fragmented and destabilized by deamination and depurination, which can greatly disturb PCR amplification and result in non-specific products or incorrect sequences. Roberts and Buikstra (in press) note that in archaeological contexts aDNA is present in low quantities and must therefore be amplified before analysis. The most effective amplification strategy to date has been PCR but it requires a known target sequence to function due to the extreme degradation of aDNA. They conclude that a potentially productive avenue for future analysis would be the development of non-sequence specific amplification methods. Donoghue *et al* (1998) identified *Mycobacterium tuberculosis* complex in calcified pleura from remains dating from AD 600. They report the first example of *Mycobacterium tuberculosis* DNA in non-mummified tissue. Mays *et al* (2002) state that mycobacterial DNA is more likely to survive than human DNA, due to results obtained from previous studies done by Mays *et al* (2001) and Taylor *et al* (2000).

3.1.3.3 Differentiation between M. tuberculosis and M. bovis

Hopefully, a better understanding of the conditions that result in well preserved, amplifiable ancient DNA will make it easier to select specimens with longer pieces of surviving target sequences. This will help answer some questions concerning the differentiation of *M. bovis*

and *M. tuberculosis* and the evolution of *M. tuberculosis* (Spigelman and Donoghue 1999). Recently Mays *et al* (2001) were able to determine the former by using the mtp40 element to differentiate between the *Mycobacterium tuberculosis* complex. If this element is present it is most likely infection from *Mycobacterium tuberculosis*; if it is absent, the infection is most likely due to *Mycobacterium bovis*. By using the sequence of the pncA gene they were also able to differentiate between *M. tuberculosis* (which is pyrazinamide-sensitive) and *M. bovis* (which is pyrazinamide-resistant). They were also able to differentiate between the *Mycobacterium tuberculosis* complex by spoligotyping. *M. bovis* can be differentiated from *M. tuberculosis* by the absence of the terminal five spacers (nos 39-43) at the 3' end of the DR region. Finally they also used *M. bovis* specific fragments with the PCR, although Spigelman *et al* (2002) advise that only well preserved DNA will provide information in these cases.

3.1.3.4 Mycolic acids

Gernaey *et al* (1999) showed that mycolic acids analysis can also be used in the identification of tuberculosis in archaeological specimens. They confirmed PCR results by using *M. tuberculosis* specific mycolic acids to identify tuberculosis in a 1,000-year-old medieval rib. In a later paper (Gernaey *et al* 2001), the use of mycolic acids as a biomarker is demonstrated to be a sensitive tool to detect ancient tuberculosis as DNA is not distributed homogeneously and requires multiple sampling. The stability of mycolic acids show that they can be of value in tracing the palaeoepidemiology of TB. Biomolecular analysis can be used to diagnose TB when the disease does not show on the skeleton (Roberts and Buikstra in press). Ubelaker *et al* (2000) have recently used molecular analysis to help in identifying a forensic skeleton from the American Southwest, and the authors suggest the technique may be of use in other cases.

3.2 The understanding and treatment of TB in the past (Antiquity to the 19th century)

The term tuberculosis has only been in use for around 120 years. To examine the history of the fight against TB, it is important to look at how tuberculosis was understood in the past. The next section contains a short chronology of the understanding of tuberculosis through time.

3.2.1 Antiquity (4-5th century BC to 2nd century AD)

In antiquity, tuberculosis was not recognised as a separate disease. Hippocrates (5-4th century BC in Greece) used 'phthisis' for all diseases that resulted in a feeble state. He is also thought to have recognised that all phthisics came from another phthisic, without recognising the method of contagion (Santos 2000). He would prescribe rest for acute cases, baths and liquid diets. In chronic cases, he suggested moderate exercise, an easily digested diet and walks (Porter 1996, Santos 2000). Aristotle (2nd century BC) described the tubercle nodules and named them '*phymos*'. He was one of the first to believe that the disease was contagious (Gladykowska-Rzeczycka 1999). The word '*tuber*' comes from the Latin meaning all kinds of degenerative protuberances or tubercles. The word '*tubercula*' is already found in Pliny and Celsus' works (1st century AD) (Magyar 1999). According to their texts, *tubercula* were protuberances that have a coat of their own to enclose themselves. Pliny prescribed travels by sea and a change of air to a drier environment to treat haemoptysis, a sign of TB. He also advocated rest and a good diet. Included in his diet was "wolf lung boiled in wine" mixed with bear bile and honey (Castiglioni 1933 in Roberts 1987, Santos 2000). Aretaeus of Cappadocia (2nd century AD) singled out tuberculosis from other cachetic diseases (disease which leave you in a feeble state) (Gladykowska-Rzeczycka 1999). Magyar (1999) believed that Galen, who also lived in the 2nd century AD, used phthisis to denote pulmonary consumption. Galen, along with Aristotle, believed in the contagious nature of tuberculosis according to Pease (1940 in Roberts 1987, Santos 2000).

3.2.2 Middle Ages (11th to 16th centuries AD)

The Middle Ages (11th to 16th centuries AD) was the time when tuberculosis (known at the time as phthisis), began to be seen more generally as having a contagious nature. It was also called at this time 'the white plague' as the infected subjects had a distinctive pallor to their skin. During this period, the fight against tuberculosis was based mainly on isolation (Gladykowska-Rzeczycka 1999). The healing touch of the Monarch was used on the type of tuberculosis referred to as scrofula (tuberculosis of the glands of the neck) in England and in France. Edward I touched 533 victims in one month, and Philip of Valois (1328-1350) put the king's hand on 1500 patients in a single ceremony (Webb 1936). However, Charles II is supposed to have touched the incredible number of 92,102 scrofulous patients. (Guthrie 1945) **(Fig 1).** Fracastoro (1483-1553) worked on proving the infectiousness of tuberculosis in the 16th century. Writing in 1546 about contracting tuberculosis from the belongings of a tuberculous person (Daniel *et al* 1994), he stated that the invisibles particles could survive outside the body for several years and still infect (Dormandy 1999). This work promoted the growing belief in contagiousness during the period.

Fig 1 – Touching for the King's Evil (Wellcome Library)

3.2.3 Age of Enlightenment (17-18th centuries)

The first man to discover a causal connection between symptoms and the cause of the illness was De la Boe Sylvius (1614-1672), a Frenchman living most of his life in Holland. According to Sylvius (1695, in Flick 1925), the small protuberances (tubercles) originated in from the lymphatic glands in the lungs. The lungs themselves were of a glandular nature, and therefore the illness actually had its origin in a certain kind of lymphatic degeneration (Evans 1998). Morton (1635-1698) was the first to declare that these *tubercula*, described by Sylvius, were a necessary and preliminary condition for pulmonary consumption (Morton 1733, cited in Magyar 1999: 26, also Evans 1998)

3.2.4 Eighteenth to twentieth centuries

The major developments in the fight against tuberculosis appeared in the 18th to 20th centuries. Miliary tubercles (tubercles the size of millet seeds) were first described by Pierre Manget at the beginning of the 18th century (Dormandy 1999). Miliary tuberculosis has an important part in the history of tuberculosis as it caused high mortality especially in children.

Auenbrügger in Vienna (1722-1809) first described the technique of clinical percussion but this technique was rediscovered by Corvisart (1775-1821) during the golden age of French medicine. It was Corvisart who was to teach Laënnec (1781-1826) who would relate the clinical to the pathological findings (the pathological signs which had been taught to him by Bayle) by using the palpation method (Evans 1998).

Finally, Bayle (1774-1816) proved definitively that *tubercula* were the cause of the illness (Bayle 1810, cited in Magyar 1999). At this time, the term tuberculosis begins to appear in medical language and although it is often associated with Bayle, he did not use it. The terms used by Bayle were '*phthisie tuberculeuse*' or '*phthisie pulmonaire*'. The term tuberculosis resulted from Bayle's discovery and was coined in the first decades of the 19th century.

Tuberculosis at the time of Bayle was still responsible for more than a third of the dead individuals autopsied by Bayle and Laënnec in Paris. Laënnec announced that the various lesions that were found in phthisical patients were shown to be from the same disease. This was very remarkable because at that time the causative agent of tuberculosis had not been discovered and Laënnec did not have the use of a microscope. However, he introduced the stethoscope to medicine. In 1882, Koch discovered the tubercle bacillus, which was shown to be the causative agent of tuberculosis (discussed in more detail in a later section). Thirty-five years after Laënnec's discovery that the different lesions were all from the same disease, the term 'tuberculosis' was suggested by a Swiss physician J L Schloenlein in 1839 because the tubercle was the anatomic basis of the disease, a name that survives today (Lincoln and Sewell 1963, Porter 1999).

In Germany, Klencke in 1843 experimented on rabbits by injecting them with caseous material, but it was not until twenty years later that a French army surgeon named Villemin (1827-1892) showed by extensive experiments that tuberculosis could be transmitted from humans to various animals. He was also the first to produce evidence to suggest that there were different strains of tuberculosis. He proved this by injecting rabbits with tuberculous strains from a cow and a human, and he concluded that the rabbits that had been injected with the bovine strain developed a more rapidly fatal form of tuberculosis than the rabbits inoculated by the human strain. In 1898 at Harvard, Theobald Smith showed that there were microscopic, morphological and toxic differences between the different bacilli (Smith 1898).

The discovery of the tubercle bacilli in 1882 by Robert Koch (1843-1910) was a great step forward in the fight against tuberculosis. Koch developed coloration techniques, namely

staining, and was the first to use solid culture environments that allowed him to isolate and observe the shape and development of several species of micro-organisms (Daniel *et al* 1994; Porter 1996, both cited in Santos 2000).

Before this discovery was made, TB was thought to be hereditary in nature, but Koch proved that it was microbial in origin. As late as 1881 Austin Flint stated in his textbook, *The Principles and Practice of Medicine*, that "the doctrine of contagiousness of the disease has now, as hitherto, its advocates but the general belief is in its non-communicability". According to Koch's postulates, in order to prove that a certain organism is responsible for contagion four conditions must be observed: the organism must be present at all times during infection, must be cultivated in a pure culture medium, must cause disease when inoculated in a guinea pig and, finally, may be recovered from the inoculated animal and grow in a pure culture, all of which are fulfilled by tuberculosis (Koch 1982 cited in Santos 2000, Koch 1994).

There were several treatments used for TB in the recent past. At first, the traditional treatment of blood letting and horse riding was used when the poet Keats (1795-1821) was being treated for TB by Sydenham, his doctor (Pesanti 1995, Daniel 1997, Dormandy 1999). Dr Benjamin Allen of Braintree in Essex in the 1700s would prescribe a pint of sheep's dung in a pint of milk steeped overnight, strained and drunk as a cure. John Wesley believed that the relief would come in cold baths and milk (little did he know that milk could cause the disease). He also believed that patients should cut up a little piece of fresh turf in the morning, and lie down and breathe into the hole for a quarter of an hour. He would also prescribe sleeping in the cow-house as close to the cows as possible (again this could actually cause the disease if the cows were infected by tuberculosis) (Lewis 2002). Live snails were also eaten, as it was believed that they would eat the phlegm off the chest and cure the consumptive. Snails were added to many dishes such as soups and ales for added 'bite'. As late as 1875 some doctors' cure would insist on having such items as 2 ounces of mouse ear (Lewis 2002). Italy and Spain both accepted that tuberculosis was contagious in the sixteenth century as proven by the reception that people such as Chopin (1810-1849) or Keats received when they tried to retire to the Mediterranean to search for a cure. Authorities would wait for their boats at the port and would refuse to let them disembark or they had to pay for disinfecting their rooms when they left (Lincoln and Sewell 1963, Dubos and Dubos 1952). By 1800, the treatment of TB was mostly based on moving to a warm climate, and abstention from alcohol and meat (Pesanti 1995). The other treatments ranged from a change of climate,

air, and altitude (e.g. travel to the Alps) and diet, and also access to sanatorium treatment, sun, cleanliness, and the King's Touch.

The development of several surgical techniques and chemotherapy to treat tuberculosis would also bring important names to the forefront of the tuberculosis battle. Collapse therapies such as artificial pneumothorax had been suggested as early as 1821 by James Carson, but was not actively practised until 1892 by Carlo Forlanini (Dormandy 1999). It became the basis of treatment for the first half of the 20th century without any real effectiveness. Chemotherapy, developed in 1943, was to bring a newfound hope in the fight against tuberculosis. Selman A. Waksman was nominated for a Nobel Prize (1952) for the discovery of streptomycin, the first antibiotic for TB treatment (Cule 1999). The discovery of para-amino salicylic acid (PAS) by Lehmann followed in 1946, and isoniazid (INH) in 1952 by Dogmagk and Fox. Many drugs are used today to fight tuberculosis. The most common are ethambutol (1968), isoniazid (1952), pyrazinamide (1970) and rifampicin (1968) (Roberts and Buikstra in press). Most therapies today also include multiple drugs to try and prevent resistance.

3.2.5 Causes of TB documented in historical data

There were thought to be many causes of TB. It is important to link the past causes of tuberculosis as they can give insight on how tuberculosis was treated in the past. They ranged from improper dress, sexual indulgence, masturbation, celibacy, and alcoholism to poverty, overcrowding, lack of hygiene, occupational hazards, foul air and being Irish (Dormandy 1999)! Even after the discovery of the tubercle bacillus, there were still some doctors who held the belief that TB was a hereditary disease. Some believed that to deny the role of heredity showed 'a reckless disregard for eugenics and the national welfare' (Dormandy 1999: 236). The fact that most studies proved that children with TB came from families where a member had TB, this was put down to inheritance rather than infection (Smith 1988). Koch's discovery of the tubercle bacilli was followed in 1890 by tuberculin. This glycerine extract of the tubercle bacilli was proposed by Koch as a new remedy, but did not fulfil his expectations of a cure against TB (Guthrie 1945). In 1908 the *Bacille Calmette-Guérin* (BCG) was discovered and this was the first vaccine to produce significant immunity against the tubercle bacillus.

There were also certain occupations that had a higher mortality from respiratory tuberculosis than others. (These can be seen in **Table 2**). These occupations would affect children because, if one or both of their parents were working in the sectors with a high mortality for

respiratory tuberculosis, the children would have a higher chance of contracting the disease in their home environment. Other factors such as poverty and overcrowding can also have an impact on whether children contract tuberculosis as these factors can lead to a decrease in the effectiveness of the immune system and the possibility of droplet infection transmission respectively, leaving them more susceptible to the disease. These factors will depress the immune system by forcing the person towards a less healthy diet and, since poorer people have less access to health care, the disease is free to progress without being diagnosed early (these issues will be discussed in Chapter 7). The understanding and treatment of tuberculosis in the 20th century will be discussed in the next section.

3.3 The twentieth century in Europe

3.3.1 The understanding of TB in the 20th century

Tuberculosis in the twentieth century has benefited from the many discoveries which occurred during the nineteenth century. Koch's work in 1882 enabled the fight against tuberculosis to take another direction. In the twentieth century the sanatorium movement continued to be used to treat tuberculosis but many other changes, such as the development of radiography and chemotherapy brought renewed interest in the fight against tuberculosis. However, although it mistakenly made people believe that elimination of tuberculosis was near, the emergence of drug-resistant strains of tuberculosis is one of the results of this complacency.

Table 2. Occupations with high mortality rates from respiratory tuberculosis

Occupation	Standard mortality ratio at ages 20-64
Grinders, metal	275
Potters, ware makers, casters, finishers	233
Glazers, polishers, moppers	230
Barmen	212
Costermongers, newspaper sellers	200
Boot, shoe workers- factory operative	188
Water transport, dock labourer	186
Masons, stone cutters, dressers	179
Waiters	178
Hairdressers, etc	162

Logan and Benjamin (1957:23). Note: in brief this represents actual deaths in 1930-1932 as a percentage of those expected if the average tuberculosis mortality rate for England and Wales, by age, had been experienced by the occupational group, i.e. Standard mortality rate all males = 100.

3.3.2 How was tuberculosis prevented?

3.3.2.1 Radiographs

In 1895, Wilhelm Conrad Röntgen (1845-1923) discovered x-rays, which became very important in the diagnosis of tuberculosis. "Chest x-rays and their lineal successors were to transform the diagnosis of tuberculosis; and the mass x-ray was to become the first and arguably still the most successful screening program in preventive medicine" (Dormandy, 1999:145-146). It was a very fast diagnostic technique as it only took a few moments for a person to be radiographed, and early diagnosis maximised the possibility of cure. Radiography equipment was made available by the Ministry of Health to local authorities. Newcastle was given this equipment in the hope that they would share it with local neighbours. They made it possible for people to be radiographed in factories and work places (where the infection rate was quite high). The County Council paid Newcastle 12d (one shilling) per head radiographed. After the war, mass radiography was widely available free of charge to the public. Radiography, along with the discovery and use of a preventive vaccine, improvements in housing and the environment after the war lead to dramatically reduced rates of TB incidence (**Fig 2**) (Taylor, 1989). However, other authors such as Davies *et al* (1999a and b) disagree with this principle and claim that improving social factors did not provide the total explanation for the decline of tuberculosis in Victorian times, rather they believe that others factors such as natural selection most probably played a role. They show that tuberculosis mortality declined at a rate much faster than any indicator of social deprivation improved for the period 1853 to 1910.

Fig 2 – Prevention of tuberculosis by radiography (Daniel 1997)

3.3.2.2 Bacille Calmette-Guérin (BCG)

As has been mentioned before, the development of the BCG vaccine by Calmette and Guérin in 1908 began a new age for prevention of TB. It was on December 28, 1908 that Calmette and Guérin announced to the Académie des Sciences that they had obtained "a new race of biliated tuberculous bacilli" presenting a "fixed attenuation of its virulence while keeping its antigenicity" (Moulin, 1999:78). In France, the children who showed negative tuberculin tests were vaccinated with BCG to protect them against tuberculosis. They also vaccinated newborns and, in combination with the oeuvre Grancher (children from at-risk urban backgrounds temporarily placed with families in the countryside to protect them from the factors that predisposed to TB (Kayne 1935, Barnes, 1995)), Calmette claimed by 1923 to have reduced infant mortality from TB by 80% in Paris (Dormandy 1999:306, also Calmette *et al* 1924 cited in Moulin 1999). The BCG was very slow to be accepted in Britain: "The vaccine BCG awaits the final verdict, but I think it is only right to say that in my opinion there remains loopholes in the evidence which call for further examination before it would be proper to sanction the adoption of the BCG method generally" (Philip, 1931: 49). The reason for the delay could be very simple: first there was the effect caused by the Lübeck disaster, when many children died after being wrongly inoculated with the virulent strain, and secondly the fact that people in Britain had invested a lot of money into hospital and sanatorium beds rather than prevention.

A review of the efficacy of the BCG vaccine was undertaken by Colditz *et al* (1995) and they concluded that, on average, the BCG vaccine will reduce the risk of tuberculosis by 50%, with tuberculosis meningitis and disseminated cases being offered more protection than other cases. The protection afforded from pulmonary tuberculosis is 78% and the protection from pulmonary tuberculosis mortality is 71%. The ethnicity of a child did not seem to have an effect on the efficacy of the vaccine; but its effectiveness does increase with the distance from the equator. Additionally, different strains of BCG are not associated with different results in trials, and, strains of BCG used in the same populations will give similar levels of protection. Datta and Swaminathan (2001) state that BCG does not prevent the spread of infection but prevents the progression of haematogenous tuberculosis and they quote a study which showed that several BCG trials have been made. Their results vary between 0 to 96% and that the efficacy of the vaccine diminishes over time (Rodrigues and Smith 1990).

3.3.2.3 Improved living conditions

Doctors also endorsed improved living conditions as a means to prevent TB **(Fig. 3).** It was suggested that floors and walls should be washed weekly with soap and water, as 'dust was a friend to tuberculosis' (Smith 1988). There was a lot of publicity to target people who expectorated publicly, and in some places fines were instigated and the use of a spittoon encouraged (Bryder 1988). "On the one hand overcrowded housing conditions or failure to isolate infectious cases from home or industrial contacts and on the other hand malnutrition, fatigue and side effects of poor social conditions foster the disease" (Logan and Benjamin 1957:21). These social factors reduce resistance and increase prevalence in a society. Cule (1999) notes that health education programmes were important in the campaign against tuberculosis. Health workers would stress the communicability of the disease and the means to avoid it was seen to be the avoidance of exposure. The people

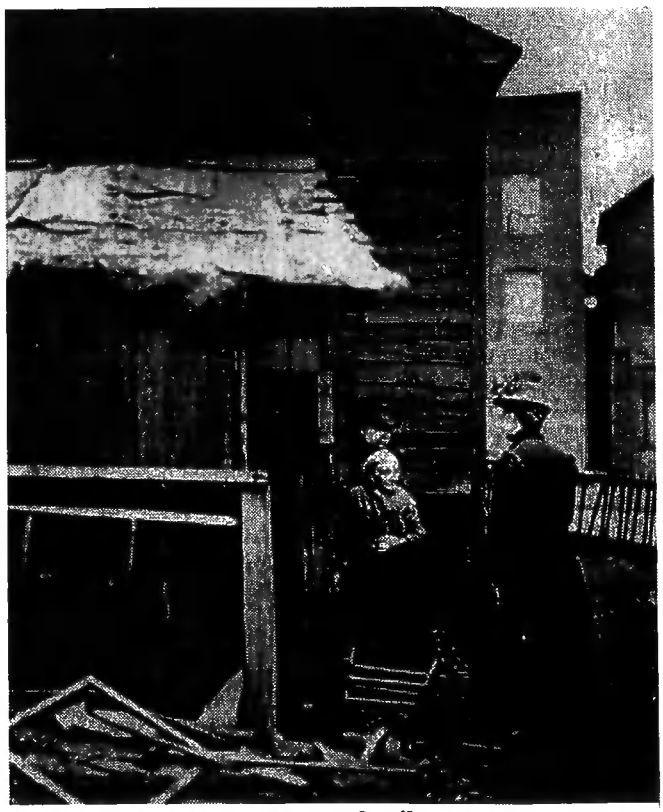


Fig. 3 Health visitor visiting a family in poor rural slum (Daniel 1997)

infected with tuberculosis came to see themselves as 'lepers', to be avoided by everyone, friends, family and even themselves (Bryder 1988, Roberts and Buikstra in press)! The stigma attached to tuberculosis was still very strong. Bryder (1996) states that, even in 1950, 55% of the population answered in a survey about public attitudes towards tuberculosis that they still believed tuberculosis to be hereditary even though it had been proved to be an infectious disease since 1882. This stigma also led several doctors to give causes of death other than tuberculosis to reduce the probability of the remaining family would have many of the resulting problems associated with a TB diagnosis such as loss of friends and employment, and the failure to get any insurance because the family would be seen as being infected with tuberculosis. Many people would also go and see doctors that they knew would not be as keen to notify their disease. Doctors were human and did not wish to bring more misery to some families already afflicted by a terrible disease (Bryder 1996).

3.3.2.4 Notification

Obligatory notification was introduced by the early 1900s in England. According to Logan and Benjamin (1957) about 10% of cases were not notified in the 1930-1940s, either because the people affected did not feel ill and did not go to the doctor's (undetected cases) or the doctors did not notify the cases. These figures were reduced in the 1950s with the spread of mass miniature radiography (a method of obtaining radiographs of the chests of large numbers of people at the rate of around two per minute) which permitted earlier cases to be notified, improved contact surveillance, in addition to giving doctors a wider appreciation of the symptoms (Logan and Benjamin 1957). It was estimated that in 1949-1950 around nine to 14 per cent of children aged five were tuberculin sensitive in the urban areas of England and Wales. This implied that there had been a history of infection as the tuberculin test turns from negative to positive after contact with tuberculosis. By the age of twenty, this proportion had risen to between 59 and 74 per cent (Medical Research Council 1952). Therefore, children were being infected all through their youth. The Ministry of Health issued a note of guidance in 1951 announcing that tuberculosis was required to be notified to stop the spread and infection and permit the government to prepare for the proper management of the infected cases and their immediate contacts. A person would be notified as 'suffering from tuberculosis', if he or she should, by suffering from tuberculosis possibly infect others, or a person who is suffering from active tuberculous lesions that necessitates medical treatment or for some modification of the patient's normal course of living (Ministry of Health 1951). Notification was seen as an essential measure of control also used in other infectious diseases. In England and Wales 1908 regulations compelled Poor Law hospital medical officers to notify any pulmonary tuberculosis cases found in their care. In 1911, notification of

respiratory tuberculosis was extended to public hospitals. Finally, on January 1st 1912 all cases of tuberculosis that came to the notice of a medical examiner were to be notified compulsorily (Logan and Benjamin 1957, Black pers. comm.). Despite compulsory notification, many cases still went unnotified even after death. Sir Robert Philip stated in an address at the University of Edinburgh that "many deaths are labelled as from pneumonia, bronchitis, measles, whooping cough, or influenza, which are really referable to tuberculosis' (Philip 1918: 294). Doctors remained very reticent about notifying some patients due to the stigma surrounding TB in the general public. Heaf stated (1939:350) that "it is not uncommon for a patient with definite early symptoms of tuberculosis to escape notification because the physician wishes to avoid the effect of such an action on the general life and future of the individual". Children presented another difficulty as doctors knew that children diagnosed with tuberculosis could often recover completely, but that, if notified, this diagnosis could follow them for life and lead to unnecessarily invalidism (British Paediatric Society 1943, in Bryder 1988). People would find it almost impossible to find a job when they had been declared a notified case. Notification was supposed to be confidential, but when a doctor notified of a patient's condition, the patient would be visited at work or at home by a public health official which greatly infringed on the patient's confidentiality (Bryder 1988).

3.3.2.5 Milk supplies

According to Atkins (unpublished manuscript) the intensification of milk production that appeared in counties like Cheshire and in urban dairies which survived in Liverpool until the 1950's, put the cattle at high risk of being infected. In the nineteenth century stocking rates increased per hectare and cows were kept in sheds and fed with controlled portions of yield-enhancing concentrates. Atkins (ibid) also adds that the farmer's practice of buying rather than breeding their replacement animals increased the spread of tuberculosis and also increased its range geographically with the movement of the animals. He continues by stating that up until the 1950's about five to ten per cent of raw milk, and a similar or slightly higher proportion of beef, would have carried live mycobacteria. This would have affected those most probably suffering from non-pulmonary tuberculosis. Atkins (ibid) additionally states that infants were more susceptible but that it caused morbidity and mortality in all ages. Atkins' (1997) own estimate is that approximately 800,000 deaths were caused by the bovine form of the disease between 1850 and 1950, making it the greatest food-borne trans-species infection in history.

There were two important points that came to the authorities attention after extensive regulations by veterinary and other inspectors employed by the Liverpool and Manchester city authorities; between the 1890's and the 1940's, the authorities discovered that the disease seems to have been less prevalent in the town cowsheds than in the country. There was also confirmation that counties such as Cheshire had a major concentration of disease (Atkins unpublished manuscript). Francis (1958) explains that there were 8,037,381 cattle in England and Wales in 1955 of which only 4,537,601 (56% or 111,666 cattle) kept in attested herds that were tuberculin tested and found to be free of tuberculosis. These numbers are repeated across the majority of counties in Francis' study. In Cumberland, there were 238,000 cattle and 4,850 attested herds of which all 238,000 cattle were in attested herds (100%). In Durham, there were 126,000 cattle in 1,753 attested herds. There were only 60,880 cattle in the attested herds, and therefore only 48% of the cattle were in attested herds in Durham. In Northumberland, the numbers are even lower. There were 214,000 cattle and 1,251 attested herds; and only 35% of these cattle in attested herds (75,540 cattle). In Westmorland, there are 104,000 cattle in 2,229 attested herds, and all of the cattle were found in attested herds (100%) (Francis 1958).

There were calls from 1880s onwards to add tuberculosis to the schedule of diseases in the Contagious Disease (Animals) Act (1878) that would result in a policy of publicly sanctioned and financed slaughter. Other diseases that affected cattle (such as rinder-pest or foot and mouth) had been dealt with in this way and proved to be successful. Tuberculosis was treated differently by the authorities for two main reasons. Firstly, diagnosis was difficult in the early stages and farmers found it hard to accept that a healthy looking animal would have to be put down. Secondly, the potential compensation bill was extremely high as it was estimated that 40% of milking cows were affected. Tuberculin testing had been available from the 1890's onwards but proved to be somewhat unreliable in the early years (Atkins unpublished manuscript). Glasgow was the first city in Britain in 1890 to actually give medical and sanitary officers power to inspect any cowshed supplying the city; these included those located outside the administrative boundaries. They were able to prohibit the sale of any milk which was found to be dangerous to health (Glasgow Police Amendment Act in Atkins unpublished manuscript) although in 1935 Liverpool was supplying about three-quarters of its school pupils with milk, that was untreated and contained mycobacteria. Therefore, according to Atkins (1993, Atkins unpublished manuscript) tuberculosis probably spread further than it would otherwise have done among poor families who consumed little milk as they could not afford it. There was a small amount of heat-treated milk sold in England from the 1880's onwards but the cost of the product was so expensive that it limited its appeal for some time. It was also believed that this type of milk had reduced nutritional value. In 1921,

it was estimated that about half of London's milk was heat treated, the procedure was bolstered by the findings of the Royal Commission on Tuberculosis in 1911 which blamed an infected milk supply for the spread of the disease (Atkins 1993).

The Public Health (London) Act (1891) gave the sanitary authorities relevant powers to restrict the sale of milk. The Medical Officer of Health from a local authority had to obtain a magistrate's order to inspect a dairy and/or cows. Another Order then could be made against the dairyman or woman forbidding the sale of milk. However this did not prevent the farmer selling to another district and therefore continuing the spread of the disease (Atkins unpublished manuscript).

Atkins (unpublished manuscript) also reports that reading the Ministry of Agriculture archives reveals a very deep resistance to the legislation. The farming and dairy trade lobbied against changes and disturbance to their business. Tuberculosis Orders were issued by the Local Government Boards in 1913 and 1914, but they were suspended due to the First World War and were only reinstated in 1925. The results of this implementation were very disappointing according to Atkins (unpublished manuscript) as the government's reluctance to pay out compensation led to the slaughter of only the most evident cases and were only the tip of the iceberg. Another method implemented in 1935 was the voluntary attestation of herds. However, the financial incentive for farmers was so low that a mere eight per cent of herds were attested by 1947. The Ministry of Agriculture (1965) implemented a compulsory programme of area eradication and the whole country was finally attested to be free of tuberculosis in 1960 (Atkins unpublished manuscript, Hardie and Watson 1992, Atkins 2000a).

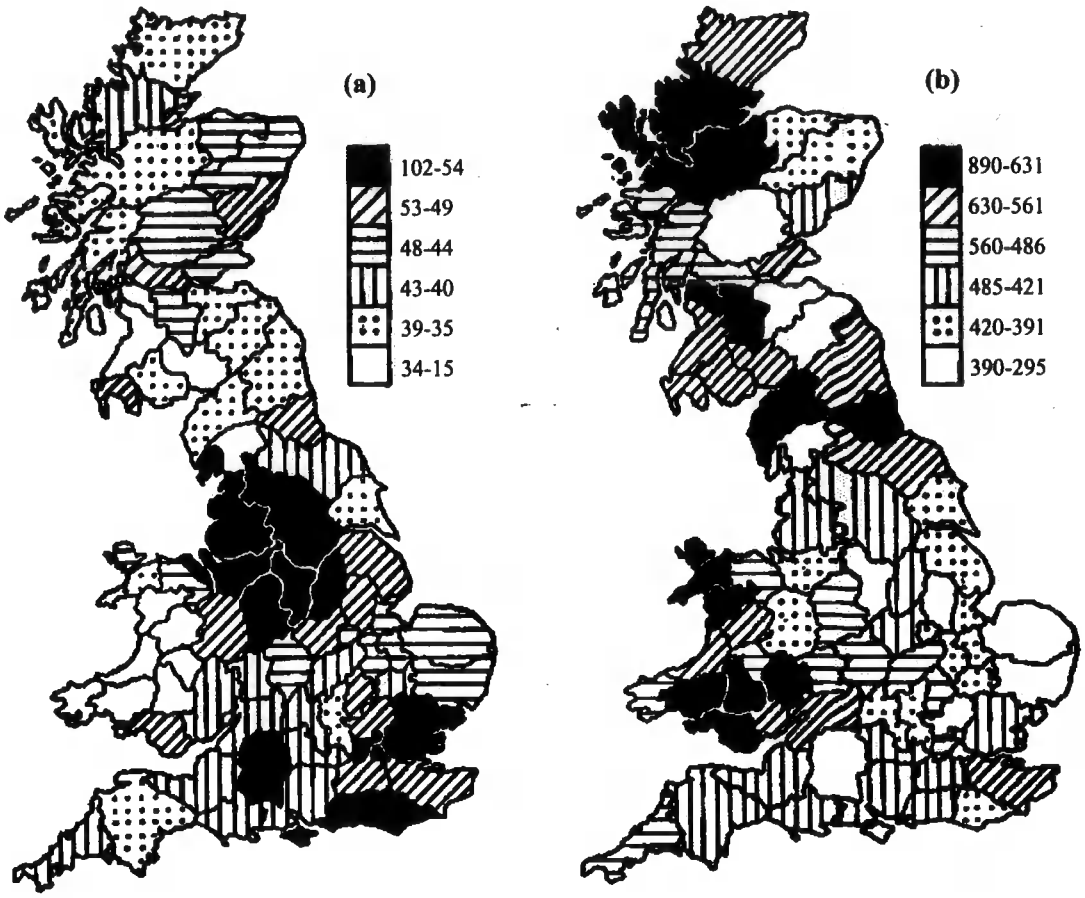


Fig. 4 - The incidence of tuberculosis in cattle (a) and the total mortality from tuberculosis in administrative counties per million population (b) 1945-1946
(Francis 1958)

M. bovis was seen to cause death in children under the age of five, suffering from tuberculosis, in 1955. It was thought that this type of infection was associated with the ingestion of contaminated milk. There was a fall from 1,107 deaths in 1921 to 12 deaths in 1953 and this was attributed to the development of safe milk in the intervening years. Hardie and Watson (1992) believe it to be a combination of pasteurisation and the control of *M. bovis* in cattle at the time. Francis (1958) indicates that in all ages bovine tuberculous infection is seen in about 23.4% of non-respiratory cases of tuberculosis in 1949. The mortality from bovine tuberculosis was about 5% of all deaths from all types of tuberculosis, but in children under five years of age the proportion was 30%. There seems to be an inverse relationship between the incidence of bovine tuberculosis and the death rate from human tuberculosis (**Fig. 4**) (Francis 1958). In 1992, there were between 20 and 40 confirmed isolates of *M. bovis* in humans marking a continuing decrease over the last 30 years. These cases are most likely to be reactivated cases who were infected before the pasteurisation of milk and the attestation of cows was introduced, or they may have contracted the disease from abroad

either from other humans or cattle (Hardie and Watson 1992). *M. bovis* does have a more predominant role in developing countries as the control measures or the laboratory equipment to differentiate between *M. bovis* and *M. tuberculosis,* are not available. This is further accentuated by the fact that most people are employed in agriculture (65% in Africa and 70% in Asia) (Cosivi *et al* 1998) and are therefore at greater risk of transmitting tuberculosis to their animals or for their animals to transfer tuberculosis to them.

The last few sections looked at how tuberculosis was diagnosed in the past, and at how it was prevented. Let us now turn our attention to how tuberculosis was treated in the past.

3.3.3 How was tuberculosis treated in the twentieth century?

There are three types of treatment for tuberculous disease documented. The 'Classical' approach which deals with such treatments as bloodletting (Type 1). Lowe wrote in 1597 "the cure consisteth in remedies universals and perticuler as in good regiment, eate litle of light digestion, abstaine from such things as ingender grosse humors, purge oft, blede in both thy armes, haunt no humid places....and drink a herbal tea" (in Pesanti 1995:9). These treatments were based on the physician's limited understanding of the cause of the disease. The second type of treatment consists of the sanatoria, where people were confined and underwent procedures such as lung collapse therapies. The third approach deals with chemotherapy starting late in the 1930s (Pesanti 1995). The treatment of tuberculosis in the twentieth century focused mainly on the second and third types.

3.3.3.1 The twentieth century overview

There were advances in the treatment of TB before the twentieth century, as aforementioned with the discovery of tuberculin by Koch (section 3.2.4). Tuberculin did not, in fact, cure tuberculosis, but skin tests (such as the Mantoux) did show whether a person had been exposed to the tubercle bacilli) although these tests show infection rather than active disease (Bradshaw 1939, Dormandy 1999)). Infected children could be removed from the house if the parents were tuberculous and could not adequately protect the child. If people who were infected with TB were unable to go to a sanatorium for treatment, they were expected to follow certain rules in order to stop the spread of disease to other members of the family. These orders changed little from 1906 to 1952.

> "The case had to have separate, marked utensils. Cracked crockery had to be thrown out. All spitting onto the floor had to cease: it had to be done into a spittoon or into the fire. The case was not to fondle or kiss any members of the family, children particularly.

> The case was to sleep separately, preferably behind a partition if the whole room could not be spared. Windows were to be opened. Food masticated properly. Onion not added to every dish. The dwelling was to be fumigated and dust in corners and behind beds swept up...the sputum flask was supposed to be boiled for ten minutes daily and its contents burned. Food scraps were to be burned and all utensils were to be boiled after use. Bedclothes had to be kept separate and boiled at home. The person attending the patient had to don a special overall on entering the room, to be kept in the case's room..." (Smith 1988: 72-73)

Some people were unable or unwilling to go to a sanatorium, but it was possible for some patients to get some treatment at dispensaries. The first dispensary was opened in the nineteenth century (1887) by Sir Philip in Edinburgh (Victoria Dispensary for Consumption and Diseases of the Chest) (Bryder 1988). Patients were able to get information, treatment and radiographs done at these dispensaries. It was also possible for nurses to make some home visits, to instruct patients on proper hygiene, and to inspect home conditions. There were no tuberculosis dispensaries in England until a clinic opened in Paddington in 1909. The Royal Seabathing Hospital, Margate (1791), catered mostly for those suffering from tuberculosis of the glands, and bones and joints. There were various kinds of specialized hospitals appearing in the 19th century of which four were voluntary and set up in London before 1960: the Royal Hospital of Diseases of the Chest (1814), the City of London Hospital for Diseases of the Chest (1848), North London Hospital for Consumption and Diseases of the Chest (1860) and finally Brompton Hospital for Consumption and Diseases of the Chest (1841). These were all in place before the first sanatorium opened in Silesia, Germany in the mid 19th century by Hermann Brehmer but none involved long-term treatment of the patients (Daniel 1997). Tuberculosis hospitals were also set up outside London in the second half of the nineteenth century and by 1893 there were approximately 1,100 beds in Britain in 17 special hospitals to treat consumption (Bryder 1988). By 1911, there were 50 voluntary dispensaries and another 14 provided by sanitary authorities (Logan and Benjamin 1957). In 1911, financial aid provided by the Exchequer permitted the National Insurance Act to set the pattern for the future health service. Widespread establishment of local clinics followed later after the Departmental Committee on Tuberculosis reported in 1912 that local authorities should be made responsible for providing diagnostic, treatment, and control facilities for the whole population, not only the insured (Logan and Benjamin 1957). The tuberculosis dispensaries now become known as 'Chest Clinics'. The NAPT (National Association for the Prevention of Tuberculosis) aimed to attack the problem of TB in three ways: educate the public in preventive measures, eliminate tuberculosis from cattle and promote the establishment of institutions for treatment (Bryder 1988).

3.3.3.2 Tuberculosis Services

Anti-tuberculosis services included dispensaries, residential institutions and after-care committees. The National Tuberculosis Service was established in 1912 (MacNalty 1942, Bryder 1988). The post-war climate of the First World War was favourable to the development of this service as an estimated 58,000 pensions were sent out to ex-servicemen who had contracted tuberculosis while serving their country (MacPherson *et al* 1923 in Bryder 1988). Bryder (1988) explains that the cost of the tuberculosis service was borne by local rates supplemented by an Exchequer grant. The amount allocated by the Exchequer grant was specific until the 1929 Local Government Act that replaced the percentage grant for health services by a bloc grant. In 1921-1922 tuberculosis cost English local authorities £800,000 in rates, but an Exchequer grant of £1,100,000 helped the problem. The procedures to be followed in the tuberculosis services remained the same between 1930 and 1952. They were, according to Logan and Benjamin (1957: 26-27), as follows:

1- Diagnosis: sometimes made by the general practitioner, but more commonly by the Tuberculosis Officer.
2- Notification: upon diagnosis the Tuberculosis Officer reported the case to the County or County Borough Medical Officer of Health. A notification fee was paid (2s. 6d. to every general practitioner, and 1s. 0d. to medical officers of institutions)
3- Treatment: County and County Borough Health Departments were empowered (and financially aided by the Government) to provide free institutional treatment for those for whom it was recommended, and domiciliary treatment for other cases was largely left to the general practitioner subject to liaison with the Tuberculosis Officer, either by the attendance of the patient at the clinic or by written report from the general practitioner. In 1948 this service changed with the implementation of the NHS. The hospitals then came under the direction of Regional Boards.
4- Follow-up: after hospital or sanatorium treatment, or in the absence of such treatment, the tuberculous patient was encouraged to attend the local clinic. An endeavour was also made to get all contacts of the patient examined and kept under necessary supervision.

New regulations that were established in 1952 simplified the arrangements. There was no longer the need to report hospital movements and all of the facilities were brought under the heading of the NHS. Notification registers, long known to be inaccurate, were no longer compulsory. More reliance was placed on the records available at the chest clinics (Logan and Benjamin 1957).

The trends in County Borough notification rates varied from region to region. Logan and Benjamin (1957) note that in Gateshead, Tyne and Wear the rate had been more than twice the national figure in most years even though figures show a sharp decline in 1954 and a further fall in 1955. They also note that Newcastle-upon-Tyne had rates nearly twice as high as those for England and Wales as a whole. Its highest level was in 1945-46, after which the

rates declined and remained nearly stationary between 1949-1953 and, although rates were still declining in the later 1950s it was still around 70 per cent higher than the rate for England and Wales (Logan and Benjamin 1957).

3.3.3.3 Sanatoria

The first sanatorium in Europe appeared in 1643 in the French city of Rheims (Roberts 1987, Warring 1981:180, Webb 1936:174), but there are no further details on this. The concept of the sanatorium originated in Britain with George Bodington of Sutton Coldfield who urged people with TB in 1840 to live in an airy house in the country (Bodington 1840). He believed that the house should be on an eminence, preferably high and dry, the soil porous, the atmosphere free of damp and fog, the cold air never too severe, and exercise should be encouraged. His principles were not readily accepted in England, but they were taken up in Germany, as has been said before, where the (most commonly believed to be) first sanatorium was opened by Brehmer in Silesia in 1859 (Brehmer 1856 cited in Evans 1998). Here the prescription was rest, fresh air and graduated exercise such as walking. This principle was also followed by Dettweiler in Faulkstein, who had been a former patient. The open air and rest policy gained a lot of popularity and the Black Forest Institution of Dr. Otto Walther at Nordrach, Germany became famous (Keers 1978). The sanatorium at Davos (**Fig. 5**) that was to become the setting for Thomas Mann's novel "The Magic Mountain" was established in 1866. The novel provided insights into the treatment of tuberculous disease at the time, and on how patients were dependent on their surroundings to get better. At this time, sanatoria were also being developed in the United States by Trudeau at Saranac Lake and in Denmark at Vejlefjord. Many British physicians visited Nordrach and then set up sanatoria in England,Wales and Scotland.

According to Dormandy (1999:148), sanatoria in the modern sense did not become popular until the second half of the nineteenth century but, once they were launched, quickly became the bedrock for treatment of tuberculosis, remaining virtually unchanged for nearly a hundred years. The effect of the sanatorium on the control of TB has not been totally understood as it did not have a direct effect on the number of people who acquired TB, meaning that, even when the sanatorium movement was at its height, people continued to be infected by TB. Sanatoria did have a positive effect by removing the infected person from their entourage, thereby reducing the risk of infection to others (www5). It also gave hope to those infected. Treatment in a sanatorium consisted of rest, lots of food, fresh air and graduated exercise. "It could be argued that the first principle of the sanatorium treatment was no more- and no less- than common sense" (Dormandy 1999:149). In England, the sanatoria later developed into

working camps which became known as the 'pickaxe cure for consumptives', where people were trained to do a particular job so that they had a chance of finding work after leaving the sanatoria (Cule 1999:33).

Notwithstanding the predominance of sanatoria by the 1930's, they were still not universally accepted in the battle against tuberculosis. Some believed that they were havens for people who were trying to get away from their jobs. Mitchell (1930:879) wrote : "It should be remembered that an idle life is not a healthy one, and many patients will live longer if he thinks less of his own health and settles down to some suitable occupation". In the 1930's the number of beds for tuberculous patients increased while the number allocated for children declined. The charge for sanatoria was a point of hot debate. Many county councils thought it impractical to charge their patients money since it would be a deterrent for the working class to enter a sanatorium, and especially remain there for long periods. The children were a different case as to pay for their treatment would bring a sense of parental responsibility and benefit the child as well. Some authors disagreed and believed that the parents would leave the children in the sanatoria as long as possible because they would be saving money by not having the child at home (Bryder 1988), but this does not always seem the case as most parents were very anxious to get their children back (as the Stannington records demonstrated).

Sanatoria buildings and therapies ranged from the rudimentary to the very elaborate, reflecting the division between the social classes. Dr. Marcus Paterson from Frimley sanatorium stated that patients undergoing treatment at a sanatoria should be given manual work as it would, at first, do much to meet the objections that members of the working class are liable to have their energy sapped and to acquire lazy habits; second, it would make them more resistant to the disease by improving their physical condition, and third, it would enable them, by its effect on their muscles, to return to work immediately after discharge (Paterson 1908). Ransome (1903) agrees that a combination of wards and rooms should be intended in the construction of a sanatorium for the poorer classes of patient. There must be greater discrimination between the different classes of patients as the well-to-do patients were accustomed to separate rooms, and they should still have these when receiving their treatment in a sanatorium. About two-thirds of all beds were for males and there were proportionately many more beds for adults than for children (Smith 1988:104). As sanatoria popularity declined, doctors were forced to adapt more modern methods of treatment to assure their survival, and therefore surgery began to be performed in sanatoria. These treatments were used at the sanatorium in Stannington, discussed in a later section. The results of the advances in the treatment of tuberculosis can be seen in the length of time that patients stayed at

sanatoria. Mercer (1964) notes the numbers for East Fortune Sanatorium (New York) 221 cases of tuberculosis were admitted in 1933 while only 39 were admitted in 1963. In 1933, there were 209 patients in residence while in 1963, there were only eight. The age of incidence also changed to older age groups and to men almost entirely.

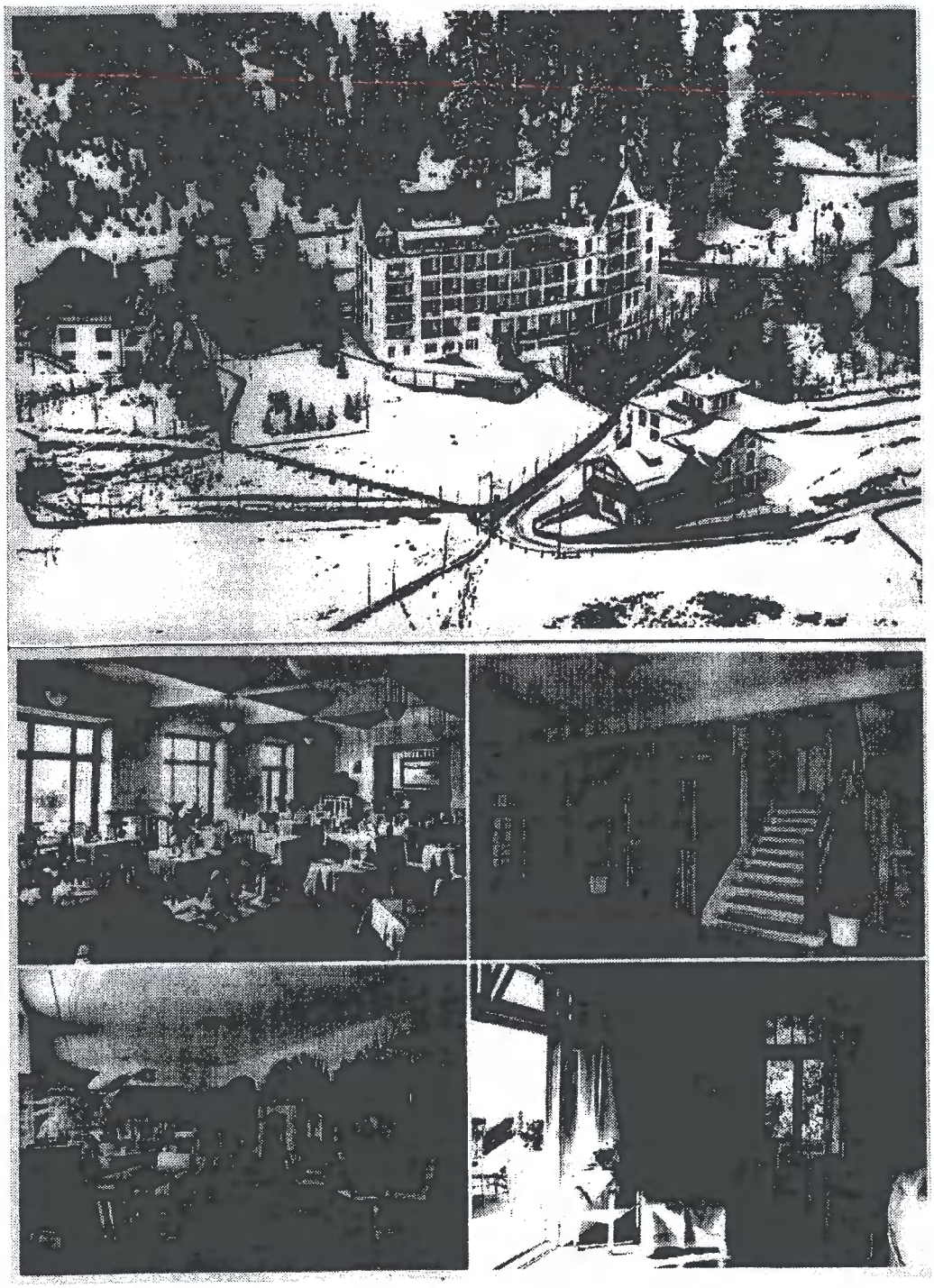


Fig. 5 – Sanatorium at Davos (setting for Mann's *The Magic Mountain*) (Postcard from hotel previously a sanatorium)

Fig. 6 Dropsy courting consumption (Wellcome Library)

The doctor's position in the sanatorium was that of a stern disciplinarian. The probability of the patient's cure was linked to his or her willingness to adhere to strict rules. Some of these rules were associated with the amount of food that the patients had to eat. "On some inverted logic from the evidently wasting nature of the disease, Sir James Kingston Fowler and R.J Godlee pronounced in 1898, 'If he can grow fat he need have little fear that the disease is making progress'" **(Fig. 6)** (Fowler and Godlee 1898, cited in Cule 1999:34). The caricature represented in Figure 6 can be interpreted in two ways: the first shows a woman suffering from tuberculosis who is very thin and she is being courted by a man. He is fat and suffering from dropsy which is a result of excesses of fluids in the tissues. The moral of this caricature is that if you flirt with unhealthy living such as the man in this picture, you risk suffering from tuberculosis. The second interpretation for this caricature is that different diseases are associated with different body types. In this case a long thing woman is associated with tuberculosis while the fat man is associated with dropsy.

(i) British Sanatoria

In Britain, many of the tuberculous were treated in Poor Law Institutions in the second half of the nineteenth century. These were set up to keep hospital beds free for people suffering from curable diseases. Some hospitals, such as the Brompton Hospital, were set up as 'specialised' chest hospitals for tuberculosis.

In 1898, the NAPT was set up to fight tuberculosis, as it was now recognized as a preventable disease. They advertised, provided pamphlets and books, and educated people about bad food and drink, air, as well as overcrowding, overwork and overstrain (Evans 1998) all being predisposing factors to tuberculosis **(Fig. 7).** In 1929 there were 1,438 beds for people with TB in England (631 local authority and 807 voluntary) but this number had dropped to 1,274 by 1935 (Bryder 1988). The number of children suffering from pulmonary tuberculosis needing beds increased as the methods of detecting tuberculosis were improved and became more systematic. The number of children suffering from pulmonary tuberculosis treated in English tuberculosis institutions dropped from around 4,000 in 1932 to under 3,000 in 1938 and the beds that had been reserved for children were now being used for other purposes (17th Chief Medical Officer of Health 1936, in Bryder 1988).

Fig. 7 – Poster for preservation of health (Dr. Black)

Public subscription in the UK paid for the construction of the sanatoria. It was a considerable investment at a time when institutions were an international remedy against tuberculosis. They were certainly attractive objects of philanthropy, as the donors could see the results of their charity in a most substantial way (Evans 1998). Discipline in the sanatorium was very

strict and "the cure" was sought by losing bad habits and gaining good ones. Men and women would be separated and would only reunite for meal times.

There were 29 private and 61 public sanatoria in England and Wales with 4000 beds by 1910 (Smith 1988:103, Roberts and Buikstra in press). Ransome (1903) added that, in order for every pulmonary TB patient in the United Kingdom to receive three months of treatment in a sanatorium, 38,000 beds would be required in the early 1900's. The total accommodation at that time was around one-twelfth of this. Before this time, in the early nineteenth century tuberculosis patients with money were sent to the south of Europe to take advantage of the warm climate (Bryder 1988). British tuberculosis specialists in the early twentieth century believed that travel to the Swiss Alps was not necessary as there were temperate climates in England, which were well suited for the treatment of TB. According to the *Tuberculosis Yearbook and Sanatoria Annual 1913-1914* (Kelynack 1914), the sanatoria in Essex (e.g. Merrivale sanatorium) were well suited for the treatment of tuberculosis as the atmosphere was dry and bracing with plentiful sunshine and little rain. They give several other examples where the conditions were sunny, bright and dry. The presence of pinewoods was also advertised as being beneficial, perhaps as an attempt to emulate the Black Forest (Bryder 1988). Ransome (1903) states that a sanatorium in England should be constructed on a southern slope of rising ground, sheltered by the hill behind, and fir trees or other means from the strong winds. It should sit on a sandy or porous subsoil that must be well drained and the sanatorium must be seen to have a cheerful outlook.

Although many of the sanatoria seemed to have been built in beautiful English countryside, there were many which were not built because of opposition from people in communities afraid of having tuberculosis-infected people nearby (Bryder 1988). Many fought against the building of sanatoria near their homes and signed petitions; some of which were successful. This was a result of the discovery that tuberculosis was not inherited but rather an infectious disease. A parallel can be seen today in the effect of 'not in my backyard' when the government discussed the area where new building such as prisons, airports and refugee camps. The Royal College of Physicians were forced to issue a statement in 1914 that, in view of the exaggerated fear of the infectivity of pulmonary tuberculosis entertained by the public, no risk would be incurred by living in the immediate neighbourhood of properly conducted institutions for the treatment of tuberculosis (Local Government Board 1914). Tuberculosis patients were not only faced with the stigma of being outcasts there was also opposition to treatment centres being introduced near communities. **Table 3** lists the sanatoria and other residential institutions approved by the Minister of Health for the

treatment of children suffering from tuberculosis (Ministry of Health 1935). Those listed refer to residential institutions and sanatoria that treated tuberculosis around the area

Table 3 List of sanatoria and other residential institutions for treating childhood tuberculosis in Cumberland, Durham, Northumberland and Westmorland and certain County Boroughs

County or County Borough	Name of Sanatoria	Who is being treated?
County		
Cumberland	Blencathra Sanatorium	Adults and children
Durham	County Sanatorium, Earl's House, Witton Gilbert	Pulmonary and non-pulmonary cases, boys
	County Sanatorium, Seaham Hall	Pulmonary cases in adults females and surgical cases in adult females and girls
	Grindon Hall Sanatorium, Silksworth	Pulmonary cases in adult females and non-pulmonary cases in adult females and children
	Stanhope sanatorium	Adult males and boys
	Wolsingham (Leaze's House) Sanatorium	Adult females and children
Northumberland	The Philipson Children's Sanatorium, Stannington	Pulmonary and non-pulmonary cases
	The Sanderson Home for Crippled Children, Gosforth	Surgical cases only
Westmorland	Westmorland Sanatorium and Home, Meathop	Adults and some children
County Borough		
Gateshead	Children's Hospital	Non-pulmonary cases only
Newcastle-upon-Tyne	City Tuberculosis Hospital, Walker Gate	Adults and children
South Shields	Cleadon Park Sanatorium	Adults and children
Sunderland	Municipal Hospital	Pulmonary cases in adults and children, non pulmonary cases in adult females

(Ministry of Health 1935)

delimited by this study (Cumberland, Durham, Northumberland and Westmorland counties). Depending on the counties listed, there were between one and five sanatoria and residential institutions in any one county that would provide treatment for tuberculosis in children. In Cumberland, only one sanatorium or residential institution was noted for treating tuberculosis (one sanatoria treating children/one sanatoria listed in county (100%) by Ministry of Health 1935). In Durham, there were 16 sanatoria mentioned of which five provided treatment for children (31%); Northumberland listed four sanatoria of which two offered treatment to

children (50%) and, finally, Westmorland listed two sanatoria of which one offered treatment to children with tuberculosis (50%). In England, in 1935, there were 174 sanatoria and residential institutions listed by the Ministry of Health for treatment of tuberculosis in children out of the 550 sanatoria and residential institutions registered (32%).

While sanatoria were built in the countryside, making it very difficult for the family to visit the patients, they were very effective at isolating the infected individual. Most sanatoria according to Evans (1998) faced south, south-east and south-west with radial pavilions, leaving no part in the shade. Activities were practised such as walking but if there was a return of fever or haemoptysis, the activities were stopped. When their health improved, patients were encouraged to take up some work, such as gardening or carpentry. If they were unable to leave their dwellings, they were asked to make mats and wooden carvings for sale (Bryder 1988). This was called the 'pick-axe cure for consumptives', where they would learn a special skill that they could practise in preparation for leaving the sanatorium (Daniel 1997, Evans 1998). For example, they were required to take walks (gradually longer until they could walk 10 miles without difficulty), and to carry mould to spread on the lawn. After three or four weeks, they were given a spade and asked to dig for five minutes and rest for five minutes. This was followed by bigger shovels and longer times. Marcus Paterson, medical superintendent at Frimley sanatorium, wrote that the regime that the patients who he looked after felt much better after doing some work, and the more they worked the better they felt (Bryder 1988). This demonstrates the difference between so-called rich and working class sanatoria: the rich were not asked to work, but the working class patients were thought to be lazy if they did not. Some of the sanatoria for working class people, such as clerks and other patients of independent means were charged two to three guineas a week to stay at these graduated labour sanatoria (for example Pinewood sanatorium in Bedfordshire and Crooksbury Sanatorium in Surrey, (Bryder 1988)). The patients at sanatoria that charged over a pound a week to stay would be people who were unused to labour and would soon tire of it. The doctors at the time thought that this type of activity was more adapted to people of the working classes, so activities such as golf were introduced to occupy higher social class patients. It has not been possible to identify which proportion of sanatoria in England was working class and how many of the sanatoria were for rich patients (many indeed might have had a mixture of both).

When a patient left a sanatorium after a cure, they would be followed-up in a dispensary where he or she would continue to receive chemotherapy and would be radiographed at regular intervals to detect any new development of the disease. However, numbers such as those published by the former medical superintendent of Westmorland sanatorium, Halliday

Sutherland, show that, of the people receiving tuberculosis treatment in the sanatorium in 1914, approximately 80% were dead by 1920 (Sutherland 1920, in Bryder 1988). This demonstrates that sanatoria were not very effective in the cure of tuberculosis but as has been discussed earlier they served to segregate the infected population to safeguard others. For example, if a father was diagnosed with tuberculosis at a sufficiently early stage and then sent to a sanatorium, he would be less likely to transmit his disease to his family, and especially his children. Tuberculosis sanatoria were popular until the introduction of chemotherapy in the 1940's, after which their popularity declined. Authors such as Bryder (1988) and Dormandy (1999) believe that the decline of sanatoria is directly related with the introduction of chemotherapy in the fight against tuberculosis as people would be able to receive their treatment at home as these drugs would render these cases non-infective in a very short period.

(ii) Stannington Sanatorium

Stannington sanatorium was founded by the Newcastle Poor Children's Holiday Association and Rescue Agency (an association of Methodist origin founded in 1891), and was situated twelve miles north of Newcastle and three miles south of Morpeth, in Northumbria **(Fig. 8)** (Bryder 1988). In 1904 the P.C.H.A report urged that a farm should be acquired for the following purposes: a farm colony for destitute boys, a boys convalescent home and a children's consumptive sanatorium (Stannington Archives 79). The estate consisted of 137 acres on rising ground a few miles from the Northumberland coast **(Fig. 9)**. The sanatorium, which opened its doors in 1907, provided treatment for all types of pulmonary and non-pulmonary tuberculosis in children. It provided 40 beds and staff accommodation. The Lady Stephenson Wing was opened in 1911 and provided a further 50 beds. In 1920, 3 other large wards and school premises were opened to meet with the increasing need for beds. In May 1926, further extensions were opened by his Royal Highness the Duke of York (later to become George VI); these consisted of the Joseph W. Brough Wing, a new Nurses Home, and a new building for Artificial Sunlight treatment. The sanatorium now had 312 beds (Stannington Archives 79). It closed its doors as a tuberculosis sanatorium in 1953 but remained open as a

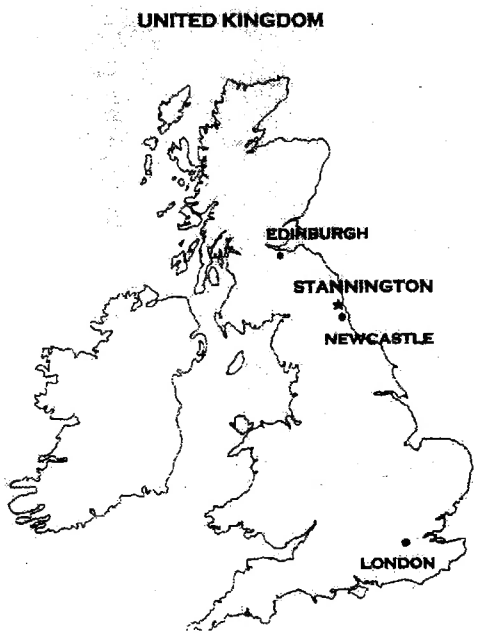


Fig. 8 Map indicating location of Stannington (N.R.O. 3000)

convalescent home for those children recuperating from long illnesses. Treatments such as artificial pneumothorax and other collapse therapies, and chemotherapy including sanocrysin and tuberculin, were available to the children as well as the more traditional treatments as immobilization, rest, fresh air and exercise. According to its publicity pamphlet (1936) the sanatorium boasted that any necessary operative and orthopaedic treatment was undertaken at

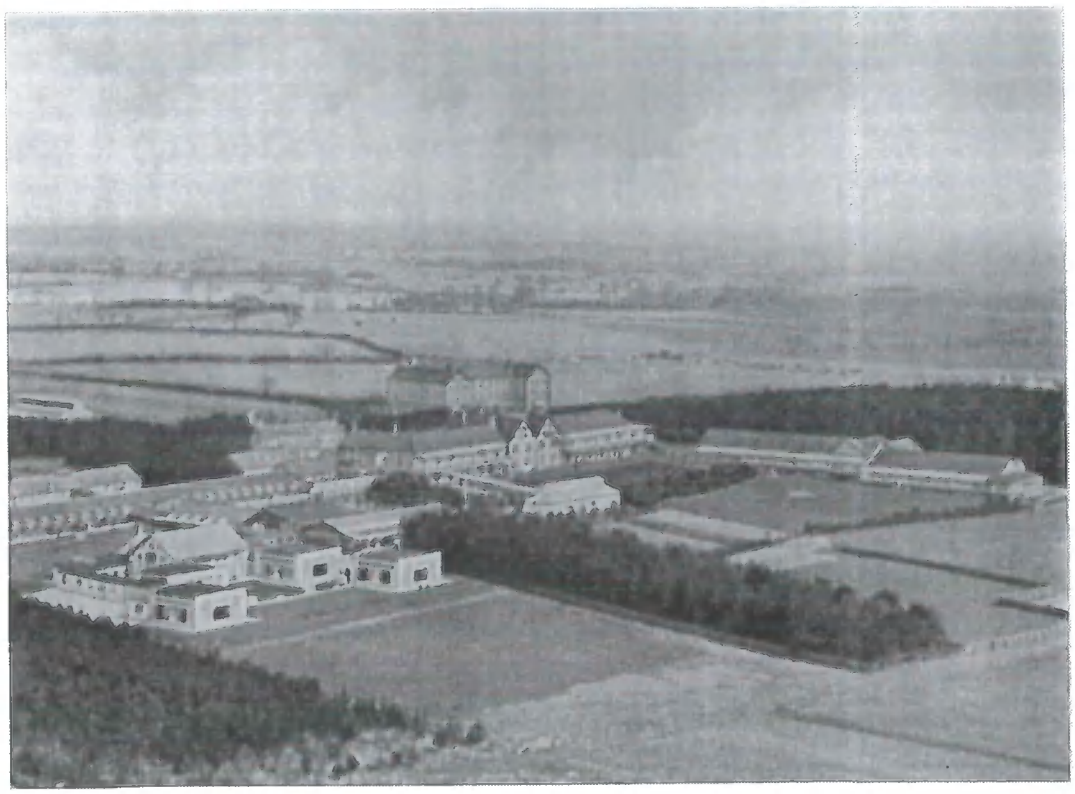


Fig. 9 – Aerial view of Stannington sanatorium (N.R.O. 3000)

the sanatorium (**Fig. 10**). They claimed to have all the most modern and spacious designs in the radiography department (**Fig. 11**) and their artificial light rooms (**Fig. 12**). A dentist visited every week to take care of the children's teeth. There was also a headmistress and a staff of eleven specially trained teachers to assist in the children's education (**Fig. 13**), and the children would attend an open-air school it would seem, whatever the weather. For example, an open-air school for tuberculosis children in Northumberland recorded temperatures inside the schoolroom of 30°F (minus 1.1°C) in November 1915 (Northumberland County Council, 1915)

The age limit of children admitted to the sanatorium was between three and sixteen years of age, suffering from all forms of TB. The records from this sanatorium (numbering around 7800) are held at the Northumberland Records Office in North Gosforth, Morpeth. They hold the complete records for the children staying at the sanatorium between the years 1937-1953.

Between 1941-1945 the sanatorium was evacuated to Hexham Hydro as the buildings of the sanatorium were being used as an emergency medical hospital during the war. Stannington sanatorium experienced difficult years. For example, during the year 1946 there were 123 children admitted to Stannington but, owing to nursing staffing difficulties, there was also a waiting list.

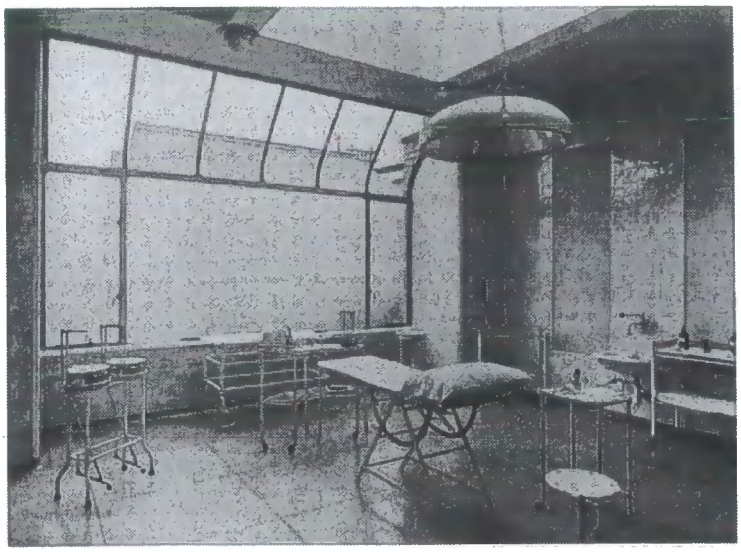


Fig. 10 – Operating room at Stannington (N.R.O. 3000)

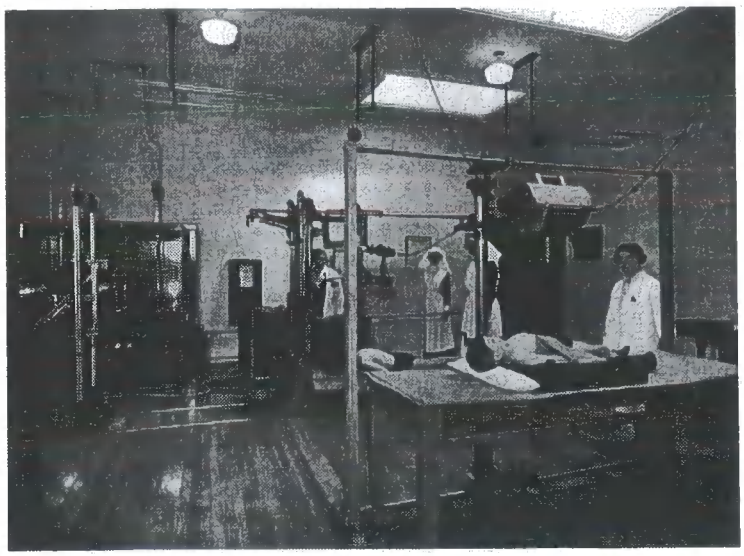


Fig. 11 – Radiography room at Stannington (N.R.O. 3000)

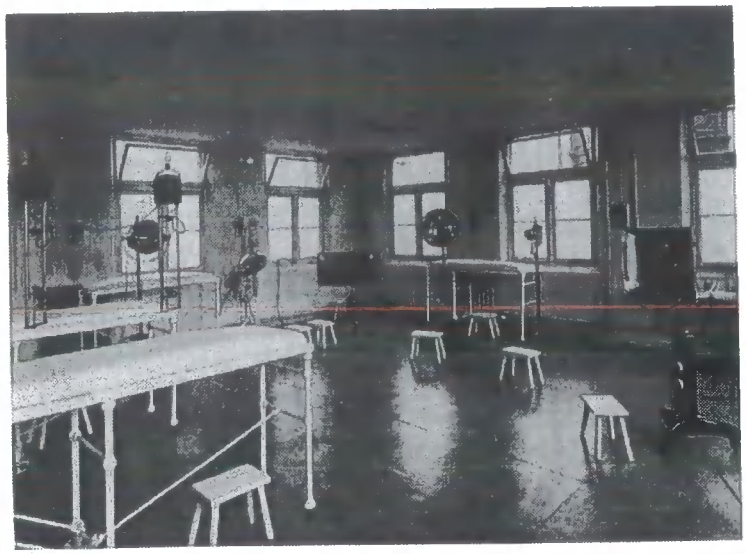


Fig. 12 – Artificial light room at Stannington (N.R.O. 3000)

Fig. 13 – Open-air school at Stannington (N.R.O. 3000)

The administration decided that there must be a selection process developed for their admissions procedure to make sure that the most urgent types be admitted to avoid any unnecessary occupation of beds (Tilley 1947).

3.3.3.4 Surgery

The development of surgery in the 1930s provided some means of treatment for tuberculosis patients. The two operations most performed at Stannington were artificial pneumothorax (introducing air into the pleural cavity) and thoracoplasty (removal of some of the upper ribs). These operations collapse the lung, permit it to rest, and therefore potentially cure itself.

Fig. 14 Artificial pneumothorax at Stannington (N.R.O. 3000)

Artificial pneumothorax was invented by James Carson in 1821, but it was not until 1882 when an Italian doctor, Carlo Forlanini carried it out successfully and presented it to an international tuberculosis congress that it became recognised as a tool in the fight against tuberculosis (Evans 1998). It would still take some time before being introduced in Britain, which resulted in many expatriates in tuberculosis sanatoria abroad remaining where they were as they would be unable to receive their refills in England. This became for some the magical cure for tuberculosis as Clive Rivière wrote in 1917 "no more hopeful ray of sunshine has ever come to illuminate the dark kingdom of disease than that introduced into the path of the consumptive through the discovery of artificial pneumothorax" (Rivière 1917:145). Many successful cases of artificial pneumothorax **(Fig. 14)** were reported (Burrell and MacNalty 1922) but they neglected to mention their failures. Bryder (1988) states that there are no figures on the fatalities that resulted from collapse therapies such as artificial pneumothorax. Other operations mentioned in the contemporary literature were phrenic evulsion (where the nerves attached to the diaphragm would be cut to depress the diaphragm) (Bryder 1988), multiple intercostal neurectomy (nerves are resected under anaesthesia), lung resection (Bickford *et al* 1952), apicolysis (performed during the thoracoplasty operation, involving the dissection of the lung apex causing the site affected by disease to collapse downwards and inwards (Bryder 1988)), and extrapleural pneumolysis which involved local collapse of the lung which was then secured by separating the parietal pleural membrane from the chest wall and by filling the space thus formed with a foreign body to prevent its return (Davies 1930: 689, Dickson 1930, Punch 1934, Heaf 1935, Young 1936, Roberts 1938, Edwards *et al* 1941, Cule 1999). The war years between 1939 and 1945 have been named the 'hospital treatment era' (Bryder 1988:178) as the treatment of pulmonary tuberculosis moved from the sanatorium to the hospital, which was simply a very modern sanatorium, and Bryder (1988) states that the only differences were the addition of surgical facilities. Surgery never really proved to be of value but it did increase the prestige of the doctor and the sanatorium where it was performed (Kearns 1995)

The prognosis and the need for surgery in children and adult cases differed. It was only to be used as a last resort for children suffering from skeletal tuberculosis as the children were still growing. In pulmonary tuberculosis, if a lobar resection was done on a child the remaining lung will continue to grow and normal pulmonary function may be restored, while in the adult a space filling procedure will usually also be performed (Ross 1951). Before the advent of anti-tuberculous drugs surgery was rarely considered in children and was confined to cases of chronic pulmonary tuberculosis (Nohl and Steel 1960). Even when surgery was performed, extra-pleural pneumothorax and thoracoplasty were contraindicated in children in favour of resection and adenectomy (Nohl and Steel ibid).

3.3.3.5 Sunlight therapy and fresh air

Fig. 15 Exposure to ultraviolet rays at Stannington (N.R.O. 3000)

The conservative types of treatment such as sunlight therapy dominated the treatment of surgical types (bone and joint, abdomen, lymphatic glands and skin) of tuberculosis in the inter-war period. This therapy was based on the treatment that Auguste Rollier had instigated at Leysin (Switzerland) in the Alps. It was widely adopted for non-pulmonary tuberculosis in Britain even though the climate did not always help (Bryder 1988) and treatment entailed exposure of the skin to sunlight for as long as possible **(Fig. 15).** There are images of the patients in Leysin, for example, skiing dressed only in shorts, exposing as much skin as possible. The tanning of the skin was thought to bring protection to the patient (Bryder 1988). Outdoor schools were also implemented in Britain as it was thought that the open air would do the children good and they would also benefit from the sun **(Fig. 13).** The fresh air outside was thought to clear their minds and be much better than the stuffy air in the classrooms. Many doctors also believed that being outside would harden the children's immune systems, but many relapsed back to disease when they returned to their homes (Bryder 1988). People who did not go to the sanatoria to get treatment were also advised to get as much fresh air as possible and even to sleep with the windows open at all time (Dormandy 1999). Stannington is also near the coast which was thought to be of great benefit for those suffering from TB as the air is bracing and fresh (Bryder 1988).

3.3.3.6 Diet and exercise

While diet and exercise were widely used in the past in the treatment of tuberculosis, there are no details as to these aspects of treatment at Stannington. There is an assumption that they were in use at Stannington, but there are no specific details of these treatments in the medical records. In terms of diet, people in sanatoria would be encouraged to eat as much as possible for, as tuberculosis was a wasting disease, it was believed that eating would stop its progression. Other sanatoria, on the other hand, as a result of nausea and overeating stated that patients would not have to eat any more food than they could digest and measured each person's food intake (Bryder 1988). Even though overfeeding went out of fashion quite rapidly, fats and milk were considered essential features of the tuberculous diet in the early twentieth century. As discussed above, exercise interspersed with rest was also considered a very important feature of sanatoria treatment in the twentieth century. Activities, such as walking, digging and gardening were suggested as activities which would help a consumptive cure him or herself (Dormandy 1999). This has been covered on the previous section on British sanatoria and will not be delved into again.

3.3.3.7 Chemotherapy

The first drug that was developed to fight tuberculosis was sulphonamide in 1938 (Pesanti 1995). However, it did not cure tuberculosis; Rich and Follis (1938) showed that sulphonamides inhibited the growth of *Mycobacterium tuberculosis* in guinea pigs, but that it did not cure any of the animals. This began the era where tuberculosis could be seen to be cured by chemotherapy. In the 1940s anti-tuberculosis drugs such as streptomycin were developed and were to be the first effective drugs in the fight against TB. Some patients were known to relapse however as tuberculosis developed resistance to this drug. In Europe, researchers developed para-aminosalicylic acid (PAS) around the same time and, the combination of the two (PAS and streptomycin), became the norm if patients were diagnosed early enough. Chemotherapy was held responsible for the decline in the tuberculosis death rate in Britain between 1950 and 1974. The numbers fell from 430 per million to 12 per million; this was a radical fall of 97%. Of course, Cule (1999) adds that there had already been a decline between 1848 and 1971 that was apparently unrelated to medical care, but it is quite certain that chemotherapy greatly contributed to the conquest of the disease. Luk (1999) states that the introduction of combination therapy (consisting of streptomycin, isoniazid and rifampicin (developed in 1968)) was an important step in the fight against tuberculosis. These drugs had a bacteriostatic nature and therefore the treatment period had to be quite long (up to 9 to 12 months). This length of time for drug taking has led to non-compliance and the resurgence of drug-resistant strains today. However, there are second line drugs in use today

to help with the treatment of patients with poor immune responses (such as those with HIV) or those infected with drug resistant strains. The two most important second line drugs are ethambutol and pyrazinamide. Luk (1999) describes a study in Korea by the Medical Research Council that showed that isoniazid plus rifampicin for 6 to 9 months was as effective as people being treated for 18 months with INH and PAS or ethambutol. In a study done in the United States, on drug resistance, Binkin *et al* (1999) showed that in 1997 there were a total of 15,080 culture-positive cases without a previous history of TB. Of these, 88% (13,224 cases) had results of drug susceptibility to at least one of the first line drugs. Around 7.5% that were resistant to isoniazid, 1.7% resistant to rifampin, 1.5% resistant to ethambutol, 5.9% resistant to streptomycin and 2.1% resistant to pyrazinamide. Multiple drug resistance was reported in 1.2% of cases. They reported that drug resistance was more frequent in the 5% of the cases that had a previous history of tuberculosis. Tuberculosis sufferers' survival prospects have improved from the 1940s onwards with the development of anti-tuberculous chemotherapy but in the 1990s a series of factors have made the fight against tuberculosis a major problem. The combination of poverty, resistance to drugs and HIV have made tuberculosis a threat once more (Roberts and Buikstra in press). The drugs that were used at Stannington will now be discussed.

(i) Streptomycin

Streptomycin arrived at a key time in Britain: at the end of the Second World War and before the implementation of the National Health Service (NHS). It was discovered at the Department of Microbiology of the New Jersey Agricultural Experiment Station, Rutgers University by Selman A Waksman in 1943. He was to win the Nobel Prize for this discovery in 1952. Along with drugs that followed in its wake (PAS in 1948 and INH in 1951) streptomycin helped cut annual TB mortality from some 25,000 deaths just after the Second World War to a few hundred during the 1970s (it is assumed that the numbers refer to Britain, but the original author did not specify). This success also brought about the closure of sanatoria that consumed vast amounts of public expenditure (Yoshioka 1998). Merk & Co. began commercial production of it in 1944. In England demand for the drug remained far in excess of its supply, and therefore a trial was instituted (as they did not have enough of the drug to treat all the general public who needed it). People treated were affected by: acute rapidly progressing tuberculous broncho-pneumonia at ages 15-25 years (numbering 100) (Medical Research Council (MRC) 1947, MRC 1948a), tuberculous meningitis in children (small number MRC 1948b), acute tuberculous broncho-pneumonia at ages under five (small number), and acute miliary tuberculosis at ages 15-25 years (small number) (MRC 1950). The numbers in these last groups were not specified. The list of centres used in the trial were

the Brompton Hospital, the Middlesex County Council Sanatorium, the London County Council's Colindale hospital for case-type A (pulmonary TB in young adults), the British postgraduate Medical School and Hammersmith for case-type B (tuberculous meningitis in children), the Alder Hey Hospital (Liverpool) and Glasgow Children's Hospital for case-type B and C (as above, and tuberculous broncho-pneumonia in children) (Yoshioka 1998). In December 1946 50 kilograms of streptomycin were imported from the USA to treat around 200 cases (Bryder 1988). The trials taking place in London, Liverpool and Glasgow dealt with tubercular meningitis in children. They did not use controls for this study as there was no cure known previously for this type of tuberculosis. Only children up to the age of 7 were accepted for treatment as drug supplies were so scarce (Bryder 1988). A report published in 1950 showed that, before the introduction of streptomycin, 300 children with tuberculous meningitis in 13 years had died in Dublin, Ireland, but with streptomycin one in four or five children survived if they were detected soon enough (Bryder 1988). Following these trials, the Ministry of Health made streptomycin available to patients suffering from tuberculous meningitis in September 1947, and streptomycin was available by prescription by November 1949.

When given as a sulphate salt streptomycin is rapidly absorbed and the majority is excreted in 24 hours. It diffuses readily into the serous fluids, making it an important player in the fight against tuberculous meningitis. The therapeutic dose for children is 30-40 mg per kg of body weight given as a singular intramuscular injection (Miller 1982) while Inselman (1996) puts the maximum dose of 20-40 mg per kilogram of body weight. The drug is both bacteriostatic and bacteriocidal, but it does not penetrate the host cell.

(ii) Para-aminosalicylic acid (PAS)

This was introduced in the war against tuberculosis shortly after streptomycin. It was discovered in 1946 by Lehmann in Sweden. This drug, again, was given to the public but went through another trial. This was not as widely publicised as streptomycin. However, it clearly showed it effectiveness during the clinical trials, especially in reducing the risk of developing streptomycin-resistant strains of the tubercle bacillus. Eleven hospitals were involved in the three month trial (Bryder 1988). It is a bacteriostatic drug and, contrary to streptomycin, does not diffuse into serous fluids. It played a very important role in the war against tuberculosis in the early days of chemotherapy as PAS prevented the development of resistant strains. The usual dose is 200mg/per kg with a maximum dose of 10 g per day given in 3 doses (Miller 1982) while Inselman (1996) puts the dose at 150 mg per kilogram of body

weight. According to Miller, who treated children in the Newcastle area and at Stannington sanatorium:

> "PAS was always given with INH but rarely if Streptomycin was also used as a triple therapy was not then a common practice. The dose of INH was first determined and the PAS was prescribed separately, the amount being determined by the weight of the child. Since the tablets or cachets were large for children, we arranged that PAS could be made up in a 25% suspension with option of several flavours to the choice of the mother and child. Since the mixture was unstable it required a fresh prescription each two weeks but this did not appear to cause any difficulty either with the parents or the hospital. Such an arrangement is possible only under favourable conditions but it does illustrate that PAS can be used and made acceptable" (Miller 1982:97).

The side effects of the drug's toxicity are more common than with either streptomycin or INH. The most common are nausea, a sharp rise in temperature, along with headache and vomiting, but they all cease as soon as the drug is stopped.

(iii) Isoniazid (Isotronic acid hydrazide, INH)

This drug was also very important in the fight against tuberculosis. It was discovered and administered in New York by Robitzek and Selikoff in 1952 (Evans 1998). INH has many advantages over other anti-tuberculous drugs: it can be taken by mouth, instead of via painful injections, and is cheap, stable and easily transported. The dose is completely absorbed, enters the cells and body fluids and is excreted in the urine. The dosages recommended vary from author to author around 5-10mg/kg of body weight. The usual dose is 40mg daily (Miller 1982) while Inselman (1996) puts the usually daily dose at 10 to 20mg. It is more common to find hepatoxicity (poisoned liver) in adults than in children being treated with INH (Hakim and Grossman 1995).

There are many reasons why children should not be treated as if they were miniature versions of adults, but primarily it is because the types of tuberculosis that are treated with chemotherapy are different in adults and children. Most adults who receive chemotherapy today suffer from destructive pulmonary tuberculosis and are chronically ill, while most of the children who are treated with chemotherapy are free from symptoms (but show a positive tuberculin test) and only a small percentage of them are clinically ill or have complications.

According to Lincoln and Sewell (1963:58) "Toxic reactions to antimicrobial agents may differ in children and in adults, and the dosage level at which good response to therapy is secured may also vary". For example, Promizole (developed in 1945) was more effective as a drug and less toxic in children. Children generally receive much larger amounts of isoniazid than do adults, but neurotoxicity (poison to nervous tissue) is rarely seen.

Although children do not develop resistance to anti-tuberculous drugs frequently, the use of combined therapy is still recommended. Isoniazid seems to be the most valuable drug according to Lincoln and Sewell (1963) and streptomycin should be used as a second antimicrobial agent in the treatment of complications with a very serious prognosis such as meningitis. When complications of a less serious nature appear, children should be treated with INH and PAS. When recovery seems assured, PAS should be substituted for streptomycin. According to Souilamas *et al* (2001) true multi-drug resistance (MDR) is defined as having an organism that is resistant to at least isoniazid and rifampicin, although they state that the resurgence of the use in surgery to treat tuberculosis is related to the rise of MDR tuberculosis.

(iv) Present day therapy

The drugs that are used today to fight tuberculosis are many. Those that are most commonly used are ethambutol (1968), isoniazid (1952), pyrazinamide (1970) and rifampicin (1968) (Roberts and Buikstra in press). According to Davies (1999) the essential first line drugs available are isoniazid and rifampicin. The other first line drugs are pyrazinamide, ethambutol and streptomycin. The second line drugs are many and come from two categories: the old represented by ethionamide, cycloserine, capreomycin, amikacyn, kanamycin, PAS and thiocetazone. The new second line drugs are represented by the quinolones, the macrolides, clofazimine, amoxycillin and clavulanic acid (www5). Children suffering from tuberculous meningitis today are put on a cocktail of four drugs for three months (streptomycin, isoniazid, rifampicin and pyrazinamide) followed by another six months with three drugs (isoniazid, rifampicin and pyrazinamide) (Thwaites *et al* 2002). Drugs today are often given in an observed fashion referred to as DOT (Directly Observed Therapy) or DOTS for Directly Observed Therapy Short-Course (this was considered in Chapter 2 in the section on tuberculosis today). The discovery of rifampicin led to the development of short-course therapy regimens largely as a result of the British Medical Council (Raviglione and Pio 2002). Here people are asked to come into a clinic where they will be given their drugs and will be observed while taking them. This strategy was developed because of the increase in drug resistant disease in the world. This new strategy

(DOTS) provided an effective framework for tuberculosis control through five essential elements. The case finding through bacteriological examination of patients with respiratory symptoms, and administration of short course therapy by direct observation are the first two elements and are technical. The other three are managerial and include generating more political commitment to mobilize funds to fight tuberculosis, supplying a regular supply of anti-tuberculosis drugs where they are needed, and finally establishing a reliable information system that provides data for monitoring and assessing case findings and treatment activities (Raviglione and Pio 2002).

3.4 The implementation of the National Health Service (NHS)

3.4.1 Implementation of the NHS (1948)

The implementation of the NHS happened on July 5, 1948 was subsequently called Vesting Day (Timmins 1996). Around 90 per cent of general practitioners joined overnight and within a matter of months, 97 per cent of the population had enrolled in it and have since remained in it (Castle 1976). Today all British residents are enrolled in the NHS by default, but they are free to get private insurance as well (Le Bruin, DoH, pers comm.)

The service was universal, comprehensive and free. Freedom from doctor's charges was an enormous relief for many. A doctor who qualified in the first week of the NHS recalled how he saw people who had not visited a doctor for years. The services provided met with a mass of unmet needs. This attracted many people who had never seen a doctor and also those who wished to abuse the system by asking for wigs, free surgical spirit and aspirin. All the services were accessible and the aim was to 'universalise the best'. Working-class women gained especially from the NHS as they had had limited access to services before (Klein 1995, Timmins 1996, Berridge 1999).

3.4.2 The first few years

The spending in the first nine months exceeded estimates by two-thirds. According to Timmins (1996: 3) the sea of unmet need, the sheer difficulty of predicting in advance the costs of the new service, the rising expectations it generated and the costs of medical advance had all combined to blow the early budgets.

The issue of rationing was raised within months of the implementation of the NHS. It began with patients in clinical trials. When a drug's value had been proved, patients in designated centres were given medication, although it was still in short supply and very expensive. Only

then was more general prescribing allowed. These steps were repeatedly followed as new production methods and the synthesising of artificial analogues of naturally occurring compounds lowered their price and consequently the cost to the service (Timmins 1996:4)

The NHS had to fight to get the funds it needed. In 1950 the Korean War came and disrupted the battle as more spending was needed on arms and less on social services. In April 1951 Bevan resigned and Labour found itself in a period of internecine warfare from which it would take 10 years to recover. Bevan fought the new Labour Chancellor of the Exchequer, Hugh Gaitskell, who wished to introduce a 'hotel' charge for beds; he also brought in the prescription charge (which Labour had legislated and Bevan had managed to resist), and he also wished to scrap the dental service. Bevan managed to reduce these changes to charges for spectacles and some charge for dental treatment (especially dentures), but he then resigned (Timmins 1996). Shortly after Bevan's resignation the conservatives defeated the Labour government and a flat-rate for dental treatment and a prescription charge of one shilling was introduced in 1952 (Timmins 1996). The key themes which were to dominate the history of the NHS were established: the problem of how to run the system administratively; its relations with its most powerful group of professionals, the doctors; the task of coping with rising expectations and medical advance; how to ration and develop services; and how to fund the NHS (Timmins 1996).

3.4.3 Tuberculosis and the NHS

"The Public Health (Tuberculosis) Act of 1921 required county and county borough councils to provide a service outpatient and inpatient treatment of tuberculosis for all" (Great Britain. Parliament 1921:5 cited in Pater 1981:17). Local authorities became responsible for tuberculosis prevention and treatment in their respective areas. There were some 83 council borough councils and 62 county councils (including the London County Council). In London this was shared between the London County Council, the city council and the 28 metropolitan boroughs (Bryder 1988). The Public Health Act of 1921 only required local authorities to provide treatment for the cases that did not come under the purview of the Board of Guardians and, therefore, although the number of tuberculosis institutions were growing, many tuberculosis patients were still being treated in poor Law infirmaries in the 1920's. In 1929 a Local Government Act abolished the Board of Guardians and delegated their function to the Public Assistance Committee that was under the control of the local authorities. They acquired the Poor Law infirmaries and changed them into institutions for other public health services. This increased the number of beds available to tuberculosis patients by 1,000. In 1934 there were still 5,867 tuberculosis patients being treated in Public Assistance institutions

(old Poor Law infirmaries) in England and Wales (20th CMOH Annual Report 1939, in Bryder 1988). Therefore, the implementation of the NHS did not have a direct effect on who was being treated for tuberculosis in hospitals at the time. As the NHS had been a hospital focused service since its inception there was a reallocation of beds, as the demand for TB beds declined along with the tuberculosis rates in England (Berridge 1999).

The Joint Tuberculosis Council published a report in 1944 where they stated that the administration of clinical work and the social problems arising from tuberculosis should both be regarded as important (JTC 1944). They were concerned about the government's plan to split the services, where the clinical part would be dealt with by the regional hospital boards and the public health aspect would fall under the local health authorities (Bryder 1988). They believed that tuberculosis patients would be better served if their services were to remain fused and transferred to the new hospital organisation (JTC 1946). The NHS disbanded the tuberculosis service along with maternity and child welfare services. The tuberculous patient would now have to deal with several authorities depending on which type of treatment they would be receiving. They would have to deal with the regional hospital boards if receiving residential treatment, or preventive work, and after-care was under the responsibility of the local health authorities; the Ministry of National Insurance provided financial assistance, the National Assistance Board helped those patients with special needs (although these special needs are not specified) and, finally, the Ministry of Labour dealt with rehabilitation schemes (Bryder 1988). Under the NHS tuberculosis officers became chest physicians with both consultative and public health functions.

The Medical Research Council began the trial for streptomycin for TB in 1946. This has already been discussed in this chapter on treatment of TB and will not be discussed again here only to mention that it marked the introduction of the rise of the controlled clinical trial (Bryder 1999). The discovery of streptomycin and other anti-tuberculous drugs was to revolutionise the treatment of tuberculosis. "The effect of penicillin, the sulphonamides and other drugs had begun this therapeutic revolution in the decade before the establishment of the NHS and the post-war period saw a further expansion in the production of new and effective drugs and therapies" (Berridge, 1999:30). The 1950s also saw the results of the 1950 BCG trial being published (Bryder 1999). Early in 1938, according to Pater (1981), a survey was made of beds that might be available if needed in World War Two. It showed that 35,000 beds were in isolation hospitals and tuberculosis sanatoria. Britain preferred the curative rather than the preventive model to treat tuberculosis (Bryder 1999, Berridge 1999). The next section will deal with the statistics on tuberculosis at the time of this study. We

know how people were treated at the time, so it is now time to look at how many people were requiring the treatment.

3.5 Tuberculosis statistics for England (1930-1950)

It is important to demonstrate the difference between infection and disease. In any population where tubercle bacilli have been circulating freely, there will be a high percentage of people infected (before or during adolescence), but only a small number of these will have active disease (Logan and Benjamin, 1957). Most primary infections will heal uneventfully, without the person even knowing they were infected.

Many surveys produced in England and Wales in the 1930s and 1940s indicated that the general or average risk of infection in the population was small in infancy and early childhood. However it rose rapidly around school age (occurring at a rate of about 4 per cent per year of age), until the age of 16 where approximately 50% were infected; at age 21 this rose to around 70%.

The difference between mortality rates in children and adults suffering from tuberculosis in 1955 is set out in **Table 4**. Showing that children are dying from different types of TB than the adults. For example, many more children than adults die from tuberculosis of the meninges and central nervous system, but many more adults die from tuberculosis of the respiratory system. This tends to be a result of children suffering from primary tuberculosis of the lungs that can often heal spontaneously compared to adults who do not suffer from primary tuberculosis, but rather chronic pulmonary tuberculosis that is much graver in prognosis. This also stems from the fact that parents had been infected in childhood and suffer reinfection later in life. Tuberculosis of the meninges was invariably fatal before the advent of antituberculous drugs (see next chapter on Childhood Tuberculosis).

When analysing the figures from **Table 5** (mortality rate from respiratory TB) are considered more closely, a steep decline in rates since 1947 is apparent, especially in the young and middle ages. For the 20-24 year olds, in both men and women the rate in 1954 was only 1/16 that of 1947. Undoubtedly, according to Logan and Benjamin (1957:15) "chemotherapy, with streptomycin, PAS and isoniazid making the principal contribution, and, as a further benefit of antibiotics, safer and therefore bolder chest surgery have combined together with many other advances in the management of tuberculosis patients to produce this rapid decline".

Davies *et al* (1999a and b) show that drugs did not have the impact that it is mostly given in history as rates in England and Wales had already been steadily declining before the advent of chemotherapy at the time.

Tilley (1947) reported that there had been a slight rise in the number of deaths from tuberculosis between 1945 and 1947, the rates being 233 and 242 respectively, but the death rate remained stationary at 0.59 per 1000 as in 1945. These could have been related to the Second World War. Men (those men who went to fight in the war) would have slowly been returning from the War and the harsh conditions they had endured might have weakened their immune system and therefore put them at an increase risk of contracting tuberculosis.

Table 4. Deaths from tuberculosis, England and Wales, 1955

Type of TB		Age (years)		Total
		0-14	15 and over	
1. Respiratory system	Male	7	4165	4172
	Female	18	1647	1665
2. Non –respiratory system -total	M	56	305	361
	F	67	227	294
Including				
Meninges and CNS	M	38	29	67
	F	41	24	65
Intestines, peritoneum and mesenteric glands	M	3	42	45
	F	6	35	41
Vertebral column	M	-	52	52
	F	1	34	35
Other bones and joints	M	-	21	21
	F	-	11	11
Skin and subcutaneous cellular tissue	M	-	1	1
	F	-	3	3
Lymphatic system	M	1	10	11
	F	-	10	10
Genito-urinary system	M	-	87	87
	F	-	52	52
Other organs	M	1	16	17
	F	1	19	20
Disseminated TB	M	13	47	60
	F	18	39	57

Taken from Logan and Benjamin (1957:10)

The notification rates for non-respiratory tuberculosis seen in **Table 6** demonstrate again a sharp decline in notifications for children under 15 in both males and females after 1950, while the decline is not so sharp for adults. Although the notifications drop, there were still many people suffering from tuberculosis at this time in England. Again, this could have been due to improved housing conditions at the time (Davies *et al* 1999a and b), or to the fact that there was still a stigma attached to the notification of tuberculosis (Bryder 1988)

Table 5. Tuberculosis of respiratory system: Death rates per million population by sex and age. England and Wales, 1931-1945 and 1946 to 1955

Years	0-	5-	10-	15-	20-	25-	35-	45-	55-	65-	75+
Males											
1931-35	85	42	64	490	963	961	1140	1368	1176	723	275
1936-40	61	20	44	366	742	785	937	1210	1216	718	296
1941-45	76	24	34	339	581	674	811	1114	1203	741	295
1946	68	22	23	239	481	615	687	1020	1165	768	340
1947	77	15	29	241	500	632	679	1034	1213	812	267
1948	56	10	14	211	445	603	633	961	1166	881	334
1949	34	7	14	127	366	497	592	869	1159	937	400
1950	38	9	8	78	229	395	428	751	1024	891	411
1951	30	7	7	46	171	292	364	636	978	953	464
1952	15	4	10	35	102	201	287	503	829	843	447
1953	14	4	3	18	71	156	214	413	712	814	445
1954	9	2	1	13	55	130	192	370	643	778	406
1955	3	1	1	8	30	93	151	307	535	705	420
Females											
1931-35	74	43	143	840	1138	911	646	475	394	306	170
1936-40	55	24	98	658	1016	759	511	377	339	272	160
1941-45	72	24	76	591	916	692	427	304	269	220	123
1946	60	25	69	468	842	662	382	261	242	207	119
1947	70	24	63	502	899	730	411	267	249	224	133
1948	52	19	53	462	812	702	367	255	235	218	105
1949	33	10	30	351	682	622	348	254	249	236	139
1950	29	8	15	199	429	444	273	229	212	212	144
1951	25	8	14	108	278	347	238	192	180	198	135
1952	18	5	6	58	169	230	166	131	148	150	159
1953	17	5	3	32	122	174	146	116	130	162	140
1954	11	2	3	31	84	143	145	104	107	137	117
1955	6	2	4	12	56	113	101	84	95	111	115

Taken from Logan and Benjamin (1957:16).

Table 6. Non-respiratory tuberculosis: Notification rates per million population by sex and age, England and Wales, 1938-1955

	Males					Females				
	All ages	0-	15-	25-	45+	All ages	0-	15-	25-	45+
1938-50	290	744	341	151	72	264	641	403	172	61
1941-45	269	698	326	148	64	261	632	413	178	63
1946	217	569	250	123	53	210	518	334	149	47
1947	202	518	227	114	54	196	455	317	144	51
1948	197	505	243	99	53	199	473	333	138	46
1949	171	423	211	93	50	174	399	304	127	40
1950	151	350	186	93	48	164	343	288	139	39
1951	149	327	196	98	48	159	314	300	131	46
1952	135	275	196	91	50	146	272	242	135	54
1953	122	233	163	85	59	133	224	240	129	51
1954	109	192	149	93	48	133	199	245	140	56
1955	96	145	154	85	48	109	144	203	126	48

Taken from Logan and Benjamin (1957:19)

3.6 Summary

This chapter has considered the history of tuberculosis by discussing its understanding and treatment through time by exploring themes that were put forward in Chapter Two. It has been possible to establish that tuberculosis as a disease has been known since antiquity, but it was only in the nineteenth century with the discovery by Koch of the tubercle bacillus that tuberculosis really became understood as a disease that was not hereditary, but rather microbial in nature. This revolutionised the understanding and treatment of tuberculosis, and the twentieth century saw great developments in the fight against tuberculosis, with the development for the first time of effective anti-tuberculous drugs. The implementation of the NHS was briefly outlined as well as tuberculosis statistics in England and Wales 1938-1955. This knowledge on tuberculosis and how it was treated in the past will help in the consideration of the specific types of tuberculosis that children suffer and have suffered from in the past.

Chapter 4

Childhood Tuberculosis

In it I made use of the impressions gathered during my three weeks' stay. They were enough to convince me of the dangers of such a milieu for young people – and tuberculosis is a disease of the young... it can, in a relatively short time, wholly wean a young person from actual and active life

(Thomas Mann, *The making of the Magic Mountain,* 1927:721)

Introduction

The two previous chapters have provided background information about TB and described the understanding and treatment of this infection in the past. This chapter aims to document the characteristics of childhood tuberculosis and the differences it may have to adult tuberculosis. Childhood tuberculosis differs from adult tuberculosis in several ways. Children differ in the type of tuberculosis from which they suffer, the symptoms they show, and the way they are treated. This section is an overview of tuberculosis in children, especially the types of tuberculosis from which the children at Stannington suffered. Tuberculosis in children today is also explored as this part of the population will be the future infectors if they are not properly treated. Treating tuberculosis in children will also lead to a decline of drug-resistant tuberculosis if they are treated rapidly and effectively. If children do not acquire drug resistance, when (and if) they suffer reinfection or reactivation of the disease later on in life they will not spread a drug-resistant form of the disease. Over 98% of all children in industrialized countries survive through their pre-school years but in some developing countries there are still as many as 15% who die before the age of five (Azuh 1994, Corsini and Viazzo 1997 in Foggin *et al* 2001). In fact, some authors suggest that four-fifths of child mortality happens in the first year of their lives (Agha 2000, Yassin 2000 in Foggin *et al* 2001). Childhood tuberculosis is important as the full spectrum of the disease is seen more often in the case of children and symptomatic disease may occur earlier and in any organ in the course of infection (Hakim and Grossman, 1995). Childhood tuberculosis is the result of adults with pulmonary disease transmitting it by droplet infection from sputum expectoration (Donald and Beyers 1998).

It was estimated that around 80 to 85% of all deaths from TB in England during the 20th century resulted from the pulmonary form of the disease (there is no distinction made here between adults and children), although non-pulmonary forms did have more statistical importance as these were the forms to which children were more susceptible (Bryder 1988).

Of the number of children dying from tuberculosis, nearly 85% of tuberculosis deaths under the age of five were due to the non-pulmonary forms of the disease as well as 70% of those between the ages of five and 14 (Bryder 1988). In 1947, in Newcastle-upon-Tyne, tuberculosis still accounted for 24% of the deaths of children under 10 in hospital, of which over 90% came from the poorer classes (Dormandy, 1999:79). The major forms of non-pulmonary tuberculosis to affect children are tuberculosis of the bones and joints (hands, feet, knee, and hip) (Lincoln and Sewell, 1963), of the lymph nodes (scrofula), the abdomen, the meninges and the nervous system, and finally of the skin (*lupus vulgaris*) (Bryder 1988). The reason for the distribution pattern in the skeleton is that the distribution of haemopoietic marrow in infants and children is more widely distributed than in adults, resulting in the tuberculous foci occurring in the tubular bones of the hands and feet, in the tarsal and carpal bones, and on occasion in the diaphysis of the long bones. The vertebrae, ribs and sternum have a large amount of haemopoietic marrow at all ages, which explains the frequency of tuberculosis of the spine throughout life (Ortner and Putschar 1985).

According to Donald and Beyers (1998) there is a tendency for infection to happen during the winter months, leading to a disease peak in the spring and summer months (but this information is not specified whether for adults, children or both). They argue that the closeness and duration of contact will increase the chance of infection. The frequency of coughing as well as poor household ventilation will all add to the chance of infection. They also note studies which indicate a slight predominance of male infection but more female adolescents with the disease than young males; this leads them to believe that it might be related to some endocrinological or metabolic factor (such as the onset of menses) (Grigg 1958, Roelsgaard *et al* 1964, Styblo *et al* 1969a and b, Schaaf *et al* 1996). Children who are in contact with a parent or grandparent with 'open tuberculosis', or a sputum smear-positive experience, have a considerably higher morbidity and mortality than those who are in contact with adults who only have positive sputum on culture (Shaw and Wynn-Williams 1954, Styblo and Sutherland 1982).

Bovine infection was associated predominantly with children in the pre-antibiotic era. It was estimated in 1931 that over 1,000 children under the age of 15 died each year of tuberculosis of bovine origin in England and Wales (Bryder 1988: 3). This is believed to be because children would be the largest consumers of unpasteurised milk (and therefore possibly infected by tubercle bacilli). Tuberculosis of bovine origin was preventable, so why was it still killing so many children? The solution was as easy as pasteurising milk as already discussed (Engel *et al*, 1938, Dunlop 1938, Cutbill and Lynn 1944). Even as early as the late 19th century Queen Victoria (1819-1901) had her cows tested for TB, cows that were

supposed to be of the highest quality, and the results showed that 35 of her 40 cows proved to be tuberculin positive (Dormandy 1999:331). The primary reason why effective elimination of bovine tuberculosis had never been attempted in Britain was economic. "Tuberculosis is so widespread in dairy cattle that measures of elimination on an extensive national scale would not only be very costly, but would gravely embarrass agriculture and the continuance of an adequate milk supply" (Savage 1933: 908). Tuberculosis of bovine origin, contracted through the consumption of infected food or milk is thought to cause disease in the cervical lymph nodes and more rarely of the gastro-intestinal tract (Aufderheide and Rodríguez-Martín 1998). Bovine tuberculosis of animals, which was once widespread in Great Britain, is now focused in southwest England, southwest Wales and parts of the Midlands. The arrival of bovine tuberculosis in a new area is almost impossible to predict as it can spread from inward movement of infected animals or from possible reservoir hosts, but routine monitoring should pick up any new cases infected in these ways (Wint *et al* 2002).

Datta and Swaminathan (2001) have reviewed the available data for childhood tuberculosis from around the world and have stated that the epidemiological data is scarce and the burden of illness estimates should therefore be regarded as 'guesstimates'. This may partly be because diagnosis in children is difficult, and also it is considered to be of less of public health importance, as children tend to be non-infectious (Donald and Beyers 1998). Data from the Global Tuberculosis Control Report (WHO 2000) in Datta and Swaminathan (2001) report that smear-positive TB in children between one and 14 years of age accounted for 0.6-6.9% of the total number of reported tuberculosis cases. Keeping this in mind, they also state that the incidence in children has been rising, particularly in regions where poverty and overcrowding exist together. They indicate that tuberculosis in children often involves more than one system, where extra-pulmonary forms of the disease are as common as the pulmonary ones, at least in the hospital setting. **Table 7** outlines the differences between adult and childhood tuberculosis.

According to Starke (2001), differences between adult and childhood tuberculosis affect the treatment that they will receive. Firstly, children usually develop disease as an immediate complication of the primary infection that will typically involve closed caseous lesions with small numbers of mycobacteria. In adults, large cavitary populations of bacilli are usually found in pulmonary tuberculosis. Children are less likely to develop secondary drug resistance as this resistance is directly proportional to the size of the bacterial population. Secondly, children have more propensity than adults to develop extra-pulmonary forms of tuberculosis such as disseminated disease. Thirdly, children in general will tolerate larger amounts per kilogram of body weight and will have fewer adverse reactions to anti-

tuberculous drugs than adults. Finally, most commercially available drugs that are manufactured around the world are made in adult dosages and therefore require some alteration to give the medication to children (such as crushing of pills, or making suspensions, and these are not well studied or standardised) (Starke 2001).

Table 7 Tuberculosis in children compared to adults

Feature	Adults	Childhood
Symptoms	Cough, fever, chest pains, haemoptysis, loss of weight	Negligible symptoms at time of primary infection
Lesions	Apical, upper lobes most commonly involved	Peripheral, often middle and lower lobe
Cavitation	Common	Uncommon, seen during infancy and adolescence
Glands (hilar or mediastinal)	Uncommon	Very common
Dissemination	Uncommon	Common
Healing	Fibrosis, less than one third heal spontaneously	Calcification, most often heals spontaneously
Infectivity	Patients with smear positive pulmonary tuberculosis are infectious to others	Paucibacillary disease, usually not infectious

Taken from Datta and Swaminathan (2001)

There are several studies that have demonstrated recently that tuberculosis in children has been on the increase. In California, Lobato *et al* (1998) showed an increase in tuberculosis of 22% in children aged between 0 and four years of age and an increase of 66% in children five to 14 years of age between 1985 and 1995. Children who were not from white backgrounds had a higher rate, from 6 to 34 times, than those from white backgrounds. Another study in South Africa (Van Rie *et al* 1999) demonstrated that in an urban community the case notification rate for children between birth and five years of age was three and a half times the case notification rate for adults. This study also linked certain factors which they believed led to the increase in the notification rates. Childhood TB rates were correlated with low parental education, low annual household income and crowding (Van Rie *et al* 1999). In Scandinavian countries tuberculosis is mostly found in the immigrant population which Rosenfeldt *et al* (1998) associated with the incidence in their home countries, and their poorer and crowded living conditions. Japan, however, shows a different trend with cases there being less numerous in 1990-1994 than 1975-1979, the former rate being half of the latter (Ibe *et al* 1997). In England and Wales the current incidence for all tuberculosis in children aged 0-14 years is 11.9/100,000 and for non-pulmonary tuberculosis it is 1.9/100,000 (data from the Public Health Laboratory Service, Communicable Disease Surveillance Centre in

Carrol *et al* 2001) with the majority of the cases in infants and children under the age of five years of age. Between the ages of five and 15 years there was an apparent period of resistance to tuberculosis when the primary focus resolved spontaneously, resulting in a low rate of tuberculous disease (Carrol *et al* 2001).

The strongest risk factors for childhood tuberculosis infection are mostly socio-economic, especially poverty. Other factors, which are often mentioned in the literature, are under-nutrition, overcrowding and the possibility of close contact with a positive case (Datta and Swaminathan 2001). There is a very thin line between infection and disease in children. Primary infection, as has been stated, can often be asymptomatic and undiagnosed in 90% of cases as it is only manifest in an alteration of the skin test. Whether a child will progress to disease will depend on several factors such as age, nutritional and immune status of the child and the size of the infecting dose. When infection is found in a child under two years of age, or an infant, it is very dangerous and at this age is most likely to be followed by disease especially in the form of tuberculous meningitis or miliary tuberculosis. The incidence of disease will then decrease with age from five until ten years of age when the disease increases again in adolescence (Lincoln 1950 in Datta and Swaminathan 2001). If the primary tuberculous lesion is not treated, around 15-20% of children that are infected in the first year of life will develop tuberculous meningitis or miliary tuberculosis within two years. Seven per cent will also develop bone and joint disease. For children under the age of five years, the risk of developing either tuberculous meningitis or miliary disease within two years is about four per cent, and the risk of developing bone lesions is around one to two per cent. For children over five years of age the risk of disseminated disease and haematogenous lesions decreases until the age of ten; at puberty it increases somewhat but there is insufficient data to give any numerical estimates (Miller 1963 in Carrol *et al* 2001). Tuberculosis still figures among the 10 major causes of death for children as almost 500 children die every day from tuberculosis globally. The mortality of children from tuberculosis has been shown to correlate with the socio-economic status of the population. Raj Narai and Diwakara (1975) demonstrated that in a rural slum in Chennai, India the annual tuberculosis mortality rate for children was 239/100,000 compared to rural areas where the annual tuberculosis mortality rate was 52-55/100,000. Chakraborty (2000) has shown in another study that mortality from tuberculosis can be 1.5/100,000 between the ages of zero and four. The disseminated forms of tuberculosis, such as tuberculous meningitis, cause the highest case-fatality in early childhood.

In the United States the total number of cases with pulmonary tuberculosis has risen in recent years, while the percentage of cases decreased from 82% in 1990 to 78% in 1993 (Centre for Disease Control 1987, Centre for Disease Control and Prevention 1993 and 1994, Inselman 1996). This rise has also been seen in children of all ages and is most prominent in those suffering from tuberculous meningitis, lymphatic disease, miliary tuberculosis and tuberculosis of the bones and joints (Centre for Disease Control 1986, Centre for Disease Control and Prevention 1994, Inselman 1996).

4.1 Primary tuberculosis

The term primary tuberculosis usually includes the primary complex itself (local disease at the portal of entry and the lymph nodes that drain the primary focus) and the progression of any of its components (Lincoln and Sewell 1963, Ortner 2003). Pulmonary tuberculosis which develops in the first five years after infection is referred to as primary, and when it is diagnosed more than five years after the primary infection it is called secondary or post-primary tuberculosis (O'Reilly and Daborn 1995). The incubation of the tubercle bacilli is said to be between two and eight weeks, the norm being between three and five weeks. Infection is nearly always acquired from adults through infected droplets (Hendrie 1934, Hakim and Grossman 1995). The father, according to Hendrie (1934), is the most often named tuberculous contact, although it is uncertain whether this information still holds true.

Tuberculous infection in children is nearly always heralded by a fever. It will often last less than a week and rarely more than two weeks. At this time the tuberculin test will usually change from negative to positive. It will sometimes happen that the onset of tuberculosis will resemble the onset of pneumonia. Here the signs are a high fever, dullness, bronchial breath sounds and crepitations in the lungs. They resemble the sound of bubbles of different sizes being burst. There might also be a rapid respiratory rate and signs of acute illness such as heamoptysis. The tuberculin test is almost invariably positive at the beginning of pneumonic onset (Miller 1982, Starke 1999).

Ninety-five per cent of primary tuberculosis appears in the lungs (Lincoln and Sewell, 1963, Miller 1982, Ortner 2003). All manifestations of progression within the lung are considered to be part of the primary focus, and when the disease expands beyond the lungs the resultant foci are considered complications. For example, pleurisy with effusion may result from the invasion of the pleural space by tubercle bacilli from the primary focus. Most of the complications from primary tuberculosis stem, however, from the dissemination of the

tubercles through the blood and the lymphatic systems. The initial infection is usually unrecognised and it is at this time that the tubercle bacilli will disseminate throughout the body. A child's immunity and hypersensitivity to tuberculin will develop usually between three to five weeks after infection and the spread of infection will stop as soon as the foci are walled-off. The organisms then remain dormant for a while and reactivate, depending on several factors (such as the presence of under-nutrition, physical and emotional stresses), to cause disease. Children are at a higher risk of developing secondary disease when they acquire TB early in life, and often within one year from the onset of infection (Hakim and Grossman 1995).

Primary tuberculosis is studied principally in children because evidence of it is found most often in children rather than adults. It would seem that, according to Lincoln and Sewell (1963), it appears in the right lung more often than the left. It is also possible to study in children the onset and evolution of the infection. Most of the complications in primary tuberculosis occur within a year of onset. Generalised haematogenous tuberculosis and meningitis usually occur in the first four months, but rarely occur until after three or four weeks after onset. After the fourth month, the risk of these complications diminishes gradually. Pleurisy with effusion, on the other hand, is more likely to develop six to twelve months after the onset of the disease. Pleural involvement is thought to be a component of the primary complex as it is such a very common complication of primary involvement (Smith and Marquis 1987 in Hakim and Grossman 1995, Donald and Beyers 1998). Osteoarticular involvement appears generally between 12 and 24 months after infection (Donald and Beyers 1998). The complications that are associated with tuberculosis of the skeletal system are relatively frequent compared to adults and often develop early in children with haematogenous TB (Lincoln and Sewell 1963, Ortner 2003). According to Ortner (2003) primary tuberculosis will, in most people, heal without leading to progressive disease.

4.2 Secondary tuberculosis

4.2.1 Tuberculosis of the abdomen

This type of tuberculosis used to be common before the pasteurisation of milk (Hakim and Grossman 1995). Tuberculous involvement of the abdominal lymph nodes was known as '*tabes mesenterica*'. Tuberculosis of the abdomen is harder to study than primary tuberculosis in the lungs as the primary complex cannot be detected before complications develop (such as abdominal pain, sausage-like tumour, acute or sub-acute intestinal obstruction) or calcium is deposited in the nodes months or years later denoting an old, long-

infected node (Miller 1982). Abdominal TB may heal with calcification without causing any symptoms. The primary focus is usually found on the intestinal mucosa, and the regional mesenteric nodes become enlarged and caseous. Before any specific anti-tuberculosis drugs were available, tuberculosis of the abdomen would often heal spontaneously. Peritonitis (the inflammation of the peritoneum) can be either local or diffuse, developing by infection from an abdominal lymph node or salpingitis (Hakim and Grossman 1995). Peritonitis is often insidious in onset, while in others intestinal obstruction is the first indication of disease (Hakim and Grossman 1995).

4.2.2 Tuberculosis of the skeletal system

According to Hakim and Grossman (1995), when there are skeletal complications, they result from dissemination via haematogenous (Ortner and Putschar 1985, Resnick 1995, Aufderheide and Rodríguez-Martín 1998) or lymphatic spread or by direct extension from adjacent structures. Usually the complications appear early in the infection, most often during the first six months, although Donald and Beyers (1998) have stated that the interval can be between 12 and 24 months. In Lincoln and Sewell's (1963) study in Belleview hospital of a thousand children with tuberculosis, bone and joint complications were seen in only about five per cent of the group during a 10-year period. According to Ortner and Putschar (1985), and Resnick (1995), skeletal tuberculosis only occurs in three per cent of the total tuberculosis cases (pulmonary and non-pulmonary) and about 30% of extra-pulmonary TB; Carrol *et al* (2001) state that skeletal lesions account for around four to five per cent of all cases of tuberculosis and about 10-15% of extrapulmonary cases (Girling *et al* 1988, Rieder *et al* 1990, Houshian *et al* 2000). The most common sites of involvement seen in Lincoln and Sewell's 1963 study were (in order) spine, small bones of the hands and feet, hip and knee, while El-Hassani *et al* (2002) state that the vertebrae are most likely to be affected at 56% (of non-pulmonary cases), followed by the hip. Furthermore, yet another study (Carrol *et al* 2001), states that the spine is most often affected and will appear in 30 to 50% of cases of childhood TB. The bones most commonly affected are the femur, tibia and the small bones of the hands and feet (Hopewell 1995). The disease onset is different for the type of bone affected. For example, in the bones of the hands and feet, the onset is usually a month after primary infection, but for the hip joint it is around two years (Hakim and Grossman 1995). Although often referred to as bone and joint tuberculosis, they are two separate entities, and according to Aufderheide and Rodríguez-Martín (1998), about 90% of skeletal lesions in tuberculosis involve a joint. The sites most affected by tuberculosis will be discussed in more detail below.

The typical response of tissue according to Resnick (1995) is the formation of tubercles that are sharply demarcated from their surrounding tissues. The central caseating necrosis is a characteristic of these tubercles and are incited by the tuberculin produced by the bacilli. Contemporary with the necrosis is the degeneration of the epithelioid cells which become grouped into an amorphous mass. The growth around the tubercle is associated with the amount of new mononuclear cells that become epithelioid cells, and this process continues until neighbouring bacilli are present. The healing of the lesion is associated with the production of hyaline fibrous nodules. The encapsulation of these large foci may lead to the replacement of the tubercle by a connective tissue scar. Calcification and ossification of the caseating lesions might also occur. When the infectious process occurs within a bone, it increases the remodelling process (Lagier 1999). The pathological process usually begins in the metaphyseal portions of the epiphyses. Granulation tissue and caseation develop as the lesion progresses and bone is destroyed. This necrotic process may invade the surrounding tissues and form a cold abscess. Any bone can be affected by tuberculous osteomyelitis as described above. The lesions may be single or multiple but they are usually asymmetrical. A characteristic feature of tuberculous arthritis is that it produces an identical lesion on the apposing surface of the affected joint (Aufderheide and Rodríguez-Martín 1998).

The clinical features expected in bone and joint tuberculosis according to Fraser (1914) are: thickening, pain, muscular wasting, abscess formation in bones, stiffness, alteration in use and position of the joint, tenderness and increased heat, swelling, and alteration in the bony outlines of joints in radiographs. Resnick (1995) state that tuberculous arthritis can lead to pain, swelling, weakness, muscle wasting and a draining sinus and that all these manifestations of the disease can be present for one or two years prior to diagnosis; a history of local trauma is also present in 30 to 50% of cases. According to Cremin (1999a, 1999b: 237) there are a few basic facts about tuberculous infection in the bones of children:

1. " It is an indolent and initially painless condition
2. The process is lytic (bone destruction) which causes cystic (radioluscent) areas.
3. The progress and appearance of these lesions will eventually depend on
    a) effects of weight-bearing forces in the weakened bone
    b) effects of growth stimulation in the area
    c) effects of any healing or repair processes"

Aufderheide and Rodríguez-Martín (1998: 138) show seven features that are almost always present in joint tuberculosis (although they do not specify whether there are any differences between adult and childhood TB). (1) osteopenia: there will be deossification (loss) of the bone distal and proximal to the joint which appears when the limb is rested, (2) there will be marginal erosion of the bone, (3) there will be deep destruction of the subchondral bone, (4) the periarticular destructive lesions will be oval in shape, with well marked edges and without

periosteal reaction, (5) sequestrum formation is rare, (6) the new bone formation is much less in tuberculosis than in other infectious osteoarthropathies and, finally, (7) the primary osseous focus is located in the metaphysis of the long bones.

The diagnosis of bone and joint tuberculosis, in the early 20th century, was made by asking questions about the child's life such as:

- Has the child been fed with infected milk?
- Is there a possibility of contact from a tuberculous relative?
- How old is the child? Fraser's (1914) study showed that tuberculosis of the bones can appear at any age, but it is more common between five to twelve years. Tuberculous disease of the bones and joints is quite rare during the first year of life and then is increasingly common until they reach their acme at 10 years.
- Where does the lesion occur? There are certain sites that are more predilected for bone and joint tuberculosis.
- What are the child's symptoms, physical signs, and radiograph and tuberculin test results?

Carrol *et al* (2001) state that a prompt diagnosis will be dependent on several factors such as a 'high index of suspicion' by the clinician as the clinical signs may be non-specific and microbial confirmation in children is difficult. The most affected sites of bone and joint tuberculosis will now be discussed in more detail: Pott's disease of the spine, and disease of the hip, knee, ankle, upper limb, hands and feet, and other sites of bone and joint tuberculosis.

4.2.2.1 Tuberculosis of the spine (Pott's disease)

Currently the vertebral column is estimated to be affected in 25 to 60 per cent of cases of skeletal tuberculosis (Fraser 1914, Resnick 1995, Hakim and Grossman 1995, Aufderheide and Rodríguez-Martín 1998). This information does not specify whether it relates to adult tuberculosis, childhood tuberculosis or both. The most affected children are under five years of age (Bailey *et al* 1972 in Hakim and Grossman 1995). Resnick (1995) has also reported that the mortality rate for tuberculous spondylitis (tuberculous disease of the spine) has been reported in the past to be as high as 26 to 30% but this has decreased in recent years although it still remains relatively high. The spine is usually affected through the lymphatic spread of the disease when the primary site might have turned quiescent (Luk 1999). The upper lumbar or lower thoracic areas are the most vulnerable to the disease (Lincoln and Sewell 1963, Bailey *et al* 1972, Omari *et al* 1989, Hakim and Grossman 1995, Resnick 1995, Ortner 2003).

Cervical tuberculosis is rare but neurological complications are more common and serious when a patient's cervical vertebrae are affected. Sudden death has also been associated with cervical tuberculosis (Koseoglu *et al* 2002). The infection will usually begin in the vertebral bodies, extend to the intervertebral disk and spread to adjacent structures. The infection is first established in the anterior aspect of the vertebra at either the superior or inferior end plate. Erosion and bone destruction of the anterior vertebral body margin follows. Subsequent involvement of the intervertebral disk or spread under the anterior and posterior spinal ligaments allows spread and eventual vertebral body collapse (Aufderheide and Rodríguez-Martín 1998, Luk 1999, Sebes 1999). According to Resnick (1995), the angular posterior projection of the spine will appear at the site of maximum spinal involvement (kyphosis); the angulation due to vertebral body destruction will be more acute when dealing with only one or two vertebrae, especially in the thoracic region. This kyphosis will only compress the spinal cord enough to cause paraplegia in 10% of cases. This paraplegia can occur years after the acute infection where the spinal cord can be compressed by bony bars or calcified caseous material (Aufderheide and Rodríguez-Martín 1998, Luk 1999). According to Luk (1999) the age of the patient, the location of the disease, and the number of vertebrae affected will all affect the patient's severity of symptoms ranging from simple systemic upsets and back pain to spinal defects and neurological damage. According to Fraser (1914) this type of tuberculosis occurred slightly more often in boys than in girls (also Resnick 1995).

Abscess formation is a major complication of bone and joint tuberculosis that has been left untreated (once more it is not specified whether this information applies to adults, children or both). According to Miller (1982:191) "when caseation progresses to the formation of pus the fluid is first contained by the anterior, lateral and posterior vertebral ligaments. Thus the first indication that an abscess is present is obtained from radiological examination". The most common abscess formed is in the psoas muscle. When the disease is untreated, the compression of the vertebrae and of the spinal cord may result in paraplegia, or the burrowing abscesses can extend to incredibly long distances before perforating an internal viscus or the body surface (Miller 1982, Resnick 1995). These complications can be found in five per cent of cases (Resnick 1995).

4.2.2.2 Tuberculous disease of the hip

In tuberculosis of the joints, the destruction of the articular surface can be minimal if the disease is restricted to the synovium. As Ortner (2003) notes, undermining and resorptive grooving of the articulating bones frequently occurs along the line of the synovial or ligamentous attachments. If the juxtaposed bone is diseased, the destruction of the affected

articular surface and of the epiphyses, with formation of cancellous sequestra and/or cavitation, can occur (Ortner 2003). If the infection is found on or near a growth plate this will lead to a growth deformity, deficit, or can even lead to excessive growth (Ortner 2003). Joint tuberculosis can heal, often terminating in bony ankylosis with varying degrees of bone density loss (Ortner 2003).

According to Ortner (2003) tuberculosis of the hip is the second most frequently affected bone and joint site after the spine (also Aufderheide and Rodríguez-Martín 1998). The majority of cases start in childhood and the disease is rare after 25 years of age. The maximum age of onset is four to six years of age with another small peak around puberty. However, Aufderheide and Rodríguez-Martín (1998) have stated that the most common ages to be affected are between three and ten years. Over 90 per cent of cases occur during the first decade of life and, according to Fraser (1914), 50 per cent of those cases appear in the interval between three and five years of age. It is rare in children prior to learning to walk (Miller 1982). The way the hip is constructed permits the infection, which usually starts in the femur, to cross easily into the joint space (Ortner 2003).

The infection usually begins in the epiphysis of the femur and sometimes in the synovial membrane. The first signs and symptoms are often muscle spasm and a limp. It seems to be a disease that nearly always affects children. It is equally distributed between boys and girls, although boys seem to have a slightly higher occurrence, which Fraser (1914) explains as their increased liability to injury (i.e. they play rougher). Resnick (1995) reports that tuberculosis of the hip may reactivate after local resistance has decreased such as a result of trauma, especially in the hip. When the disease progresses, the patient will mostly weight bear on the normal leg; muscle atrophy will appear early and resistance to extension, adduction and internal rotation are usually present. By this time a cold abscess has often formed (Lincoln and Sewell 1963). The end result of advanced hip tuberculosis is the extensive destruction of bone with an upward extension of the acetabulum that may lead to a partial or complete dislocation (Aufderheide and Rodríguez-Martín 1998). If the dislocation of the femoral head and neck are complete then another 'acetabulum' (neo-acetabulum) is formed on the lateral surface of the iliac wing. This may appear to resemble a congenital dislocation but the head of the femur will be more eroded in tuberculosis, and there will be no groove for the *ligamentum teres* which will have been destroyed by the infection before the dislocation occurred. The first acetabulum will not be rudimentary and the neo-acetabulum will show signs of infection. If there is extensive destruction of the acetabulum, the interior/pelvic aspect will show lytic lesions, and perforation of the pelvic floor can occur with the remnants of the proximal femur (Ortner and Putschar 1985, Ortner 2003). The main

differential diagnosis for tuberculosis of the hip remains septic arthritis. In septic arthritis the destruction is much more limited and the process is rapid. No upward or central dislocation is usually observed. There is little, if any, bone loss of the joint constituents, terminating in bony ankylosis, although in infants septic arthritis might result in the complete destruction of the femoral head, but this condition is usually accompanied by osteomyelitis of the bone's shaft (Ortner 2003).

4.2.2.3 Tuberculous disease of the knee

The majority of cases of tuberculosis of the knee appear in infancy, childhood and adolescence, with around 50% of cases appearing before the age of five years, with nearly equal distribution between the sexes (Fraser 1914, Miller 1982, Aufderheide and Rodríguez-Martín 1998, Ortner 2003). Aufderheide and Rodríguez-Martín (1998) state that hip involvement is secondary only to the spine but that in some series (they do not name which) the knee actually surpasses the hip as the second most affected joint. They also state that the knee joint is affected in around 16% of cases, and the hip affected in 20% of cases (Aufderheide and Rodríguez-Martin 1998)! The majority of cases begin as synovial tuberculosis and may remain that way. However, the disease may also spread along the capsular insertions of the femur and the tibia along the attachments for the cruciate ligaments. In this case there is a linear cortical erosion and undermining destruction of the adjacent portion of the articular surface. There may be large numbers of lytic lesions of the femoral condyles or the tibial plateau if a primary focus (or simultaneous haematogenous spread) with or without a sequestrum appears. These foci of destruction most frequently appear in the femoral condyles or in the tibial epiphysis, and more rarely in the fibula and the patella (Carrol *et al* 2001, Ortner 2003). Synovitis will occur as soon as the joint becomes infected. Swelling may be present, and will be associated with atrophy of the thigh and calf. Again, tuberculous disease of the knee is essentially a children's disease, but it is not as exclusive as hip or spine TB (Miller 1982).

The end result of healing is a bony or fibrous ankylosis (Ortner and Putschar 1985, Aufderheide and Rodríguez-Martin 1998, Ortner 2003). This may be very difficult to differentiate between rheumatoid or septic arthritis in the final stages if there is limited bone destruction. As differential diagnoses, both rheumatoid and tuberculous arthritis are usually accompanied by osteoporosis of the affected limb. Tuberculosis and septic arthritis are more often unilateral compared to rheumatoid arthritis, and rheumatoid arthritis appears more usually after the fourth decade. In the most severe cases, especially in children, dislocation and valgus (knock-knee, or inward bending of knee) or varus (bow-legged, or outwards

bulging of knee joint) deformity of the knee is observed. Generally tuberculosis of the knee in adults is less destructive than in children (Ortner 2003).

4.2.2.4 Tuberculous disease of the ankle

Skeletal disease located in the ankle may start as synovitis resembling a strain. If this is the case, then movements will be restricted, and there will be swelling and pain. The disease is more common in childhood than in later life (Miller 1982, Ortner 2003). There are nearly twice as many boys than girls affected in this location (Fraser 1914), which has again been explained by the greater occurrence of injury in boys.

The tibio-talar joint is the site most affected by tuberculosis in the ankle (Aufderheide and Rodríguez-Martín 1998). It mostly affects children of three years of age (Ortner 2003). The process starts with a haematogenous osseous focus. In tibio-talar tuberculosis of talar origin, the talus is cavitated and will ultimately be destroyed. However, if the disease begins in the tibia there will be extensive destruction of the distal tibial epiphysis and sometimes of the metaphysis. Healing at this site will always lead to tibio-talar bony ankylosis (Ortner 2003). If the disease is advanced the talo-calcaneal joint may become involved at any age, but the disease rarely starts there. If the talus is completely destroyed, tibio-calcaneal ankylosis will develop with a resulting up-tilted calcaneus. This would not be the case in juvenile rheumatoid arthritis, where the ankle can also be affected. The ankle is a weight-bearing joint, and therefore limited perifocal osteosclerosis will occur although Ortner (2003) does not explain further. If the talo-calcaneal joint is involved in isolation, the results will most likely be bony fusion of the talus and calcaneus as this infection is mainly due to a secondary extension of a calcaneal focus. This occurs in older children between the ages of seven and 16 years (Ortner and Putschar 1985, Ortner 2003).

When tuberculosis affects the tarsal bones the talus and calcaneus (especially) are most commonly involved. This is the result of high vascularity in the region and the development of the bones themselves, ossification only occurring at 17-18 years of age, but can be as late as 20-22 years (Schwartz 1995). In early childhood, tuberculosis of the calcaneus may heal without permanent traces because of the effect of growth and remodelling (Ortner 2003).

4.2.2.5 Tuberculous disease of the upper limb (elbow, shoulder and wrist)

Tuberculous disease is much more frequent in the lower than the upper limbs (Fraser 1914, Miller 1982, Resnick 1995, Aufderheide and Rodríguez-Martín 1998) and this is why the upper limb has been regrouped in this section. Pain on movement is usually the first

symptom to appear, and it does so often after trauma. Tuberculous disease of the shoulder joint is rare in children (Aufderheide and Rodríguez-Martín 1998), and it occurs much less frequently than tuberculous disease of the hip and knee (Miller 1982, Ortner 2003). In children, tuberculous disease of the shoulder might heal, and septic arthritis is again the main differential diagnosis. There is much less extensive bone destruction, and the lateral grooving and undermining defect seen in hip TB is not seen on the humeral head (Ortner 2003).

According to Fraser (1914) tuberculous disease of the elbow is relatively common and affects girls more often than boys, while Ortner (2003) believes that there is a higher prevalence of male cases and that the right side is three times more affected than the left. Tuberculous disease of the elbow is the most common joint for tuberculosis in the upper extremity with the majority of lesions appearing between one and twenty years of age (Ortner 2003). The osseous focus is most frequently seen in the distal humerus (Aufderheide and Rodríguez-Martín 1998), followed by the proximal ulna and, finally, the proximal radius. It is also not uncommon in very young children to see a tuberculous focus in the olecranon as a part of multiple skeletal foci (Ortner 2003). Again, tuberculosis here may heal in children, resulting in bony ankylosis. It might be impossible to differentiate tuberculosis here from rheumatoid or septic arthritis if there is ankylosis without severe bone loss (Ortner 2003).

Disease of the wrist joint is distinctively rare in children and occurs mainly following an extension from a carpal infection (Aufderheide and Rodríguez-Martin 1998). The right side is more often affected than the left and is said to appear in a proportion of about two per cent of all bone and joint cases (Miller 1982, Lincoln and Sewell 1963). The joints affected by tuberculous disease will differ between children and adults. In children, the carpometacarpal joint is usually involved and the radiocarpal joint is spared. In adults, the disease begins in the radiocarpal joint and spreads to the other joints of the hand (Ortner 2003).

4.2.2.6 Tuberculous disease of the hands and feet

According to Hardy and Hartmann (1947) tuberculous dactylitis occurs in 0.6 to 6% of paediatric TB cases, while Resnick (1995) reports that it can be found in 0.5 to 14%. It occurs mainly in children of less than two years of age and also occurs eight times more often in the hands than the feet (Hardy and Hartmann, 1947, Hakim and Grossman 1995). Dactylitis occurs chiefly in infants and young children (Aufderheide and Rodríguez-Martín 1998). It consists of involvement of the tubular bones of the hands and/or feet with exuberant periostisis resulting in *spina ventosa* (Panuel *et* al 1999, Ortner 2003). The commonest period of incidence is during the first five years of life (Fraser 1914, Lincoln and Sewell 1963,

Resnick 1995). When it is seen in older children, it is usually associated with obvious tuberculous disease elsewhere. The basic pathology is a tuberculous endarteritis, and the greater frequency in children is usually associated with the higher vascularity of these bones during infancy. The first abnormal sign is usually thickening of the bone, which is often ignored as it is painless. If the swelling goes unchecked, it will continue, and the skin overlying the infection will become thin, glossy and dark.

4.2.2.7 Other sites of bone and joint tuberculosis

Tuberculous disease of the sacro-iliac joint is uncommon in all periods of life but it is distinctly rare in children (Miller 1982). Tuberculous disease of the bones of the skull is usually secondary to tuberculosis in other parts of the body (Miller 1982). The majority of cases occur in the cranial vault in children under ten years of age. The disease is usually spread through the haematogenous route (Ortner 2003), and the disease in the lower jaw will often make its appearance with the permanent dentition.

The ribs are a region that might also be affected by tuberculous disease. They may become infected by primary tuberculous osteomyelitis, or they may become involved in tuberculous disease via a neighbouring infected part such as the pleura when the disease appears as periostitis (Fraser 1914). The disease process creates a lytic lesion with fusiform enlargement of the involved area and often perforations of the cortex leading to chest wall abscesses. The middle ribs are more often affected than the upper or lower ones with ribs four through eight most commonly affected by periostitis according to Kelley and Micozzi (1984) (Ortner and Putschar 1985, Ortner 2003). According to Wassersug (1941) it usually occurs in young adults and is seen more often in males than females (3-5:1). Tuberculosis disease, as seen in the rib in the form of periostitis, could become a very useful diagnostic tool for identifying tuberculous disease in skeletal remains. Kelley and Micozzi (1984) were the first to look at ribs in this context. They stated that from their study of the twentieth century Hamann-Todd collection, Cleveland, USA (of 445 skeletal individuals with documented causes of death) they found that, of the 39 individuals exhibiting rib lesions, 31 had a known cause of death as tuberculosis and they concluded that the frequency of skeletal lesions may actually be twice that reported in the medical literature. They established that the lesions found on the ribs took one of two forms: either a diffuse periostitis or localized abscesses. They also conclude that the diffuse lesions (periostitis) are more common than the localized ones (abscesses). They found around 16% of the individuals had skeletal tuberculosis if they included the rib lesions and the actual known cases of skeletal tuberculosis. They also found that the left side was actually more affected than the right and the shaft of the rib more affected than head neck or

angle. Roberts *et al* (1994) did a similar study on the twentieth century documented Terry skeletal Collection curated in Washington, USA. Both these studies had known age, sex and cause of death for most of their individuals, although Roberts *et al* (1994) state that there are some doubts as to the reliability of this information; the sample is biased to people with a low socio-economic status and the causes of death might not be entirely accurate. They established 52.1% (215 of 413 individuals with known cause of death) had rib lesions and a cause of death listed as pulmonary disease (which included pulmonary tuberculosis and non-tuberculous disease). They also found that 157 of the 255 people who died from pulmonary tuberculosis had lesions on the ribs (61.6%), and that the head, neck and angle of the rib were mostly affected in those having died from tuberculosis while in the non-tuberculosis group the most affected part was the anterior part of the shaft. Chundun (1991) also established that the head, neck and angle of the ribs were mostly affected by tuberculosis in an archaeological sample. Lambert (2002) and Santos and Roberts (2001) have stated that proliferation lesions on the ribs have proved difficult to use as a diagnostic tool and these lesions tend to be radiologically invisible and can therefore go unnoticed in clinical settings. Both studies show that subadults show more rib lesions than adults but conclude that this is not pathognomonic of tuberculosis as the single source of infection (Roberts 1999b). A clinical study done by Eyler *et al* (1996), where they assessed the width of ribs in patients with chronic pleural disease, was able to demonstrate that rib enlargement was displayed radiologically in some cases of chronic pleural disease. Their four groups consisted of 1) 41 patients with widened ribs and pleural disease, 2) 30 patients with clinical tuberculosis for 5 years or more, 3) 25 patients with clinical diagnosis of empyema, and 4) a control group of 60 patients. They found that rib enlargement was mostly associated with tuberculosis, and they found no rib enlargement in association with pleural disease of short duration. These studies all show that tuberculosis and rib lesions can be associated in both the archaeological and clinical record, and therefore more research needs to be done in this field to determine whether it will be possible at some point to identify precisely whether a rib lesion is due to tuberculosis, particularly just by identifying the site of the lesion.

4.2.3 Miliary tuberculosis (haematogenous spread)

The clinical use of this term according to Carrol *et al* (2001) is a pathological process where the haematogenous spread of the mycobacteria has not been controlled and this results in multiple disseminated foci in different organs such as the liver, lungs, spleen, bone marrow and brain. The spectrum of manifestation of this disease depends on the number of organisms released and to host susceptibility. Smith and Marquis (1987) usually categorise this spread into three clinical forms: 1) an occult dissemination (which occurs usually before tuberculin

reactivity develops (Hakim and Grossman 1995)), 2) a protracted multiform haematogenous disease, rarely seen in the therapeutic era; in the pre-therapeutic age this form often resulted in TB meningitis (Hakim and Grossman 1995), and 3) a miliary disease which is analogous to bacteremia with pyogenic bacteria. It is, according to Hakim and Grossman (1995), the most commonly recognised form of disseminated infection. It is often an early complication of TB in infants and young children, occurring three to six months after the onset of primary TB. Many children with acute miliary TB will develop meningitis if they are not diagnosed and treated promptly (Hakim and Grossman 1995). According to Lincoln and Sewell (1963) a single generalised dissemination, and repeated or protracted dissemination, are also means by which this disease can spread. It is one of the most dangerous forms of tuberculosis along with tuberculous meningitis. This type of TB has the ability to kill or cripple children if it is not diagnosed and treated rapidly enough. Clinicians will only diagnose miliary tuberculosis when a radiograph shows the classical appearance of reticulonodular shadowing (a somewhat net-like chest radiographic pattern, with nodular thickening at the intersections of the lines; or a non-specific interstitial pattern) (Carrol *et al* 2001).

4.2.4 Tuberculosis of the meninges

Tuberculous meningitis is the most important complication of disseminated spread of tuberculosis and also accounts for the majority of morbidity and mortality in tuberculosis in children (Miller 1982, Hakim and Grossman 1995, Carrol *et al* 2001). Before effective chemotherapy was available, tubercular meningitis was almost invariably fatal. Most cases occur within two years of primary infection (Miller 1982). However, according to Hakim and Grossman (1995) it is estimated to occur in one of every 300 primary infections, and develops around three to six months after primary infection, mostly in children between six and 24 months of age. As the tubercle bacilli circulate through the lymph and blood during primary infection, they may lodge in the cerebral cortex. If the bacilli fail to grow, then no tubercular focus is created. When they do grow, a caseous lesion forms and increases in size until it reaches the overlying meninges and infects the subarachnoid space. In some instances the tuberculous focus may suddenly discharge caseous and tubercle bacilli into the cerebrospinal fluid and fulminating tuberculous meningitis can then occur (Lincoln and Sewell 1963). The diagnostic signs and symptoms are irritability, lassitude, listlessness, headache and vomiting. Thirty per cent of patients with tuberculous meningitis still die today despite receiving anti-tuberculous therapy, and the delay in diagnosis and treatment are seen as the main factors in this mortality rate (Thwaites *et al* 2002).

4.2.5 Tuberculosis of the pleura

Pleurisy with effusion is a usual complication of primary pulmonary tuberculosis (Donald and Byers 1998). It is also one of the most common complications in children. The effusion develops from the discharge of bacilli and/or antigenic material into the pleural cavity from a subpleural parenchymal focus or lymph node (Hakim and Grossman 1995). While pleurisy might develop at any age, the most commonly afflicted are children of school age (around six years of age). There are twice as many boys as girls who develop pleural effusion, but this has not yet been explained satisfactorily in the literature (Lincoln and Sewell 1963, Miller 1982, Hakim and Grossman 1995). The prognosis of TB pleurisy in children is good compared with other sites of infection, and with the same process in adults (Hakim and Grossman 1995).

4.2.6 Other types of TB affecting children

4.2.6.1 Superficial lymph nodes

Lymphadenitis (especially cervical glands) is usually an early complication of primary tuberculosis and appears most often in the first 6 months after infection. It will appear in five to 15% of children with TB (Lincoln and Sewell 1963, Hakim and Grossman 1995). The most common mode of infection for this type of tuberculosis is by way of the blood and lymph route. Clinical evidence of the disease is found by enlargement of the superficial lymph nodes during the first few months after onset. An abnormal chest radiograph can be helpful but it is often normal even with TB cervical adenitis (Jawahar *et al* 1990 in Hakim and Grossman 1995). This type of tuberculosis has been recognised since early times and would be referred to as *scrofula* in the past. It is also the most common form of extrapulmonary tuberculosis. It was most likely to be caused by *Mycobacterium bovis* in the past, and acquired by drinking unpasteurised milk.

4.2.6.2 Cutaneous tuberculosis

Involvement of the skin is not common and is divided into four groups: direct exogenous inoculation, local extension, haematogenous spread and hypersensitivity (Hakim and Grossman 1995). There are also non-specific skin reactions such as *erythema nodosum,* which can be found in tuberculous and non-tuberculous cases. This occurs most usually in teenage girls as an early manifestation of TB and appears on the legs and occasionally on the arms as large painful nodules (Lincoln *et al* 1944). *Lupus vulgaris* is a form of cutaneous tuberculosis that is rare in children, although when it is found it is most often seen on the cheeks (Hakim and Grossman 1995). It is very hard to diagnose as it exhibits considerable variability in its morphological features and is included in the differential diagnosis of many

other skin disorders (Kiss *et al* 1999). It is thought to be found more often in females and is thought to represent the spread of TB to the skin from a remote internal source in the setting of a high degree of tuberculin sensitivity (Moschella and Cropley 1992). Papulonecrotic tuberculids are the skin lesions that are frequently seen in children and adolescents. The lesions resolve promptly with TB therapy (Held *et al* 1988). They are a very important diagnostic sign as they indicate recent spread through the blood. They are usually found on the back of the thighs and legs and on the posterior aspect of the arm (Lincoln and Sewell 1963).

4.2.6.3 Tuberculosis of the eye

Tuberculosis of the eye is uncommon in children but may be the result of a primary infection, post-primary infection or a hypersensitivity reaction (Hakim and Grossman 1995). The conjunctiva and cornea are the most common sites for tuberculosis of the eye in children (Lincoln and Sewell 1963), while Hakim and Grossman (1995) also add the uveal tract. Phlyctenular conjunctivitis nodules are small greyish, jellylike nodules that do not contain tubercle bacilli but are found regularly in cases of tuberculosis. Phlyctenular conjunctivitis is important in the diagnosis of tuberculosis as it is usually due to tuberculin sensitivity (Miller 1982, Hakim and Grossman 1995).

4.2.6.4 Chronic pulmonary tuberculosis

This is also known as tertiary tuberculosis, phthisis, adult, or reinfection tuberculosis. This type of tuberculosis differs greatly from primary pulmonary tuberculosis. The tubercle bacilli encounter an accelerated reaction in tissues already sensitized to tuberculin that tends to localize the organisms and prevent progression (Miller 1982). Chronic pulmonary disease usually remains a pulmonary disease and is unlike primary tuberculosis as the initial phase of a systemic infection. Chronic pulmonary TB can occur in children who have had primary TB. They may have an exogenous or an endogenous reinfection. Many investigators, according to Lincoln and Sewell (1963), have found that the risk of developing chronic pulmonary tuberculosis is greater for the adolescent and young adult than for the young tuberculous child. The risk of reinfection is also greater for girls than for boys. According to Miller (1963, 1982), in the 1950's, until 10 years of age the numbers of boys and girls affected were equal, but from 10-15 years there were twice as many girls.

4.3 Summary

This chapter has discussed the types of tuberculosis that affect children, and potentially the patients who suffered from tuberculosis at Stannington. There are wide ranging different types of tuberculosis and they also affect children differently to their parents. Primary tuberculosis is the type of TB most studied in children as it is in childhood that the primary infection most often occurs. However, children suffer from many other types of tuberculosis that are not given as much space where tuberculosis in children is discussed. Now that general information on tuberculosis has been covered, along with the understanding and treatment of tuberculosis in the past, and also the types of tuberculosis from which children suffer it is now possible to move on to the data collected from the Stannington medical files. The next chapter deals with the methods used to obtain permission to work on the files from Stannington at the Northumberland Record Office and as well as how the data was collected and analysed.

Chapter 5

Materials and Methods

Let me first of all tell you something of the origin and conception of the novel, just as the events of my life brought them about
(Thomas Mann, *The making of the Magic Mountain,* 1927:720)

This chapter deals with the methods that were used to access, record and analyse the patient records from Stannington sanatorium held at the Northumberland Record Office in Morpeth, Northumberland. The medical records of the children admitted to Stannington sanatorium are normally closed to the public. Therefore, to access these records, permission was needed from the Northumberland Medical Ethics Committee and an NHS doctor had to be used in order to facilitate access (**Appendix C**). To obtain permission, Dr Nicol Black of the Communicable Disease Control Unit (CDCU) at Newcastle General Hospital was approached and agreed to act as 'supervisor' for the data gathering. Following receipt of permission (**Appendix D**), work was begun on the records. Admission and discharge sheets, as well as medical records, were recorded (**Appendix E**). Files were entered into a database directly using the Access 2000 program (**Appendix F**). The confidentiality of the former patients had to be guaranteed as it was required that none of the records should be recognisable to any former patient. Therefore, only a limited database is included with this work (including record number, sex, age, rural or urban origin, year of admission and discharge, weight at admission and discharge, time in sanatorium (in days), result of treatment, contact, type of TB, side affected, bones affected, radiographs taken, drugs given, surgery, tuberculin test and treatment given). A complete database will be held at the Northumberland Record Office to be accessed only when an application is made to the Medical Ethics Committee (containing those variables listed above and the following: date of birth, address, date of admission and discharge, details on contact/family history, personal/TB history, part affected, radiography report, consent for surgery, reason for discharge, miscellaneous, and where admitted from).

No work had ever been done on these records which hold information about tuberculosis in children in the recent past. The wealth of information they contain permits us to provide historical information and epidemiological predictive models which will be of help to today's clinicians, medical historians, and palaeopathologists as very little work exists on childhood tuberculosis and this research is based on an archive collection of historical data. Although it is believed that approximately 7,800 records from Stannington are held at the

Northumberland Record Office in Morpeth (Sue Wood, Senior archivist, pers. comm.), only 1,897 medical records available for study (24.3%). The initial plan was for a sample to be taken from pre- and post- Second World War years but as time permitted, it was possible to record all the medical files archived (n=1,897). Obviously, the number of records for each year held at Morpeth varies as the records were all held in different parts of the buildings of the sanatorium. Furthermore, between 1941 and 1945 it was an emergency war hospital and the patients and records were evacuated to Hexham Hydro.

There are comparatively few records for 1936-1938, 1940-1942 and none at all for 1939. The reasons for this are not quite clear. It could be a result of pre-war and wartime rationing on paper (Poor Children's Holiday Asssociation 1942) or the files might not have survived their transfer to Hexham and back. The Royal Air Force Website (www7) describe that on the 8th of August 1940, the Home Security Report mentioned that "comparatively little damage was done, except to a sanatorium at Stannington (Northumberland) previously reported – and only one person is said to have died from amongst the few seriously injured". The damage was done by mines and not high explosive (HE) bombs, as was first feared. Nothing relating to this event is mentioned in the records at Stannington, although, if it had been, this record could have been lost or destroyed with the move to Hexham Hydro and back. The official report by the Deputy County archivist only mentions regrettable gaps with no other explanation (Steward 1983). Therefore, for the purpose of statistical tests, years with very few files are only included when the sample as a whole is being analysed.

This chapter deals specifically with the methods that were used to generate data that could be analysed for statistical significance. These data were also tested so as to reduce the possibilities that the results seen were due to chance. A chi-square test of significance was used to test the differences between the number of affected males and females and the proportion of bone and joint cases in Stannington compared to the non-bone and joint cases, and a general linear model (univariate analysis using SPSS statistical package) was used to test the time that the children stayed at Stannington in relation to the introduction of chemotherapy, the end of the Second World war and the implementation of the NHS.

The following categories of data were recorded from the files: sex of the patient, age at admission, address, weight at admission and discharge, health at admission and discharge, radiography reports duration of stay in Stannington, rural versus urban origin, socio-economic status/housing conditions, contacts, type of tuberculosis, results of treatment, pre- versus post-antibiotics eras, pre- and post- Second World War, pre- and post- implementation of the

National Health Service, month admitted to Stannington and the treatment provided to the children suffering from tuberculosis.

The medical records were accessed by filing in a 'demand sheet'. The archivist would then retrieve the box containing the medical records. One 'demand sheet' had to be filled out per item requested. About 50 medical files were stored per box, and were classed by year. Until 1945, the files do not contain much information, being relatively incomplete, and consist mostly of name, age, date of birth, address, weight at admission and discharge, and result of treatment. In effect, they contained on average about 60% (18 of 30 categories recorded) of the necessary information. They improve in the years afterwards, being relatively complete from 1946 until the sanatorium's closure in 1953. The files at this point are between 90 and 100% complete. These files contain the same information as those previously mentioned but also include details on treatment and radiographic reports.

There were certain problems encountered at this point in the work. To begin with, the handwriting in the files was sometimes illegible, either it had been 'erased' by time, or was just badly written by the concerned. Another problem encountered was the change in medical terminology that has occurred over time. For example, in the Stannington records MMR denoted mass miniature radiography whereas today it would denote the three diseases of mumps, measles and rubella. The author of this thesis does not have any medical credentials and therefore help with this area of the research was provided by Holger Maehle from the Philosophy Department at Durham University. Other abbreviations such as C.L.O (cod liver oil) were cited as treatment and lead to some initial confusion. The names of the drugs were also hard to establish as they also changed over time, and when more than one doctor examined a child, different diagnoses or treatments could be given. Finally, the problem of the incompleteness of the files made completion of the database difficult because it was hard to establish whether the information was negative or not given (i.e. whether a child had not been given drugs (negative), or whether the child had been given drugs but the information is missing from the records)

5.1 Male and female sex distribution at Stannington

The sex of the patient was taken from that provided in the files. This information was provided for all 1897 cases. The sex of the patient was recorded to establish whether one sex or the other were more at risk of contracting tuberculosis and one would be more predisposed to a certain type of tuberculosis.

5.2 Age at admission at Stannington

The age of the patient was, again, directly derived from the information provided in the files. If no specific age was given, but a date of birth was provided, it was possible to calculate the patient's age on entry into the sanatorium. When no age or date of birth were provided it was obviously impossible to establish age; this occurred in 14 male and 16 female cases. The age of the patient was recorded to establish whether any specific age groups were more susceptible to tuberculosis or whether certain age groups were more vulnerable to certain types of tuberculosis.

5.3 Duration of stay at Stannington

The time spent in the sanatorium was calculated by counting the days from the date of admission into the sanatorium until discharge. For example, if a patient was admitted on June 7th, 1941 and discharged on September 14th, 1941 the number of days would be calculated as 23 days in June + 31 days in July + 31 days in August +14 days in September = 99 days + one day (the 7th the day of admission). Therefore, this patient would have been in Stannington for 100 days. The numbers was recalculated for children who were admitted to Stannington more than once. The number of days when the children were temporarily away from Stannington (for example to receive surgery at Newcastle Hospital) were not calculated as they were deemed to have remained patients at Stannington during their stay in hospital (i.e. their files had not been transferred to the hospital where the operation took place). The leap years were also taken into account with 1936, 1940, 1944, 1948, 1952 all being leap years when February has 29 days.

This information was collected to identify any difference in duration of stay between tuberculosis patients. For example, were children suffering from one type of tuberculosis staying longer in the sanatorium than children with another type of tuberculosis? Did any of the treatments require the children to stay in the sanatorium for long periods of time? In a later section, the results of treatment analysis will also be divided into the types of tuberculosis.

5.4 Rural versus urban areas of origin for admissions

When asking whether patients came from rural or urban areas, the data were accessed in two ways. The first was to take the address from the file and consult two maps, dated 1931 and 1951, provided by the Ordnance Survey (**Fig 16a, 16b**), and the second was to consider the census for 1951 (**Fig 17a, 17b, 17c**). It was then possible to look at which region the child originated, and then attribute it to a rural or urban area from the addresses provided in the files. The county reports of the censuses provide maps that indicate whether an area was urban or rural (General Register Office 1954a, b, c). These were used in association with Ordnance survey maps from 1931 and 1951, where any area with a population density below 400 per square mile was considered rural, and anything above was urban. For example, if a child came from Newcastle, the information from the census would indicate that it was an urban area. This was then added to the information from the Ordnance Survey maps that also showed that the patient came from an urban area. When in doubt the information from the survey maps took precedence as they had the most detailed information. For the purpose of this work it should be noted that *urban* pertains to a population living in a city or town with its own government and who generally find employment within developing industries. *Rural* relates to a population living in the countryside and practicing agriculture (Hanks *et al* 1979, cited in Lewis *et al* 1995). Senior *et al* (2000) state that most studies, which have explored the geographical aspects of the rural/urban divide, draw the conclusions that urban areas tend to have pockets of poor health while the rural areas usually have low rates of mortality and morbidity. Senior *et al* (2000) also state that this pattern is replicated for all major disease classes. However, Gilthorpe and Wilson (2003) state that deprivation devices such as the Townsend index remain insensitive to the rural/urban differences and therefore they conclude that their finding highlight the need to investigate more carefully the role of urban and rural differences across a large diverse geography if we are to explain the outcomes of the components of the depravation index. This is also concluded by Verheij (1996) who believes that after controlling for differences in demographic factors and socio-economic differences the tendency towards believing in better rural health disappears.

This information was recorded to determine where the children had rural or urban origins, as tuberculosis was known to be a disease of urban areas where the population density would be high enough to spread the disease and also whether urban/rural divide correlates with the pulmonary/gastrointestinal tuberculosis rates seen at Stannington.

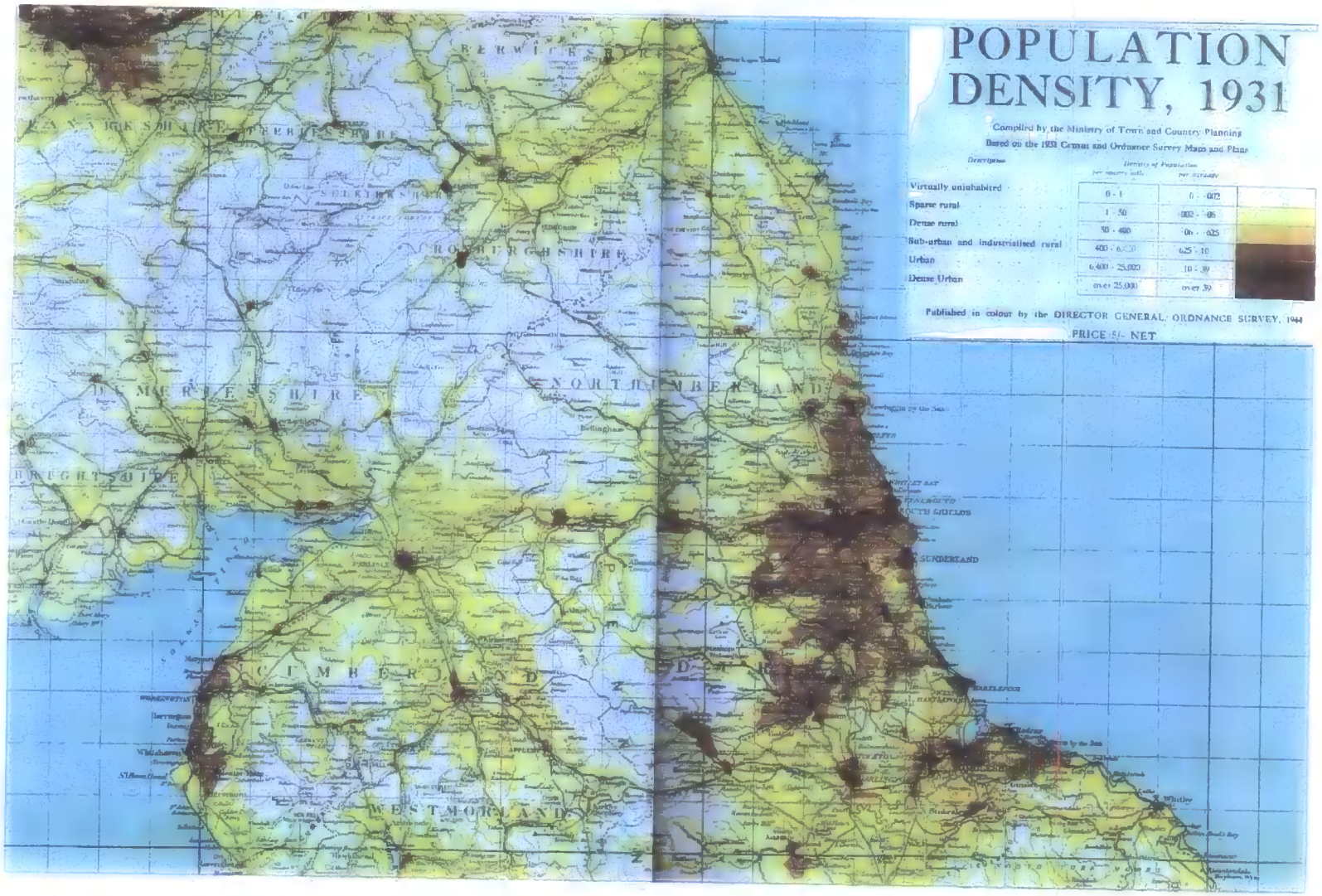


Fig. 16a - Ordnance Survey Map 1931 (Population density)

(Ordance Survey 1944)

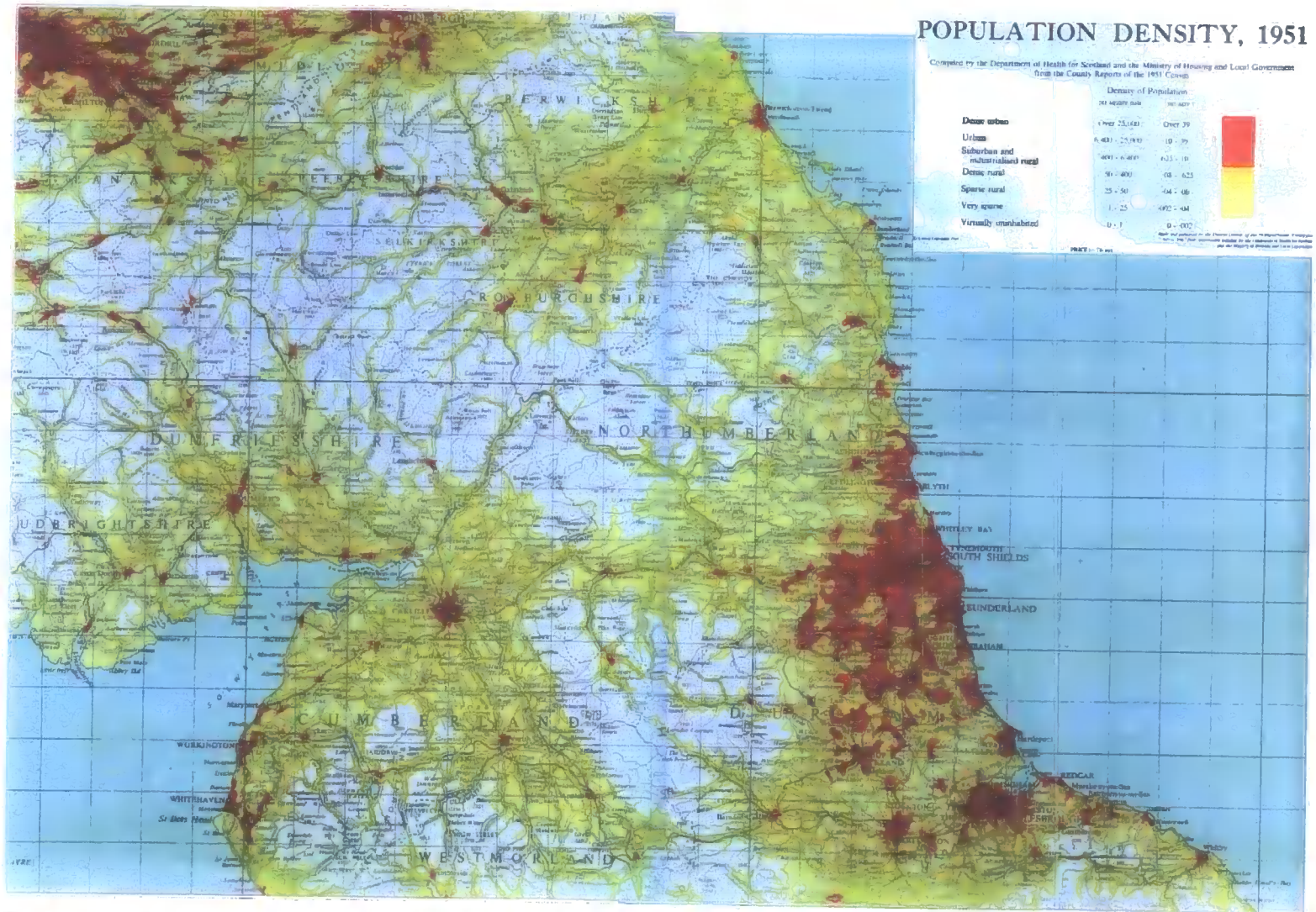


Fig. 16b - Ordnance Survey Map 1951 (Population density)

(Ordance Survey 1961)

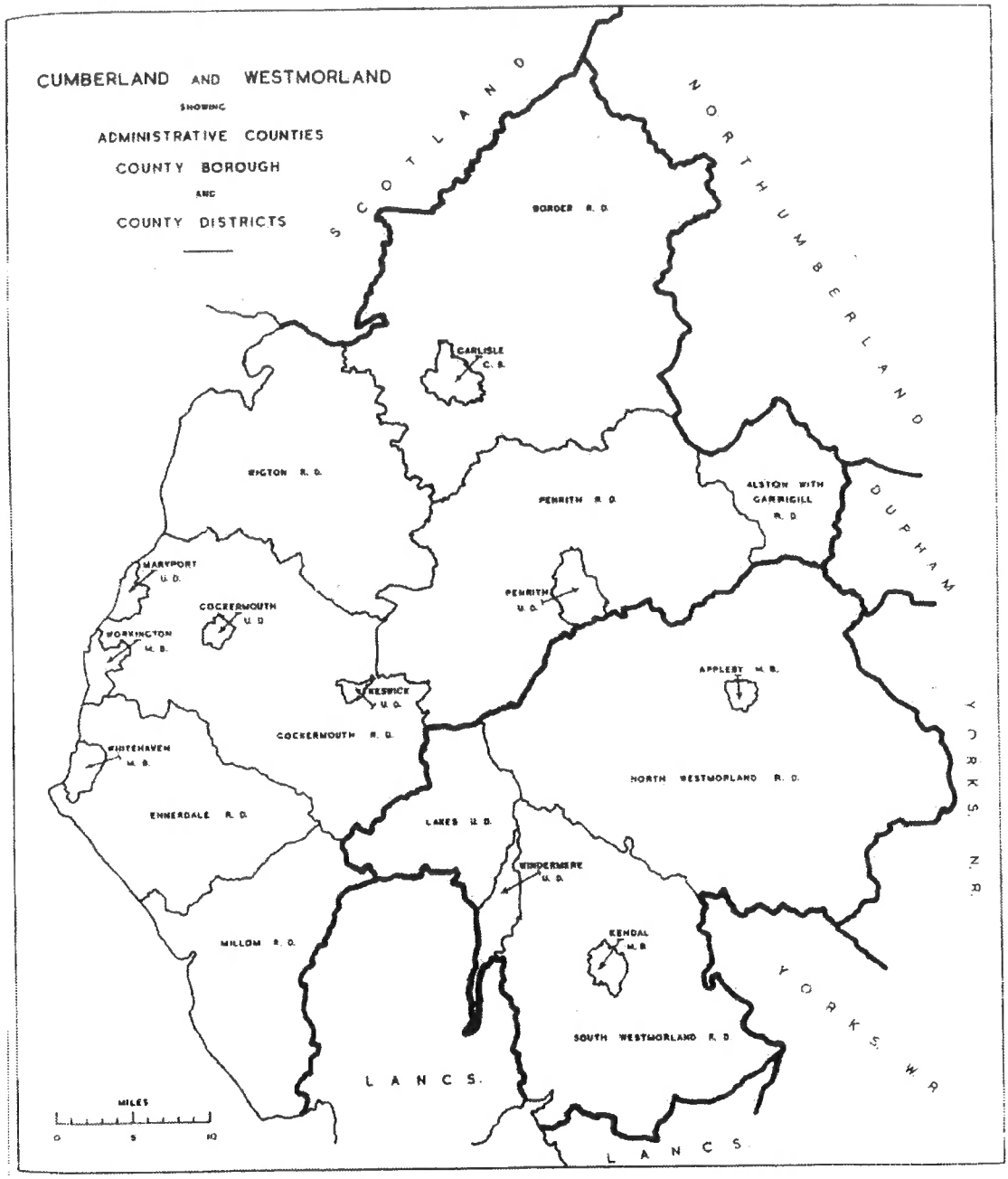


Fig. 17a – 1951 Census map for Cumberland and Westmorland (G.R.O. 1954a)

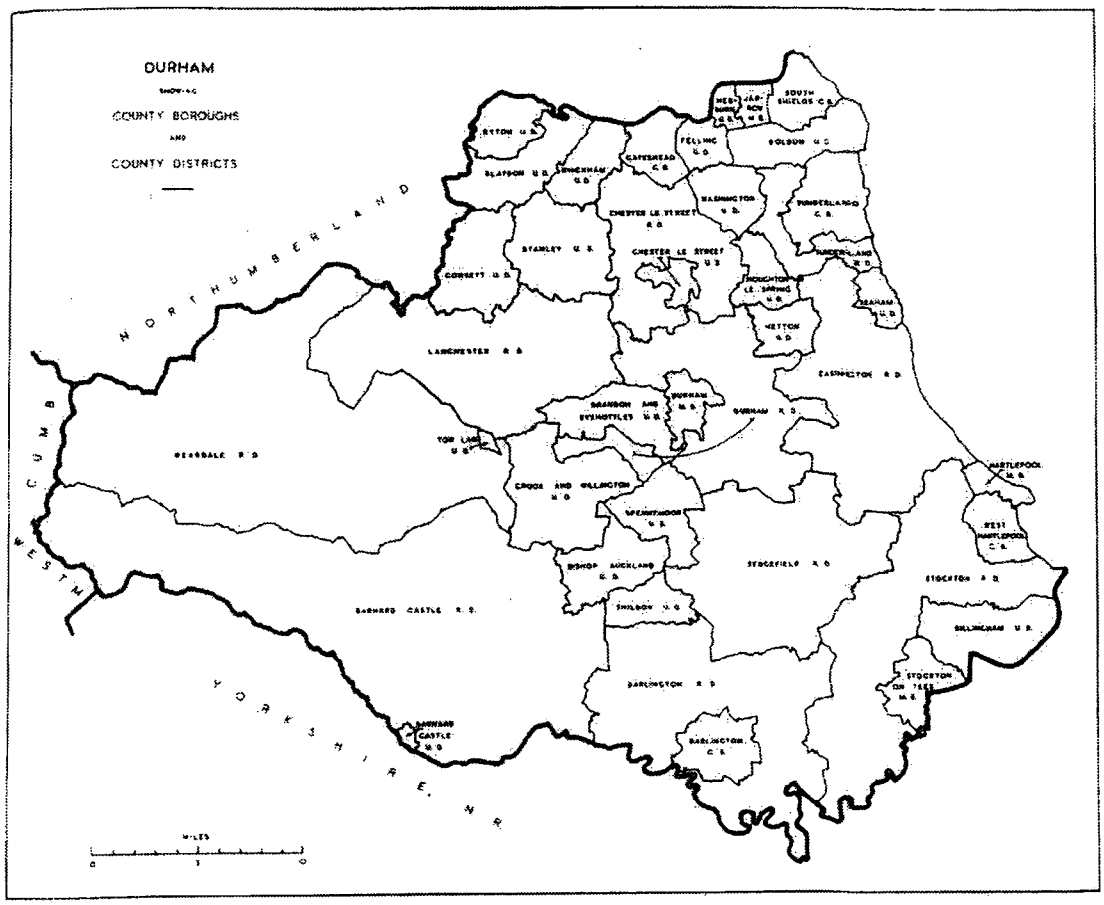


Fig. 17b – 1951 Census map for Durham (G.R.O. 1954b)

5.5 Socio-economic status/housing conditions of the children at Stannington

To determine the socio-economic and housing conditions of the children and their families in this study, it was possible to compare the data from the files to the 1951 Census (Housing Report 1956) and determine the socio-economic status of the patient. From the information in the medical records, it was possible in some cases to establish the size of the family, the number of rooms the family was living in, and in some cases the number of bedrooms in the house was included, as well as the profession and position (employed or not) of the parents.

This data was gathered to identify whether the children came from poor backgrounds, as tuberculosis was thought to be a disease of the poor. Also, many professions had elevated mortality rates from tuberculosis, and if a parent was engaged in this type of work they might be putting the child at an elevated risk of contracting tuberculosis.

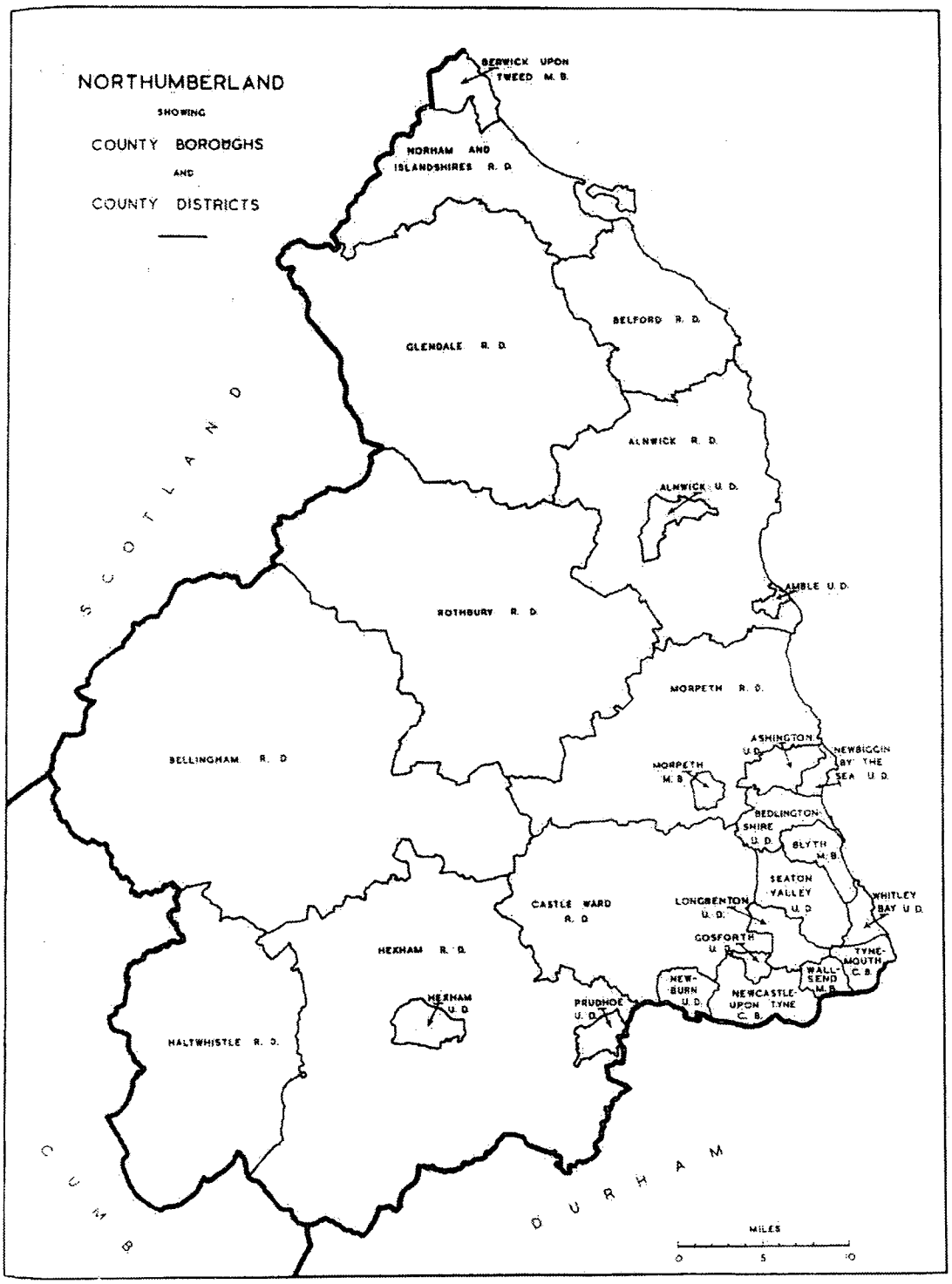


Fig. 17c – 1951 Census map for Northumberland (G.R.O. 1954c)

5.6 Contacts of admissions to Stannington

It was also possible to establish whether a child had a tuberculous contact or not. The information on the contact was taken directly from the file. The contact was recorded 'positive' if a contact was named (for example the father), it was recorded 'possible' if the

contact was not clearly stated (for example, if the file stated that the grandmother was the contact but the child had had no contact with her). It was recorded 'negative' if the file stated that there was no family history or contact with tuberculosis. Finally, if there was no information on this variable, it was recorded 'not available' (N/A). Whether the child had a contact or not was recorded for several reasons. To begin with, if the child had any siblings and a parent was recorded as the contact, it would put the other siblings at a much higher risk for contracting tuberculosis. It was also recorded to establish if there were any trends in who was being identified as contacts. The fathers were away at war for a large part of this study, and it was instructive to see whether there were any increases in the fathers being named as contacts after the end of the Second World War. Finally, it was also important to identify where the children contracted tuberculosis; if not from a member of the close family, who did they contract it from?

5.7 Type of tuberculosis treated at Stannington

The type of tuberculosis was also provided in the information in the records. It was possible to establish in nearly all the cases the type of tuberculosis suffered. However, these types were all regrouped into 'parts affected' to facilitate the analysis of the type of tuberculosis. Therefore, when a patient suffered from primary tuberculosis, pulmonary tuberculosis, pleurisy or primary tuberculosis of the tracheo-bronchial glands these would all be grouped together as 'tuberculosis affecting the lungs'. The types of tuberculosis suffered from were tuberculosis of the abdomen, bone and joints, glands, glands/abdomen, possible lung, lung, meninges, miliary, more than one, possibly more than one, non-tuberculous, not confirmed, not available, skin and other. This variable was recorded as it was important to demonstrate which type of tuberculosis these children were suffering as this will provide information on the epidemiology of tuberculosis in children in the North-East of England. Pulmonary tuberculosis is commonly known to be the type of tuberculosis most people suffer, was this true of the medical records from Stannington? There are also differences between the sides of the body affected in tuberculosis. Contemporary literature indicates that the right side is most likely to be affected; again, recording this information from the files permitted this to be determined.

5.8 Result of treatment at Stannington

This information was provided on the cover and the discharge sheet of each file (**Appendix E**). When these two sources did not correlate, the discharge sheet would take precedence

over the file cover as these were completed by the doctor who had treated the child while in the sanatorium. This was recorded to identify how many children were discharged as 'cured' from the sanatorium, how many did not finish their course of treatment, and how many had to return for further treatment.

5.9 Pre- v post- antibiotic eras: demographic structure

The difference in pre- and post- antibiotic eras (1937 to 1943 and 1944 to 1953) was calculated by considering the number and type of cases before and after the introduction of chemotherapy as a treatment. The chi-square test was not used on this data as there are too few cases recorded before the introduction of chemotherapy. The general linear model was used to determine whether the children stayed longer in the sanatorium when they were receiving chemotherapy or not.

5.10 Pre- v post- World War II: demographic structure

The outbreak of the Second World War in 1939 did not necessarily have a statistically significant effect on the number of children admitted to Stannington, but there were too few cases before the outbreak of Second World War for which we have the medical files to be able to test this theory. The number of cases during the war (1939 – 1945) were also low as the sanatorium patients were evacuated to Hexham Hydro between 1941 and 1945. This information was gathered to determine whether there were any changes in the demography of the population admitted to Stannington and whether fathers returning from the war would have an effect on who was being named as contacts for the children admitted to Stannington. A general linear model was used to determine whether the children's length of stay in Stannington was affected by the Second World War.

5.11 Pre- v post- National Health Service: demographic structure

The implementation of the National Health Service happened on the 5th of July 1948. Pre-and post-NHS admissions were recorded by using the date of admission as a reference. This was recorded to identify any trends in the types of TB, or the treatments that these people received, before and after the implementation of the NHS. Again a general linear model was used to determine whether the time that the children stayed at the sanatorium was affected by the implementation of the NHS.

5.12 Month children admitted to Stannington

The month the child was admitted to Stannington was established by taking the date of admission of the patient to Stannington over all the years of this study. There were a few cases where this information was not available. This variable was recorded as there are some studies that identify the spring and summer months as being more common times for children to contract TB. This information allowed a study of when the children were more likely to be admitted to Stannington and to determine if there were any trends in the children admitted with different types of tuberculosis.

5.13 Treatment of admissions to Stannington

The type of treatment that the children received while in Stannington was established by looking at the individual records and establishing whether the patient had received the following treatments: drugs (streptomycin, PAS, IHN, other), surgery (artificial pneumothorax, adhesions division, arthrodesis, other) or 'other'. The types of treatment considered under 'other' were ultraviolet ray treatment, casts, braces and other types of immobilising apparatus. It was not considered necessary to name 'bed rest' as it was identified in treatment regimes in all cases and, if it was not mentioned, it was considered self-evident. This variable was recorded to identify trends in treatment over time and by type of tuberculosis.

5.14 Summary

Although not all the files were complete, they contained a substantial amount of information that was useful to analyse and interpret in terms of the demographic population of children admitted to Stannington. This will indeed provide information to those studying tuberculosis today about the epidemiology of tuberculosis in children in the past. The information in these files may help in providing an understanding of tuberculosis that will help us build predictive models for those suffering with the disease today. This chapter has considered the data accessed, and methods that were used to analyse the data. The statistical analysis methods used in this study were also described. The following chapter describes the results of the data collected from Stannington.

Chapter 6

Results

"It has long been recognised that tuberculosis often behaved as an opportunistic infection: in other words it tended to flare up in the wake of some other illness...Nobody counted, but it was estimated that a quarter of the survivors of the Spanish flu were later discovered to be suffering from tuberculosis"
(Dormandy *The White Death: a history of tuberculosis*, 1999:235)

This chapter describes the results derived from the data collected from the individual patient records from Stannington sanatorium. It was hard to establish how representative of the actual patients admitted to Stannington this sample was (1,897/7,800 or 24.3% Sue Wood pers.. comm.). It was possible to see from the Poor Children's Holiday Association Annual Reports (1942-1945) that there were, on average, 204 patients at Stannington in 1942, with 216 admissions and 233 discharges, while only 55 medical files were recovered from 1942. The information given for 1943 demonstrates that there were 203 children at Stannington on average in that year; there were also 214 discharged that year, only 173 files were recovered for that year. In 1944 the average daily number of patients was 196 and there were 294 discharges, but there were 227 medical records recovered for 1944 from Stannington. In 1945 there were 183 patients in Stannington in January and 172 patients in by the end of the year; there had been 153 discharges recorded, while there were 117 medical files accessed for that year.

There seems to be some confusing information provided at this point. In Chapter 3, it was established that Stannington sanatorium had 312 beds from 1926 onwards. If all the beds were filled every single year that it was open as a tuberculosis sanatorium, there would have been a maximum of 5,304 beds available in total, making the percentage of recovered medical records at 1,897/5,304 (or 35.8%). To look at the representativeness of the medical files per year that Stannington was used as a tuberculosis sanatorium, the number of files retrieved was divided by the total number of beds available. The numbers are too low before 1942 therefore these have not been calculated. In 1942, 17.6% (n=55) of the beds were in use by people who were admitted in that year. In 1943, these numbers of beds in use rose to 55.4% (n=173), in 1944 this rose again to 72.8% (n=227). By 1945, there were 117 patients admitted using 37.5% of the beds available. In 1946, 63.8% (n=199) of the beds available were in use by people admitted that year. In 1947, there were 51.6% (n=161) of beds available in use and

this number rose to 57.1% (n=178) beds for 1948. The numbers decline slightly in 1949 and 1950 to 49.4% (n=154) and 44.1% (n=138) respectively. In 1951, the number of beds in use increased to 162 (or 51.9%) and stayed at a similar level for 1952 (51% or n=159). Finally in 1953, the date of the closure of Stannington as a tuberculosis sanatoria, there were 150 beds in use by people admitted that year or 48.1%. These numbers do not take into account how many people were still in the sanatorium having been admitted in previous years and the time that they actually spent in Stannington. For example, bone and joint cases were staying on average around three years in Stannington, therefore they would still be using the beds when other patients were admitted into the sanatorium. Also if a pulmonary case was admitted in July, and stayed for the average treatment time of around a year for these types of cases, this child would still be in the sanatorium when the patients of the next year were admitted in January. To achieve the exact number of patients who were in the sanatorium at any one time, every single case would have had to be calculated independently of the others and still, the numbers would have been skewed as a result of the medical files that were never retrieved.

The actual number of medical files accessed for this research can be seen in **Table 8**. This shows that, although not all files are accounted for, there were a large percentage included in this study. It is understood that there are problems with the data as the patients admitted to Stannington do not represent the whole of Britain but only the North-East of England, therefore not a representation of childhood TB in Britain. This chapter will give the results in numbers (instead of graphs) to allow the readers to see the actual numbers which were affected. The following chapter (Chapter 7 Discussion) will provide the graphs to help the reader identify patterns seen in the data.

Table 8 Total number of records by year (male and female)

Total number of records by year	Male		Female		Total
	Number of cases	% of cases	Number of cases	% of cases	Number of cases
1936	1	100	0	0	1
1937	0	0	2	100	2
1938	2	67	1	33	3
1940	2	50	2	50	4
1941	5	38	8	62	13
1942	23	42	32	58	55
1943[1]	83	48	90	52	173
1944	91	40	136	60	227
1945	52	44	65	56	117
1946	104	52	95	48	199
1947	66	41	95	59	161
1948[2]	74	42	104	58	178
1949	76	49	78	51	154
1950	68	49	70	51	138
1951	77	48	85	52	162
1952	81	51	78	49	159
1953[3]	73	49	77	51	150
1954	1	100	0	0	1
Total	879	46	1018	54	1897

The years in bold indicates the years during the Second World War, [1] indicates the development of streptomycin, the first effective anti-tuberculosis drug, [2] indicates the implementation of the National Health Service in Britain, and [3] indicates the closing of Stannington as a sanatorium for tuberculous children

6.1 Males and females sex distribution at Stannington

There were slightly more female than male patients admitted to Stannington between the years of 1936 and 1954 in a proportion of 54 to 46% (1018 to 879) (**Table 8**). The proportion of children in the North (Cumbria, Durham and Northumberland counties were found to be the same proportion as those for England and Wales as a whole (i.e. they were both found to be a proportion of 51% of males and 49% of females). Chi-square analysis (**Table 9**) proved to be statistically significant at the 0.001% level.

Table 9 Chi-square results for male versus females cases at Stannington from SPSS statistical package

1=M, 2=F

	Observed N	Expected N	Residual
1.00	879	967.5	-88.5
2.00	1018	929.5	88.5
Total	1897		

Test Statistics

	1=M, 2=F
Chi-Square[a]	16.510
df	1
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 929.5.

The result of this test was 16.510, or statistically significant at the 0.001% level, indicating that there is very little chance that these numbers came up due to chance. The breakdown of the numbers of male and female cases can be seen in **Table 8** listing the cases of tuberculosis by year. There were more records for males than females admitted to Stannington in 1936, 1938, 1946, 1952 and 1954. There were more records for females than males admitted to Stannington in 1937, 1941-1945, 1947-1951, and 1953. There were equal numbers of records for both the males and females for the year 1940.

6.2 Age at admission to Stannington

The ages of admission for the children admitted to Stannington sanatorium between 1936 and 1954 were between one and 16 years of age. As can be seen in **Table 10**, there was a first peak at the age of six, and a second peak at the age of 13, which is particularly obvious in the female cases. There were also a higher number of female cases above the age of 13 years compared to the male cases.

6.3 Duration of stay at Stannington

The average number of days spent at Stannington can be seen in **Table 11**. Here time spent in Stannington has been separated into the different types of TB from which the children suffered. However, not all the different types of TB had the same number of cases so this is taken into account by taking care with conclusions made on types of tuberculosis with very

few cases (i.e. glands/abdomen, possible lung cases, skin, other, meninges, miliary, possibly more than one, not available and not confirmed). There were also 37 male and 49 female cases who had been admitted to Stannington previously; these cases may have been in Stannington suffering from another form of TB previously or, more often, they had a resurgence of the disease and needed to be readmitted to Stannington. These were included in the same table and can be seen in the 'readjusted' column for both the males and the females. There were major differences in the length of stay for the male bone and joint cases, glands/abdomen case, possible lung (?lung) and other cases. The females show an important difference in numbers of days admitted to Stannington for the bone and joint cases, the possible lung cases and the children suffering

Table 10. Age at admission for males and females (all years)

Table for age at admission (all years)					
Ages	Male		Female		Total
	Number of cases	% of cases	Number of cases	% of cases	Number of cases
1	4	66	2	34	6
2	24	43	32	57	56
3	70	55	58	45	128
4	67	51	65	49	132
5	79	52	74	48	153
6	84	50	83	50	167
7	69	52	64	48	133
8	63	49	65	51	128
9	62	50	63	50	125
10	67	43	88	57	155
11	54	38	89	62	143
12	65	43	87	57	152
13	83	46	96	54	179
14	48	37	83	63	131
15	24	35	45	65	69
16	2	20	8	80	10
N/A	14	47	16	53	30
Total	879		1018		1897

from more than one type of tuberculosis. The children who stayed the longest were the bone and joints cases for both the males and the females (except for the one male readjusted case of glands/abdomen who returned to the sanatorium more than once to get treatment). The children who spent the least amount of time in the sanatorium were the non-tuberculous cases and those suffering from tuberculosis of the meninges.

6.4 Rural versus urban areas of origins for admissions

It was possible to establish that most of the children came from urban areas, especially Newcastle and Gateshead. There were 1642 cases from urban areas (86.6%), and 28 other cases coming from 'possible' urban areas (1.5%). There were 79 children from rural areas (4.2%), and another 22 from possible rural areas (1.2%). There were 29 children from 'colliery towns/villages' (1.5%). This information was not available for 97 children (5.0% of the total records) **(Table 12).** The urban centres, providing the most children admitted to Stannington, are given in **Table 13**. The urban areas which had low numbers of children admitted to Stannington (less than 3) were not included. If they had been included it may have been possible to identify the people and, because one of the conditions of this study was

Table 11 Average number of days in Stannington for males and females by type of TB (all years)

	Average number of days in Stannington			
	Male	Readjusted	Female	Readjusted
Abdomen	305	343	314	324
Bone and joint	1082	1204	969	1090
Glands	223	278	310	314
Glands/Abdomen	218	1383	-	-
Lung	280	285	424	428
?Lung	274	346	333	729
Meninges	104	104	175	175
Miliary	339	339	333	333
More than one	458	479	392	446
More than one ?	292	292	308	308
Non tuberculous	179	179	99	103
Not available	362	362	504	504
Not confirmed	72	72	-	-
Other	145	282	247	247
Skin	148	148	-	-

'Readjusted' in this table refers to the cases who were admitted more than once to Stannington. The numbers in the male and female columns are taken for the last stay (in which the file was archived) and the readjusted columns take into account all their previous stays in Stannington

confidentiality, this would not have been upheld. The numbers from **Table 13** account for 1301 of the urban cases out of 1642 (79.2%). The rural addresses have not been shown in a table as they would make the cases easy to identify. This is because individual cases came from different rural areas, i.e. only one child came from one particular rural area, and would therefore be identifiable. The types of tuberculosis will be also looked at in terms of rural and urban differences in section 6.7.

Table 12. The origin of admissions to Stannington?

Where did they come from	Number of cases	Percentage
Urban	1642	86.6
Possibly urban	28	1.5
Rural	79	4.2
Possibly rural	22	1.2
Colliery	29	1.5
Not available	97	5.0
Total	1897	100

Table 13 Children from urban areas

Children from urban centres	Number of cases
Newcastle	548
Gateshead	180
Blyth	99
Wallsend	54
North Shields	40
Bedlington	36
South Shields	34
Stockton	34
Jarrow	32
Ashington	25
Whitley Bay	22
Hebburn	20
Morpeth	19
Berwick	18
Workington	17
Lemington	16
Newbiggin	15
Darlington	15
Sunderland	15
Hexham	12
Consett	12
Prudhoe	12
Maryport	9
Hartlepool	7
Carlisle	7
Whickham	3
Total	1301

6.5 Socio-economic status/housing conditions of children at Stannington

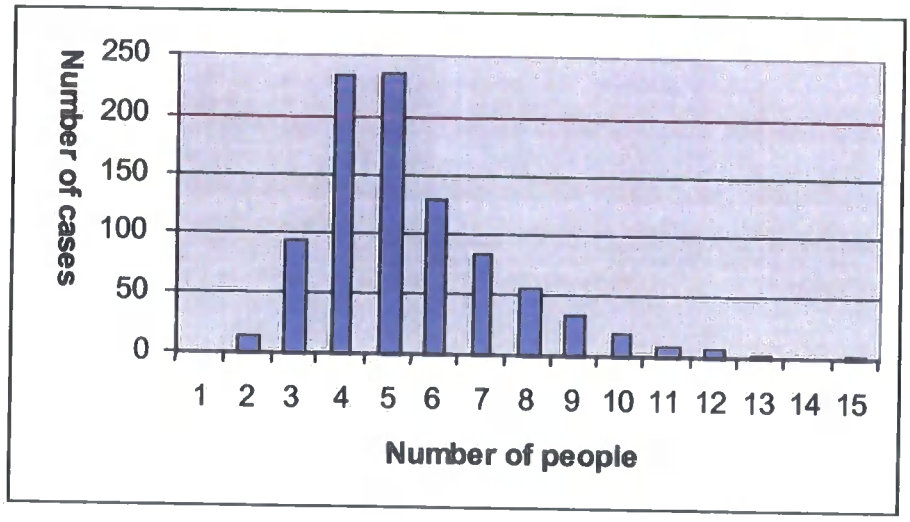
There were 596 (31.4%) children for which information on socio-economic status/housing conditions were given (**Table 14**) in the records. It was possible to establish that 82 (13.7%)

children lived in households that were in good condition. This meant that there were less than two people per room, good conveniences and modern sanitation. It was also considered 'good' if the doctor specified that the conditions were 'satisfactory' (although these parameters are never defined in any of the files). Conditions were seen to be 'bad' in 116 (19.5%) of the cases, where there were more than two people per room, limited conveniences and poor sanitation. The doctor could also specify the conditions to be 'poor' in the medical records (again without giving any specific conditions). The great majority of the files did not permit a distinction to be made between what was 'good' and 'poor' housing conditions. For example, the information in the file could simply read 'the family live in 4 rooms'. This does not give information on how many people lived in these rooms and the condition of the room with the amenities. This was the case for 398 (66.8%) children and was be entered as 'undetermined'. There were 1301 cases that did not provide this information.

Table 14 Housing conditions/ socio-economic factors

Housing conditions/socio-economic factors	
Good	82
Poor	116
Undetermined	398

Fig. 18 Average size of family from patients admitted to Stannington sanatorium (n=919 individuals for which this information was provided)



The size of the families that these children were coming from varied between families of 2 (one child and one parent) to families of 15 (children and parents included). This information

was provided for 919 children (48.4%) but it did not necessarily collate with information on housing conditions or socio-economic status. The distribution of the sizes of the family from which the patients came can be seen in **Fig. 18**. Children came mostly from families of four (n=234) or five (n=236) people (470 cases or 51.1%). It was also possible to establish in 314 cases (16.5%) the number of rooms that these families lived in. There are also data for a further 188 cases (9.9%) on the number of bedrooms they possessed. There were 174 (55.4% or 174/314) families who lived in 3- and 4-roomed houses. The majority of the families had either two or three bed-roomed houses (n=73 for 2 bedrooms, n=79 for three bedrooms, n=152/188 or 80.9% for both two or three bedrooms). It was not always possible to establish whether the home conditions were suitable for the return of the child back home or not as the information was not always available.

As for the occupation of the parents, it was possible to establish the fathers' occupations in 638 cases or 33.6%. They consisted of miners, unskilled labourers, and men in the Forces (miners n=118, labourers n=90, men in Forces n=40, 248/638 or 38.9%) while the mothers were mostly 'housewives' (215/270 cases 79.6%). This information on mother's occupations was provided only in 270 cases (14.2%). These numbers can be seen in **Tables 15 and 16**. These also made possible the determination of the socio-economic group and the social class as determined from the 1951 Census Report (General Register Office 1958). The mothers for which the information was given (n=35, or 13% of cases given) came mostly from socio-economic group number 8 (62.86%, n=22), and 82.86% (n=29) of them came from the Social Class IV or V. There were 20 cases for which the information was not given (7.41%) and of the remaining cases, 215 of 270 were housewives where no information was given on their socio-economic group or social class. Social Class I includes occupations where higher education is needed. Social Class II are intermediate occupations. They are usually obtained through promotion such as in the case of managers of industrial and commercial organisations. Social Class III are skilled occupations, Social Class IV are the semi-skilled occupations and Social Class V are the unskilled labourers. As for the socio-economic group, they are divided into 13 groups. Group 1 includes the farmers, group 2 agricultural workers, group 3 are the same as Social Class I, group 4 are other administrative, professional and managerial positions, group 5 consists of shopkeepers., group 6 clerical workers, group 7 shop assistants, group 8 personal service, group 9 foremen, group 10 skilled workers, group 11 semi-skilled workers, group 12 un-skilled workers and, finally, group 13 are the armed forces (other ranks). In the case of the fathers for whom this information was given 86.2% (349 of 405) of them came from a socio-economic group number 10 to 12. On the other hand there were only 399 cases for which there was information on social class. This discrepancy comes from the fact that there were six patient's fathers who were associated with socio-

economic group number 10 but were also associated with more than one social class. The great majority (over 90%, n=380) of the fathers came from the lower Social Classes (levels III to V) with the majority of those being from Social Class III (50.13%, n=200/399). There were 147 fathers for which social class was ambiguous (between two classes, for example II-III) and these were not included in the numbers given previously. There were only 141 fathers for whom information on socio-economic group was not ambiguous (the reason for the discrepancy in 6 cases is given above). There were no cases for the mothers.

Table 15 and 16 Occupation, Socio-economic group and Social class for mothers and fathers

Table 15 (Mother)

Mother occupation	Number of cases	Socio-economic group	Social class
Housewife	215		
Housewife and works part time	6		
Cleaner	11	8	V
Canteen worker	7		
Domestic service	5	8	IV
Factory worker	4	11	IV
Works in a shop	3		
Nurse	2	4	II
Barmaid	2	8	IV
Employed	2		
Works part-time on farm	2	2	IV
Housemaid	1	8	IV
Buffet maid	1	8	IV
Dairymaid	1	8	IV
Shop assistant	1	7	III
Cook	1	8	III
Glassworks	1	11	IV
Machinist	1	11	IV
Manages her own work	1	5	II
Has her own business	1	5	II
Cane screener	1		
Veterinary assistant	1		
Total	270		

Table 16 (Father)

Father occupation	Number of cases	Socio-economic group	Social class
Miner	118	10-11.	III-IV
Labourer	90	12	V
Forces/Navy	40	13	III
Unemployed	30		
Driver	25	10	III
Works	13		
Bricklayer	12	10	III
Dock/Shipyard worker	12	12	V

Joiner	10		
Clerk	9	4-6.	II-III
Bus driver	9	10	III
Fitter	8	10	III
Painter	7	10	III
Railway staff	7	4	II
Railway worker	7	11-12.	IV-V
Butcher	6		
Farm Labourer	6	12	V
Engineer	6	10	III
Storekeeper	6	10	II-III
Steel worker	5	11	IV
Factory worker	5	11	IV
Moulder	5	10-11.	III-IV
Bus conductor	5	11	IV
Driller	5	11	IV
Builder	4	10	III
Crane driver	4	10	III
Bakery work	4	10	III
Police	3	10	III
Hairdresser	3	8	III
Leather worker	3	10	III
Traveller	3	7	III
Electrician	3	10	III
Salesman	3	7	III
Warehouseman	3	9	III
Fireman	3	11	IV
Fisherman	3	11	IV
Barman	3	8	IV
Has own business	3	5	II
Shop assistant	3	7	III
Shoe maker	3	10	III
Machinist	3	11	IV
Musician	2		
Window cleaner	2	12	V
Building foreman	2	9	III
Riveller	2	10	III
Gardener	2	2	V
Retired	2		
Gas fitter	2	10	III
Coal teemer	2	11	IV
Boiler man	2	11	IV
Cinema operator	2	10	III
Packer	2	11	IV
Quarry man	2		
Blacksmith	2	10	III
Plumber	2	10	III
Plater	2	10	III
Caretaker	2	8	IV
Motor mechanic	2	10	III
Welder	2		
Coach builder	2	10	III

Boiler maker	2	11	IV
Turner	1	10	III
Hotel manager	1	4	II
Golf course supervisor	1	10	III
Railway engineer	1	10	III
Dustman	1	11	IV
Steel inspector	1	10	III
Receptionist	1		
Asphalter	1	11	IV
Rivet operator	1	10	III
Belt man	1	10	III
Sculptor	1	4	II
Drainage engineer	1		
Plater's helper	1	11	IV
Storeman	1	10	III
Horse keeper at pit	1	11	IV
Linoleum layer	1	11-12.	IV-V
Milk roundsman	1	11-12.	IV-V
Time keeper	1		
Printer	1	10	III
Shipchandler	1		
Company secretary	1		
Boiler man at pit	1	11	IV
Club	1		
Pump station attendant	1		
Turbine attendant	1		
Rope splicer	1	11	IV
MP	1	3	I
Hawker	1	12	V
Schoolmaster	1	4	II
Grocery manager	1	5	II
Foreman	1	9	III
Upholsterer	1	10	III
Surgery attendant	1	8	IV
Telephonist	1	10	III
Cooper	1		
Tramway driver	1	10	III
Tram conductor	1	11	IV
Prison	1		
Milling machinist	1	10	III
Masher barber	1		
Fire prevention officer	1	10	III
Marine fitter	1	10	III
Boiler and pipe coverer	1		
Coal filler	1	11	IV
Scrap dealer	1		
General dealer	1		
Shipyard porter	1	12	V
Store manager	1	5	II
Glass worker	1	11	IV
Cutter grinder	1	10	III
Customs official	1	10	III

Coal cutter	1	10	III
Shoe repairman	1		
Furniture remover	1		
Machine worker	1	11	IV
Hotel chef	1	8	III
Carter	1		
Road mender	1	11	IV
Long distance lorry driver	1	10	III
Cleaner in market	1	8	V
Colliery winding engine man	1		
Guard	1	10	III
Grocer	1	7	III
Marine engineer	1	9	III
Electrician linesman	1	10	III
Maintenance engineer	1		
Maintenance gas worker	1		
Check weighliner	1		
Ministry pensions	1	4	II
Excavation driver	1	10	III
Ministry of National Insurance	1	4	II
Tube cleaner	1		
Taxi driver	1	10	III
Rigger	1	11	IV
Steward in QE2	1	8	III
Kennel huntsman	1	8	III
Post Office worker	1	10	III
Shop steward	1	7	III
Ship right	1		
Fishmerchant	1	11	IV
Lead worker	1	11	IV
Stoneman at pit	1		
Gas company	1	11	IV
Foreman carpenter	1	9	III
Civil servant	1	6	III
Boiler cleaner	1	11	IV
Printing factory	1	11	IV
Garage worker	1	10	III
Pitman	1	11	IV
Coal merchant	1	11	IV
Electrician's mate	1	11	IV
Munitions worker	1	11	IV
Wholesale fruiter	1	5	II
Brickyard worker	1	11	IV
Refuse disposal	1		
Ministry of Supply	1	6	III
Photographer	1	8	III
Acetylene burner	1	10	III
Total	638		

6.6 Contacts of admissions to Stannington

It was possible to establish that there were 774 'positive' contacts (40.8%), 69 'possible' positive contacts (3.6%), 574 where no contact was found (30.3%) and 480 cases where this information was not available (25.3%). The information for positive contacts divided by year and sex is seen in **Table 17.**

Contacts of patients, i.e. those who may have transmitted tuberculosis to the child, were identified where possible. The mothers (n=198 or 25.3%) were cited most often as the tuberculous contact with the father coming second (n=165 or 21.3%), followed by the sister (n=90 or 11.6%) and the aunt (n=57 or 7.4%). There were also multiple contacts named in 95 (12.3%) of the cases where it was not possible to establish which of these contacts had been the initial contact; for example, they would name the father, brother, sister and aunt but also state that the father was at war and the aunt would sometimes baby-sit the children. There were many more multiple contacts for the females than the males. The numbers can be seen in **Table 18**. The majority (64% or 498 cases) of the contacts came from the nuclear family (either the mother, father, brother or sister). Of this number (498), there are more cases where females were named as contacts rather than males. For example, the mother and sister make up 58% (or 288) of the named cases from the nuclear family.

Table 17 Number of cases with positive contacts recorded, by years and sex

	Positive contacts by year and sex				
Year of admission	**M**		**F**		**Total**
	Number of cases	% of cases	Number of cases	% of cases	Number of cases
1936	1	100	0	0	1
1938	1	100	0	0	1
1940	1	100	0	0	1
1941	2	33	4	67	6
1942	10	40	15	60	25
1943	28	40	42	60	70
1944	41	37	71	63	112
1945	15	38	25	62	40
1946	41	47	47	53	88
1947	24	37	41	63	65
1948	25	38	41	62	66
1949	32	50	32	50	64
1950	35	51	33	49	68
1951	20	38	33	62	53
1952	27	45	33	55	60
1953	30	56	24	44	54
Total	333	43	441	57	774

Table 18 Contact details for males and females (all years)

Contact details (all years)	Male		Female		Total
	Number of cases	% of cases	Number of cases	% of cases	Number of cases
Mother	91	(46)	107	(54)	198
Father	71	(43)	94	(57)	165
Brother	14	(45)	31	(55)	45
Sister	34	(38)	56	(62)	90
Grandmother	2	(22)	7	(78)	9
Grandfather	3	(38)	5	(62)	8
Aunt	29	(51)	28	(49)	57
Uncle	12	(57)	9	(43)	21
Cousin	11	(69)	5	(31)	16
Acquaintance	10	(34)	19	(66)	29
Other	12	(46)	14	(54)	26
Not available	7	(47)	8	(53)	15
Multiple	37	(39)	58	(61)	95
Total	333	(43)	441	(57)	774

Table 19 Type of tuberculosis by sex

Type of tuberculosis	Male	Female	Total by type of TB	(%) of all types of TB
Abdomen	31	33	64	3.4
Bone and joint	110	120	230	12.1
Glands	49	52	101	5.3
Glands/abdomen	1	0	1	0.05
?Lung	3	2	5	0.3
Lung	542	657	1199	63.2
Meninges	6	7	13	0.7
Miliary	14	14	28	1.5
More than one	24	28	52	2.7
More than one?	4	9	13	0.7
Non TB	79	89	168	8.9
Not available	7	2	3	0.2
Not confirmed	2	0	9	0.5
Other	4	5	2	0.1
Skin	3	0	9	0.5
Total	879	1018	1897	100

6.7 Type of tuberculosis treated at Stannington

There were 1,204 cases of pulmonary tuberculosis (1,199 cases of pulmonary TB and 5 cases of possible pulmonary TB or 63.5% of 1,897 patients), 442 cases of non-pulmonary tuberculosis (23.3%), and 251 cases (13.2%) for which it was not possible to establish whether it was pulmonary TB or not (this will include the patients whose data were not available, not confirmed, non-tuberculous and those patients who were suffering from more than one type of tuberculosis). There were a high number of cases of tuberculosis of the bones and joints (12.1% or 230 cases) **(Table 19).** This was proven to be statistically significant by chi-square analysis of the difference between the bone and joint cases and those children not suffering from bone and joint tuberculosis (there were 230 children suffering form bone and joint TB and 1667 who did not), this resulted in $\chi^2 = 125.582$ which is at the 0.001% critical level **(Table 20).** However, in total, there were 244 children where tuberculosis of the bones and joints occurred. In addition to the 230 cases of tuberculosis of the bones and joints, there were 11 cases where more than one type of tuberculosis was recorded, which included bone and joint tuberculosis. There were also three other cases that included bone and joint tuberculosis in the 'possibly more than one type' of tuberculosis.

The bones that were the most affected by tuberculosis were the hips (n= 77), followed by the spine (n=75), and knee (n=42). The breakdown of the bones affected can be seen in **Table 21**. The different regions of the spine were affected in different frequencies. There were 10 cases for which this information was given and it was possible to establish that the cervical spine was the region the least affected, with only one case. The thoracic region (on its own) was affected in 2 cases and the lumbar vertebrae were affected in 4 cases on their own. There were a further 3 cases where both the thoracic and lumbar vertebrae were affected **(Table 22).**

Of the 1,199 pulmonary cases **(Table 23),** there were 14 children suffering from tuberculosis of the adult type (chronic pulmonary tuberculosis) (2 males and 12 females), 241 cases suffering from pleural effusion (144 male and 97 female), 482 cases suffering from primary tuberculosis (206 male and 276 female), 447 cases suffering from pulmonary TB (182 male and 265 female), and finally 15 children suffering from another type of pulmonary TB (8 male and 7 female).

When looking at the rural and urban differences in the type of tuberculosis, the proportions of the types of tuberculosis affecting the children are slightly different. The proportions given above are for the rural and urban cases together. For the rural cases alone, however, there were 42 children affected by the pulmonary type of tuberculosis (53.2%), 17 children were found not to be suffering from TB (21.5%), children suffering from tuberculosis of the glands made up 12.7% (n=10), the bone and joint cases made up 7.6% of the cases (n=6), and finally, abdominal tuberculosis, miliary TB, those suffering from more than one type of TB and the not available cases made up the remaining 5% of cases (n=1 each).

Table. 20 Chi-square test results for bone and joint cases at Stannington from SPSS statistical package

1

	Observed N	Expected N	Residual
.00	1667	1783.0	-116.0
1.00	230	114.0	116.0
Total	1897		

0 indicates a non-bone and joint case and 1 indicates bone and joint cases

Test Statistics

	1
Chi-Square[a]	125.582
df	1
Asymp. Sig.	.000

a. 0 cells (.0%) have expected frequencies less than 5. The minimum expected cell frequency is 114.0.

Table 21 Bones and joints affected for males and females (all years)

Bones and joints affected	
Hip	77 (31.6%)
Spine	75 (30.7%)
Knee	42 (17.2%)
Ankle	8 (3.3%)
Foot	4 (1.6%)
Shoulder	3 (1.2%)
Elbow	3 (1.2%)
Hip and knee	3 (1.2%)
Wrist	3 (1.2%)
Spine and knee	2 (0.8%)
Spine, hip and knee	2 (0.8%)
Hip and femur	2 (0.8%)
Humerus	2 (0.8%)
Rib	1 (0.4%)
Spine and elbow	1 (0.4%)
Spine and ankle	1 (0.4%)
Ankle and tarsus	1 (0.4%)
Hand and spine	1 (0.4%)
Knee and ankle	1 (0.4%)
Knee and elbow	1 (0.4%)
Spine, elbow and mastoid	1 (0.4%)
Hip, shoulder, ankle and knee	1 (0.4%)
Spine, knee, elbow, hip	1 (0.4%)
Elbow, foot, metatarsal, vertebrae	1 (0.4%)
Toe, knee and humerus	1 (0.4%)
Spine and shoulder	1 (0.4%)
Tibia and metatarsal	1 (0.4%)
Vertebrae and ulna	1 (0.4%)
Tibia, ankle and cuboid	1 (0.4%)
Mastoid	1 (0.4%)
Astragaloid	1 (0.4%)
Total	244 (100)

Table 22 Region of spine affected

Region affected	Number of cases
Cervical	1
Thoracic	2
Thoracic-lumbar	3
Lumbar	4

Table 23. Different types of tuberculosis affecting the lungs mentioned in the Stannington files

Type of pulmonary TB					
	Male	%	Female	%	Total
Adult type	2	(14)	12	(86)	14
Pleural effusion	144	(60)	97	(40)	241
Primary TB	206	(43)	276	(57)	482
Pulmonary TB	182	(41)	265	(59)	447
Other type	8	(53)	7	(47)	15
Total	542	(45)	657	(55)	1199

When looking at the side of the body affected by tuberculosis it was possible to establish this variable in 554 cases (29%) **(Table 24).** There were slightly more children affected on their right side rather than their left (295 right, 259 left). When looking at these numbers by type of TB the right side was affected in 214 pulmonary cases, 63 bone and joint cases, 11 cases of tuberculosis of the glands, six cases suffering from more than one type of TB and finally one case sent home as being non-tuberculous. When considering the children affected on the left side, there were 182 cases affected by pulmonary tuberculosis, 55 cases of the bones and joints, 13 cases of tuberculosis of the glands, 7 cases of children suffering from more than one type of TB and two children who were sent home as being non-tuberculous.

Table 24 Side affected by type of tuberculosis

Side affected by tuberculosis					
	Right		Left		Total
	Number of cases	% of cases	Number of cases	% of cases	Number of cases
Pulmonary	214	54	182	46	396
Bone and joint	63	53	55	47	118
Glands	11	46	13	54	24
More than one	6	46	7	54	13
Non-tuberculous	1	33	2	67	3
Total	295	53	259	47	554

6.8 Result of treatment at Stannington

There were 1502 children who left the sanatorium quiescent (79.3%). Others improved (n=53 or 2.8%), while sadly 21 (1.1%) children died while in the institution. There were a surprisingly high number of non–tuberculous cases (n=169, or 8.9%). The breakdown of the cases can be seen in **Table 25**.

Table 25 Result of treatment at discharge from Stannington

Result of treatment (all years, male and female)	Number	%
Quiescent	1502	79.2
Improved	53	2.8
Lesion healed/resolved	14	0.7
No material improvement	17	0.9
Died	21	1.1
Transferred	33	1.7
No definite signs of TB	15	0.8
Non-tuberculous	169	8.9
Other	21	1.1
Not available	52	2.7
Total	1897	100

6.9 Pre- v post- antibiotics eras: demographic structure

There were no differences in the types of TB from which the children suffered who were admitted prior to the introduction of anti-tuberculous drugs or 1946 when streptomycin was first introduced to Stannington. In **Tables 26, 27 and 28** the proportion of cases, the number of contacts of children and types of TB affecting children before the advent of the chemotherapy age of treatment at Stannington are shown. There are nearly equal numbers of male and female cases in the pre-antibiotic eras. There are slightly more female cases with contacts in the pre-antibiotic era. There are also around one third of the abdominal and gland cases admitted to Stannington prior to the introduction of anti-tuberculosis therapy at Stannington. There are a low number of cases not suffering from tuberculosis admitted prior to 1943.

Table 26 Pre-antibiotics era (Number of cases)

Number of cases male	(%)	Number of cases female	(%)	Total
116/879	(13.2)	135/1018	(13.3)	251/1897

The number of cases indicates the number of cases admitted to Stannington before the introduction of chemotherapy (1943) over the total number of cases (male, female and total). The percentages refer to the percentage of the cases which occur pre-chemotherapy (for males and females)

Table 27 Pre-antibiotics era (Number of contacts)

Number of cases male	(%)	Number of cases female	(%)	Total
43/333	(12.9)	61/441	(13.8)	104/774

The number of cases (male, female and total) refer to the number and percentage of cases for which a contact was identified prior to the introduction of chemotherapy

Table 28 Pre-antibiotics era (Type of TB)

Type of TB	Male	(%)	Female	(%)	Total
Abdominal	7/31	(22.6)	9/33	(27.3)	16/64
Bone and joint	21/110	(19.1)	21/120	(17.5)	42/230
Glands	15/49	(30.6)	18/52	(34.6)	33/101
Glands/Abdomen	0/1	-	0/0	-	0/1
?Lung	0/3	-	0/2	-	0/5
Lung	60/542	(11.1)	75/657	(11.4)	135/1199
Meninges	0/6	-	0/7	-	0/13
Miliary	1/14	(7.1)	0/14	-	1/28
More than one	3/24	(12.5)	4/28	(14.3)	7/52
More than one?	1/4	(25)	2/9	(22.2)	3/13
Non-TB	6/79	(7.6)	4/89	(4.5)	10/168
Not available	0/7	-	0/2	-	0/9
Not confirmed	0/2	-	0/0	-	0/2
Other	1/4	(25)	1/5	(20)	2/9
Skin	0/3	-	0/0	-	0/3

The numbers and percentages refer to the number and percentage of cases (male and female) of each type of tuberculosis admitted before the introduction of chemotherapy

6.10 Pre- and post- World War II: demographic structure

There was a difference in the number of children who were admitted to Stannington before, during, and after the Second World War, but this relates to the number of files that were left from Stannington to analyse. As stated before, there are so few cases before 1943 that any analysis would provide unreliable data, as Stannington was bombed in 1940 and then the sanatoria patients were moved to Hexham Hydro between 1941 and 1945. In **Tables 29, 30 and 31** the proportion of cases admitted to Stannington (male and female), the number of

contacts, and the different types of tuberculosis in patients admitted before the end of the Second World War are all presented. Around thirty per cent of the total number of cases admitted to Stannington for which we have the files were admitted prior to the end of WWII. Again, there are around a third of both male and female cases for which we have information on the contact before the end of WWII and, as for the different types of tuberculosis, around half of the abdominal, gland and 'more than one type' cases were admitted before the end of the Second World War which means that, proportionally, there were fewer cases of abdominal and glands TB after the Second World War.

Table 29 Pre-World War II years (Number of cases)

Number of cases male	(%)	Number of cases female	(%)	Total
259/879	(29.5)	336/1018	(33)	595/1897

The number of cases indicates the number of cases admitted to Stannington before the end of the Second World War over the total number of cases (male, female and total). The percentages refer to the percentage of the cases which occur pre-end of WWII (for males and females)

Table 30 Pre-World War II years (Number of contacts)

Number of cases male	(%)	Number of cases female	(%)	Total
99/333	(29.7)	157/441	(35.6)	256/774

The number of cases (male, female) refer to the number and percentage of cases for which a contact was identified prior to the end of the Second World War

Table 31 Pre-World War II years (Type of TB)

Type of TB	Male	(%)	Female	(%)	Total
Abdominal	15/41	(48.4)	23/33	(69.7)	38/64
Bone and joint	34/110	(30.1)	43/120	(35.8)	77/230
Glands	32/49	(65.3)	29/52	(55.8)	61/101
Glands/abdomen	0/1	-	0/0	-	0/1
?Lung	1/3	(33.3)	1/2	(50)	2/5
Lung	154/542	(28.4)	204/657	(31.1)	358/1199
Meninges	0/6	-	0/7	-	0/13
Miliary	2/14	(14.3)	0/14	-	2/28
More than one	4/24	(16.7)	6/28	(21.4)	10/52
More than one?	2/4	(50)	5/9	(55.6)	7/13
Non TB	12/79	(15.2)	21/89	(23.6)	33/168
Not available	1/7	(14.3)	1/2	(50)	2/9
Not confirmed	0/2	-	0/0	-	0/2
Other	1/4	(25)	2/5	(40)	3/9
Skin	0/3	-	0/0	-	0/3

The numbers and percentages refer to the number and percentage of cases (male and female) of each type of tuberculosis admitted before the end of the Second World War

6.11 Pre- and post- NHS: demographic structure

The implementation of the NHS in 1948 does not seem to have had an effect on who was being treated at Stannington, or on the methods that they were using to treat the children. Neither does it seem to have had an effect on the type of tuberculosis that was being treated at the sanatorium. The proportion of cases, contacts and types of TB can be seen in the three following tables (**Tables 32, 33 and 34).** There were around 60% of cases admitted before the implementation of the NHS and that the numbers recorded from the files do not decline suddenly after 1948. The same holds true for the number of contacts, the numbers being around the same as the average of 60% of these were admitted before the implementation of the NHS. At this point in time, we should be expecting that fathers who were at War to be returning to their families but we are not seeing a proportional rise in the fathers being named as contacts at this time. As for the types of tuberculosis, around 75% and 90% of the abdominal and gland cases, respectively, were admitted to Stannington. If the proportions hold, there should have been around 70% of cases from all the types of tuberculosis that should have been admitted to Stannington. This actually only holds true for the children suffering from tuberculosis of the abdomen, glands and those not suffering from tuberculosis. Could this be a result of the types of treatment that these children received while at Stannington? The children were mainly treated by rest, fresh air and sunlight treatment. There is no reason provided in the files to make us believe that implementation of the NHS had an effect on the treatment that these children received. It could be a result of the fact that open-air treatment was becoming out of fashion with the advent of chemotherapy. This could have pushed the directors at Stannington to accept only the most advanced cases at Stannington while the others could have easily received their treatment under the NHS. It could also be related to the fact that these types of tuberculosis are associated with infection from the bovine strain, and the introduction of pasteurisation at this time could have meant that fewer children were being infected by this type of tuberculosis.

Table 32 Pre-NHS years (Number of cases)

Number of cases male	(%)	Number of cases female	(%)	Total
503/879	(57.2)	630/1018	(61.9)	1133/1897

The number of cases indicates the number of cases admitted to Stannington before the implementation of the NHS (1948) over the total number of cases (male, female and total). The percentages refer to the percentage of the cases which occur pre-implementation of the NHS (males and females)

Table 33 Pre-NHS years (Number of contacts)

Number of cases male	(%)	Number of cases female	(%)	Total
189/333	(56.8)	286/441	(64.9)	475/774

The number of cases (male, female) refer to the number and percentage of cases for which a contact was identified prior to the implementation of the NHS

Table 34 Pre-NHS years (Type of TB)

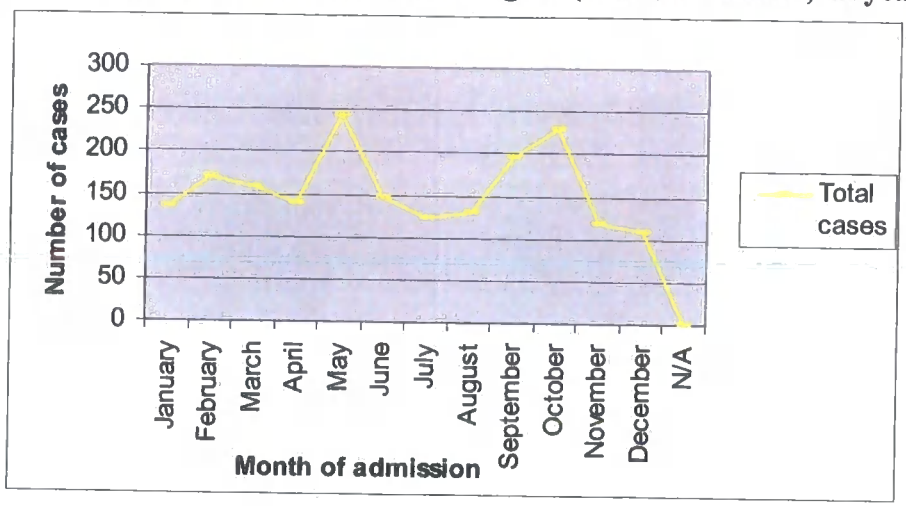
Type of TB	Male	(%)	Female	(%)	Total
Abdominal	24/31	(77.4)	25/33	(75.8)	49/64
Bone and joint	61/110	(55.5)	63/120	(52.5)	124/230
Glands	43/49	(87.8)	47/52	(90.4)	90/101
Glands/abdomen	1/1	(100)	0/0	-	1/1
?Lung	1/3	(33.3)	½	(50)	2/5
Lung	288/542	(53.1)	389/657	(59.2)	677/1199
Meninges	0/6	-	2/7	(28.6)	2/13
Miliary	5/14	(35.7)	5/14	(35.7)	10/28
More than one	11/24	(45.8)	11/28	(39.3)	22/52
More than one?	2/4	(50)	6/9	(66.7)	8/13
Non-TB	61/79	(77.2)	76/89	(85.4)	137/168
Not available	2/7	(28.6)	½	(50)	3/9
Not confirmed	0/2	-	0/0	-	0/2
Other	3/4	(75)	3/5	(60)	6/9
Skin	0/3	-	0/0	0	0/3

The numbers and percentages refer to the number of cases and percentages of the cases (male and female) of each type of TB which occurred prior to the implementation of the NHS

6.12 Month children admitted to Stannington

Children were being admitted to the sanatorium mainly during spring and autumn. **Fig. 19** shows the month of admission for both males and females all years. The peak of admission happened in May and October, while the other months had average admissions at a much lower rate. There would be on average 100-150 admissions every month, except for May and October which peak at between 200-250 admissions.

Fig. 19 Month of admission to Stannington (male and female, all years)



6.13 Treatment of admissions to Stannington

There were several different types of treatment offered to the children admitted to Stannington sanatorium. There are also large variations in the number of cases for which the details of treatment were given. These have all been tabulated into **Table 35**. All the children were prescribed rest for a time while at the sanatorium, and therefore this was not taken into account with respect to other types of treatment given during their stay at Stannington. The reason for this is that it would greatly inflate the numbers for which treatment was given, as all cases would have received treatment if rest was included. This part of the research focuses on the cases which had more invasive forms of treatment. For example, all the cases of pulmonary tuberculosis were prescribed rest as a treatment, but only 155 (12.9%) were given treatment other than rest while at Stannington. This complication comes from the fact that many records (especially prior to 1945) were quite incomplete and therefore it is hard to establish whether the information was negative or not available. Therefore for this section, to account for some of the low numbers, treatment will only be recorded when explicitly stated. For the children suffering from tuberculosis of the abdomen, only 25% (n= 16) received any chemotherapy, surgery or other types of treatment.

Table 35 Percentage of cases on which information on treatment is given

Type of tuberculosis	Number of cases with information	Total number of cases of this type	Percentage of cases on which information is given
Abdomen	16	64	25%
Bone and joint	201	230	87.4%
Glands	29	101	28.7%
Glands/abdomen	0	1	0%
?Lung	0	5	0%
Lung	155	1199	12.9%
Meninges	7	13	53.8%
Miliary	20	28	71.4%
More than one	24	57	42.1%
More than one?	2	13	15.4%
Non-TB	2	168	1.2%
Not available	2	9	22.2%
Not confirmed	0	2	0%
Other	1	9	11%
Skin	0	3	0%
Total	459	1897	24.2%

There were 1,199 cases of pulmonary tuberculosis and, of these 1,199 cases, there were 275 (22.9%) cases for which information was not available. There are therefore 924 (77%) cases for which information on treatment was provided. There are a further 551 (45.9%) cases for which no treatment data was given except for rest (i.e. no drugs or surgery). As bed rest is implied for all the cases these are examined only in a superficial way in a later section when trends are studied. There were 373 (31.1%) cases for which information was present on either drug treatment, surgery or other types of treatment. Of these cases, there were 218 (18.2%) who were not treated with anti-tuberculous drugs or drugs were used to treat another existing condition which was non-tuberculous (i.e. vitamins such as virol (a compound of malt, bone marrow and fats which was used at that time to build-up the health of children (Taylor 1989), or penicillin). Therefore, there are only 155 (12.92%) children for whom information on anti-tuberculous drugs, or surgery used to treat the cases is given; for the children suffering from tuberculosis of the meninges, the situation is similar. There were 13 children who suffered from this type of TB but there is only information for seven of the cases (53.8%). For the non-tuberculous cases, there were only 2 cases out of 168 for whom treatment was given (1.2%). For those children who suffered from types of tuberculosis that were 'not available', 'possible more than one', 'non confirmed', 'possible lung', and tuberculosis of the skin the numbers are very similar. There were only two cases out of nine for whom information was given on treatment for which the type of tuberculosis was 'not available' (22.2%) and also only two cases out of 13 children suffering from 'possibly more than one type of tuberculosis'

(15.38%). None of the cases which were 'not confirmed', or those of the skin, and 'possible lung', had details about their treatment. In the case of the children affected by 'other' types of TB, there was only information from one case that gives details about chemotherapy and surgical treatment (11%). For the bone and joint cases there was treatment details about drugs and surgery used in 201 of the 230 cases (87.4%). There were 29 children suffering from tuberculosis of the glands who received anti-tuberculosis drugs or surgery (of the 101 cases or 28.7%). The children suffering from miliary tuberculosis were given anti-tuberculous drugs or surgery in 71.4% of the cases (20 out of 28 cases). Finally, there were 57 children suffering from tuberculosis of 'more than one type', and 24 of these received anti-tuberculous drugs, surgery or other forms of treatment (42.1%).

The children suffering from tuberculosis of the bones and joints, as already explained, stayed the longest time in the sanatorium of all the types of tuberculosis. The reason for this is quite simple. They were receiving the most complex forms of treatment. There are details of treatment for 201 out of the 230 bone and joint cases at Stannington (87.4%). There was one child treated in 1943 who may have been treated with streptomycin and PAS, one case treated with streptomycin in 1944, one case in 1946, three cases in 1948, eight cases in 1949, five in 1950, five cases in 1951, and four cases in 1952 who were treated with streptomycin only and other forms of treatment (i.e. plaster and braces). The cases being treated with more than one anti-tuberculous drug (be it streptomycin, PAS, INH, and any combination of these) were one in 1948, three in 1949, three in 1950, 15 in 1951, 11 in 1952 and six cases in 1953. There are 67 children out of 230 (29.1%) who received anti-tuberculous therapy at Stannington.

There were 14 cases that were treated with artificial pneumothorax surgery before 1944 (including three cases who also underwent aspiration of abscesses). There were 11 cases who had abscesses aspirated, and one of these also had an arthrodesis. These were nearly all performed, except for two, before 1947. One amputation was performed in 1945, and an arthrodesis was performed on 12 cases with three of them possibly performed at Stannington (all the others were performed at other hospitals). These operations were performed after 1948. There was also one child who went through a leg lengthening operation in 1950 and one patient had a sequestrectomy in 1952. There are only four children who did not receive any other form of treatment (i.e. plaster or braces). There were 16 cases that received all three types of treatment (drugs, surgery and other apparatus). The children receiving chemotherapy stayed slightly longer in the sanatorium than those who did not. Those children receiving chemotherapy stayed on average 785 days and those without chemotherapy stayed on average 605 days. This could be because only the children who were suffering from the most advanced cases of tuberculosis while staying at Stannington would receive

chemotherapy, thus increasing their period of stay. The type of immobilization most used in Stannington was the plaster of Paris immobilization, followed by splints and braces. A full list of these immobilization methods can be seen in **Table 36**.

The single Thomas splint shown here is to immobilise tuberculous disease of the hip joint **(Fig. 20).** It is worn continuously except for periodical removal for cleansing. It consists of a long flat bar of wrought iron which runs straight down the back of the affected side from just below the axilla to the buttock. It then bends gradually forming a concavity for the buttock and then continues straight down the leg. The leg portion is parallel to the trunk portion. Cheyne (1911) states that to apply the splint correctly, it is necessary to rotate the trunk part slightly so that it may rest on the curved part of the thorax. Therefore, in a right-handed splint the bar is rotated to the left and vice versa. There are three cross-bars attached to the vertical bar: upper wings which grasp the body just below the axilla, middle and upper part of the thigh and the lower part of the calf. The splint is fastened to the body by a bandage at the upper part acting as a shoulder brace, and then bandages are placed around the calf of the leg and the middle of the thigh.

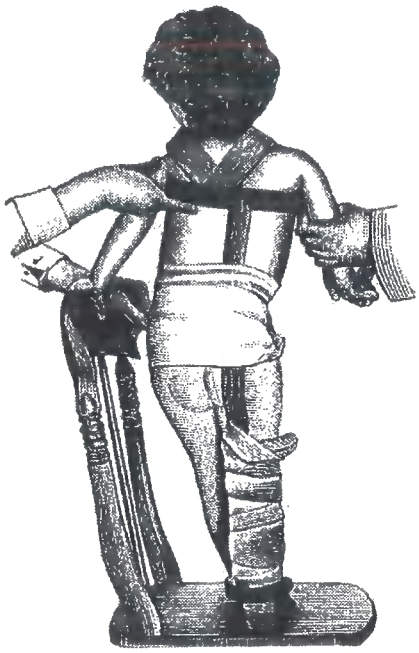


Fig. 20 Single Thomas splint for hip joint (Cheyne 1911)

The Thomas knee splint consists of a groin ring with two lateral rods running down the inner and outer portions of the affected leg, and three broad leather bands support the limb. This splint is arranged for walking in **Fig. 21,** and therefore the patient is given a patten on the unaffected leg and crutches to propulse him/herself without damaging the affected joint. The groin ring is of an ovoid shape with the narrowest part being on the outside and the inner part is thickly padded. In the case of a bed splint, the lateral rods are attached at the longest diameters of the ovoid; in the walking splint the inner rod is attached further back. The straps are placed at about the middle of the thigh, one behind the knee and one at the lower part of the calf (Cheyne 1911).

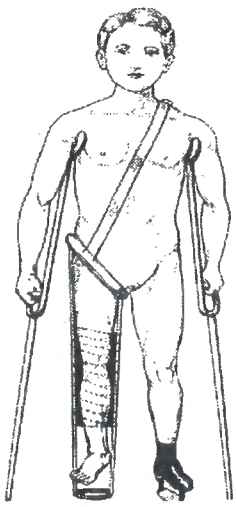


Fig. 21 Thomas knee splint arranged for walking (Cheyne 1911)

Table 36 Types of immobilization used in Stannington

Type of immobilization	Number used
Plaster	105
Thomas splint	52
Brace (including Taylor)	33
Traction	28
Splint	20
Extension	12
Bradford frame	9
Calliper	9
Chance's brace	6
Glassona splint	6
Liston splint	5
Immobilisation	4
Jordan's low back brace	4
Sheath splint	1
Abduction frame	1
Jury Mast	1
Cramer wire gutter splint	1
Peacock brace	1
Jone's brace	1
Sling	1

Paster of Paris was also widely used to immobilise children. **Figs. 22 and 23** show two types of plaster cast used to immobilise tuberculous disease of the spine. In **Fig. 22**, Plaster of Paris is used to immobilise the disease in the cervical region. Cheyne (1911) states that this immobilization method is used in children that are very restless. In **Fig. 23**, the plaster is used to immobilise a patient with Pott's disease. These arrangements are used only in conjunction with complete recumbency and should last at least six months. Also in **Figs. 24 and 25**, it is possible to see that hyperextension was also used to fight tuberculous disease of the spine. These

Fig. 22 Plaster of Paris for cervical disease (Cheyne 191 1)

Fig. 23 Plaster of Paris for Pott's disease (Cheyne 1911)

girls were suffering from tuberculous disease of the spine and were set in plaster in a hyperextended position hopefully to counteract the deformity of the spine. **Fig. 24**, demonstrates a child put in the hyperextended position and then settled in the sun to get sunlight treatement. As can be seen in **Fig. 25,** another child is lifted by a crane and put in an hyper-extended position and then set in plaster. Another type of immobilization used at Stannington were braces as seen in **Figs. 26 and 27**, both used for disease of the spine. **Fig. 26**, the Bradford bed brace was used to immobilise children suffering from tuberculous disease of the spine and would hopefully stop the child from moving, permitting the spine to set itself in the correct position. **Fig. 27** demonstrates head extension to ease pain and pressure in cervical disease.

Fig. 24 Child placed in hyperextended position (N.R.O. 3000)

Fig. 25 Child placed in Plaster of Paris in In hyperextended position (N.R.O.3000)

Fig. 26 Bradford bed brace (Cheyne 1911)

Fig. 27 Head extension for cervical disease (N.R.O. 3000)

It is now possible to look at other types of TB in a little more detail. Of the 16 abdominal cases for which we have details on the treatment, 10 out of 16 who were treated with UVR

(58.8%). These are the cases that were treated at the sanatorium between 1944 and 1946. Thereafter, there are no cases for which we have details until 1952 when six remaining cases were treated with anti-tuberculous drugs (three with streptomycin and PAS, one with streptomycin, PAS and INH and the remaining two with streptomycin and INH). The time period that the children spent in the sanatorium when treated with UVR treatment was on average 270 days, while children being treated with chemotherapy stayed an average 296 days which is quite unexpected as one would have thought that children would be staying for shorter periods of time when they were receiving anti-tuberculous therapy. This could be a result of more advanced cases being admitted over earlier ones.

For children suffering from tuberculosis of the glands, 29 children received treatment, other than rest, at Stannington (28.7% out of 101 cases). Prior to 1948, there was no effective anti-tuberculous chemotherapy given to children suffering from tuberculosis of the glands. Two cases necessitated surgery for aspiration of the glands before 1948. Until 1947, the most recommended form of therapy seems to be heliotherapy (or UVR) as 17 of 19 children treated before 1948, for which we have details, received this type of treatment. Two of these cases received streptomycin only as a drug therapy, and three cases received streptomycin and PAS (these three also received surgical treatment in the form of curettage and aspiration of glands). The average duration of stay for the children receiving chemotherapy for tuberculosis of the glands was 235 days, while for those receiving no chemotherapy, but for which we have information on treatment not including rest, was 306 days. The children receiving no chemotherapy stayed around 30% longer than those receiving chemotherapy at Stannington.

The children suffering from tuberculosis of the lungs did not receive any anti-tuberculous drugs until 1948, and after that most of the cases treated were treated with at least one drug. Of the 155 cases for which we have information on the type of treatment used, there were 106 cases (68.4%) that received some form of anti-tuberculous drug (streptomycin, PAS, INH or any combination of these). There were no cases of anti-tuberculosis therapy before 1948 but from 1949 onwards, chemotherapy became the leading form of treatment in Stannington for the pulmonary cases. This could be the result of drugs being more widely available to treat all types of TB. There were 40 children (25.8%) who received surgical treatment during their stay at Stannington (though not necessarily at Stannington), with three of these being treated with drugs simultaneously; 30 of these cases were also treated before the advent of chemotherapy at Stannington in 1948. The surgical procedures cited at Stannington were artificial pneumothorax (30 cases, with 18 of those being performed with another type of surgery: adhesion divisions, phrenic crush, pneumoperitoneum and thoracoplasty). There is one case of phrenic crush being performed on its own, two cases of the child's glands being

aspirated, four cases of exploratory aspiration, one case of pneumonectomy, one case of thoracoplasty, and one amputation. When chemotherapy was commenced at Stannington the number of cases being treated by surgery declined rapidly and were replaced by anti-tuberculous drugs. The number of days that these children stayed at the sanatorium depended again on the type of treatment received; children receiving no chemotherapy stayed around 527 days, while those receiving the chemotherapy stayed around 454 days. There were three cases for which this information was not given. Again, the children who stayed longest did not receive any chemotherapy. This suggests that for this type of tuberculosis, along with tuberculosis of the meninges, the effect of anti-tuberculous therapy was to greatly reduce the time that the children had to stay at the sanatorium. This is also related to the fact that the amount of surgery declined when chemotherapy made its debut.

Children suffering from tuberculosis of the meninges had information on treatment for seven of the cases (again not including those that were prescribed rest). Four cases received streptomycin, and two cases received streptomycin and PAS. One case received a lumbar puncture but was not given any chemotherapy, and another received UVL. There were no other forms of treatment given to these cases apart from rest. As for the duration of stay in the sanatorium, the children receiving chemotherapy stayed around 115 days, while those not receiving any chemotherapy were there for around 227 days.

There are no details on treatment, save for rest, for miliary cases before 1948. After 1948 there are 8 cases treated with streptomycin only, and a further 12 cases who were treated with more than one anti-tuberculous drug. One case received a lumbar puncture and no other cases received any surgical therapy. There were no cases that received any other type of treatment. The average stay at Stannington for those suffering from miliary tuberculosis receiving chemotherapy was 362 days.

For those children suffering from more than one type of tuberculosis, of the 24 cases receiving some form of intervention at Stannington, ten children received streptomycin as the only drug (five of these also had plaster of Paris treatment at some point, one also had surgery, and one had surgery along with a plaster of Paris splint at the same time). Another seven children received more than one anti-tuberculous drug (these cases appear after 1951). Another seven cases did not receive any chemotherapy or surgery but had some other form of immobilization of a limb, or limbs, for some time. The difference in duration of stay between the children receiving chemotherapy and those not receiving chemotherapy was 174 days, those receiving chemotherapy stayed 506 days and those not receiving chemotherapy stayed

for 332 days. There were also two cases that suffered from 'possibly more than one type' of tuberculosis. One of these only received immobilization and extension of a diseased limb as treatment while the other case received streptomycin and INH.

There were only two cases of children not suffering from tuberculosis receiving treatment; one received postural drainage while the other was treated with a plaster boat and a calliper. The two cases suffering from a form of tuberculosis that was not specifically cited were treated with streptomycin and PAS (and one was also treated with a Thomas splint, patten and crutches, while the other also received surgery). Both of these cases were from 1952. Finally, there was only one case suffering from 'other' type of tuberculosis and they received streptomycin and PAS; this was a 1953 case.

There are several trends that can be seen in terms of the children being treated at Stannington. There were few cases before the end of the Second World War. In 1943 there was a rise in the amount of information provided in the files. Drugs were being used at Stannington at this time, but they are not what were known as anti-tuberculous drugs; rather they were penicillin and sulphonamides that were the only drugs available at the time thought to have an effect on tuberculosis. They did not, in effect, have an effect on tuberculosis. However, sulphonamides would stop the proliferation of tubercle bacilli, but they did not cure tuberculosis when people were already infected. There are still many cases for which the information is not given.

1944 sees an important increase in the use of drugs to treat tuberculosis, especially in pulmonary cases, although, once more, these drugs were not considered to be anti-tuberculous. Again, there are still many cases for which we have no details on treatment and the same can be seen in 1945. In 1946, which saw the introduction of streptomycin, PAS and INH (which came later) in the fight against tuberculosis at Stannington, we can see that there were more cases treated with drugs, but the vast majority were still receiving no chemotherapy at all while at Stannington. This same trend can be seen in the years to follow until 1953 where there were nearly as many cases that were being treated by drugs than cases that were not. This rise in the use of chemotherapy can be inversely mirrored by the use of surgery to treat tuberculosis. Although surgery was never widely used, there is a definite decrease in its use at Stannington as chemotherapy takes its hold.

As for the other types of treatment, the types of tuberculosis that required other forms of treatment were the non-pulmonary types, with TB of the abdomen and of the bones and joints

requiring the most diverse forms of treatment. TB of the abdomen required UVR and UVL treatment, while tuberculosis of the bone and joints required all types of immobilizing apparatus (such as plasters, braces and splints).

6.14 Summary

This chapter has described the results of the analysis of the data from the patient records at Stannington. There were more females than males admitted to Stannington in the period studied, and a wide range of ages, but there were also more teenage girls than boys. The time spent in the sanatorium depended largely on the type of tuberculosis suffered. Most of the children (79%) came from urban areas, especially around the Newcastle and Gateshead area, and a number of cases either the children came from: good (n=82) or bad (n=116) housing conditions. The most cited contacts came from the nuclear family (either mother, father, brother or sister, or a combination of them). The children suffered from a wide range of types of tuberculosis, the largest group suffering from pulmonary tuberculosis. Most of the children left the sanatorium quiescent, although 21 of the children died while in the institution. Anti-tuberculous therapy only came late in the fight against TB at Stannington. When it arrived, there were no marked changes in the types of TB being treated but there were major changes in therapy, and the time the children spent in the sanatorium. There did not seem to be any changes in the demographic profile at Stannington between the period during the Second World War and later. A similar statement can be made about the introduction of the NHS, when there did not seem to be any demographic differences in the population at Stannington. These three last 'period markers' (introduction of anti-tuberculous therapy at Stannington, the Second World War and the implementation of the NHS) are very hard to differentiate in terms of the data collected because they impact around the same time. The difference in impact will be nearly impossible to establish as drugs available for TB treatment appeared in 1943 (but in 1946 in Stannington), the Second World War ended in 1945 and the implementation of the NHS happened in 1948. The children were admitted mainly during the spring and autumn months. Finally the type of treatment that the children received largely related to the type of tuberculosis from which they suffered, with pulmonary cases being treated with rest and fresh air, and abdominal and gland cases receiving rest, fresh air and sunlight treatment. The bone and joint cases are the cases that necessitated the most complex forms of treatment, including rest, fresh air and immobilizing apparatus. The next chapter will discuss the data by relating it to our understanding of tuberculosis in children in the first half of the twentieth century.

Chapter 7

Discussion

"Phthisis causes pauperism in one generation and pauperism causes phthisis in the next"

(Dr John McVall, 1911, in Smith 1988:174)

This chapter discusses the results provided in the previous chapter in relation to all the background information presented in Chapters Two, Three and Four. Modern and contemporary literature sources will also be discussed relating to the patients admitted to Stannington sanatorium. Limitations to the data were discussed in Chapter 6, however, it is necessary to repeat at this stage that the data contained in this work is limited to the North-East of England and does not represent a definitive study of childhood TB as a whole. However, this may not represent as severely the 'osteological paradox' that most osteologists would be faced with (Wood *et al* 1992). The osteological paradox faced by most researchers studying human remains limit the amount of data that can be analysed in several ways. Most of the skeletal populations discovered are only a sample of the original living population, those that are found dead are not representative of the living population, they are those 'who have not made it'. Human remains do not always preserve very well and the bones of the skeleton needed to study tuberculosis would not necessarily survive, as well as pathological bone is more fragile than normal healthy bones. Additionally, not everyone will develop skeletal lesions for the osteologists to find. The sample of children's records we have from Stannington is still a sample as not all the files have been recovered, and these again only represent the diseased part of the population that were admitted. This group of medical records is only a sample of the children who were ill in the North-East which is only a sample of the sick children in Britain. The files that were recovered were only a sample of those that were admitted to Stannington as was shown in the previous chapter. It was difficult to assess to what degree the sample represented the population as a whole. Therefore, even though it is not a 'osteological paradox', it is a paradox all the same. This chapter will present the data recorded from the medical files from Stannington in graphic form to show more clearly the trends that were in place at the sanatorium. If details are needed about the actual numbers, please refer to the previous chapter or the database at the end of this work in **Appendix F**.

Table 37. Population of England and Wales 1951, and admissions to Stannington (all years)

Population of England and Wales (1951), and Stannington (all years)				
Age at last birthday	**England and Wales**		**Stannington (age at admission)**	
	Male	Female	Male	Female
0	338 009 (6.1%)	320 996 (6.1%)	0 (0%)	0 (0%)
1	352 598 (6.4%)	336 511 (6.4%)	4 (0.5%)	2 (0.2%)
2	373 179 (6.8%)	354 480 (6.7%)	24 (2.7%)	32 (3.1%)
3	410 799 (7.5%)	392 673 (7.4%)	70 (8.0%)	58 (5.7%)
4	428 971 (7.8%)	409 427 (7.7%)	67 (7.6%)	65 (6.4%)
5	329 728 (6.0%)	314 799 (6.0%)	79 (9.0%)	74 (7.3%)
6	350 206 (6.4%)	333 869 (6.3%)	84 (9.6%)	83 (8.2%)
7	334 734 (6.1%)	319 444 (6.0%)	69 (7.8%)	64 (6.3%)
8	318 901 (5.8%)	305 504 (5.8%)	63 (7.2%)	65 (6.4%)
9	282 824 (5.1%)	271 926 (5.1%)	62 (7.1%)	63 (6.2%)
10	273 080 (5.0%)	263 398 (5.0%)	67 (7.6%)	88 (8.6%)
11	289 434 (5.3%)	279 733 (5.3%)	54 (6.1%)	89 (8.7%)
12	291 190 (5.3%)	283 116 (5.4%)	65 (7.4%	87 (8.5%)
13	290 346 (5.3%)	281 343 (5.3%)	83 9.4%)	96 (9.4%)
14	284 551 (5.2%)	275 743 (5.2%)	48 (5.5%)	83 (8.2%)
15	279 427 (5.1%)	271 574 (5.1%)	24 (2.7%)	45 (4.4%)
16	277 078 (5.0%)	269 445 (5.1%)	2 (0.2%)	8 (0.8%)
N/A	0	0	14 (1.6%)	16 (1.6%)
Total	5 505 055 (51%)	5 283 981 (49%)	879 (46%)	1018 (54%)

Numbers for England and Wales taken from General Register Office (1958) *Census 1951 General Report.*

7.1 Male and female sex distribution at Stannington

The numbers of males and females were studied to demonstrate whether any of the sexes were more susceptible to contracting tuberculosis. The differences seen at Stannington are discussed in relation to infection rates, notification rates, the annual risk of tuberculosis infection (ARTI) and mortality from tuberculosis. At Stannington there were more females than males admitted during the period studied, there were more males than females in the enumerated population compared to Stannington (51% of males to 49% of females in the enumerated population of England and Wales compared to Stannington's 46% to 54% as seen in **Table 37**). There were also more males than females (under 16 years of age) in a proportion of 51 to 49% in Cumberland, Durham and Northumberland at the time (General Register Office 1954a, b, c), therefore for some reason, there are more females admitted to Stannington in proportion to the enumerated population of children under 16 years of age for Cumberland, Durham and Northumberland. Is this true of other studies? Beal's (1935) study also showed a preponderance of female over male TB cases in the 6-15 year age range between 1932 and 1935 in the Sunderland Tuberculosis Dispensary. Hurtado *et al* (2003)

demonstrated in the study of the Aché in Paraguay that males and females were equally likely to have been diagnosed with tuberculosis between 1971 and 1979. Donald and Byers (1998) on the other hand note studies in the Netherlands (between 1911 and 1945) and South Africa (more recent dates although not specified) that indicate that there was a slight predominance of males with tuberculosis but that there were usually more female adolescents with the disease than young males. This leads them to believe that tuberculosis might be related to some endocrinological or metabolic factor (such as the onset of menses) (also Grigg 1958, Roelsgaard *et al* 1964, Styblo *et al* 1969a, Schaaf *et al* 1996). The fact that there are also differences in the ages of the children admitted to Stannington (as can be seen in the next section) could very well be a factor that determined that young girls would be more likely to contract tuberculosis than young males because of the onset of menses. Sen (1961) demonstrated that there were twice as many females suffering from skeletal tuberculosis associated with pulmonary tuberculosis in a study in India. The contrary was shown to be true in Stannington; of the ten bone and joint cases with associated pulmonary disease, seven of them were male and three of them female.

Nyboe (1957 in Holmes *et al* 1998) demonstrates that in a study conducted in 15 countries around the world by the International Tuberculosis Campaign between 1948 and 1951 the tuberculin prevalence rates from mass BCG campaigns differed between males and females. Nyboe concluded that the prevalence of infection was nearly equal in males and females at younger ages, and that between 10 and 16 years of age male prevalence began to exceed female prevalence. Holmes *et al* (1998) also state that a similar study in equatorial Africa done by Roelsgaard and colleagues (1964), showed that prevalence surveys carried out displayed similar age and sex patterns. Another study, from India shows that from a randomly selected 119 villages in the Bangalore District between 1961 and 1968 there were similar prevalence rates of infection until the age of 14 years, after which the males had 20-71% higher prevalence rates of infection (Gothi *et al* 1974 in Holmes *et al* 1998). Again, another study, this time in Korea showed that the prevalence of positive skin tests was roughly the same in both sexes until the age of nine after which males older than 15 had a three to 30% higher prevalence rate than females (Ministry of Health and Social Affairs and the Korean National Tuberculosis Association 1965, 1970, 1975, 1980, 1985, 1990, cited in Holmes *et al* 1998).

According to Kumaresan *et al* (1996) there is an estimated 2:1 male to female ratio of tuberculosis cases notification worldwide. In cases of abdominal tuberculosis Machado *et al* (2001) state that in their study there was a male to female ratio of 5:4. However this may not necessarily be the case as Kumaresan *et al* (1996) state that women are more likely to get

health care from the private sector where it was likely that their disease would not be notified to the authorities. Tuberculosis has a profound social, economic, and physical impact on women especially in developing countries. They face stigmatization from family and society. Women fear discussing their illness with their neighbour, friends, family or even their spouse, for fear of rejection and ostracism. Unmarried women also fear being unable to find a husband. Women in some countries will also have less access to health care as their decision-making power is lower and their health seeking behaviour is different to that in men. Women prefer to go to health workers in the private sector and doctors may often delay in making a diagnosis in women although the reasons for this are not quite clear (*The Lancet Infectious Diseases* 2002). Some studies by Fine (1993) and Murray (1991) have shown the progression rate (from infection to disease) might be much greater in women of reproductive age than among men of the same age. It is not understood what reproductive age means here (is it related to the beginning of the menses?). Other studies (Hudelson 1996) examine the possible socio-economic and cultural factors which can affect these differences and call for further study into sex differences in the epidemiology of tuberculosis.

There are tuberculosis notification rates for pulmonary tuberculosis that compare sex differentials from industrialised countries. Holmes *et al* (1998) cited three examples from Denmark (1939-41-Groth-Peterson *et al* 1959), Norway (1937-Norwegian National Health Screening Service 1937), and England and Wales (1952-54-Styblo 1973). These three studies demonstrated consistent age and sex differences. In all three studies, the rates were similar under the age of 15 years for both sexes, but women had 10-35% higher notification rates through their mid-twenties and early thirties, and men had higher rates over the age of 40 years. Holmes *et al* (1998) indicate that notification rates are a good mirror of the incidence of TB if there are few barriers to care (such as quality and organisation of the health care system, whether practitioners are highly aware of TB symptoms, and high quality diagnostic and reporting systems) provided by the health care system. However, there are problems with notification rates which have been discussed in an earlier section, particularly the stigma attached to TB diagnosis. According to the studies discussed above (Denmark, Norway, and England and Wales) there was a shift in the age and sex pattern of tuberculosis notification rates when industrialised countries moved from a period of high to low incidence. As the studies show (Holmes *et al* 1998) in England and Wales, Denmark and Norway females had higher notification rates for the 15-34 age group (15-24 for Norway), but in the middle of the century gave way to slightly higher rates in men of all age groups in the 1970's. The age distribution shifted to older men, while the women's peak notifications stayed in the lower age groups as notifications declined (Holmes *et al* 1998). In low–income countries, recent notification rates are similar to those in the middle of the century in industrialised countries.

The higher notification rates among young to early middle-aged women observed in industrialised countries were not observed in the low-income countries studied [Nicaragua-(Cruz-Gonzalez 1993), Kenya-(Kibuga 1992), Tanzania (Ipuge and Styblo 1995) and China (Tuberculosis Project Office 1994), Holmes *et al* (1998)]. Here males and females had similar notification rates until the age of 14 years after which males had higher rates. It was possible to establish notification rates from non-pulmonary tuberculosis between 1938-1955 in England and Wales and from this (**Table 6** Chapter Three) it can be seen that in England and Wales, males had higher notifications rates than females for non-pulmonary tuberculosis in all years although the gap was slowly narrowing in the 1950's.

Hudelson (1996) discusses why there is such a sex differential in the under-notification of women in low-income countries. Men do not have the same number of constraints as women do in the same societies. Women have greater constraints caused by their lower income, restricted legal rights, inferior social status and reduced access to education. Also mentioned are the religious inequalities, traditional customs, as well as the political climate in some of these societies. Borgdorff *et al* (2000) conclude in their discussion that it is still unclear why there is such a wide male/female divide in tuberculosis prevalence. They suggest that overall differences in TB notification rates are due to sex differences in TB prevalence. They do not believe that the difference in notification rates is associated with women's lower access to health care in certain countries. They do not, they insist, believe that there are no sex inequalities in health care in some countries, but the notification rates do not mean that women will have less access to health care. A study of sex differences in pulmonary tuberculosis diagnosis in male and female patients in Vietnam showed that women with pulmonary tuberculosis were diagnosed on average about two weeks later than males. They state that a difference in clinical symptoms between men and women suffering from pulmonary tuberculosis can lead to different levels of suspicion between men and women resulting in the differences in the rate and investigation of the disease (Hoang Long *et al* 2002).

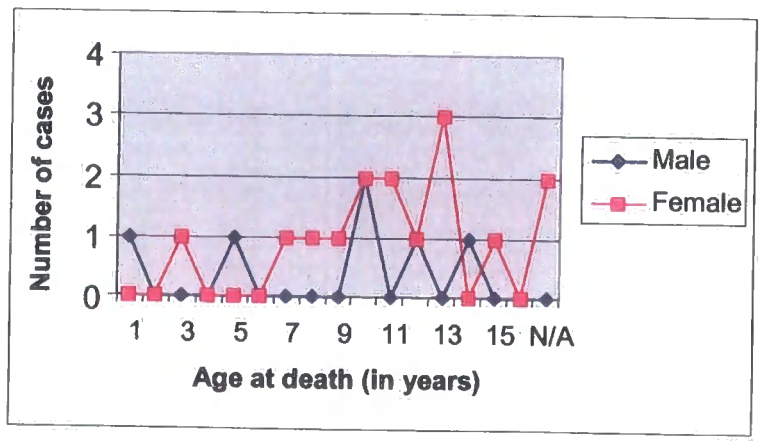
Holmes *et al* (1998: 97-98) also explain that there are differences in the sexes in the annual risk of tuberculosis infection. This is derived from the increases in prevalence of infection with age observed in groups of children and young adults, or in cohorts of children repeatedly tested over time. It measures the likelihood of a population becoming primarily infected or reinfected with tuberculosis over the course of one year. Sutherland and his colleagues (1983) tested this and found that there was little or no difference between the ARTI in males and females between the ages of six and twelve, but between the ages of twelve and eighteen

there was an excess in the ARTI of 10.2% in males. This seems to contradict what we see in Stannington. Styblo and colleagues (1969) have also studied this same issue and have found that there was an excess of males of 9% of the same age range among army recruits and schoolchildren from 1956 to 1966 in Holland. According to Holmes *et al* (1998) there are two reasons that may explain these differences in rates. Firstly, there may be differences in the numbers of contacts inside and outside the household; until adolescence, males and females may have the same number of contacts inside and outside the household and after this period, males have more contacts with the outside (also in Hudelson 1996). The second reason is that women may have less reaction to the tuberculin test (reduced delayed type hypersensitivity) to infection than men (Holmes *et al* 1998, also in Fine 1993).

Gothi *et al* (1974) showed that women in low-income societies had a 130% higher risk of progressing from infection to disease between the ages of 10 and 44 years. Several other studies cited by Holmes *et al* (1998) show the same trends. As for tuberculosis mortality, Holmes *et al* (1998) reported an Indian study (Rao 1982) where females had slightly higher tuberculosis mortality in the 5 to 14 age group and that between the ages of 15 and 34 they had rates 10 to 36% higher than those in men. After 35 years of age, however, men had a mortality rate several times higher. Another study, this time in China (Ministry of Health of the Republic of China 1985), showed that women had higher mortality rates from birth until the age of 29 years. After this age men have higher mortality rates. These rates are mirrored in industrialised countries 50 to 75 years earlier (Holmes *et al* 1998). According to Blacklock (1932) there were negligible differences by sex in the cases he autopsied in Glasgow after their death from tuberculosis in their first year in the late 1920's, but from then onwards there were more female than male cases. He explains that this could be on account of females at the time being restricted to the house as their duties would limit their movements outside the house (for example caring for their younger siblings) while males were not restricted to the house. There is a 70% excess of male over female tuberculosis cases reported globally in 2000 and the case fatality rate seems to be higher among women (*The Lancet Infectious Diseases* 2002). This seems to be mirrored in Stannington. There were 21 (6 male and 15 female) children who died while at Stannington in the period studied **(Fig. 28).** It is estimated that almost 1 billion women and girls are infected with tuberculosis worldwide. In 1998 about three-quarters of a million women died of tuberculosis and over 3 million contracted the disease (*The Lancet Infectious Diseases* 2002). As can be seen, there were more females than males admitted to Stannington at this time and that some of the clinical and contemporary literature is in accord with this finding. There were also more females dying of tuberculous disease at Stannington.

Women have a stronger immune response as a result of two factors: the selective pressures that are associated with the hazards of pregnancy and childbirth in women and the sex-related differences in physiology, particularly in sex hormones (Ortner 1998). Ortner (1998) states that the general enhanced female immune reactivity may be one of the adaptations the body has to the increased hazard to exposure and infection that females go through when pregnant. A woman's immune status during pregnancy is very low to minimize the risk of rejecting the foetus, therefore women are particularly at risk of infection during pregnancy and immediately following birth. However, women need an enhanced immune response when they are not pregnant so that more will survive and permit reproduction to maintain the species (Ortner 1998). Stini (1982) has also studied this phenomenon and agrees that females can better ward off environmental stresses because of their need to support pregnancy and lactation. However, Stinson (1985) believes that after a careful review of the literature, there is, at best, weak support for the hypothesis that males are less buffered than females against environmental stresses. The evidence from some underdeveloped countries have shown that males actually have lower mortality rates, although associated with this statement is the fact that males can have preferential treatment in some societies. Stinson (1985) agrees that there are some communities in which preferential treatment is given to males, but this does not explain every single case where male mortality rates are lower than the females. She concludes that for the prenatal period the hypothesis that males are less buffered than females against environmental stresses is attractive, however, during the postnatal period there are too many complications faced by certain cultural practices that limits the ability to test for this hypothesis. For example, cultural differences in the access to food can have an effect on the prevalence of infection. In countries where men have preferential access to food, women are put at a much greater disadvantge which can become extreme during periods of famine (Ortner 1998).

Fig. 28 Age at death of Stannington population

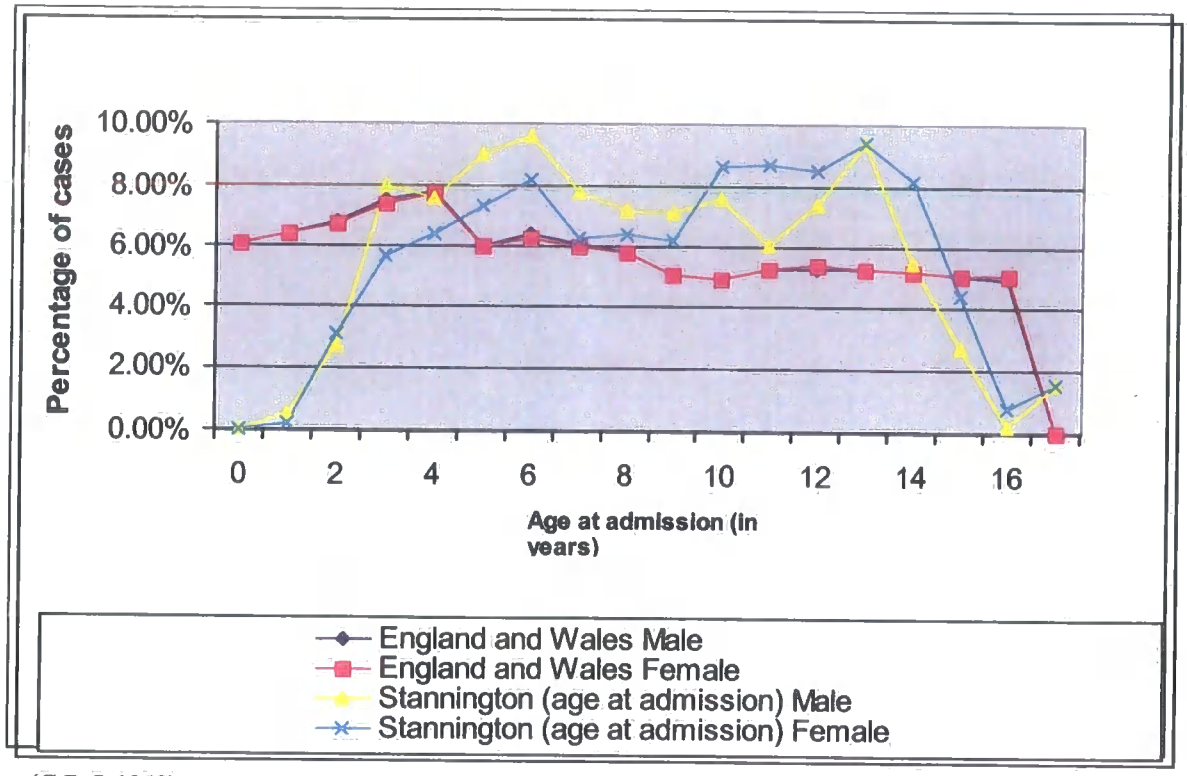


7.2 Age at admission to Stannington

Age at admission was recorded to see whether there were any ages when children were more susceptible to contract tuberculosis, and to see whether different types of tuberculosis affected children at different ages. The number of children in Stannington under the age of three cannot be compared with the enumerated population as children of that age should not have been admitted to Stannington according to its publicity pamphlet (although as can be seen, a few were).

The earliest age of admission to Stannington (from its publicity pamphlet) was three years of age and it is not stated why there were also children under three admitted. The higher number of three and four year-olds that are seen in the enumerated population are probably a result of the 'baby-boom'. The percentage of the enumerated population for England and Wales are compared to the admissions from Stannington in **Fig. 29**. The 'baby boomers' is the name used to refer to those people born between 1946 and 1964 (in the United States) and is commonly thought to be an indirect result of the War when people wanted to return to family values (i.e. the wife at home in the kitchen and the large family). This baby boom resulted in 76 million babies being born between those years in the United States. The United Kingdom also went through this baby boom, but it has not been possible to find the population statistics for it. There is a slight increase in the numbers for both the enumerated population and Stannington for the six year olds. There is a general decrease in numbers from the ages of 10 and above for the enumerated population but the reverse can be seen for Stannington. Finally, the number of female cases between the ages of 10 and 13 are much higher than the males, and also in the enumerated male and female population.

Fig. 29 The percentage of children's age for population of England and Wales and admissions to Stannington



(G.R.O 1958)

Hurtado *et al* (2003) demonstrated in their study that the Aché children between birth and five years of age were the least vulnerable to tuberculosis. Notification data from some European countries during the height of tuberculosis prevalence showed different rates in men and women. More women were reported to be suffering from tuberculosis particularly in the 20-34 year age group compared to the men in the same age group. Due to socio-cultural and economic reasons, there are under-diagnosis and notification rates among women in developing countries (Hoang Long *et al* 2002). Some hypotheses have been proposed to explain the differences in reported TB between men and women. Hoang Long *et al* (2002) state that in these developing countries men have a higher exposure to infection after 15 years which leads to their higher incidence of tuberculosis (Holmes *et al* 1998, Hoang Long *et al* 2002). Swaminathan (2001) states that tuberculosis in children is directly related to the prevalence of infectious tuberculosis in adults, and that it is also a good index of recent transmission as children seem to suffer from primary tuberculosis more than adults. The annual risk of tuberculosis infection is the only available index for current transmission levels and is calculated by assessing tuberculin reaction sizes in children between 0 and 9 years of age within a population. Datta and Swaminathan (2001) determine that there is a close relationship between the age of the patient and vulnerability to disease. The younger a child

is, the greater risk they have to progress from infection to disease, the greater severity of disease they will suffer from, and they will also suffer from a greater fatality rate. They conclude by stating the importance of diagnosing and treating tuberculosis in children promptly and correctly. In France, Gaudelus (2003) demonstrated that children (people under the age of 15) represented 5.5% of the notified tuberculosis cases in the year 2000. He states that the risk for children developing tuberculosis disease from infection will vary with age. If they contract the disease before the age of one, they have a 43% chance of developing the disease, if they are infected between the ages of one and five years of age they have a 24% chance of developing the disease and in adolescents (between 11 and 15 years of age) a 16% chance of developing the disease. In adults, this risk of developing the disease from infection is only between five and 10%. Could this be an explanation as to why the younger children were admitted to Stannington? To protect them from the risk of progressing to disease from their infected state?

When the age distribution of the Stannington admissions is analysed by type of TB different patterns emerge. For the abdominal cases **(Fig. 30)**, there is a male/female divide in the number of cases. The male cases seem to suffer from tuberculosis of the abdomen much earlier than their female counterparts. There is a peak in the male abdominal cases at three years of age, followed by a decline, a smaller peak at five, a decline until the age of seven, a sharp increase at the age of nine, and then a general decrease until the age of 16 (the maximum age a child could stay at Stannington). The female cases on the other hand are low in the early years and then there is a sharp rise from the age of nine, and the numbers generally stay high (except for a short decline at the age of 12) until the age of 16. Blacklock (1932) demonstrated in his study of tuberculosis in children in Glasgow that the largest number of abdominal cases were found in the first two years of life and were half the number of cases in the third year after which the numbers became too small to have any real significance. The numbers from Stannington do not represent the male to female ratio of 5:4 seen by Machado *et al* (2001).

Fig. 30 Number of cases by age and sex (abdomen cases and glands/abdomen)

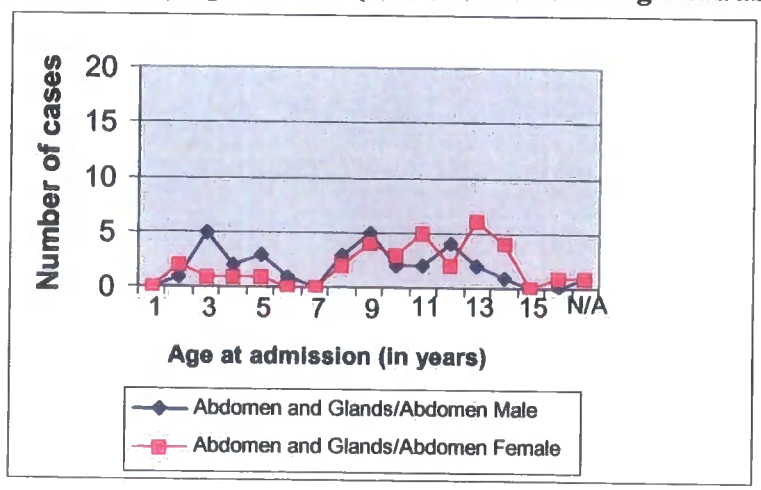
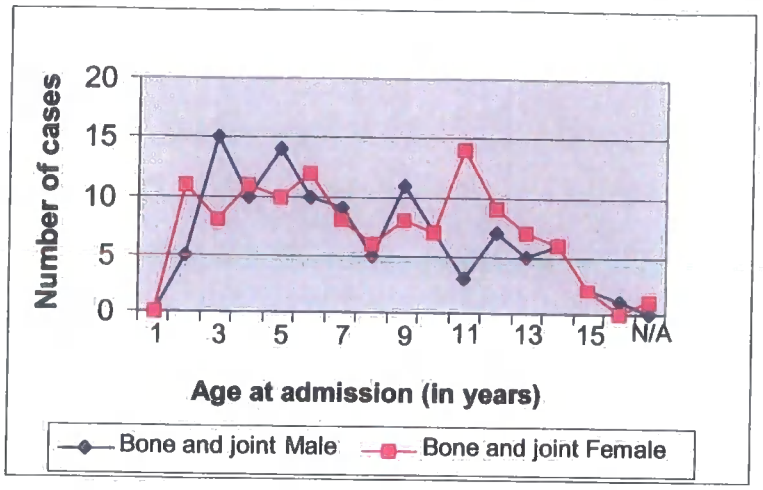


Fig. 31 Number of cases by age and sex (bone and joint cases)



When looking at the bone and joint cases, it is possible to establish other trends **(Fig. 31)**. There were many cases of TB of the bones and joints in the younger ages for both the males and the females. There were, again, more cases for the males until the age of seven, then the numbers decreased steadily except for a peak at the age of nine. The females on the other hand had their higher peak at 11 years old. Their numbers then decrease steadily. This type of tuberculosis has been associated in the past to the bovine form of the disease with at least 35% of cases (Blacklock 1932). Sadly it was not possible to establish this at Stannington because the differentiation between bovine and human TB was not performed on the patients. However, Blacklock (1932) states that his numbers were much lower than those found by Fraser (1912) in his Edinburgh study where he found that 61% of the patients suffering from bone and joint tuberculosis were infected by the bovine form of the disease. There were more younger children affected (those under the age of five years) in Blacklock's (1932) study than those over the age of five to 13 years of age suffering form tuberculosis of the bones and joints. The breakdown in age was not given for this type of tuberculosis.

Fraser (1914) states that tuberculosis of the bones and joints is rare in children of less than one year of age and increases between the ages of five to 12 years, reaching its peak at the age of ten. The example of Stannington differs from this statement. At Stannington, there were a few cases before the age of five, especially for the boys, and there were more male cases of tuberculosis of the bones and joints under the age of 7 than in females. The numbers for the

males then decrease while the female cases increase rather more steadily than the males. There was a peak for the female cases at 11 years of age and the cases for both boys and girls decrease after that age **(see Fig. 31).** As for the different types of bones and joints affected, in the cases suffering from tuberculosis of the spine there were several small peaks for the male cases at two, four and 14 years of age, with the age of the average case being 7.5 years of age. There was only one peak for the female cases and this appeared at five years of age, although the average was a little lower at 6.7 years of age. According to Bailey *et al* (1972) the most affected children are under five years of age for this type of tuberculosis (also in Hakim and Grossman 1995). The children suffering from tuberculosis of the spine were, on average, younger than those suffering from tuberculosis of the hip and knees. Tuberculosis of the spine appears in different frequencies in different studies but, according to Fraser (1914) and Resnick (1995), the vertebrae are the bones most likely to be affected in 25 to 60% of cases reported; Fraser (1914) also notes that it occurs more often in boys than girls. At Stannington, however, there were more girls than boys suffering from tuberculosis of the spine by a count of 40 to 35 cases **(Fig. 32).**

Fig. 32 Age of patient affected by tuberculosis of the spine

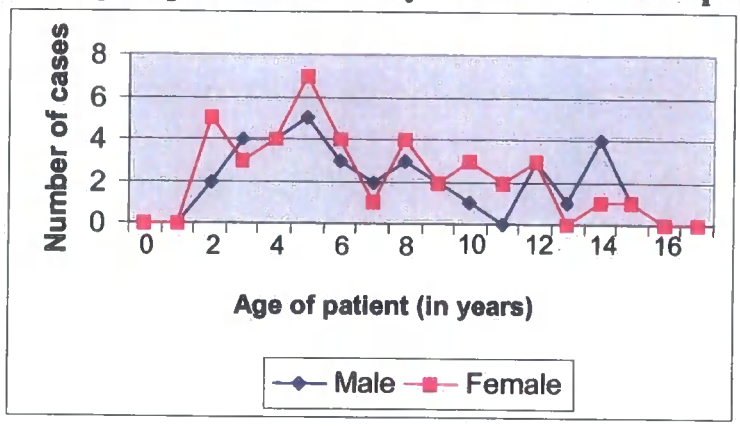
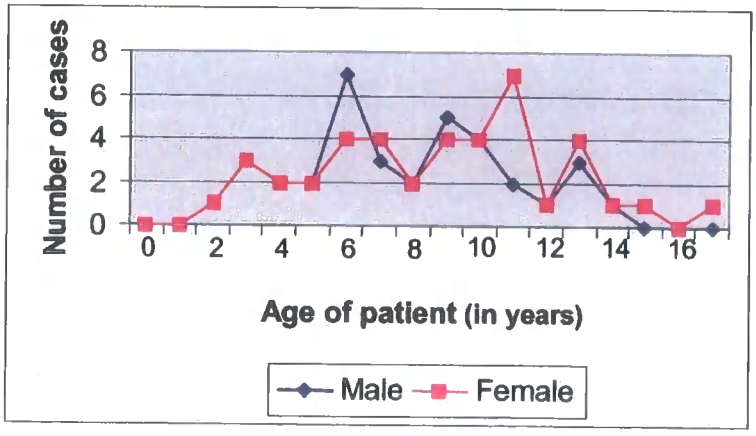


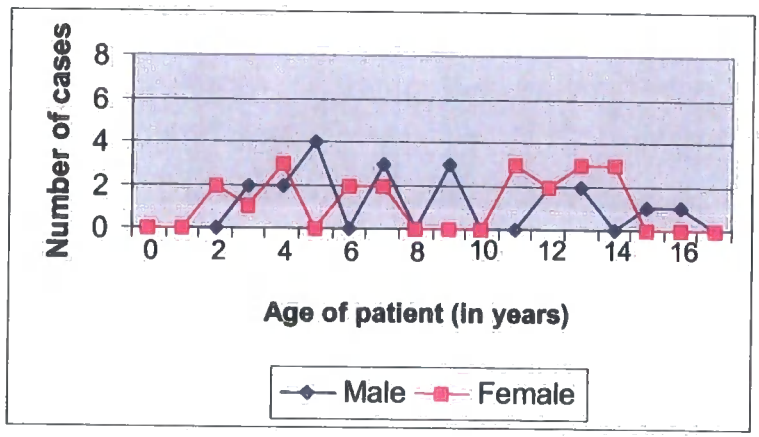
Fig. 33 Age of patient affected by tuberculosis of the hip



As for tuberculosis of the hip, according to Miller (1982), it is rare in children who have not walked. Fraser (1914) agrees and adds that over 90% of these cases occur during the first decade of life with 50% of those appearing in the interval between three and five years of age. It is equally distributed between boys and girls, although boys seem to have a slightly higher occurrence that Fraser (1914) explains to be due to their increased liability to injury. The data from Stannington do not necessarily agree with these statements **(Fig. 33).** The male cases show two peaks (one at six and the second at nine years of age), data that agrees with these statements, but the females show their largest peak at 11 years of age. The average for both the boys and the girls was 8.3 and 8.6 years respectively. The trend in the data shows that the children affected by tuberculosis of the hip seem to be of a slightly older age than the children suffering from tuberculosis of the spine. There were 36 males and 41 females who suffered from tuberculosis of the hip.

The number of children suffering from tuberculosis of the knee are lowest overall of all the major types of TB with only 20 males and 22 females affected **(Fig. 34);** Fraser (1914) states that boys and girls are affected almost equally. There are no clear peaks for either sex. The male cases average out at 8.2 years and the female cases to 8.7 years of age that is around the same age as the cases of tuberculosis of the hip.

Fig. 34 Age of patient affected by tuberculosis of the knee



The other types of tuberculosis were all regrouped together due to there being so few of cases at Stannington **(Fig. 35).** Looking at tuberculosis of the ankle, there were five male and three female cases. The male cases average out at 5.8 years of age, while the female cases average out at around 8.3 years of age. Fraser (1914) explains that there are more boys than girls

affected by this type of tuberculosis as boys of this age, according to him, are more liable to injury. As for tuberculosis of the shoulder joint, it occurred in only three cases at Stannington (two girls and one boy). This agrees with Miller's (1982) statement that it is quite rare in children as tuberculous disease will affect more often the lower rather than the upper limbs. Tuberculous disease of the elbow is common in childhood and affects more females than males. This was not found to be the case at Stannington as tuberculous disease of the elbow was only found in three children, with two of them males. According to Miller (1982) tuberculous disease of the wrist is distinctly rare in children and should appear in about two per cent of all bone and joint cases. In Stannington, tuberculous disease of the wrist appeared in three cases (2 males and 1 female). It appears as often as a disease that is considered to be common in children (tuberculous disease of the elbow). As for its proportion, it appeared in 1.2% (n=3) of the cases of tuberculous disease of the bones and joints overall. Finally tuberculous disease of the hands and feet should appear, according to Hardy and Hartmann (1947), in about 0.6 to 6% of cases, while Resnick (1995) states 0.4 to 15%. It is also more common in the hands than in the feet (in a proportion of eight to one) and appears more often during the first five years of life, although when seen in older children it is usually associated with tuberculous disease elsewhere (Resnick 1995). At Stannington tuberculous disease of the foot was seen more often than tuberculous disease in the hand. It appeared in 2 males and 2 females (males aged seven and six, and the females aged three and four) while tuberculosis of the hand occurred in one case (along with tuberculosis of the spine, a female case aged six). Tuberculosis in the foot occurred in another five cases that were associated with multiple skeletal sites of tuberculosis (for example toe, knee and humerus or tibia, ankle and cuboid).

Fig. 35 Age of patient affected by other sites of bone and joint tuberculosis

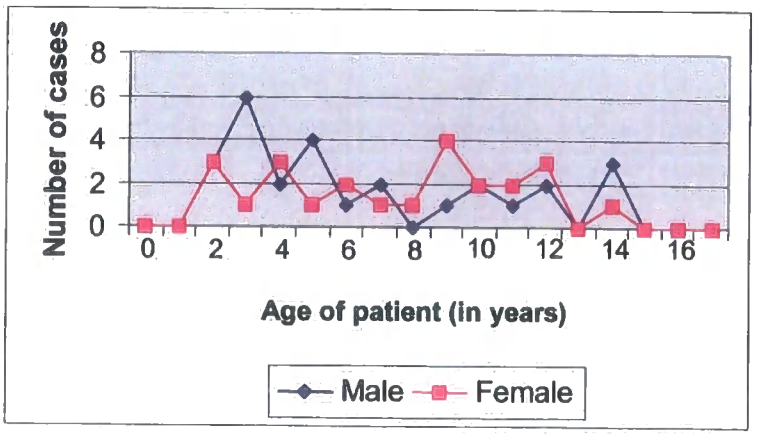
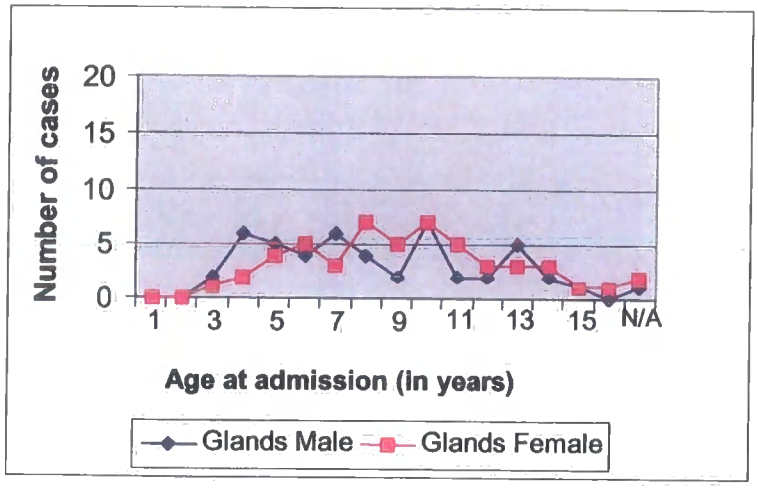


Fig. 36 Number of cases by age and sex (tuberculosis of the glands)

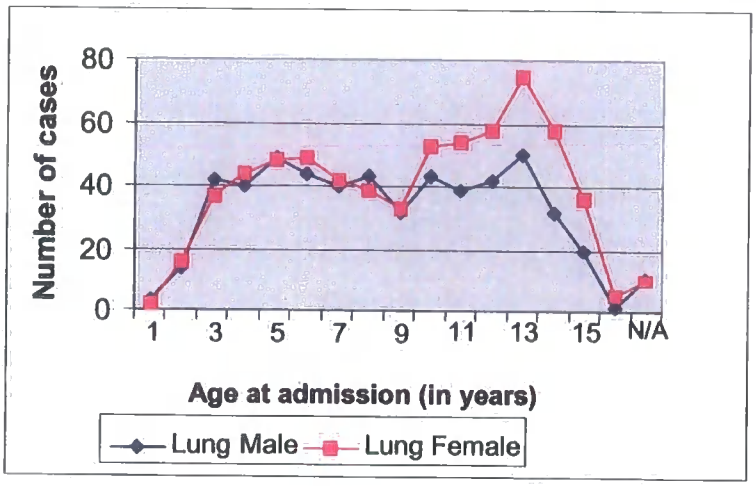


Tuberculosis of the glands show again different trends to tuberculosis of the bones and joints and abdomen **(Fig. 36).** The males show several peaks until the age of 14, while the females seem to have a more gradual curve with their highest peak at eight and ten years of age. Blacklock (1932) again demonstrates that this type of tuberculosis was associated with bovine tuberculosis in the past as the children would most likely be drinking unpasteurised milk and would therefore be more likely to succumb to this type of tuberculosis. Blacklock's study (1932) showed that around 65% of the children affected by this type of tuberculosis suffered from the bovine strain. There were nearly as many cases in the first five years of life as from the five to 13 age range in Blacklock's study (1932) suffering from tuberculosis of the glands. The breakdown of age distribution was not provided for this type of tuberculosis.

Pulmonary tuberculosis **(Fig. 37)** follows the age distribution from Stannington. There are a low number of cases under three years (as had been explained before, the age limit for the children admitted to Stannington was between three and 16 years of age). The numbers remain relatively stable until the age of 10 when the female cases continue to increase while the male cases decrease. There has not been any concrete reason suggested by anything in the medical files at Stannington as to why there were more females than males of that age in the sanatorium. Some authors (Johnston 1953, Grigg 1958, Lincoln and Sewell 1963, Roelsgaard *et al* 1964, Styblo *et al* 1969, Schaaf *et al* 1996) have explained the higher number of female adolescents of that age to be related to their menarche. This in turn affects their immune system and makes them more vulnerable to succumbing to tuberculosis. Johnston (1953) suggested that changes in girls' nutrition during their adolescence could be a factor that helped to explain the increased rate of pulmonary tuberculosis in females of this age group.

Other factors to consider would be the suffering from a negative nitrogen and calcium balance and the onset of the menses which could all affect the endocrine system and act as a possible trigger to the disease. However, no satisfactory explanation of the phenomenon exists (Johnston 1953 in Lincoln and Sewell 1963). According to Donald and Beyers (1998) there are studies that indicate that there is a slight predominance of male infection but that there are more female adolescents with the disease than young males, which is what is seen at Stannington. According to Lincoln and Sewell (1963) there is no statistically significant difference in the rate of boys and girls developing later pulmonary disease if their primary tuberculosis is diagnosed before the age of seven. They also state that children who had primary tuberculosis when they were seven or older developed chronic pulmonary tuberculosis at a much higher rate and that girls also have a much higher rate than boys. Regardless of the age when the first infection was diagnosed, more children developed later pulmonary disease during adolescence than at any other period at Stannington.

Fig. 37 Number of cases by age and sex (lung and possible lung cases)

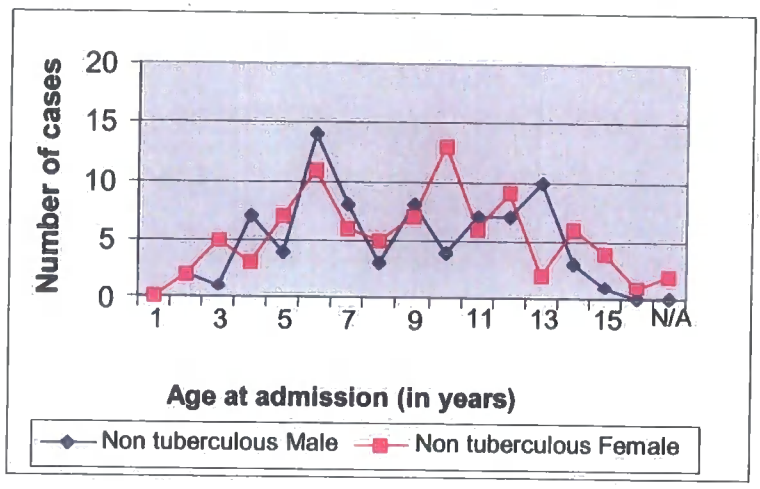


Finally the children who did not suffer from tuberculosis at all show different trends **(Fig. 38).** There is a high peak at age six for the boys and another smaller peak at the age of 13. The female cases show three peaks at six, 10 and 12 years of age.

As can be seen in the data, there are more younger males infected with TB under the age of nine years and more adolescent girls infected with TB after the age of nine years **(Fig. 29).** The cases seem to mirror themselves, but they do not follow the curve shown by the enumerated population. According to Bates (1992) a person's resistance is especially poor at

three times in life: the first three years, the period between puberty and approximately the 25th year, and old age (the reasons for this are not clear). During the first period children are more likely to develop the disease outside of the lungs (Bates 1992:8), i.e. extra-pulmonary tuberculosis.

Fig. 38 Number of cases by age and sex (non tuberculous cases)



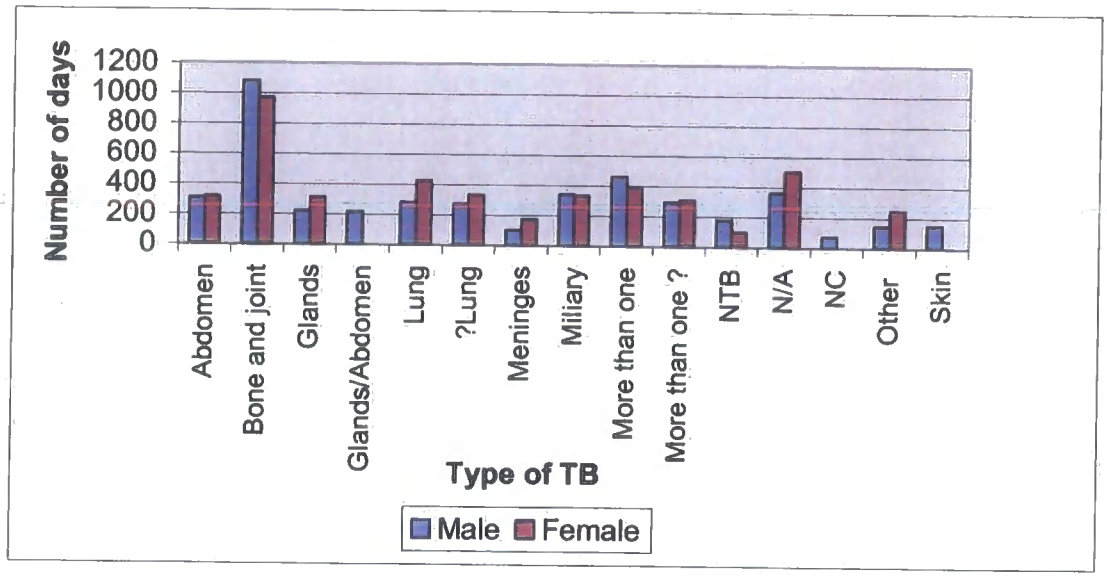
According to Murray and Lopez (1997 in Hudelson 1999) the age groups of people most affected by tuberculosis are also affected by male and female frequency rates. Today, tuberculosis is a major cause of death for females in the 15-44 year age group. This is important, as these are the years when the females are in their reproductive years. Spence *et al* (1993) indicated that in a study of tuberculosis in Liverpool between 1985 and 1990 the largest increase in tuberculosis was in young females, older females and older males. Johnston (1995) also states that the age groups most affected in contemporary groups are those from birth to the age of five, puberty to 30 years of age and old age (60 and beyond). The younger people affected at this stage are more likely to develop primary disease leading to active disease and sooner death. By affecting people in their most productive years (puberty to 30 years of age) tuberculosis is a very important disease economically. Those who suffer from tuberculosis in their old age are most likely suffering from a reactivation of the disease that they acquired in their youth. Today, there are also differences between industrialised and non-industrialised countries. In the higher incidence countries, the highest incidence is in the age group between 15 and 24 years of age (www.1) while in industrialised countries the highest incidence is found in the over 65 age group (Snider *et al* 1994).

Hakim and Grossman (1995:117) declare that tuberculosis is a childhood disease that can affect adults. The frequency of disease in children is a good indicator of the disease in adults as children will be infected by adults, especially though the inhalation of infected droplets. Kochi (1991) has estimated that there would be 1.3 million children infected with tuberculosis in the last decade of the 20th century and 450,000 deaths from tuberculosis would happen per year. In the United States, Starke *et al* (1992 in Jacobs and Starke 1993) recorded a 39% increase in TB in the cases of children under five years of age between 1987 and 1990.

7.3 Duration of stay at Stannington

The average number of days spent in the sanatorium has been described in the previous chapter. It was established that there was a large variation in the duration of stay for children with different types of tuberculosis **(Fig. 39).** The shortest periods of stay were for the children suffering from tuberculosis of the skin, 'other' types of TB, the non-confirmed cases, tuberculosis of the meninges, along with the non-tuberculous cases. For tuberculosis of the skin, 'other' types, and the non-confirmed cases, the explanation may be that there were a small number of these cases, and therefore the numbers shown do not necessarily represent the time that the children spent at the sanatorium at that time. For the children suffering from tuberculosis of the meninges, the answer may well lie in the fact that tuberculous meningitis was invariably fatal before the introduction of antibiotics, and that the low average number of days spent in the sanatorium could be the result of these children dying quite rapidly (although not necessarily at Stannington). This may be due to the fact that in the earlier years there was no anti-tuberculous chemotherapy available, and in the later years could be influenced by the fact that the children were being brought too late to the sanatorium for any chemotherapy to be effective. Only one of the female cases who died while at Stannington died from tuberculous meningitis. The majority (12/21 or 57%) of the cases who died suffered from pulmonary tuberculosis. The non-tuberculous cases are simple to explain: the low average number of days they stayed at Stannington is a direct reflection of them not suffering from tuberculosis, and therefore they were sent home after an initial observation period, which could be as short as a few days.

Fig. 39 Average number of days in Stannington by type of TB



?Lung = possible lung tuberculosis, NTB= non-tuberculous, N/A = not available, NC= not confirmed

Patients with tuberculosis of the glands, and of the lungs, usually stayed 200 to 300 days at Stannington **(Fig. 39).** These were the cases that would require rest and fresh air, and would have high success rate from the treatment. Those patients staying over 300 days (i.e. tuberculosis of the abdomen, miliary tuberculosis, and those for which this information was not available) would experience the same type of treatment as that reserved for the pulmonary cases (rest and fresh air), but these types of tuberculosis also had other types of treatment attached to their regimen such as UVR for the abdominal cases.

Finally, the cases that stayed the longest in the sanatorium were, of course, the bone and joint cases **(Fig. 39).** These children usually stayed on average around 1000 days. Again this is reflected in the types of treatment that they were receiving as they needed to arrest tuberculous development, and then correct any deformity that might have occurred from the disease. These were the patients who were most often seen in the outpatient review at Stannington sanatorium. They would be requested to return for check-ups periodically until they were considered cured (after an average time of five years).

Bardswell (1910) studied the results of 241 patients who came under his care between 1899 and 1905 and he was able to establish that, where people came from a middle class environment (i.e. those engaged in business and similar occupations who had therefore enjoyed the benefits of comfortable homes and favourable conditions), that the average length

of stay for patients in a sanatorium would vary. If the disease was in its earliest stages a stay of six months would be enough, while if the disease was advanced then a stay of one year was not too much. He concluded that an average stay of six to nine months was quite usual for the average patient. The length of stay of a patient in a sanatorium is usually a compromise between the patient's interest in their work and their interest in their own health. Bardswell (1910) reports that the average time of stay is very hard to determine and that most patients believe that a three to four month stay will be sufficient to arrive at a cure, but he concludes that the average patient does not stay as long as needed to effect a cure. He preferred to know that the patient could do everyday activities without feeling ill and they had to have a constant temperature before he discharged them. Muthu (1922) stated that his patients who suffered from pulmonary tuberculosis would need at least six months of treatment in the sanatorium if they were expecting a cure. Starke (1999) notes that there are not many studies that provide direct information on this type of question, but that most people being treated in sanatoria would be there for at least six months. Clubley (1996) states for bone and joint cases that a stay of two and a half years in a sanatorium for tuberculosis of the hip was usual. This included plaster immobilization and a brace afterwards. Gomez-Pastrana *et al* (1999) showed that the children in their study stayed in hospital on average 63.8 ± 18.9 days while receiving treatment while the other children who were not in hospital were on average receiving treatment, for 80 days ±17.3 days. Starke (2001) states that the DOT program has helped decrease treatment time in Houston, Texas where children receiving anti-tuberculosis therapy used to take approximately 11 months to complete a 6-month therapeutic regime while, since the arrival of DOT, the average time for a child to receive a 6-month course of chemotherapy is now six and a half months. In later sections (7.9, 7.10 and 7.11) the average time that the children stayed at the sanatorium will be analysed with respect to the introduction of chemotherapy at Stannington, the end of the Second World War and the implementation of the NHS.

7.4 Rural versus urban areas of origin for admissions

Again, the results from the analysis of this variable were not surprising. Nearly 80% of the children came from urban areas, especially around the Newcastle and Gateshead areas. These results are to be expected as these were the big urban conglomerations around Stannington at that time. The parents were also likely to send their children to a sanatorium that was near their home so that they would be able to visit them on visiting days. There are various sources, of course, that indicate that tuberculosis is an urban disease (Bryder 1988, Berridge 1999, Cule 1999, Dormandy 1999). Indeed, TB does need close contact to permit

transmission. The conditions for transmissibility would not necessarily be present in rural areas. It would have been interesting to determine whether the bovine form of the bacillus had affected the cases that came from rural areas.

Dormandy stated (1999) that tuberculosis still accounted for 24% of hospital deaths under 10 years in Newcastle-upon-Tyne in 1947, and most of these people came from poor neighbourhoods. There are more under-privileged neighbourhoods in the big urban areas than the rural areas. Francis (1958) states that the death rate for England and Wales in 1946-1947 was about 50% greater in County Boroughs and other urban districts than it was in rural districts. Roberts and Buikstra (in press) note that urbanism and industrialisation would have provided the necessary population densities to enable tuberculosis to spread in the community. Overcrowding promotes the spread of pulmonary tuberculosis in urban areas so it is unsurprising that when conditions improve, tuberculosis rates decrease accordingly. People in rural areas today will have less chance of contracting tuberculosis by the respiratory route than their urban peers if their cattle are free from tuberculosis just because of the lack of high population density in rural areas. Both the rural and urban populations came from families with an average of four to five people. However, in the past (as well as today in developing countries) if people were sharing their accommodation with their animals and these were infected with tuberculosis they would have an increased risk of contracting the disease. Elender *et al* (1998) demonstrated in their study on tuberculosis mortality in England and Wales that there was a strong link between tuberculosis and overcrowding. Mantagni *et al* (1995) estimated that for every one per cent increase in the number of people living in crowded conditions there would be an associated 12% increase in tuberculosis notification rates. Roberts and Buikstra (in press) note that there can also be sex differences related to this. On the one hand, females can spend more time at home in crowded conditions, therefore increasing contact time and possibly increasing their chances of contracting tuberculosis but, on the other hand, males are more likely to contract tuberculosis as they will be exposing themselves to the pathogens through their different social and work related activities. They may also be working with animals that carry the infection and transmit it to them.

As has been noted previously, bovine infection was still important in cattle at that time. According to Atkins (unpublished manuscript) the intensification of milk production that appeared in dairy counties like Cheshire and in the urban dairies which survived in Liverpool until the 1950's, put cattle at high risk of being infected. This would have affected those most probably suffering from non-pulmonary tuberculosis. Atkins (unpublished manuscript) states that infants were more susceptible but that it caused morbidity and mortality at all ages.

Atkins (1997) own estimate is that approximately 800,000 deaths were caused by the bovine form of the disease between 1850 and 1950.

The pasteurisation of milk was also slowly accepted. The large dairy companies were the first to implement it, but their motive was to extend the shelf life of their product, not to make the milk safe for consumption. People who lived in small towns or in rural areas had to wait until the 1940's or 1950's to benefit from pasteurisation. Doctors at the time were against it, arguing that it destroyed vitamins and might endanger human fertility (Atkins unpublished manuscript, Hardie and Watson 1992). Other doctors such as Clive Rivière believed that drinking infected milk contaminated by tubercle bacilli was a way of obtaining some immunity against tuberculosis (Bryder 1988). This may not have been as crazy as it sounds as repeated infections with small doses of tubercle bacilli could indeed lead to some immunity. The problem, however, was that it was nearly impossible to judge how much infection had actually occurred. The Ministry of Health pronounced itself in favour of pasteurisation in its 1931 report on bovine tuberculosis stating that it was safe and did not impair its nutritive and commercial value (Bryder 1988).

The problem with bovine tuberculosis is that it is not obvious in its early stages. When there are signs and symptoms such as emaciation or a cough, the meat and milk are already infected and dangerous for human consumption (Atkins 2000a). *M. bovis* can also survive in butter for up to five months and also for long periods in certain cheeses (Atkins ibid). Abdominal TB, generally thought to be associated with the bovine form of the infection, brought about the vaccination of milk herds and the accreditation of milk. The best milk that could be bought (thought to be milk of the highest order) was pasteurised, followed by tuberculin tested (TT) milk, accredited milk, and finally normal milk. This grading of milk was abolished in 1964 as it was considered to be no longer necessary (Atkins 2000b). By 1939, one of the major causes of TB in humans (milk from tubercular cows) was being tackled with increased success. There were thought to be several reasons for this, mainly because there was stricter legislation, more thorough enforcement of regulations concerning dairy herds and cowsheds, and the development of a simple and reliable test to detect tubercular cattle. The Government had passed measures to help in the elimination of TB but the First World War had put a stop to them, and their enforcement was only reinstated in 1925. "By this time, the Medical Research Council had discovered a simple and reliable TB test for cattle: earlier tests were widely mistrusted and considered unreliable, and an estimate in 1907 suggested that if all animals which reacted positively to the tests then available were destroyed, 30% of all the cows in the country would have been slaughtered" (Taylor, 1989: 72). The District Councils were also responsible for keeping up standards but the inspectors were not veterinary

surgeons and were seldom qualified to say whether a cow was diseased or not (Taylor ibid). After 1925, it was made illegal to use infected cows for milk production and a system of compensation was instituted for dairy farmers whose diseased animals had to be slaughtered. When the District Medical Officer suspected that there was tubercular milk in his area, it was his duty to inform the County Medical Officer who would send the County Veterinary Officer to inspect and to conduct post-mortem examinations on cows where TB was thought to be the cause of death (Taylor ibid).

Tuberculosis in cattle has recently reappeared in England. An article in *The Guardian* (April 20, 2002) showed that bovine tuberculosis is still present in Britain and that it is spreading rapidly. Tuberculosis testing of cattle had stopped in light of the foot and mouth epidemic which hit the country in 2001. According to Meikle (2002), the figures covering Britain as a whole for January and February 2002 suggest that 184 herds have been confirmed as having new TB cases (147 in England, 34 in Wales and three in Scotland). Although only the diseased animals are slaughtered (unlike foot and mouth) in tuberculosis, the others are put under movement restriction and tested again two months later. The wrath of the farmers have now turned to badgers, which they believe transmit the disease to cattle, while wildlife campaigners are fighting to save badgers from being culled (Meikle ibid).

The infection from badgers seems to come from their urine rather than their faeces as cows have been known to consume pasture contaminated by badger urine within eight hours of deposition, but cows will avoid pastures which have been contaminated by badger faeces which occurs most commonly around their 'latrines' (Benham and Broom 1991, Brown and colleagues 1994, O'Reilly and Daborn 1995). It is believed that cows can contract tuberculosis by licking, smelling or sniffing pastures heavily contaminated by fresh urine or sputa from badgers or from a dying or dead badger (O'Reilly and Daborn 1995). Coleman and Cook (2001) state that there are several other animals which can be infected with tuberculosis but that these species are not capable of maintaining the disease in their own population and are probably unlikely to spread the disease to livestock. The species that they believe can suffer from tuberculosis as amplifier hosts are hedgehogs, pigs, cats, sheep, goats, stoats, hares and rabbits. Delahay *et al* (2002) undertook a similar study in the UK and demonstrated that, apart from the badger, the evidence did not support the existence of a self-maintaining reservoir of infection in any other wild animal.

As has already been discussed (Chapter 3, section 3.3.2.5), death in children under the age of five, suffering from tuberculosis, was seen as a sign of infection by *M. bovis* in 1955. It was thought that this type of infection was associated with the ingestion of contaminated milk.

There was a fall in deaths from TB between 1921 and 1953 and this was attributed to the development of safe milk in the intervening years. Hardie and Watson (1992) believed that this resulted from a combination of pasteurisation and the control of *M. bovis* in cattle at the time. At Stannington, there were 64 abdominal cases, 230 bone and joint cases, and 101 cases of tuberculosis of the glands (cervical), with one other case suffering form tuberculosis of the glands of the abdomen and these are the cases that would be expected to be caused by bovine tuberculosis (395 cases or 20.8%), but as aforementioned, it was not possible to identify whether the children at Stannington were infected by the human or the bovine strain of TB. *M. bovis* does have a more important role in developing countries as they do not have the control measures or the laboratory equipment to differentiate between *M. bovis* and *M. tuberculosis* and many people there are actually employed in agriculture (65% in Africa and 70% in Asia) (Cosivi *et al* 1998). Therefore, it is hard for doctors and scientists in these areas to identify whether workers are infecting the cattle or whether the cattle are infecting the workers. If the cattle are infecting the workers then the cattle must be culled but, as has been discussed in a previous section, farmers are quite reluctant to have an animal killed that does not seem to have any symptoms. Cattle do not show any symptoms until the disease is well advanced and it has been infectious for some time. Naturally the children at Stannington would have been at a higher risk of contracting tuberculosis if they had been drinking milk which was not pasteurised which would have in turn affected on the number of abdominal cases, bone and joint cases and tuberculosis of the glands. The introduction of pasteurisation would have greatly reduced their chances of contracting tuberculosis in that way. There were almost 30% of all non-pulmonary tuberculosis deaths and two per cent of pulmonary tuberculosis deaths in the British Isles due to *M. bovis* in the 1930s (Bryder 1988). It was nearly impossible to expect the poor to buy properly accredited milk as they could not afford it. In Newcastle, the high cost of this tubercle-free milk meant that only seven per cent of milk sold came into that category even though there was a nearly unlimited supply of tuberculin-tested milk (Bryder 1988). By 1941 less than 50% of milk distributed in all counties was pasteurised and about 15% was heat-treated in some other way. In smaller towns, much less was pasteurised and practically none of the milk from the rural areas was treated (Bryder 1988), drastically increasing the rural children's chances of contracting TB from contaminated milk. As has been said previously, it was not possible to establish whether the children had been infected by the human or bovine strain of the disease therefore, it was not possible to establish whether the children had been drinking infected milk or not. If they were given school milk as was done in large urban areas such as Newcastle, the children would also have been at a higher risk of contracting tuberculosis. Therefore, it might be logical to conclude that whether children were coming from rural or urban areas, they would have the same chance of contracting tuberculosis by ingesting infected milk. The children

coming from urban areas would have a greater chance of contracting the disease as has been stated as a result of the higher population densities which occurred in the larger cities (for example Newcastle), this however, is closely related to overcrowded conditions which were found in the cities at the time and will be discussed in the next section. The data between rural and urban differences will not be taken any further at this point because the number of cases from the rural areas are so low.

7.5 Socio-economic status/housing conditions of children at Stannington

The children in this study (for which the information was available) came from mostly poor backgrounds and most of the parents came from manual labour (blue collar) backgrounds. The size of the family from which the tuberculous child came from was mostly of four or five people for both the rural and the urban cases. There were 38 cases that had 10 or more members in the family. These people did not necessarily all live together and the information in the files would sometimes suggest that, although there were six people in the family, only four lived under the same roof as other members were either in the Armed Forces or living away from home (for example, a married daughter). There also were cases where the family would have four members but 10 people would be living under the same roof; this was the case when more than one family would have to share the dwelling. From the census data from the three regions providing the data for this study (Durham, Northumberland and Cumberland and Westmorland) (G.R.O 1954a, b, c), however, the families were of a much larger size than those found in this study. In these regions the census found that families of five or more members were more numerous than those of smaller sizes. It was also possible to establish that, according to the Housing Report from the 1951 Census (G.R.O 1956), the average size of the houses of the population in these regions (Durham, Northumberland and Cumberland and Westmorland) was a four to five roomed houses, although these northern regions had the highest number of one to three roomed housing. The data from Stannington demonstrated that the average house for the families in the study consisted of between three and five rooms and only three families had a house of six rooms of more. As for the condition of the housing, it was possible to evaluate its condition from the records of the patients at Stannington. Here, again, the results are to be expected in that there were many more cases for which the doctors from Stannington assessed the housing to be 'poor' (n=116) than those that were assessed to be 'good' (n=82). Of these 116 cases where the conditions were considered 'poor' 26 were cited by the doctors to be 'poor' without any further details. The other 90 cases were determined to be 'poor' with conditions of the houses given as overcrowded and damp. Of the 82 cases that were deemed to be 'good', there were 38 where

the doctors expressively admitted that the housing conditions were 'good'. A further 44 cases were determined to be 'satisfactory' by calculating the density of the number of people per room, it being fewer than two people per room; these families also possessed 'modern conveniences'. There were details for 188 cases where the number of bedrooms for the families was given although this information did not necessarily coincide with the details on the number of people in the household. There were 23 families with one bedroom, 73 with two, 79 with three, 11 with four, and two with five bedrooms. As stated previously, this information did not coincide with the size of the families and therefore it would be hard to relate these findings to one another. There were a further 398 cases for which the details given were not complete enough to determine whether the housing conditions were good, poor or otherwise.

Elender *et al* (1998) discuss poverty and overcrowding associated with the frequency of tuberculosis. They found that overcrowding had a highly significant statistically positive association with all tuberculosis mortality groups studied. They also state that studies have shown that for each one per cent increase in the numbers of people living in overcrowded accommodation, the average notification rates increase by 12% (Mangtani *et al* 1995 in Elender *et al* 1998). Of all the variables looked at in the study by Elender *et al* (1998) (poverty including overcrowding, ethnicity and AIDS) overcrowding was the sole significant variable for women. They explain that women spend more time in the home than do the males, and therefore they are exposed longer to the tubercle bacilli that are in the infected house. Overcrowding is often associated with poverty as Enarson and Rouillon (1994) have shown, and poverty often leads to poor nutrition, a significant risk factor in tuberculosis. Poor people are more likely to live in crowded conditions where there might be a reduced intake of protein that can lead to a depressed immune system (McMurray and Bartow 1992). The stress of living in impoverished conditions can also lead to a suppressed immune system as evidenced by Khansari *et al* 1990. They state that an impoverished condition leads to stress as both psychological and physical stress can create pathological changes that enhance disease susceptibility. Hunt (1997) also reports that in 1911, 48.3% of children living in Newcastle-upon-Tyne were living in accommodation with more than two people per room. The government believed that only 3.9% of dwellings were officially overcrowded in 1931, but there were still over 60,000 families that were living in situations with more than four to a room (while a density of two or more persons per room is considered overcrowded) (Hunt 1997). There are many studies that look at overcrowding and the incidence of tuberculosis, but generally there is no simple direct relationship between TB and overcrowding; there are also social and economic reasons that encourage TB such as poverty and unemployment (Hunt 1997).

The condition of the house has also been discussed as a factor associated with an increased incidence of disease. Factors such as dampness, mould growth, house dust mites, and cold are all associated with increase in disease compared to housing which does not have these factors. Damp conditions (such as condensation) lead to the growth and proliferation of fungal spores which live on organic material on walls and in cavities, and thrive on wallpaper, plaster, and wallpaper paste. Moulds have been known for a long time to cause severe allergic reactions that can occasionally require hospitalisation. Dust mites love damp and flourish in conditions of 40% or more humidity. Their debris, especially their faecal pellets, act as allergens. The major health problems caused by mites include asthma and wheeze. Cold houses can be a result of several factors such as the economic inability to heat the house during the cold months. This can have drastic results as there have been an excess of winter deaths for some time resulting from hypothermia that especially affects younger and older people in a community. This has been linked to housing temperatures below 16°C. Other consequences of cold can be less severe such impaired lung function, triggering bronchospasms (acute airflow limitation due to the constriction of smooth airway muscles) and respiratory tract infections (Hunt 1997)

Tuberculosis is also stated as a disease of poverty in many cases in the past (Smith 1988). Farmer (1999) has noted that tuberculosis and social inequality can often go hand in hand as tuberculosis can be found in countries where poverty, inequality, and refugee status associated with war and disruption are found. There have been differences noted in mortality rates between the rich and the poor in Britain in the past (1930-1970 from the Black Report Black *et al* 1992). There are many factors which can account for the differences seen in Britain in the past and those are that poverty will lead to a decrease in the level of living environment conditions, diet, hygiene, and access to health (Roberts and Buikstra in press). MacIntyre (1998) also notes that poorer health and shorter lifespan are associated with each lower position in any given society, whether that be measured by social class, prestige, education or access to material resources. Therefore, the poorer you are, the lower social status and prestige you will have in a given population. Roberts and Buikstra (in press) report that the fact that people in the past affected by tuberculosis tended to be poor resulted in the disease being neglected; the poor people have the highest rates of tuberculosis and being the least powerful group in society. Farmer (1999) has also noted that the disease did not matter as long as it affected the poor, but when it started affecting the rich, money began to pour in to try and fight the disease once more. This could be a result of the 'arrogance' of the rich thinking that the poor are being affected because it is 'their own fault'. An example of this could be the AIDS epidemic in the United States. In the beginning, homosexuals and

intravenous drugs users were target groups for the disease and this implied that if they caught it was their own fault! Of course, when the disease began to affect the more prosperous groups in society it became a problem once again and money was found to try and find a cure. Again, similarly, tuberculosis stopped being a problem when it stopped affecting the rich! Spence *et al*'s (1993) study in Liverpool England illustrated that there was an association between socio-economic conditions and tuberculosis frequency. By using the Townsend and Jarman depravation indices they were able to report a tuberculosis frequency of 12.7/100,000, and that the rates of poverty were associated with the rates of tuberculosis. The strongest correlation came with the Jarman Index variables. The Jarman Index notes underprivileged areas where the general practitioner's workload was expected to be high. The Townsend Index reflects material deprivation. Bhatti *et al* (1995) made a similar study in 403 local authorities in England and Wales, and Hackney (inner city district in London). They were able to show that the notification rates rose by 12% in England and Wales with 35% of those being in the poorest tenth of the population, and 13% in the next two poorest tenths. They reported that there was no increase in the remaining 70%.

Hunt (1997) states that the occurrence of tuberculosis is all related to the human need for adequate shelter and its state of repair, structure, fabric, insulation, ventilation, heating, number of rooms, cooking facilities and sanitation are all factors in its occurrence. Lack of, or low levels of these factors, in addition to a lack of space, ventilation, sunlight and poor sanitation, can aid in the appearance and maintenance of pathogenic organisms. Hunt (1997) also describes that the Medical Officer of Health made an address to the Sanitary Institute in 1894 stating that there was a 50% higher overall, and infant, mortality from tuberculosis in houses that were 'back to back' compared to those with through ventilation. Rosen (1993) discusses that overcrowded housing conditions favour the spread of respiratory infectious diseases and that inadequate washing facilities will increase the rate of gastrointestinal infection. He also discusses that there had already been decreases in the TB mortality rates even before the advent of chemotherapy to treat TB. Overcrowded conditions were found in Newcastle at the time delimited by this study and would therefore be a factor in the high childhood tuberculosis infection rate found at Stannington. Improvement in living conditions and health services over time have led to a decrease in mortality in general, and infant mortality in particular, but as Rosen (1993) notes there are still differences between classes within a population, and between different populations, as well as inequalities in health today that are inextricably linked with fundamental problems of poverty.

According to Bowden and McDiarmid (1994) there are three types of occupations where there is a risk of contracting tuberculosis. Firstly, there are the unskilled labourers (food handlers, migrant farm workers and lower paid health workers). Secondly, labourers such as miners (Wright 1940 in Roberts and Buikstra in press), sandblasters and potters as these can lead to silicosis and other lung infections, and finally, those occupations which increase exposure to the infection (such as in prison guards, hospital workers etc). There have been quite a few papers written on the latter and prison workers in particular (MacIntyre *et al* 1999, Balinska 2000, Cooper-Arnold *et al* 1999). The National Insurance Act of 1946 in England listed 38 diseases for which compensation could be claimed and, of these, tuberculosis was number 38 (Hunter 1955 in Roberts and Buikstra in press). As has been said before, if the patient's parents were practicing professions that had high risk of contracting tuberculosis (or high mortality rates from tuberculosis), the children, by being in contact with them, would also have higher risks of contracting the disease than those children whose parents did not.

7.6 Contacts of admissions to Stannington

The children were expected to have been infected by their close family as the mode of transmission of tuberculosis dictates close contact for transmission of disease to occur. Children do not, of course, contract tuberculosis spontaneously! When a child is diagnosed with tuberculosis it is very important to look at their immediate family (parents, and other household contacts) to test any adults that might be the transmitter of disease (Gaudelus 2003). Active contact investigation is needed when a child is found to have tuberculosis as the risk of progression from infection to disease can be very rapid in children (Khan and Hassan 2002). Although Fraser (1914) and Hendrie (1934) state that fathers are more likely to be named as contacts, this was not found to be true at Stannington. The reason for this could be that fathers were fighting in the Second World War for a large part of the period studied. If this was true, we would expect to see a large increase in paternal contacts in the years following the war. This was not possible to establish because the medical records do not show a large increase in fathers being named as contacts at the end of the war. It would also take time for fathers to return from the war so that the increase that we would expect would be seen in later years if the sanatorium files had continued for that period. The number of other contacts might be due to war restrictions. People were living together in larger families when men went to war because the women who were not working could take care of the children of the other mothers in the household (Hill pers comm.).

According to Lincoln and Sewell (1963) for the children who were from poorer households in their study, the most common contact would be a member of the family or a boarder. For children coming from higher-class families the source case is usually more difficult to find and they are less likely to have developed extensive disease when they are first diagnosed. Spaulding (1933) demonstrated in her study of 611 children from the Lymanhurst School for Tuberculous Children in Minneapolis, USA, that of the 593 children for whom data was available 75% of them lived at some point in time with someone with tuberculosis and these children were also shown to come from poor backgrounds. On the other hand, Beal (1935) showed in his study that in only 28.5% of the cases he treated was it possible to identify a contact.

It is also interesting that there are so many cases at Stannington for which no contact is given or known. This is surprising, as the children must have contracted tuberculosis from someone else. The reason for this could be that there was still stigma attached to people suffering from tuberculosis and parents would not want the doctor to think that they were not taking good enough care of the child. It should not be forgotten that there were still schemes that would remove infected children from their environment and place them with families in the country until the infected person in their original environment had received treatment and was no longer a threat to the child. Stigma was strongly attached to tuberculosis in the past (Bryder 1988, Dormandy 1999). People would not necessarily be shunned if they did not show any exterior signs, but if they were suffering from *lupus vulgaris* or had some skeletal involvement (such as Pott's disease) they would be more easily identifiable and people would tend to stay away from them. People who suffered from tuberculosis could be treated as 'lepers', or people who should be avoided. People who showed other signs such as emaciation, and haemoptysis would also be shunned (Roberts and Buikstra in press). The beliefs that people had in the hereditary nature of the disease, its association with poverty, and decreased suitability for marriage, occupation and life insurance would ostracise families believed to be suffering from the disease (Dubos and Dubos 1952). There were also different stigmas between males and females seen in a previous section on sex differences at Stannington. A study of two tuberculosis clinics in Chicago, USA of African American poor showed that patients with tuberculosis felt that they were a threat to their families which they compared to AIDS even though they knew that the disease they were suffering from was curable (Kelley 1999). A study in Pakistan by Khan *et al* (2000) demonstrated that people were so afraid of the stigma attached to TB that they kept their diagnosis secret and would not even share previous treatment information with their health workers which could lead to future drug-resistant cases. A further study done in Pakistan by Liefooghe *et al* (1995) stated

that a whole family could be shunned if one of its members was found to be tuberculous. Husbands may also be able to take another wife.

Each child with TB has contracted this disease from an infected adult and therefore the best way to help children not to contract tuberculosis was to cure the adults around them. When the prevalence of adult tuberculosis declines the incidence in children will also fall (Nair 2001). Contact tracing is the most important step to take when there is a child in a tuberculosis infected family which, sadly, will often result from poor active case finding results. To explain, when the results of the active case finding are not carefully analysed, certain patients can be missed and slip through without being detected which will put that person's contacts at a higher risk of contracting the disease. Active case finding is very expensive and over 80% of patients will have already sought care at the time of mass screening campaigns, but it is still more cost-effective than immigrant screening and surveillance programmes (Nair *et al* 1971, Nair 2001). People will be at a higher risk of contracting tuberculosis if there is close and prolonged contact with someone with active pulmonary disease. Smear-positive patients infect a larger number of contacts while smear-negative cases only infect one fifth of those cases in which they are in contact (Rieder 1999) and the probability of being infected decreases with decreasing proximity to the index case (Nair 2001). The number of people the positive case can infect can indeed be considerable, depending on the social context of the said case, as adolescents tend to have large social groups (contacts at school, extra curricular activities, and friends). In industrialised countries the group most affected by tuberculosis tends to be the elderly and the chance that they will infect children is quite small compared to developing countries where grandparents are involved in the rearing of the children.

Nair (2001) states that there are also several factors that will increase a child's chance of contracting tuberculosis in a household where there is a positive case such as overcrowding and poor ventilation; in these situations active case finding takes on an even higher priority. An important way of determining active cases is to discover whether a child has been infected recently as an infected child would immediately point to an infected adult. In most cases, the infected adult will be a parent or a member of the household (Nair 2001). A study made in the 1980's in North Carolina, USA, demonstrated that 80% of infected children were detected through contact tracing compared with 17% through symptoms, and three per cent were found on routine screening (Dasgupta *et al* 2000). Therefore, these points demonstrate that it is indeed very important to try and trace as many contacts as possible because if the children are infected they might actually recover without any treatment at all, but might become further contacts for other children later in life when they have reactivation of disease. To have any

impact, however, contact tracing must be followed up with investigations for infection or disease and cases treated as appropriate. This is borne out by a recent study done by Beyers *et al* (1997) where they showed that there was a rise in childhood tuberculosis in the face of a reduced incidence among adults in the United States. They concluded that this rise was a result of the failure to identify and provide preventive therapy to all children who were contacts of index cases (Nair 2001). Young children who are exposed to positive cases should be treated with preventative medicine until infection can be excluded, and those that are found to have active disease should be treated with the appropriate regimen (Starke 1999, Nair 2001).

In developing countries most national programmes will give preventive therapy to those children under five years of age as they are the most likely to develop the disseminated forms of the disease which can often be fatal. However, preventive therapy is not given to older children and adolescents as the disease is less life threatening in those age ranges. It is also not economically possible to extend the vast screening techniques and preventive therapy to the vast number of possibly infected individuals, even though adolescents would also benefit from preventive therapy. It is important to give adolescents preventive therapy as they are likely to develop pulmonary disease at that age and they would increase the risk of tuberculous transmission (Nair 2001).

There have been many instances recently in the UK where tuberculosis has been discovered in a school pupil and mass screenings have shown that adults who believed themselves free from TB were actually the contacts for the schoolchildren. There have been outbreaks in a Leicester school (April 2001), a Newport High School (April 2001), Aberdeen (May 2001), a university student in Southampton (November 2002), a nursery in Glasgow (January 2003) (www8), and a primary school in Manchester (May 2003) (Anonymous in *The Guardian* May 20, 2003).

7.7 Type of tuberculosis treated at Stannington

Khan and Hassan (2002) state that the exact number of children suffering from TB is unknown. They estimate that children represent between three and 13% of overall cases. They conclude that tuberculosis in children is a sign of an endemic disease as the transmission to children comes mostly from the adults around them. These children will act as a pool of future cases from which new tuberculosis cases will arise (Khan and Hassan 2002). This section will be separated into two areas, the first dealing with tuberculosis cases of pulmonary origin and the other with cases of non-pulmonary in origin. There was a large proportion of

cases at Stannington that were pulmonary in origin, and this is to be expected as the largest proportion of cases in all studies were pulmonary cases (Lincoln and Sewell 1963, Miller 1982, Humphries and Lam 1995, Donald and Beyers 1998, Gaudelus 2003). There are several points that need discussing here. There were more females suffering from tuberculosis of the adult type (also referred to as chronic or post primary tuberculosis), and the females were also much older on average than patients with the other types (nearly all cases, except one occurred after the age of 10). This agrees with Miller's (1982) study where he found that, until 10 years of age the numbers of boys and girls affected were equal, but from 10-15 years there were twice as many girls. Adult reinfection happened more commonly in girls at Stannington as Armand-Delille (1935) also reported in his study. He found that there were four times as many girls than boys affected by adult tuberculosis during adolescence between the ages of 12 and 15 years.

There are also many more cases of male pleural effusion than in females and the reasons for this have not been explained successfully in the literature (Lincoln and Sewell 1963, Miller 1982, Hakim and Grossman 1995). As for the side affected in pulmonary TB, the right side was affected more often than the left (214 right and 182 left) and that accords with Lincoln and Sewell's (1963) and Blacklock's (1932) studies. While pleurisy might develop at any age, the most commonly afflicted are children of school age (around 6 years of age) (Miller 1982). Gaudelus (2003) states that pleural effusion is very rare in children under the age of two years, but is seen in older children (but does not specify at which age).

According to Blacklock (1932) in his study he determined that 61.1% of his cases had their primary site of infection in the thorax, 35.7% in the abdomen, 2.1% in the cervical glands, and the primary site of infection was not found in 2.5% of cases. Notifications of tuberculosis in England and Wales fell almost continuously from when they began except for a short interruption during the Second World War where they increased. The age distribution also changed over time with young adults (especially females) having steeply declining rates compared to middle-aged and older adults. In the 1990s the disease mostly seems to affect middle-aged and older men in developed societies, while it affects younger individuals in immigrant communities and developing countries. In 1987 in England and Wales the decline in notifications ended and began to rise in 1988. By 1993, notifications had risen by 17.2% with an increase of 49.5% for non-respiratory tuberculosis and 8.5% for respiratory notifications (Hayward and Watson 1995).

Other findings relevant to this section are surprising as there was a much larger number of bone and joint cases at Stannington than would be expected. The reasons for this are not clear. Could it be because these cases were better diagnosed than pulmonary tuberculosis which could be misdiagnosed as pneumonia or chronic bronchitis? Or could it possibly be because these are the cases that needed treatment for the longest time in the sanatorium? With the implementation of the NHS (discussed later in section 7.11), it seems reasonable to believe that the more common pulmonary cases could have been treated at home, in hospital or in dispensaries. Patients with bone and joint TB (who were bed ridden) have deformities that had to be corrected which necessitated a longer stay in the sanatorium compared to the pulmonary cases that could be treated at home and at dispensaries. According to Lincoln and Sewell's (1963) study this does not seem to be the case. What other explanation could be given for this higher number of expected cases? The answer could simply be that these were the cases that were the easiest to identify for the doctors, as they would show some form of deformity in their bones and joints or problems with mobility. According to a study by Davies *et al* (1984), of 4,172 patients in England and Wales in the 1970's 4.8% of the cases had bone or joint lesions, with the spine being the area the most affected. Today, bone and joint tuberculosis is responsible for 10% of the extrapulmonary cases in the United States according to Gaudelus (2003). However, its diagnosis is often retarded as the development of the disease can happen after the initial infection or be a reactivation of the disease years later, therefore those suffering from this type of tuberculosis might be diagnosed at a later date and have more advanced disease when diagnosed compared to the pulmonary cases. Jaffe (1972) reports that there are as many as 30% of extrapulmonary cases that have skeletal involvement. Gaudelus (2003) agrees with most authors in stating that the spine is the most affected site of bone and joint tuberculosis. At Stannington, as has already been discussed, the hip was the joint most affected by tuberculosis, followed by the spine and knee.

Gaudelus (2003) indicates that miliary tuberculosis is usually found in infants, with 50% of these cases occurring before one year of age, but that they are found at all ages. In France, around 20% of tuberculosis cases in children today were found to be suffering from miliary tuberculosis. There were 14 male and 14 female children suffering from miliary tuberculosis at Stannington (28 or 1.5%) which is much lower than Gaudelus' (2003) 20% of cases in his study. There are several scenarios that might possibly explain this. The children in Stannington might have been dying off sooner than modern cases as miliary TB was a killer in past populations and still is today. The methods of diagnosis might not have been accurate enough to identify early cases in Stannington which might have greatly increased their chances of surviving. The drugs that are in use today might not be as effective in treating tuberculosis and might not stop the spread through the blood resulting in more modern cases

than those at Stannington, or alternatively, the strains might be adapted to the drugs we use today to treat it. Finally the cases in the French study might be more likely to be coming from Africa where high rates of HIV infection might also interfere with the treatment of miliary tuberculosis.

The children infected by tuberculosis of the abdomen (n=64) and tuberculosis of the glands (n=101) (also one case of tuberculosis of the glands/abdomen) accounted for 8.8% of the total cases of tuberculosis at Stannington. As already discussed, it was not possible to establish whether any of the children were suffering from the bovine type of tuberculosis as this information could not be accessed from the medical records. Lincoln and Sewell's (1963) study considered that tuberculosis disease of the glands would occur in 5% of their patients, while neither Lincoln and Sewell (1963) nor Miller (1982) give any idea of how many cases of the abdominal type of tuberculosis they have found in their experience. This seems to point to a gap in the literature. These types of tuberculosis were associated with bovine tuberculosis in the past. There were quite good results as to the different types of tuberculosis suffered from in rural and urban areas. It was possible to see in the previous chapter that there were differences in the type of tuberculosis suffered in rural areas compared to the urban areas in Stannington, again the discussion of this topic can not go very much further as the rural case numbers are so low (n=79), but it would be important to note that children suffered from a substantially higher proportion of tuberculosis of the glands in the rural areas and only 53.2% if the children were suffering from the pulmonary type of tuberculosis.

Today, it is estimated that there are around 50 million tuberculosis infected cattle and two-thirds of these are in developing countries where there is little or no regulation to deal with this problem (Thoen and Steel 1995). In Britain during the 1930s approximately 30% of all non-pulmonary tuberculosis deaths were caused by bovine tuberculosis. Children were especially at risk as they were the ones who consumed the most unpasteurised milk (Bryder 1988). As 40% of cows at that time were thought to have tuberculosis it is not surprising to see such a high rate in humans. Francis (1958) reports that in 1918 in the UK there were 3,382 deaths attributed to bovine tuberculosis, 1,945 in 1927 and 1,195 in 1938. Muthu (1922) indicated in his report on the treatment of pulmonary tuberculosis that he did not encourage the sterilisation of milk in a sanatorium. He found that his patients would thrive better on fresh milk and he was convinced that milk would be more nourishing and easier to digest if given in its raw fresh state. However, he does not state whether this milk was provided from cows that had been tested and were found to be tuberculosis-free or not! In 2000 there were around 30 cases of bovine tuberculosis in humans in England and Wales per year (Meikle 2002). Most of these cases were older people who had reactivation of the

disease. Most human tuberculosis in developed countries results from infection with *Mycobacterium tuberculosis*, because the pasteurisation of milk, tuberculin testing of cattle and the slaughter of cattle found to be infected has greatly reduced the incidence of *Mycobacterium bovis* infection in these developed countries (Centre for Disease Control 1990, Hardie and Watson 1992, Inselman 1996). Bovine tuberculosis in developed countries is often a reactivation of an old infection, as has been discussed previously, but it can also develop following exposure to infected animals, but in developing countries, these practices (pasteurisation of milk, tuberculin testing of cattle and slaughter of cattle if found infected) are not maintained and *M. bovis* disease remains prevalent (Habbib and Warring 1966, Wigle *et al* 1972, Fanning and Edwards 1991, Thompson *et al* 1993, Inselman 1996). In a later section (7.11) the implementation of the NHS will be examined to see whether its introduction had any effect on who was being treated at Stannington and from what type of TB they suffered.

There were also a high number of children who were non-tuberculous but were sent to the sanatorium anyway. These children were sent back home quickly as the beds were needed for the sick. There were patients, however, who remained in the sanatorium and others such as those with pulmonary tuberculosis who were kept at the sanatorium for social reasons. The reason for this was that if they were sent back home, they may fall back into bad habits and poor living conditions and run an even greater chance of contracting tuberculosis. As can be seen there is a gap in the published literature at this point as it has not been possible to discuss all types of tuberculosis in this section.

7.8 Result of treatment at Stannington

The results of treatment were as expected with most of the children being discharged from the sanatorium quiescent. However, there were no studies undertaken to follow up the patients from the sanatorium to assess their survival rate. This, however, has been done in previous studies at Frimley, Surrey where life expectancy was very low; as many as 50% of the patients were dead within five years (Bryder 1988). The only children who came back to the outpatient clinic at Stannington were those with bone and joint TB and these had very good success rates where the children would be considered cured of tuberculosis and discharged after a certain time (usually around five years). Again, the surprising number of children who were sent home because they were considered to be-non-tuberculous is quite high. Starke (2001) states that there are very good success rates for tuberculosis treatment in the United States, South Africa, Greece and India today in that 95% of those suffering from pulmonary

tuberculosis are completely cured and 99% have significant improvement. Results of treatment of children suffering from tuberculous lymphadenitis have only been recorded in one six month trial and the results were found to be very similar to those suffering from pulmonary tuberculosis (Jawahar *et al* 1990) in that they had a very good success rate. Children suffering from extrapulmonary tuberculosis have not been studied as extensively as pulmonary cases, and Starke (2001) states that these studies are virtually non-existent. In some studies, extrapulmonary cases are included in some pulmonary studies but are not analysed separately. Bardswell (1910) followed his patients between four and nine years after they had left the sanatorium and returned to their homes. As stated previously, the people who were at his sanatorium were mostly middle-class people who had the benefit of comfortable living conditions. The majority of the cases that he treated were adults suffering from the pulmonary type of tuberculosis. He reports that the patients followed in his study would be classified as being either *well* (i.e. in very good health, able to do his or her work, quite compatible with arrest of the disease), *alive* (i.e. patient has to make the care of his/her health his/her chief consideration in life possibly to the exclusion of everything else. This situation is quite incompatible with serious work, although it may be compatible with a certain degree of health), or *dead.* He concluded that if people adhered to the sanatorium principles after they left they would have a greater chance of surviving. His numbers showed that the death rate fell considerably after the first and second year (at which the rate was around 15-20%) to about 3 to 5% annually.

7.9 Pre- and post- antibiotic eras (1943): demographic structure

This variable was studied to examine whether the introduction of chemotherapy against tuberculosis had an effect on who was being treated at Stannington and how long they stayed in the sanatorium. As had been mentioned previously, the first effective anti-tuberculosis drug is seen in 1943. They do not come into general use before 1946 in Stannington. In contrast, according to Yoshioka (1998) streptomycin only became available for general prescribing in 1949. Chapter 6 demonstrated trends of treatment that were seen in Stannington, and also showed that any or all of the drugs against tuberculosis at the time (streptomycin, PAS and INH) were used in nearly half the cases treated at Stannington by 1953. Therefore, we should not expect the introduction of chemotherapy to have a direct effect on who was being treated at Stannington, but it might still have had an effect on how long they were treated. The duration of stay for children in the sanatorium was affected by the year at which they entered the sanatorium, although using the general linear model it was not possible to establish which year-range that was. The introduction of chemotherapy at

Stannington would have an effect on the length of time children stayed at Stannington **(Table 38).** Receiving surgery alone as a form of treatment at this time would also have an effect on a patient's duration of stay; and they would be expected to stay on longer. For example, if they were receiving artificial pneumothorax they would have to remain to receive their refills for a certain period. The introduction of chemotherapy also had an effect on the duration children stayed at Stannington but, again, it does not tell us whether they were staying for longer or shorter periods. At Stannington, when taking into consideration those records on which we have details of treatment, it was possible to establish that, for the pulmonary cases, those suffering from tuberculosis of the glands and tuberculosis of the meninges, patients stayed for shorter periods of time when receiving chemotherapy. On the other hand, the abdominal cases, the bone and joint cases and those suffering from more than one type of TB were actually staying longer when receiving the chemotherapy. Although there are many studies written on the introduction of chemotherapy, they are vague in the extreme and most of them merely state that chemotherapy had revolutionized the treatment of tuberculosis by saving miliary and meningitis cases which had, up until then, been given a death sentence if diagnosed in young children.

The results for this data are not as clear as expected. The introduction of chemotherapy in the fight against tuberculosis does not seem to have a very clear effect on the time that the patients were staying in the sanatorium. The length of stay was affected by the patient receiving surgery as treatment but it was not possible to establish whether this was a positive or negative correlation. As stated above, for some of the cases were staying for shorter periods when receiving chemotherapy and some were staying for longer periods when receiving the chemotherapy, therefore there was a difference in the time that patients stayed in Stannington. According to Millard (pers. comm.) and Pedersen (pers. comm.), this table states that there is a difference with the advent of chemotherapy in the length of stay of the children at Stannington but that this table also only gives the correlation for 7.5% of the sample (143 cases), therefore the discussion of this data will not be taken further as a result of the low number of cases affected.

Table 38 Univariate analysis of variance of introduction of chemotherapy

Between-Subjects Factors

		N
DRUG#	1.00	802
	2.00	551
SURGERY#	1.00	1251
	2.00	102
1	.00	35
	1.00	1318

1=Introduction of chemotherapy (0= not introduced, pre 1943, 1= introduced, post 1943); Drug #: 1= no drugs were given, 2= drugs given; Surgery #: 1= no surgery, 2= surgery given.

Tests of Between-Subjects Effects

Dependent Variable: TIME

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	10155651.7[a]	7	1450807.391	15.586	.000
Intercept	41822318.9	1	41822318.93	449.293	.000
DRUG#	238464.528	1	238464.528	2.562	.110
SURGERY#	1388749.848	1	1388749.848	14.919	.000
CHEMO	5549510.166	1	5549510.166	59.618	.000
DRUG# * SURGERY#	103566.150	1	103566.150	1.113	.292
DRUG# * CHEMO	5190.396	1	5190.396	.056	.813
SURGERY# * CHEMO	318965.571	1	318965.571	3.427	.064
DRUG# * SURGERY# * CHEMO	741223.178	1	741223.178	7.963	.005
Error	125199079	1345	93084.817		
Total	283957076	1353			
Corrected Total	135354731	1352			

a. R Squared = .075 (Adjusted R Squared = .070)

df= degrees of freedom; Sig.= significance (the lower the number the more significant it is deemed to be)

7.10 Pre- and post- World War II (1939-1945 respectively): demographic structure

For the children who were admitted before and after the Second World War it was possible to establish a correlation between the duration the children stayed in the sanatorium and the type of treatment they received **(Table 39).** Those children who were receiving surgery alone, again, stayed longer in the sanatorium than those who did not. The general linear model permits us to establish that there is an effect of the Second World War on the duration of stay in the sanatorium without suggesting whether it was a positive or negative correlation. The general linear model also shows that whether children were being treated by both drugs and surgery would also affect the time that they stayed at Stannington. Looking at contacts pre- and post- WWII, there was no difference in the proportion of male or females being named as a contact. One question that was to be tested was whether the end of the Second World War would show an increase in the number of fathers being named as contacts as they would be

returning from the war gradually and some of them would have contracted the disease while serving their country. *The Lancet* (Anonymous 1942) reported on the effect of war-time food on children and concluded that deaths from tuberculosis showed a worrying increase because in 1941, among children under ten years of age, deaths from all forms of tuberculosis were 45% higher than those of 1939. The number of children under the age of five years dying from tuberculosis nearly doubled. Although this could be a result of several factors, including the use of unboiled milk, the effect of reduced resistance from nutritional deficiencies must have also played an important part. There were also a few war-time restrictions on staff (even though it was hard to get staff to work at a tuberculosis sanatorium at any time) which could have limited the time that patients were staying at Stannington. As they would be trying to help as many people as possible, and it might have also limited the number of beds that were in use at the sanatorium. For example, Stannington had to close beds at one point in 1947 as there were not enough staff to deal with the children (Taylor 1989).

Table 39 Univariate analysis of variance of end of Second World War

Between-Subjects Factors

		N
DRUG#	1.00	802
	2.00	551
SURGERY#	1.00	1251
	2.00	102
1	.00	162
	1.00	1191

1 = the end of the Second World War (0= Second World war not ended, pre 1945; 1= Second World War ended, post 1945); Drug # : = no drugs were given, 2 = drugs given; Surgery #: 1 = no surgery, 2 = surgery given.

Tests of Between-Subjects Effects

Dependent Variable: TIME

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	18172891.9[a]	7	2596127.411	29.798	.000
Intercept	66919934.0	1	66919934.01	768.099	.000
DRUG#	26.534	1	26.534	.000	.986
SURGERY#	1920407.541	1	1920407.541	22.042	.000
WWII	11097537.2	1	11097537.19	127.376	.000
DRUG# * SURGERY#	68800.373	1	68800.373	.790	.374
DRUG# * WWII	2143.040	1	2143.040	.025	.875
SURGERY# * WWII	1610314.451	1	1610314.451	18.483	.000
DRUG# * SURGERY# * WWII	123416.939	1	123416.939	1.417	.234
Error	117181839	1345	87124.044		
Total	283957076	1353			
Corrected Total	135354731	1352			

a. R Squared = .134 (Adjusted R Squared = .130)

Table 39 only manages to explain the effect of the end of the Second World War on 13.4% (254 cases) of the cases at Stannington (Millard pers. comm. And Pederson pers. comm.) therefore, the discussion of the numbers will not be taken further as the numbers are so low.

7.11 Pre- and post- NHS (1948): demographic structure

The implementation of the NHS does not seem to have had an effect on the time that the children stayed at Stannington **(Table 40).** The only type of treatment that seems to have had an effect on whether the children stayed longer in the sanatorium or not was whether they were receiving surgery. This could also be a result of children receiving surgery as treatment who were mostly admitted before the implementation of the NHS anyway. There were no sex differences seen in the population, nor were there any differences in treatment or the type of tuberculosis suffered from before or after the implementation of the NHS. The only worthy point to note was that the number of children suffering from tuberculosis of the glands and of the abdomen seem to have mostly been admitted before the implementation of the NHS. This point is indeed interesting as these are the types of TB which are also affected by the introduction of pasteurisation of milk. The pasteurisation of milk occurred in the 1940's and 1950's in England, so these cases are the ones that are usually associated with the bovine strain of infection. The pasteurisation of milk would have greatly reduced this method of transmission of TB to children if it was practiced at Stannington. There is a big void in the literature about the effect of the implementation of the NHS on the treatment of tuberculosis. Roberts and Buikstra (in press) note that very broad generalizations about what treatments were available in a specific period of time in the past can be made for the distant past, but it is not possible to say whether a particular individual received treatment because of the many factors that affect whether a person has access to care or not. This is not true for Stannington as it is possible to see which treatment, if any, these children received. It is also clear that the implementation of the NHS made health care affordable for everyone, and therefore the patients admitted to Stannington were those receiving treatment and that had the access to healthcare.

Table 40 Univariate analysis of variance of implementation of NHS

Between-Subjects Factors

		N
DRUG#	1.00	802
	2.00	551
SURGERY#	1.00	1251
	2.00	102
1	.00	664
	1.00	689

1.= implementation of the NHS (0= implementation of the NHS has not yet happened, pre 1948, 1= implementation of the NHS has happened, post 1948); Drug # : 1= no drugs were given, 2 = drugs given; Surgery #: 1 = no surgery, 2 = surgery given.

Tests of Between-Subjects Effects

Dependent Variable: TIME

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4931433.696[a]	7	704490.528	7.265	.000
Intercept	30134697.0	1	30134697.00	310.766	.000
DRUG#	262481.561	1	262481.561	2.707	.100
SURGERY#	1511887.665	1	1511887.665	15.591	.000
NHS	374136.542	1	374136.542	3.858	.050
DRUG# * SURGERY#	222790.700	1	222790.700	2.298	.130
DRUG# * NHS	100703.294	1	100703.294	1.039	.308
SURGERY# * NHS	405974.396	1	405974.396	4.187	.041
DRUG# * SURGERY# * NHS	110630.504	1	110630.504	1.141	.286
Error	130423297	1345	96968.994		
Total	283957076	1353			
Corrected Total	135354731	1352			

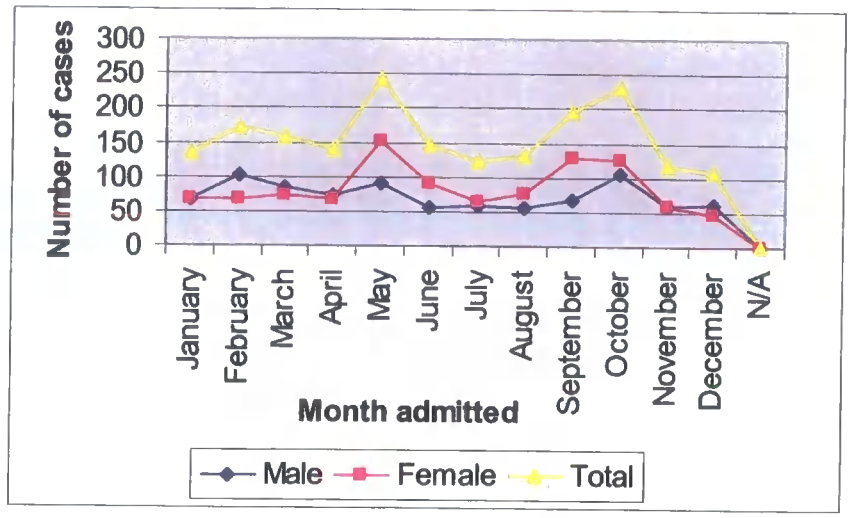
a. R Squared = .036 (Adjusted R Squared = .031)

Again here, the implementation of the NHS does seem to have had a clear effect on the time that the children were spending at the sanatorium for treatment. Millard (pers. comm.) and Pedersen (pers. comm.) explain that the information provided in this table only explains 3.6% of the data at Stannington (only 68 cases) and therefore further discussion of this variable will not be undertaken because of the low numbers of cases. What can be said of the last three variables to be explored (the introduction of chemotherapy, the end of the Second World War and the implementation of the NHS) is that they did not have a clear effect on who was admitted and the time the patients stayed at Stannington.

7.12 Month children admitted to Stannington

When looking at the time of the year that the children were admitted to the sanatorium, there are different trends evident in different years, and for different types of tuberculosis. According to Donald and Beyers (1998) (reporting Grigg 1958 and Schaaf *et al* 1996) there is a tendency for infection to happen during the winter months, leading to a disease peak in the spring and summer months. This is not directly reflected in the records from Stannington. The female, male and total cases were divided (**Fig. 40**), and the total cases show that there were increased cases admitted to Stannington in the spring and autumn, but that the summer period demonstrated the lowest frequency of patient admissions to Stannington. This may be linked to the fact that the summer period is when children would be on vacation (if not at the sanatorium and not working) and would be more likely to spend time outside. This could probably strengthen their immune system since they would spend a lot of time outside, and they would be less in contact with anyone who could be tuberculous in their own family and be a source of contamination. The increase in the cases admitted during autumn could be due to two factors. The decrease in sunlight at that time of year, and the return to school to their stuffy classrooms, could be determinants in the child's health and contacts. The increase in cases admitted in the spring may be associated with a depressed immune status from poor families due to the 'harder' winter conditions. If they came from poorer backgrounds, their houses might have been draughty, damp and poorly insulated, therefore putting the children at higher risk of contracting tuberculosis. Immigrants today to the UK coming from sunnier climes can have activation of tuberculosis within the first five years following their migration, as for example in the Gujurati Asian group in Harrow England who have high rates of post-primary tuberculosis (up to 809/100,000) (Wilkinson *et al* 2000). This is most probably related to reduced levels of vitamin D related to the lower levels of sunlight in the winter months. There were different trends in admission and discharge months for different types of tuberculosis (**Figs. 40** through **50**). Discharges of patients tended to be more continuous throughout the year without any major peaks.

Fig. 40 Month of admission for male and female cases to Stannington



Admissions nearly always outnumbered discharges, except for the summer months (June, July and August) and January, March and December showed higher rates of discharges than admissions **(Fig. 41).**

Fig. 41 Admission v discharge month

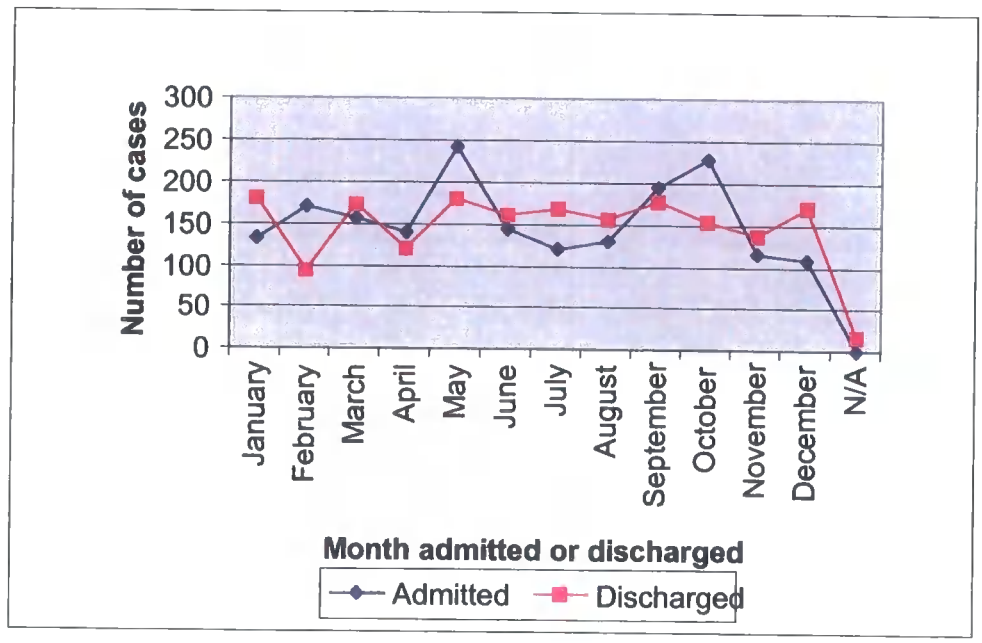
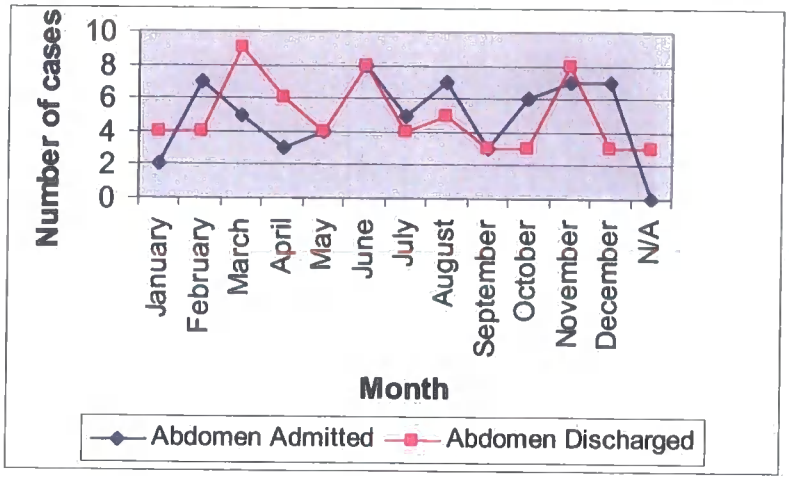
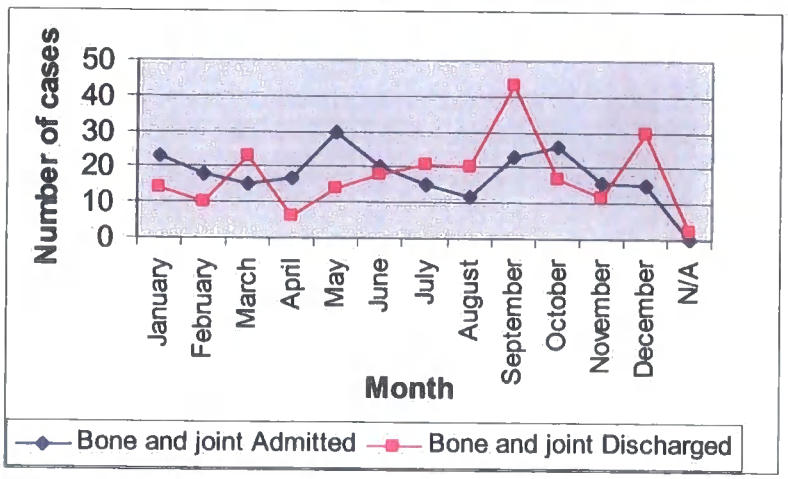


Fig. 42 Admission versus discharge month (abdomen cases)



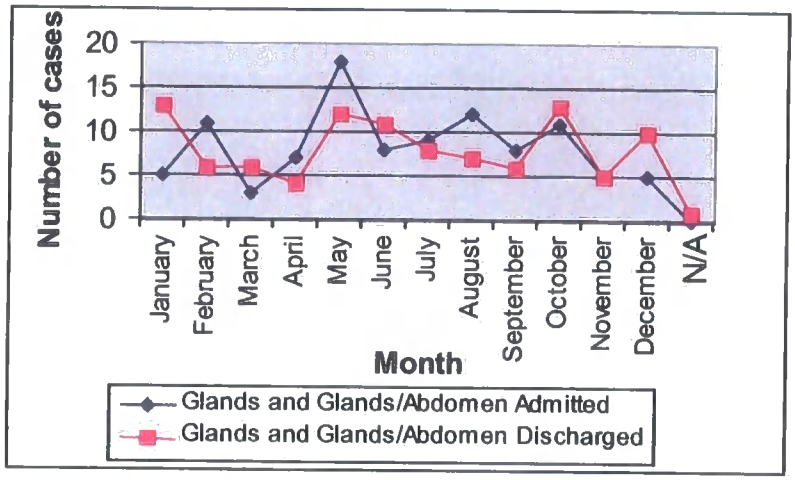
By looking at the different types of tuberculosis different trends in admissions and discharges months were identified. For the abdomen cases the peaks in admission occurred in February, June and the autumn **(Fig. 42).** The peaks in discharges happened in March, June and November. There were more discharges than admissions in March, April, June and November. Care should be taken when making assumptions about these cases as their numbers are low (n=64).

Fig. 43 Admission versus discharge month (bone and joint cases)



For the bone and joint cases, the peaks in admissions followed the trends set for all types of tuberculosis (spring and the autumn) **(Fig. 43).** The peaks in discharges occurred in September and December. There were more discharges than admissions in March, July, August, September and December. For the children suffering from tuberculosis of the glands, and tuberculosis of the glands/abdomen, the peaks in admissions occurred in May, with lower peaks in February, August and October **(Fig. 44).** The peaks in discharge occurred in January and October with lower peaks in May and December. There were more discharges than admissions in January, October and December, and there were the same number of discharges and admissions for the month of November. Again care should be taken when interpreting these numbers as they are quite low (n=101).

Fig. 44 Admission versus discharge month (glands cases)



Consideration of the lung and 'possible lung' cases **(Fig. 45)**, the peaks in admission in May and, following the same trend as the bone and joint cases, while the discharges had small peaks in January and May and were quite continuous over the year. The month with the lowest discharge rate was February. There were more discharges than admissions in January, July, November and December. For the children suffering from tuberculosis of the meninges, the peaks in admission in September and December, and the peak in discharges occurred in April **(Fig. 46).** The numbers for this type of tuberculosis are again very low (n=13), therefore care should be taken when interpreting the data. The children suffering from miliary tuberculosis (n=28) had their admission peaks in March and July while their peaks in discharge happened in January and July **(Fig. 47).** Once more the numbers for this type of tuberculosis are very low and caution should be used when looking at these trends. There

were more discharges than admissions in January, February, November and December. There were the same number of admissions and discharges in July and October. The children who suffered from 'more than one type' of tuberculosis, and 'possibly more than one type', had their peaks in admissions in January and March, with their peak in discharges in June **(Fig. 48).** The low numbers associated with these types of TB (n=65) should be taken into consideration when analysing them. There were more discharges than admissions in the summer months of May, June, July and August. For the cases not suffering from tuberculosis their peak month of admission was May and the peak months of discharge were August and December **(Fig. 49),**

Fig. 45 Admission versus discharge month (lung and possible lung cases)

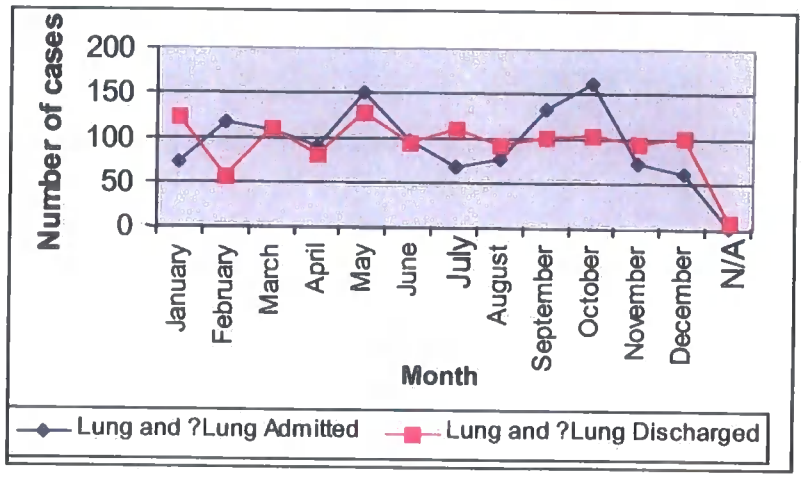


Fig. 46 Admission versus discharge month (meninges cases)

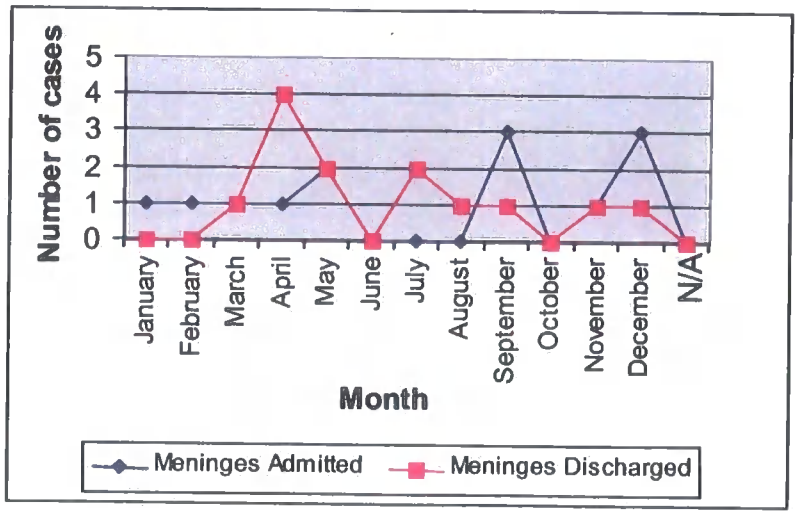


Fig. 47 Admission versus discharge month (miliary cases)

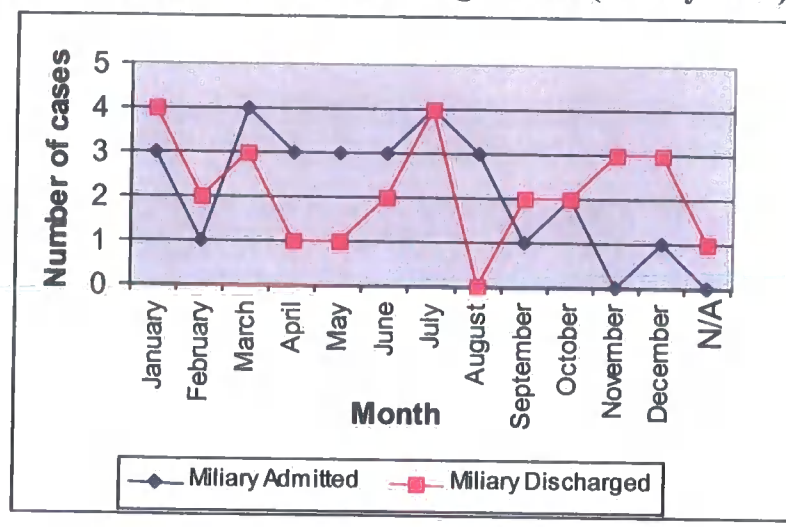


Fig. 48 Admission versus discharge month (more than one and possible more than one cases)

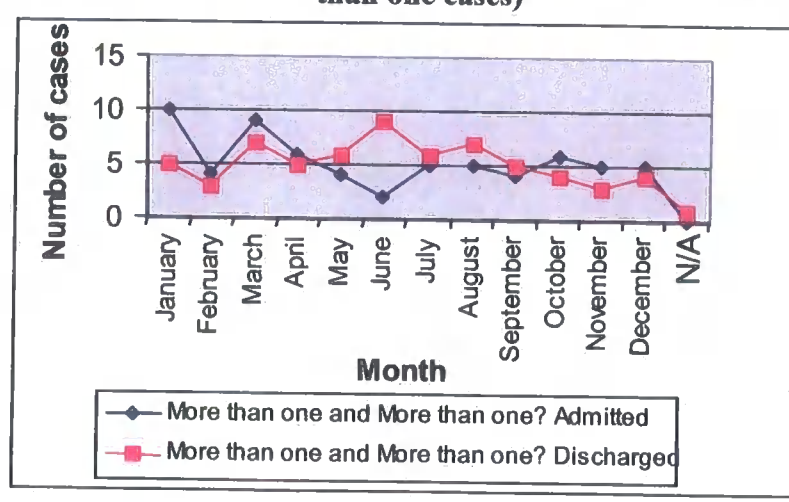


Fig. 49 Admission versus discharge month (non-tuberculous cases)

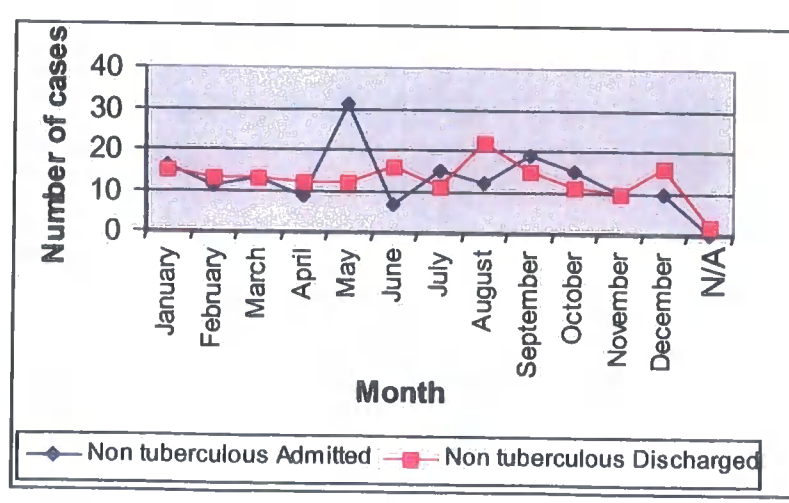
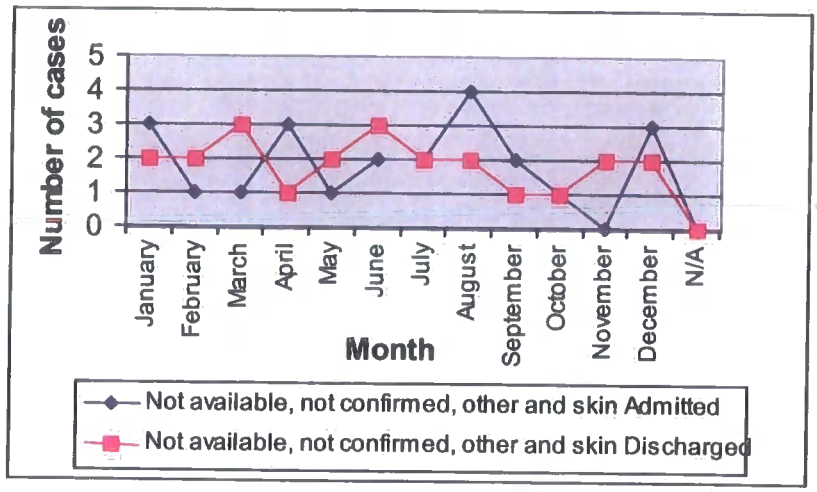


Fig. 50 Admission versus discharge month (not available, not confirmed, other and skin)



but they were quite small peaks. The numbers for those not suffering from tuberculosis mirror each other as there were similar numbers of admissions and discharges for most months. For the children suffering from the remaining types of tuberculosis (not available, not confirmed, other and skin), the peaks in admission occurred in August and there were no real peaks in the discharges. There were more discharges than admission for February, March, May, June and November **(Fig. 50).** The numbers for these types of tuberculosis are again very low (n=24) and care should be taken when interpreting the results. Many children were discharged on the same day. The reasons for this are unknown. It might be that they needed to clear a ward to clean it and prepare it for the next influx of children admitted to Stannington. Mann (1927:11) described in his novel, how when his hero Hans Castorp arrived at the sanatorium to visit his cousin, they gave him the room of an American woman who had died the day before. Hans Castorp's cousin Joachim explains: "but she has been gone since yesterday morning, and after they took her away of course they fumigated the room thoroughly with formalin, which is the proper thing to use in such cases". MacDonald (1997) and Clubley (1996) also explain how they were transferred from one ward to another as patients during their stay in a sanatorium. They ended up being put in wards with other children and women who were going to be discharged, and this could have facilitated the cleansing of the wards and also to facilitate the discharge of the correct children and women.

Tomkins (1993) has reported that rates of infection are related to seasons. There is only general work done in this area of tuberculosis research but other general studies have shown that there are correlations between the seasons and the rates of disease. Once again, it is possible to identify another gap in the literature. The cold and damp climate of England,

associated with a poor diet and overcrowded conditions was sure to have an effect on the health of Britons in the past as well as today. For example SAD (seasonal affective disorder) which is a disorder in which the affected individual's mood changes with the seasons. Those affected are commonly depressed in the winter and pick up in the spring (Macpherson 1995). A study by Howe (1997) demonstrated the annual mean daily hours of sunlight varied throughout the year throughout the British Isles. This showed that in Victorian London, there was a difference in the frequency of different diseases throughout different months of the year. In the autumn and winter months, respiratory disease rates were high. This reinforced the idea that a colder, damper environment is more conducive for lung complaints. This again can be seen for patients at Stannington where if they have been infected in the summer months, they might be more likely to develop active tuberculosis in the autumn months when the sunlight hours would be decreasing.

7.13 Treatment of admissions to Stannington

A significant limitation to the discussion of this section is that there is little information written on this topic for the time period related to Stannington. This was surprising. Most of the information comes from medical history concentrating on pulmonary cases, while in most of the clinical literature only case histories are published which detail abnormal cases or treatment, but give no indication about the usual treatment of tuberculosis. As can be seen in the previous chapter, there were large variations in the number of children receiving treatment when at Stannington.

For the bone and joint cases the most important form of treatment was immobilization, and these cases were the type of tuberculosis that received the most complex type of treatment. Mercer (1964) states that there have been four types of treatment offered to bone and joint cases since the beginning of the century (20th): conservative, surgical, antibiotic and chemical. The first consists of rest, fresh air, segregation, nutrition and heliotherapy. These patients often ended up with marked deformity due to bone and joint involvement and tremendous external scarring. The second type involved surgery, arthrodesis of weight bearing joints, and excision of non-weight bearing joints. Children who received surgery developed normally afterwards because of the remodelling of the bone. The third involved antibiotics and began in the 1940's with the introduction of streptomycin, the main benefit of which was improvement in the general appearance of the patient and the possibility of healing persistent sinuses in bone. The last type (chemical) was para-amino salicylic acid and isoniazid where lesions could be much better controlled, infection minimised and hospitalisation dramatically

shortened. Although this was how anti-tuberculosis therapy was seen in the 1960's, studies today have shown that chemotherapy was not the answer to the prayers of the tuberculous patients. Drug-resistant strains have now emerged and the fight to find new anti-tuberculous drugs continues. Marwah (1962) discusses the typical treatment received by early cases of bone and joint tuberculosis, conservative treatment being reserved for them. This consisted of chemotherapy, immobilization and no weight–bearing; splinting could also be used for short periods of time. This type of treatment continued for six to nine months or until normal function of the limb returned. Surgery was sometimes undertaken at this stage and could include partial synovectomy and partial capsulectomy. For advanced stages, or those cases which already had bone destruction, with or without pus formation and the articular cartilage destroyed, the ultimate aim of the treatment was bony ankylosis. Before chemotherapy, cases of this type had a very high mortality and would require treatment for around five to seven years. With the advent of chemotherapy, mortality due to this type of lesion decreased but the average duration of treatment was still around two to three years. At this stage general measures and immobilization were more important to the cure than anti-tuberculosis drugs. Here, treatment rested on cleaning up the abscesses, removing the sequestra, and putting bone grafts in wounds after a short course of anti-tuberculosis therapy.

A study was done in Rhodesia, Korea and Hong Kong to compare the efficacy of surgical treatment to that of conservative drug treatment in bone and joint cases (not specified whether children or adults). Patients were randomly allocated to one of the following: the drug treatment group, the debridment group (surgical removal of foreign material and damaged tissue from a wound) or the radical debridment plus anterior spinal fusion group. The researchers included anyone with clinical or radiological evidence of tuberculosis in the spine (except for the cervical spine) (Luk 1999). All patients were then given 18 months of two or three drug combination therapy. They then removed the abscess, sequestrum and loose disc fragments in the debridement group. The radical group included debridment of the necrotic tissue until the healthy bone was reached, followed by an anterior graft fusion (using either rib, iliac or fibula grafts). After 5, 10, and 15-year reports all three groups showed that 87% of the group had favourable outcomes. A favourable outcome was determined if the patient showed no central nervous system involvement, no sinuses, no clinically evident abscess, no radiological evidence of the disease, and no restriction to normal activity. However, when the results were regarded in much closer detail the group that had had the radical treatment (radical debridment group) had much quicker relief of pain, earlier resolution of the sinus tract and no neurological involvement. This group also had more bony fusion than the group treated conservatively (Luk 1999).

When there is deformity in early active disease it is usually flexible and can be corrected by an anterior strut graft. Later cases can be quite rigid with compensatory hyperlordosis in the spinal segments adjacent to the tuberculosis. This is serious as severe kyphosis can lead to cardiopulmonary or visceral problems, notwithstanding the cosmetic deformity (Luk 1999).

It is important to treat cases using surgery when possible as Luk (1999) reports that surgical cases in hospitals in Hong Kong (who suffer from paraplegia) as a result of late disease are patients who had been treated conservatively over 30 years before. This unpublished study (in Luk 1999) states that over 65% of the patients suffering from tuberculosis of the spine are finding that they are affected by neurological disorders more than 15 years after the onset of the disease. These are middle–aged patients with severe kyphotic deformities, and compromised pulmonary function that makes them high-risk surgical candidates. Luk (1999) suggests that the 15 years of follow-up in the Medical Research Trial was not long enough. Disease that was treated with chemotherapy alone can recur later in life. Marwah (1962) noted earlier that early lesions can usually be controlled with restitution to normal function, whereas a caseating lesion will be less likely to return to normal without the aid of chemotherapy.

Khan and Hassan (2002), on the other hand, state that their experience has shown that surgery is now rarely indicated for the treatment of tuberculosis in children. It is mainly used to obtain samples for tissue diagnosis and culture, for the treatment of constrictive pericarditis, spinal decompression for Pott's disease, and rarely used for debulking localized pulmonary disease due to multi-drug resistant tuberculosis. The bone and joint cases at Stannington were mostly treated by immobilisation with or without the advent of chemotherapy.

There are more case studies of treatment of pulmonary tuberculosis cases contemporary with Stannington. Muthu (1922) found that in his study of sanatoria patients that, even in the 1920's, some people were aware that sanatoria were not the answer to all the patients' prayers in the treatment of tuberculosis. Sanatoria treatment had limitations, just as with any other form of treatment, but Muthu (1922) states that often cases of failure are not the sanatoria's fault. How typical it is to blame the failure of the treatment on the patient. He concluded that, although sanatoria can no more cure all the cases of tuberculosis than a cascara pill can cure all cases of constipation, sanatoria had great results and could give hope to future cases of pulmonary tuberculosis. Muthu (1922) also reports that diet was important in the treatment of tuberculosis in that most cures that overfeed the patient can actually do more harm than good. As has been previously discussed in Chapter 3, there are no details as to fresh air and

diet at Stannington, so it is not possible to discuss this any further except to say that even though it is not mentioned it is assumed that apart from the other types of therapy offered at the sanatorium, diet and fresh air were also used. Khan and Hassan (2002) state that today tuberculosis is treated mainly by chemotherapy and that many studies have shown that for uncomplicated pulmonary tuberculosis a short regimen is often adequate (Rakhit *et al* 1986, Starke 1990, Vallejo *et al* 1994, American Thoracic Society 1994, Starke and Correa 1995, Joint Tuberculosis Committee of the British Thoracic Society 1998, American Academy of Pediatrics 2000, Te Water Naude *et al* 2000, all in Khan and Hassan 2002). However, it was not possible to establish how long children were receiving chemotherapy for while at Stannington. Children could receive a three-month course (but they would not have an end date stated in their records, or they would stay on it longer) while others had no beginning or end to their regimens, therefore making it impossible to calculate how long they were treated. The management of extra-pulmonary TB (with the exception of tuberculous meningitis, miliary, and bone and joint tuberculous disease) are treated today in a similar way as pulmonary TB but of longer duration. The severe types of disease (i.e. bone and joint tuberculosis, miliary tuberculosis, or tuberculosis of the meninges) are more difficult to treat according to Khan and Hassan (2002) and require more aggressive and longer duration therapy. The duration of therapy is around 12 months, four drugs for two months and two drugs for ten months, although six-month therapy has been tested on children with tuberculous meningitis but is not routinely recommended. Children with HIV or other immunocompromised children require treatment for at least 12 to 18 months for uncomplicated forms of pulmonary tuberculosis. The treatment must be longer for the severe forms of tuberculosis. Children with MDR TB (multi-drug resistant tuberculosis) can be given drugs (between four and seven kinds) for between 12 and 24 months. This type of tuberculosis is hard to treat, especially in children, as unfortunately most second-line drugs do not come in paediatric formulations.

7.14 Summary

This chapter discussed the results derived from the medical files from Stannington sanatorium. There were more females than males admitted to Stannington and some contemporary and clinical literature are in agreement with this finding. Females show higher mortality at Stannington and this is seen in most studies worldwide. It was possible to establish that the age patterns seen at Stannington are a little different from what is observed in the clinical literature. When this information was divided by type of tuberculosis many trends seen in the contemporary literature were also observed at Stannington. The time a

patient spent in Stannington was also analysed and compared to other studies; here was the first gap in relevant literature. While most contemporary studies established that a minimum stay of six months was necessary for those detected early, versus a stay of up to a year for a more advanced case, at Stannington this would vary very much on the type of tuberculosis from which they suffered. The cases that stayed the longest in the clinical, contemporary literature and Stannington were those with bone and joint tuberculosis.

The children mainly came from urban areas especially around Newcastle and Gateshead. This would have been expected as these were the urban areas around Stannington at the time. Both the clinical and contemporary literature agree that tuberculosis was, and is, an urban disease. However, there were still some children admitted from rural areas, but it could not be established if they were associated with the bovine type of the disease, as this differentiation was not done for the children at Stannington. Indicators such as housing conditions and socio-economic factors were also addressed when looking at the data from Stannington. It was possible to establish that many of the children came from 'poor' backgrounds and overcrowded and damp housing conditions. These have always been known to increase people's susceptibility to contract tuberculosis.

The children at Stannington were contracting tuberculosis mostly from their nuclear family. This again agrees with contemporary and clinical literature, although the most named contact (mother), in contrast, does not necessarily agree with the literature. The Second World War would have taken many fathers from their homes and thereby reduce their chances of being contacts for their children. The type of tuberculosis was the factor that came up with the most surprising results. Although most of the cases were pulmonary in origin, there were a high number of cases that were non-pulmonary in origin, especially the bone and joint cases. A satisfactory answer for this dilemma has not yet been found, the most likely being that the children admitted to Stannington were the very advanced cases and those needing the most help. The result of the treatments used at Stannington came as no surprise, with the majority of the children being discharged from the sanatorium as quiescent. However, there has been no study, except for the bone and joint cases, of the results of any follow up with the patients. There were no differences in the demographic structure of the population before and after the introduction of chemotherapy, before and after the end of the Second World War, nor before or after the implementation of the NHS. This section illustrated the second largest gap in the literature where the implementation of the NHS and its effect on children with TB do not seem to have been studied. The time of year children were admitted to Stannington showed that most admissions occurred during the spring and autumn months, with the clinical

literature agreeing with the spring but stating that the other important season would be the summer. This was not shown to be the case at Stannington and it has been argued that this might be the result of the breakdown of the children's immune systems with the decrease in production of Vitamin D in the autumn months, and also the fact that this would be the time when the children were returning to their school and their (possibly infected) classmates.

Finally, the type of treatment was examined. Again there was an important gap in the contemporary and clinical literature. Most of the clinical cases describe specific case studies, while most of the contemporary literature focuses on pulmonary cases. What can be said is that the treatment of tuberculosis at Stannington followed a straightforward course. The children were treated in the open-air, then followed a short period where surgery was used to treat especially pulmonary cases (and non-pulmonary cases), then the introduction of chemotherapy became the linchpin of treatment at Stannington.

Chapter 8

Conclusion

The charm it once possessed for me, its sponsor, has long since vanished; that I have finished it at all is a feat due to my convictions regarding the ethics of craftsmanship – due indeed, at the bottom, to obstinacy; and, altogether, obstinacy seems to me to have played such a part in the crabbed years-long preoccupations

(Thomas Mann *The making of the Magic Mountain,* 1927: 723)

The primary focus of this thesis was to look at the demographic profile of the children admitted to Stannington sanatorium and the effect that changes in therapy had on them during the period 1937 to 1953. The medical records held at the Northumberland Record Office contain a wealth of knowledge that are of great assistance to those who study tuberculosis in the past, in the present and in the future. This work has hopefully bridged the gap between medical history and anthropology by looking at the data from both a scientific and social perspective. The medical files at Stannington provided us with information on the treatment of different types of childhood tuberculosis in the past in North-East England. It has also provided us with information on the types of TB that children suffered in the recent past and this data can help us build epidemiological models that can be of use to those studying tuberculosis today.

This study has shown that although most children suffered from tuberculosis which affected the lungs, it is possible that children with tuberculosis of the bones and joints could have formed a larger component of total tuberculosis cases than has previously been believed. Children with bone and joint tuberculosis at Stannington made up around 12% of cases admitted which is statistically significantly higher than would be expected, as the average is around 5-7% in clinical and archaeological literature (as seen in Chapter 6). It was not possible to establish why there were so many more bone and joint tuberculosis cases at Stannington, but hypotheses include that these were the most visible cases (e.g. having a collapsed Pott's spine, compared to having a simple cough), or that with the implementation of the National Health Service in 1948 the pulmonary cases were being treated either in hospitals, at dispensaries, or at home, while the most severe cases such as those with bone and joint tuberculosis, or the miliary and meningeal cases, were treated at the sanatoria. It was not possible to establish any other data from other sanatoria which detailed the frequency of bone and joint cases. As Stannington was a tuberculosis sanatoria it could be expected that most if not all the people in the sanatorium would have TB therefore we might possibly have

more bone and joint cases just because there would be an aggregate of infected children. The problem with this hypothesis is that there were some sanatoria built especially for children suffering from bone and joint TB (such as the Royal Sea Bathing Hospital in Margate, Kent – Lewis (2002)), therefore there would not necessarily be higher numbers of bone and joint cases in Stannington as they treated all types of tuberculosis.

The first chapters dealt with the basic information on tuberculosis such as what the disease is, how it spreads, how we diagnose it, and the prognosis of those who contract it. Tuberculosis is a disease contracted by inhaling or ingesting tubercle bacilli of either the human or bovine form. It spreads by those people infected by the tubercle bacilli expectorating them in droplets, exhaling them by talking and sneezing. The diagnosis and prognosis of tuberculosis in children was briefly examined and it was shown that the Mantoux test is still the most reliable skin test used to identify whether a child has been infected or not, although there are more modern methods of diagnosis such as PCR that might be more effective in the future. The prognosis of children with tuberculosis will depend on certain factors such as sex, age, intercurrent illnesses, and unusual stresses. In Chapter Three the history of tuberculosis was discussed, and its understanding and treatment through time were also examined, by exploring themes that had been put forward in Chapter Two. Tuberculosis as a disease has been known since antiquity, but it was only in the nineteenth century with the discovery by Koch of the tubercle bacillus that tuberculosis really became understood as a disease that was not hereditary but rather microbial in nature. This revolutionised the understanding and treatment of tuberculosis and the twentieth century saw great developments in the fight against the infection with the development for the first time of effective anti-tuberculous drugs. Chapter Four discussed tuberculosis in children. There are seen to be wide ranging different types of tuberculosis that affect children differently to their parents. Primary tuberculosis is the type of tuberculosis most studied in children as it is in childhood that the primary infection most often occurs, but children suffer from many other types of tuberculosis that are not given as much attention in papers where tuberculosis in children is discussed.

Although not all the medical records at Stannington were complete, they did contain a range of information that was useful to explore the demographic structure of the population of the sanatorium. Chapter Five described the raw data accessed, and the methods that were used to analyse the data. The next Chapters Six and Seven contained respectively the results from the data analysis and an in-depth discussion of the findings. There were several questions asked in the introduction to this work:

Were more males or females admitted? There were indeed more females than males admitted to Stannington between 1937 and 1953. There were 1018 females and 879 males. There are widely ranging papers on this topic, of which some agree with the data at Stannington and others do not. The females at Stannington also showed a higher mortality rate corroborated in many studies worldwide.

Were particular age groups affected? It was possible to see that there were different trends in the age of admission in the different types of tuberculosis, although it was not possible to establish whether the children were more susceptible at any age. In summary, though, children who suffered from bone and joint tuberculosis were on average younger than those suffering from pulmonary tuberculosis. There were also a larger number of older female cases of pulmonary tuberculosis which has been associated with the onset of menstruation in adolescent females. The children's length of stay in Stannington also varied with the type of tuberculosis with those suffering bone and joint TB staying the longest (around 1,000 days), the pulmonary cases stayed around 300 days and the non-tuberculous and the children suffering from tuberculosis of the meninges stayed the shortest periods (on average around 100 days or less). The information from the contemporary studies showed gaps in the literature but stated that most studies would expect patients to stay between six months and a year (six months for an early case and a year for the more advanced ones).

Did the children come from rural or urban areas? The children mostly came from urban areas, especially around Newcastle and Gateshead areas and therefore did not have to travel long distances as they were local to the region. The literature on this point seems to agree that tuberculosis was an urban disease. There were still children who came from rural areas, but they were only a small percentage of the cases admitted to Stannington.

What was their socio-economic status? It was possible to look at some indicators of socio-economic status from the medical files at Stannington. Many of the children came from 'poor' backgrounds and overcrowded and damp housing conditions. These have always been known to increase people's susceptibility to contract tuberculosis. This result was expected as tuberculosis at that time in England was often considered to be a disease of poverty and still had quite a lot of stigma attached to its diagnosis.

Did the children contract tuberculosis from their relatives? The results from this variable were surprising as there were a number of children who did not have a tuberculous contact. It was impossible to determine whether this information had not been gathered for certain

children or whether the children could not identify the contact. Of those for which we have this information, most children contracted tuberculosis from their nuclear family. This, again, agrees with contemporary and clinical literature although the most named contact (mother) does not necessarily agree. The Second World War would have taken many fathers from their homes, thereby reducing their chances of being contacts for their children.

Did any of the children develop bone and joint tuberculosis? This also came up with surprising results as there was a much higher proportion of children suffering from bone and joint tuberculosis (12%) than would have been expected from the clinical literature (between 5 and 7%). The radiographs had been stored at Morpeth (Roberts pers. comm.) but the author was unable to access them (having been told that they were only on microfiche (Wood pers. comm.). The pulmonary form of the disease was the most common type of TB suffered at Stannington.

Were there differences in the patterns of TB in the pre- and post- antibiotic eras? The records did not show any differences in admissions according to the types of tuberculosis to the sanatorium before or after the introduction of chemotherapy at Stannington. The drugs that were most in use at Stannignton were streptomycin, PAS and INH and they seemed to have good rates of success as most of the children admitted to Stannington left the sanatorium quiescent. There were also 21 patients who died while in the institution. The drugs were used in all types of tuberculosis and it was not possible to establish whether the drugs had been more effective on certain types of TB except to say that after the introduction of chemotherapy miliary TB and tuberculosis of the meninges seem to have better survival rates.

Is the demographic profile in the sanatorium different before and after the Second World War? There were no differences in the demographic profile before and after the end of the Second World War nor were there any changes in the numbers of cases where the fathers are being named as contacts. A factor that could have increased the rates of tuberculous infection would have been a depressed immune status that might have been the result of wartime restrictions on nutrition. This was impossible to establish in the files at Stannington as the wartime restrictions were still in place at the closure of the sanatorium (1953) and there were too few cases before 1939 to hope to compare admission numbers.

Did the implementation of the National Health Service have an effect on who was being treated and on the methods that were used? The implementation of the NHS did not have an effect on who was being treated at Stannington or any of the methods that were used to treat the children at the sanatorium. All the children were treated with rest whatever the type of

tuberculosis they suffered from. The children suffering from tuberculosis of the glands and the abdomen would also receive ultra-violet light therapy. The pulmonary cases were treated with rest and fresh air, some of them received surgery and later on chemotherapy. The bone and joint cases would receive fresh air, rest, immobilization, some of them would receive surgery and later on chemotherapy as well. In summary, most of the children were treated with rest followed by a short period where surgery was used to treat especially pulmonary cases, and after 1946 the introduction of chemotherapy changed the children's treatment by becoming the linchpin of treatment at Stannington.

The month admitted to Stannington was also examined even though there is only very general limited literature available on this subject. It was shown that most admissions occurred during the spring and autumn months. The clinical literature agrees with spring but states that the other season when most admissions would occur would be the summer. This was not shown to be the case at Stannington and it was argued that this might be the result of the breakdown of the children's immune system with the decrease in Vitamin D production in the autumn months, and also the fact that this would be the time when the children were returning to their school with their (possibly infected) classmates.

8.1 Limitations of the data used

The limitations surrounding the Stannington data were covered in chapter Five so only a brief summary of the problems encountered is repeated here: the handwriting in files was at times difficult to decipher for different reason (either it was illegible, had been 'erased', or had just been plainly badly written). The change in medical terms and pharmacology over time has also proved to be a limitation to the study. When more than one doctor examined a certain child, they could give different diagnoses or treatments. Finally, the problem of the incompleteness of certain files led to some problems during the recording of the data.

There are also other types of problems that were encountered. This was mostly because there were large gaps in the literature concerning certain aspects of the research discussed here. Certain circumstances have made it a priority to finish this work inside of the three year limit, and therefore the goal was to record as much information as possible (just in case the records should be destroyed along the way) so that further research can be done on these files. The radiographs from Stannington were also not reproduced in this study having been assured by Dr Nicol Black that the NHS does not have the proper equipment to change the radiographs from microfiche into slide form that would be of a necessary clarity for analysis.

Finally, it was important to work within the constraints of medical confidentiality and the paperwork that accompanied this. It was very important to follow the conditions given by the Medical Ethics Committee as further research on these records would have been compromised had the confidentiality not been observed. This has limited the amount of detailed research that was permitted, but there are still many records available from Stannington, other than the medical files, such as minutes of meetings, available that will provide valuable information.

8.2 Future work

This is a seminal study of records not previously used for epidemiological research and which hold the potential for further detailed work. Such future work would be instrumental in furthering our knowledge of tuberculosis in the past. There are radiographs that survive from the time that Stannington treated tuberculous children, and therefore an analysis of these would also provide substantial information. This of course would be a momentous undertaking, as confidentiality agreements with patients and their families would have to be acknowledged but, with time, this future work could prove to be of great importance to everyone working or suffering with tuberculosis today and in the future. Other future work could also include several thesis or dissertations about particular aspects of this research such as the treatment children received. It would interesting as well to get a cross-country perspective on sanatoria and their treatment as well as a cross-European perspective and why not aim for a world-wide perspective on tuberculosis and its treatment.

As the number of people suffering from tuberculosis continue to increase it would be wise to take into account the considerable information provided by the files from Stannington, foreseeing that the fight against tuberculosis is still raging and will do so for some time to come...

Appendix A

Details of diagnostic procedures used in tuberculosis

1 Mantoux test

The Mantoux test is known to be the most reliable and accurate method of testing for tuberculous infection, but it is important that the test is done correctly (Miller 1982, de Charnace and Delacourt 2001). It entails the injection of tuberculin intracutaneously, and the syringe used should administer fractional parts of a millilitre accurately. The volar portion of the forearm is the usual site used for testing and the skin is washed with alcohol and allowed to dry. According to Lincoln and Sewell (1963), the needle used should preferably be a quarter of an inch long and 26 to 27 gauge (also Miller 1982). It is inserted transversely into, but not beneath, the skin and exactly 0.1 ml of test material is injected. When it is done properly a weal of at least five millimetres (mm) in diameter should form. The patient should return 48 to 72 hours after the injection, and the results read. If there is an area of induration this should be palpated and its maximum transverse diameter measured. Indurations of less than five mm indicate a negative reaction, between five and ten mm should be considered doubtful and the test should be repeated, and ten mm or more indicates a positive reaction. However, Miller (1982) states that when working with children, a reaction of six mm or more to five tuberculin units should be considered positive. The tuberculin dosage recommended is five tuberculin units (TU) and this should detect 99 per cent of those infected (Lincoln and Sewell 1963).

2 Patch test (Vollmer patch test)

The patch test consists of three squares of filter paper attached to adhesive material. Two of the squares are soaked in Old Tuberculin while the centre patch is kept as a control (Lincoln and Sewell 1963). It is applied to the interscapular region, on skin that has been thoroughly cleaned and allowed to dry. The patch remains in place for 48 hours and the test is read 48 to 72 hours after its removal. The test is positive when the middle square of skin remains neutral and the two end squares show vesicles or papules. It is painless, inexpensive and easy to do (Lincoln and Sewell 1963). However, Furcolow and Robinson (1941) recommend that because the patch test will fail to react to about six per cent of reactors to PPD, and will produce reactions in seven per cent of those not reacting to PPD, this test should not be used in mass surveys.

3 Heaf test/ Multiple puncture test

This test requires a special apparatus that will make six punctures 1mm deep through a concentrated PPD layer containing 100,000 TU per ml. The test is read five to seven days later and four papules are required for a positive reaction (Lincoln and Sewell 1963). One set of these needles can be used for 2500 punctures thus offering speed and simplicity (Miller

1982). Multiple puncture test is not considered as reliable as the Mantoux test and is not recommended for children although, for reasons unknown, the Heaf test is recommended by the British Thoracic Society (de Charnace and Delacourt 2001).

4 Tine test

This test is easy to apply as it comes pre-sterilised with four tines dipped in Old Tuberculin. It resembles the Heaf test but does not require any special apparatus (Lincoln and Sewell 1963). The test is considered positive if one or more papules show more than two millimetres of induration (Miller 1982). Again, this test is easy to perform, painless and easy to interpret, and apparently more accurate than the Patch test. It is used in the United States due to its ease of administration (Hakim and Grossman 1995).

5 Gastric lavage

The success of this technique depends largely on the timing of the lavage, the duration of the infection and the efficiency of the laboratory. The specimen should ideally be collected early in the morning after an overnight fast. As children rarely expectorate, this method renders the examination of the sputum possible (Polsen 1931, Hakim and Grossman 1995). A Levin tube is passed along the oesophagus and the child's stomach contents are aspirated and placed in a sterile container. The stomach is then irrigated with 30 to 60 ml of sterile water, which is also aspirated and placed in the same container. The specimen should be cultured promptly. It does not yield very satisfactory results as only a quarter to a third of these lavages produce positive cultures (Lincoln and Sewell 1963: 49, Donald and Byers 1998). De Charnace and Delacourt (2001) state that gastric lavage can provide positive results in 10% or less of children tested but if multiple specimens are taken of gastric aspirate, with an appropriate technique used, and these are transported quickly to the laboratory, yields of up to 50% of culture can be possible. In contrast, Inselman (1996) puts these numbers much lower with only 6% showing growth from gastric washings. Snider *et al* (1988) and Pomputius *et al* (1997) demonstrated that in children, the collection of several gastric aspirates from those with tuberculosis would yield a positive result in less than 50% of cases of *Mycobacterium tuberculosis* and the acid-fast stain is almost never positive.

6 Bronchial washing/bronchoscopy

This technique inserts a tube into the patient and flashes a saline solution and then this solution is aspirated. It is an examination used for inspection of the interior of the tracheo-bronchial tree, the performance of endobronchial diagnostic tests, the taking of specimens for biopsy and culture and removal of foreign bodies. According to Bálint *et al* (1999), bronchial

lavage is a useful technique for early diagnosis and should be performed more frequently in smear-negative cases, although Hakim and Grossman (1995) believe gastric lavage to be more effective. Abadco and Steiner (1992) state that broncheoalveolar lavage (BAL) with fiberoptic bronchoscopy does not increase the yield of *Mycobacterium tuberculosis* in children with the disease.

7 Microscope confirmation

According to Somosközi *et al* (1999), acid-fast microscopy is usually the first bacteriological test for detecting the presence of mycobacteria and confirming the diagnosis of tuberculosis. Sputum test analysis were seen to be reasonably successful in the diagnosis of tuberculosis (Bryder 1996). "It also allows the rapid identification of potentially infected patients. However, the method has limitations. The major drawback is the relatively low sensitivity as compared with culture" (Somosközi *et al* 1999:216). De Charnace and Delacourt (2001) observe that acid fact bacilli smears in sputum can provide as little as 10% of positive results in children.

8 Culture

Culture is also used to identify tuberculosis in patients and is seen as the most definite proof of tuberculous infection (referring to Koch's postulates). A sample is taken from a patient and then used to grow tuberculosis on a medium. If tubercle bacilli are cultured it is seen as a positive result indicating the presence of tuberculosis (Somosközi *et al* 1999). It should be done as quickly as possible for the results to be as accurate possible, and usually takes around three to four weeks before growth becomes apparent in the cultures. According to Lincoln and Sewell (1963) culture should always be undertaken, even if acid-fast bacilli have been found on direct examination. This is because it is important to determine the degree of susceptibility of the organisms to anti-tuberculous drugs.

9 Radiographs

A radiograph of the lung is the first diagnostic tool to be followed in the case of a positive tuberculin test as the majority (95%) of tuberculous infections are in the lungs (Lincoln and Sewell 1963). Mass miniature radiography brought to light many undetected cases of tuberculosis (Bryder 1996). When the tuberculin test has recently turned to positive following a string of negative tests it suggests a focus of primary active disease. A radiograph will help to determine the degree and location of the infection. The likelihood of finding a primary complex after the alteration of the tuberculin test from negative to positive will decrease with age. The focus in the parenchyma is usually small in relation to the size of the

involved nodes, and it may not be seen on the radiograph (Lincoln and Sewell 1963). When the chest radiograph is abnormal, de Charnace and Delacourt (2001) suggest that a fibreoptic bronchoscopy may be useful in detecting the presence of active infection .

Today there are new practical approaches to diagnosing tuberculosis in children. De Charnace and Delacourt (2001) outline a new approach in diagnosing tuberculosis in children based on their own experience. They state that, even today, tuberculosis is most often diagnosed through looking at clinical features, tuberculin tests and chest radiography. They state that a combination of newer techniques such as computerized tomography (CT) scanning, polymerase chain reaction (PCR) identification and sero-diagnosis can all be used to diagnose tuberculosis. They conclude that immunodiagnosis and amplification tests can be rapid but that they need further evaluation and validation in different geographical regions before they can be recommended for routine use. Brisson-Noël *et al* (1991) and Eisenach *et al* (1991) demonstrate that the amplification of mycobacterial DNA by PCR offers a sensitive and rapid test for detecting *Mycobacterium tuberculosis* in adults. Other studies by Pierre *et al* (1993) and Delacourt *et al* (1995) have studied the possibility of using PCR to diagnose tuberculosis in children, with the result that PCR has shown better sensitivity than conventional cultures for detecting tuberculosis in children. They also warn that positive results have been obtained in children with PCR when the child has evidence of infection but no evidence of disease, and therefore this method might have problems in differentiating between infection and disease, especially in children (Smith *et al* 1996). Further research in this area is required before the most sensitive and specific diagnostic test for use in children is found.

Appendix B

History of the implementation of the NHS

This section deals with the history of the National Health Service from its inception. This is a general introduction to a service that revolutionised the treatment of the sick in England and occurred during the period delimited by this study. It is believed that it might have affected those treated at Stannington. The most obvious starting point for the examination of the implementation of the NHS are the reports of the Royal Commission on the Poor Laws and Relief of Distress of 1909, especially the Minority Report whose best known authors were Beatrice Webb and George Lansbury (Pater 1981).

1 National Insurance Bill (1911)

The result of the Beatrice Webb and George Lansbury report in 1909 was the introduction of the National Insurance Bill in 1911, aimed at relieving poverty among manual workers during sick absences and also at providing a minimal care service (medical benefit). Manual and non-manual workers who were earning less than £160 a year were to be included and they only had a narrow range of services. Their dependants were not covered. The income level was later raised to £250 and later still to £420 (Pater 1981). As Beatrice Webb wrote in her Minority Report to the Royal Commission on the Poor Law in 1909, the liberal Prime Minister was working on Britain's 'Ninepence for fourpence' state organised health insurance which won him the election (Timmins, 1996:1). The worker would have to contribute a compulsory fourpence a week in national insurance contributions, and the employer would then pay threepence, and finally the state would pay twopence. The worker's contribution would amount to less than 1% of the average male earnings at the time. The policy, which took effect in 1911, was administered by 'approved societies'. There was also the possibility of patients giving additional voluntary contributions that would provide them with a wider range of services including spectacles and dentistry, and to those who could afford it, hospital care (Timmins 1996)

On 7 November 1918, a Ministry of Health Bill began its passage through Parliament; the Ministry itself was established on July 1, 1919. The Ministry produced an interim report in May 1920 that presented itself as no more and no less than the outline of the National Health Service.

2 Poor Law Act (1930)

The Royal Commission focused on suggestions to improve the poor law system and it culminated in the Poor Law Act of 1930 (Pater 1981). They called for the transfer of responsibility from the Guardians to the county and county borough councils which, among other things, should appoint a medical assistance committee for health services with members

drawn from the health committee, the local branch of the British Medical Association, the voluntary hospitals and other voluntary bodies (Pater 1981). They pushed for the abolition of the general mixed workhouse and the development of specialised institutions working closely with the voluntary homes and hospitals of the area. Pater (1981) states that a more original idea was proposed in that workers below a certain level or wages would be ask to join, paying a subscription for the creation of dispensaries, and this would entitle them to a doctor free of choice from the dispensary list, permitting them to have institutional treatment on the recommendation of their dispensary doctor (Fox 1986).

For Beatrice Webb and the authors of the Minority Report, the solution was clearly a full-time salaried medical service. They thought it quite impractical to try and collect money from everybody every week. They also thought that this proposal would be opposed by the trade unions and the Friendly Societies. Furthermore, they deemed detrimental that patients should have their choice of doctors, as it might bring the doctors to fight over patients and try to win them over by whatever means, be it by giving certificates of ill-health or medicine (Pater 1981, Carrier and Kendal 1998).

The 1920's and 1930's saw rising pressure for change as the voluntary hospitals were repeatedly on the edge of financial ruin (Timmins, 1996, Berridge 1999). Calls for reform mounted: from a Ministry of Health Committee under Lord Dawson in 1920, to a Royal Commission in 1926, to a British Medical Association study in 1930 and onwards up to the outbreak of the Second World War, all put pressure on the government for change (Timmins 1996).

The problem was that agencies had been created to cater for specific diseases as demonstrated in 1937 in a Political and Economic Planning (PEP) report on *The British Health Services.* It underlined how 'a bewildering variety of agencies, official and unofficial, have been created during the past two or three generations to work for health mainly by attacking specific diseases and disabilities as they occur' (Pater 1981:19 also cited in Berridge, 1999:10). By 1939, the patchwork service included voluntary hospitals on the point of bankruptcy, insurance coverage that largely excluded dependants, low morale among both general practitioners (GP) and consultants, together with the local-authority based public health service, which had taken on some Poor Law medical functions in the 1930s. The structure established for the National Health Service perpetuated many of the anomalies and inequalities of the previous system. The tripartite system that had operated before 1939 carried over into the NHS (Lewis 1992).

3 White Paper (1944)

The war demonstrated that a state organised health care could be run and the Beveridge report of 1942 introduced this (Timmins 1996). The result of this report was a White Paper (Ministry of Health 1944) - a document which sets out the government's proposal, as a preliminary to the drawing up of the bill itself - in 1944 from the Conservative-dominated but cross-party wartime coalition government. Its opening statement clearly set out its aims: "'Everybody', it said, 'irrespective of means, age, sex or occupation shall have equal opportunity to benefit from the best and most up-to-date medical and allied services available', that the service would be 'comprehensive' for all who wished to take advantage of it; that it would be 'free of charge', and that it would promote good health 'rather than only the treatment of the bad'" (Timmins 1996: 2)

Aneurin Bevan became Minister of Health in 1945 and he inherited this ill formed and incoherent plan. He gave the NHS its shape and form. He nationalised the hospitals to allow consultants to practice private alongside their NHS work to ensure that they entered the service, and he insisted the service became largely tax, rather than national insurance, funded. It was his victory in a bitter and protracted war with family doctors over the terms and conditions on which they would enter the service which ensured that the NHS did indeed become available to everyone (Timmins, 1996, Webster 1998).

Bevan was determined to achieve a universal free service, but faced vehement opposition from doctors, from sections of the Labour cabinet and also from the Conservative Party. Campbell (1987) states that Bevan had made a considerable achievement in the fight for the NHS against major professional opposition. Bevan's plan, which he put to the Cabinet in October and December 1945, contained the important policy departure of the nationalisation of the hospital system. All hospitals, whether voluntary or local authority, were to be coordinated by appointed local bodies with voluntary membership exercising powers delegated by central government. The twin proposals of nationalisation and regionalisation found favour with both Ministry of Health civil servants and with Lord Moran, one of the consultants' leaders. However, this was a clear departure from Labour Party policy. Opposition within the Cabinet was led by Herbert Morrison who, as leader of the London County Council, had responsibility for the largest public hospital system in Europe (Webster 1988a and b). He believed that moving from a rate to a tax-based system would lead to an increase in expenditure.

Lowe (1993) states that Bevan was skillful in removing two commercial intrusions into health care which had been widely resented in the inter-war period: the approved societies and the sale of GP practices. But trade union and Friendly Society insurance had been popular. Bevan eliminated the system of contributory health insurance that was retained by every other Western country, despite the knowledge that insurance was less cost effective than state provision (Lowe 1993).

4 The NHS Bill

The NHS Bill that was published in March 1946 suggested a service conducted through three main channels, hospital, GP and local authority services. The voluntary and local hospitals were to be nationalised and placed under the authority of regional boards consisting of local authority and voluntary representatives. The voluntary teaching hospitals were to be permitted considerable independence within this structure, retaining their own endowments and boards of governors. Consultants could be full or part-time, and private practice within the hospital was allowed as a more agreeable option to the proliferation of private institutional care. Counties and other county boroughs kept charge for health centres, clinics and other services such as health visiting and ambulances. GP, dental and pharmacy services were to be administered by executive councils, half professional and half lay, with local authority and ministerial appointees. Health centres under local authorities were to be the key player of the system, and doctors were to be paid on a part salary part capitation fee basis. The possibility of a full salaried service was abandoned (Berridge, 1999)

The costs would escalate as a result of the decision not to unify the services under local authority. The regional hospital structure was effectively handed over to voluntary hospital interests. The control of the Medical Officers of Health of municipal hospitals ended in 1948 and their clinical work declined because of the availability of GP services. Without adequate funding the health centres failed to develop and public health began a crisis of identity from which it has arguably yet to emerge. The alienation of the new discipline of social medicine from practical public health emphasised its decline (Lewis 1986, Porter 1997 in Berridge 1999). The NHS was officially implemented in July 1948.

Appendix C

Copy of application to Medical Ethics Committee

Multi-Centre Research [ ] Local Research [X]

(Please tick appropriate box)

NORTHUMBERLAND LOCAL RESEARCH ETHICS COMMITTEE

c/o Northumberland Health Authority, Merley Croft, Loansdean, Morpeth NE61 2DL

SECTION A

Responsible Investigator - Personal Details
Please complete in type or print in block capitals with black ink

1.Name and Qualifications:

Marie-Catherine Bernard, BA, MSc

2.Professional Address (including Department):

Department of Archaeology, University of Durham, Durham, DH1 3LE

3.Date of Registration with GMC or other professional body (if applicable):

N/A

4.Employer:

N/A

5.Post Held:

N/A

6.Junior doctors/dentists and non-medical/dental employees of NHS, must provide the name of a Consultant or other senior officer who has agreed to be the supervisor of your research project. Non-NHS employees should also name either a consultant or senior officer.

Dr. Nicol Black (CDCU Newcastle General Hospital)

7.Other workers and Departments/institutions involved with an indication of their research experience:

N/A

Consultant or Senior Officer who has agreed to be supervisor:

Dr. Nicol Black (CDCU Newcastle General Hospital)

NORTHUMBERLAND LOCAL RESEARCH ETHICS COMMITTEE

DESCRIPTION OF RESEARCH PROJECT FOR SUBMISSION TO THE ETHICS COMMITTEE

SECTION B

Please respond to every question. "Not applicable" may be an appropriate answer to some but "see separate protocol" is not acceptable as a response to any. Remember that this may be the only form that is sent to members of the Committee.

1 RESPONSIBLE INVESTIGATOR(S):

Marie-Catherine Bernard

2 TITLE OF PROJECT:

Tuberculosis in 20th century Britain: a demographic analysis of admissions to a children's sanatorium at Stannington, using the records curated at the Northumberland Records Office in north Gosforth, Morpeth

3 ABSTRACT OF PROJECT

The aim of this research is to consider the demographic profile of the population at Stannington sanatorium and looking at the change in therapy that occurred between 1937 and 1953 by looking at the medical records curated at Morpeth in the Northumberland Record Office. This work will be conducted by way of a medical record survey. These are the records from the children treated at the sanatorium and they contain a detailed recording of age, sex, personal and family history, place of habitation, results of clinical tests, radiography reports and records of progress with dates of admission and discharge. The outcome of this study will be a detailed knowledge of Stannington as a unique institution for the treatment of TB in children, which will be of use to clinicians, medical historians and palaeopathologists.

4 OBJECTIVE:

Hypothesis to be tested

Understand tuberculosis in the children's sanatorium by looking at differences between male and female patients, age frequencies, and social and economic background of patients in a sample of records taken from pre and post antibiotics, and pre and post war, years.

5 DESIGN OF THE STUDY:

Describe briefly

This work will be conducted by way of a medical record survey. These are the records from the children treated at the sanatorium between the years 1937 and 1953. There are estimated to be around 7800 of them according to Sue Wodds Senior Archivist). They contain a detailed recording of age, sex, personal and family history, place of habitation, result of clinical tests (temperature charts, treatments), radiography reports and records of progress with dates of admission and discharge

6 SUMMARY OF RESEARCH PROTOCOL

This section should fully explain the basis of the study and use lay terms. Please indicate that this investigation has not been done previously and quote your principal references.

The records, which are held at the Morpeth branch of the Northumberland record office, have never been worked on. They hold very detailed information on the children's treatment that took place between 1937-1953. It is hoped to gain a greater understanding of TB by looking at the following questions:

- Were more males or females admitted?
- Are particular age groups affected?
- Were the children from rural or urban areas and what was their socio-economic status?
- Did the children contract TB from their relatives?
- Were the children more affected by the human (*Mycobacterium tuberculosis*) or the bovine (*Mycobacterium bovis*) type of tuberculosis?
- Did any of the children develop bone or joint TB?
- Were there any differences in the patterns of TB in pre and post antibiotics eras?
- Is the demographic profile different before and after the Second World War?
- Did the introduction of the NHS have an effect on who were being treatment and their methods?

This is a unique study as no work has been done on these records before. They hold valuable information for clinicians, medical historians and palaeopathologists studying tuberculosis in children. After having collected all this information, there will be a greater understanding of TB in children in the recent past.

Principal references: Aufderheide and Rodriguez-Martin (1998) *The Cambridge Encyclopaedia of Human Palaeopathology.* Cambridge, University Press; Bates (1992) *Bargaining for Life: A Social History of Tuberculosis, 1876-1938.* Philadelphia: University of Pennsylvania Press; Bryder (1988) *Below the Magic Mountain: A Social History of Tuberculosis in Twentieth Century Britain.* Oxford: Clarendon Press; Dormandy (1999) *The White Death: A History of Tuberculosis* London: Hambledon Press; Lincoln and Sewell (1963) *Tuberculosis in children.* New York: Magraw Hill Book Company; Ortner and Putschar (1985) *Identification of Pathological Conditions in Human Skeletal Remains.* Smithsonian Contributions to Anthropology no. 28. Washington: Smithsonian Institution Press; Smith (1988) *The Retreat of Tuberculosis 1850-1950.* London: Croom Helm; Sudre, ten Dam and Kochi (1992) Tuberculosis: a global overview of the situation today. *Bulletin of the World Health Organisation,* 70 (2) : 149-159.

7 SUBJECTS:

How many subjects are needed? How will they be selected with particular reference to sex and age groups? Will pregnancy be excluded and how?

Around 1000 subjects will be needed. They will all be children as the records are from a sanatorium which treated children with tuberculosis. There will be approximately equal numbers of males and females subjects and pregnancy will be excluded (again because the subjects are children)

8 CONTROLS:

Are controls necessary? If so, how many are needed and how will they be recruited and selected?

No

9 HEALTHY VOLUNTEERS:

Will they be used? How will they be recruited?

N/A

10 SUBSTANCES TO BE GIVEN TO THE SUBJECTS:

(Special drugs etc.). List the names and doses of any drugs to be given. State route of administration and effect expected. Does it form part of the patient's treatment? Is any routine treatment to be withheld?

N/A

11 RADIATION:

(a)If any form of ionising radiation is to be used, the project should be agreed with the appropriate Radiation Protection Adviser. Please indicate that this has been done:

[ ]Yes [ ]No X]Not applicable

(b)If radioisotopes are to be used then a DoH (ARSAC) Certificate is required. Dates of certificate (if applicable).

| X Not applicable [ ]Commences_____Expires_____

(c)State cumulative exposure per subject.....

12 SAMPLES TO BE TAKEN FROM THE SUBJECTS:

(Venous or arterial blood, urine, biopsy, etc.). State type frequency and amount. Would the sample(s) be taken especially for this investigation? If the samples are taken during normal patient care, will larger quantities than normal be required?

N/A

13 OTHER TESTS TO BE ADMINISTERED:

Summarise the procedures to be carried out.

N/A

14 STATISTICS:

Has statistical advice been sought on study design?

[ ]Yes [X]No [ ]Not applicable

If yes, from whom? If no, give reasons.

Descriptive Epidemiology

15 OTHER PROCEDURES:

Describe the exact procedures which will be applied to each patient. If questionnaires are to be used, please attach copies.

N/A

16 ADDITIONAL WORK/COST:

(a)Is there extra work involved for nursing staff, laboratories, radiology etc.?

[ ]Yes [X]No

If yes, provide letters of support.

(b)Have any extra costs been agreed with the Departments?

[ ]Yes X No

If yes, please give breakdown of costs.

(c)Please include a signed statement from Chief Executive or his deputy, that costs have been agreed.

17 GENERAL PRACTITIONERS:

The GP should be informed of research involving his or her patients (e.g.. to advise of possible side effects, complications or drug interaction). Please indicate either.

(a) At what stage the GP will be informed, or

N/A

(b) If you do not intend to inform the GP, why not?

N/A

18 DRUG TRIALS:

(a)Confirm that the appropriate clinical trials certificate or exemption has been obtained.

[ ]Yes [ ]No [X]Not applicable

(b)Confirm that the company agrees to follow the most recent ABPI guidelines on patient indemnity. Attach evidence.

[ ]Yes [ ]No N/A

19 PAYMENTS, FUNDING AND GRANTS:

Please give particulars of any agreed payment, gift or any other financial interest e.g. shares, consultancy. If the project is funded by an outside body, indicate source, amount and destination of funding.

Self-Funded PhD student at Durham university

(a)State any "interest" including payment for uncompleted subjects relating to the study:

(i)Personal (If YES, please specify) YES/NO

(ii)Department (If YES, please specify) YES/NO

(b)State if any equipment has been donated for the study: YES/NO

If YES, has this been notified to the Works Department

(c)Will all the costs incurred in the hospital be covered by the grant? YES/NO

N/A

(d)Who will be responsible for any surplus funding (please specify):

N/A

20 BENEFIT FOR THE PATIENT:

(a)Is there any anticipated benefit for the patient?

[ ]Yes [ ]No [X]Not applicable

If not, what benefit is likely for future patients?

(b)Will patients receive financial reimbursement?

[ ]Yes [ ]No [X]Not applicable

If yes, how much, and will travelling expenses be covered?

21 DISCOMFORT OR DANGER:

What discomfort or interference with their activities may be suffered by the subject? Is there any potential danger involved? State precautions to be taken to minimise discomfort and/or danger.

N/A

22 CONSENT:

Please answer the following points in the space below:

(a)Who will explain the investigation to the patient?

N/A

(b)Will a written explanation be given to the patient?

N/A At the present time, there are no plans to contact any of the patients from the sanatorium

(c)Will written consent be obtained? If not, why?

N/A

(d)How and where will consent be recorded?

N/A

(e)Is any difficulty expected in obtaining consent? (e.g. are the subjects mentally disordered, or children?)

N/A

(f)If so, what special arrangements are proposed.

N/A

Please attach copies of any patient explanation leaflets and the written consent form.

23 CONFIDENTIALITY:

Indicate what steps will be taken to safeguard the confidentiality of patient's records. If the data is to be computerised, it will be necessary to ensure compliance with the requirements of the Data Protection Act.

No names are to be stored on a computer, no names are to be used (they will be codified as Case A for example). The greatest care will be taken to make sure that none of the patients will be identifiable. The information will be stored on floppy disks which will be separate from the computer, any identifiable cases will be excluded from the study.

24 STATE ARRANGEMENTS FOR INDEMNIFICATION IN THE EVENT OF INJURY TO THE SUBJECTS:

In cases of equipment, have appropriate arrangements for indemnification been made with the manufacturer?

[ ]Yes [ ]No [X]Not applicable

N/A

NORTHUMBERLAND LOCAL RESEARCH ETHICS COMMITTEE

CONSENT FORM FOR A CHILD TO TAKE PART IN RESEARCH

Name of Research Project:.....

Name of Researcher: .....

Name of Participant: .....

Age: .....

Name of Parent/Guardian: .....

I consent for my child to take part in this research project.

I understand that the research is designed to add to medical knowledge.

I have read the note of explanation about the study that is attached and I have had time to think about it.

I have had the study explained to me by .....

I have been told that I can withdraw my consent at any stage without giving reason, and without prejudice to my treatment.

I have been given a copy of this Consent Form.

Signed..... Date .....

I can confirm that I hve explained to the parent/guardian of the participant the nature of this study and have given adequate time to answer any questions concerning it.

Signed ..... Date .....

Name (block capitals) .....

Post .....

N/A

NORTHUMBERLANDLOCAL RESEARCH ETHICS COMMITTEE

CONSENT FORM FOR AN ADULT TO TAKE PART IN RESEARCH

Name of Research Project:.....

Name of Researcher: .....

Name of Participant: .....

I consent to take part in this research project.

I understand that the research is designed to add to medical knowledge.

I have read the note of explanation about the study that is attached and I have had time to think about it.

I have had the study explained to me by .....

I have been told that I can withdraw my consent at any stage without giving reason, and without prejudice to my treatment.

I have been given a copy of this Consent Form.

Signed..... Date .....

I can confirm that I have explained to the participant the nature of this study, and have given adequate time to answer any questions concerning it.

Signed: ..... Date .....

Name (in capitals): .....

Post: .....

R&D\ETHICF.CON

N/A

NORTHUMBERLAND LOCAL RESEARCH ETHICS COMMITTEE

MULTI-CENTRE RESEARCH ETHICS REVIEW

In April 1997, the Department of Health issued Health Service Guidelines HSG(97)23 which introduced a new system of Multi-centre Research Ethics Committees (MRECs), one to be established in each NHS Region.

From 1 July 1997 any research which is to be carried out within five or more LRECs' geographical boundaries must be initially considered by the MREC for the Region in which the principal researcher is based before subsequent referral to LRECs. A contact name from whom you can obtain further information on how to do this can be obtained from the LREC Secretary, or from the R & D Directorate of your NHS Regional Office.

Please confirm, by signing this form, that the research for which you are now seeking ethical approval will be undertaken in no more than 4 LRECs' geographical boundaries, and you are therefore not applying (and are not planning to apply) to more than four LRECs for approval of this research proposal.

Signed ..... Date .....

Name (Please Print) .....

XENOTRANSPLANTATION

Health Service Guideline HSG(97)23 required LRECs to ensure that clinical trials involving xenotransplantation had first been approved by the United Kingdom Xenotransplantation Interim Regulatory Authority (UKXIRA). Detail in *Guidance on Making Proposals to Conduct Xenotransplantation on Human Subjects* which accompanied HSC 1998/126 makes it clear that LRECs should not consider such applications without prior approval of the application by the Secretaries of State of the UK Health Departments.

Please indicate whether the research for which you are now seeking ethical approval will involve xenotransplantation.

Does your research involve xenotransplantation?

YES ☐ NO ☐ (please tick appropriate box)

If 'yes' have you enclosed a copy of the authorisation from the Secretaries of State?

YES ☐ NO ☐ (please tick appropriate box)

LREC disclaimer, December 1998

(Form to be on headed paper)

N/A

Centre Number:
Study Number:
Patient Identification Number for this trial:

CONSENT FORM

Title of Project:

Name of Researcher:

Please initial box

1. I confirm that I have read and understand the information sheet dated ..... (version .....) for the above study and have had the opportunity to ask questions. ☐

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 understand that sections of any of my medical notes may be looked at by responsible individuals from [company name] or from regulatory authorities where it is relevant to my taking part in research. I give permission for these individuals to have access to my records. ☐

4. I agree to take part in the above study. ☐

Name of Patient	Date	Signature
Name of Person taking consent (if different from researcher)	Date	Signature
Researcher	Date	Signature

1 for patient; 1 for researcher; 1 to be kept with hospital notes

SDS0304F

March 1999

25 STATE ARRANGEMENTS TO NOTIFY THE RESEARCH ETHICS COMMITTEE OF THE RESEARCH AND FINAL OUTCOME:

You should be prepared to submit a report after 12 months indicating progress with the study. A form will be sent to you in due course.

26 NOTES:

(a)Application must be submitted at least two months before the expected start of the project.

(b)Major modifications in the course of the study should be resubmitted to the Committee for approval. Minor changes should be reported to the Chairman.

(c)Adverse events of a series or potentially serious nature should be notified directly to the Chairman of the Ethics Committee.

27 DATE OF SUBMISSION. Feb 21 / 2001 /

Signed ..... Researcher

Signed ..... NHS Supervisor (If appropriate)

WHEN COMPLETE, PLEASE RETURN THIS FORM TO:

Mrs Ann Young
Secretary, Northumberland Local Research Ethics Committee
Northumberland Health Authority
Merley Croft
Loansdean
MORPETH
Northumberland NE61 2DL
Tel: 01670 39 4400

Appendix D

Letter of acceptance from Medical Ethics Committee

Northumberland NHS
Health Authority

Merley Croft
Loansdean
Morpeth
Northumberland
NE61 2DL

Tel:01670 394400
Fax: 01670 394501

AY

14 March 2001

Ms Marie-Catherine Bernard
Department of Archeology
University of Durham
DURHAM
DH1 3LE

Dear Ms Bernard

NLREC 35/2000 Tuberculosis in 20th century Britain: a demographic analysis of admissions to a children's sanatorium at Stannington using the records curated at the Northumberland Records Office in North Gosforth, Morpeth

Thank you for your letter of 12 March confirming the confidentiality of the cases to be used in this study. I am pleased to inform you that Chair's approval has now been given to your study.

Northumberland Local Research Ethics Committee is always interested in the outcome of research and would welcome a copy of any final report which may be produced. This should be sent to Dr Sue Gordon, Consultant in Public Health Medicine at the above address.

Can I also point out that in the event of any major modification in any study, the researcher is asked to resubmit the application for approval by the LREC. The Chairman of the LREC should be notified of any minor changes in the study.

Yours sincerely

MRS A YOUNG
LREC Administrator

POSITIVE ABOUT DISABLED PEOPLE
INVESTOR IN PEOPLE
Northumberland HEALTH ACTION ZONE haz

Chairman: Dr Michael O'Brien

Chief Executive: Mrs Jackie L M Axelby
MHSM, DipHSM, MBA

Appendix E

Admission information for patients and discharge sheet from Stannington sanatorium

Admission Form . . . . . .

THE "PHILIPSON" CHILDREN'S SANATORIUM STANNINGTON

NORTHUMBERLAND . . . . .

TELEPHONE NUMBER . STANNINGTON 227

CHILDREN ELIGIBLE AS PATIENTS

The children eligible as patients shall be those who :—
Are between the ages of 3 and 16 years, and suspected of or suffering from tuberculosis.

○

When filled up, this Form should be sent to the Secretary . . . .

GEORGE D. SHIELD

66 . PERCY STREET
NEWCASTLE-ON-TYNE

IN CONNECTION WITH THE P.C.H.A.

P.T.O.

THE "PHILIPSON" CHILDREN'S SANATORIUM

STANNINGTON • NORTHUMBERLAND

Information for Incoming Patients.

BED PATIENTS

Three Warm Nightdresses.

Three Warm Vests.

Three Pairs Bed Socks.

Hair Brush and Comb.

Tooth Brush.

Three Warm Night Shirts or Pyjamas.

Three Pairs Bed Socks.

Three Warm Vests.

Hair Brush and Comb.

Tooth Brush.

A Dressing Gown may be added in each case, if the parents can afford it.

All clothes are to be clearly marked with Patient's name. Initials not sufficient.

No patient will be admitted who has recently been in contact with any case of infectious disease. The hair and body must be clean. Where considered necessary, the hair will be cut short.

Visitors are allowed only on the first Saturday every two months. No children will be admitted on any consideration. Tea is provided for the visitors at a small charge.

No operation will be undertaken without the consent of parents, except where delay might endanger the life of the child.

Parents and Patients must conform to the Rules of the Sanatorium, under pain of dismissal. No Patient will be re-admitted if once discharged for breach of Rules.

P.T.O.

THE "PHILIPSON" CHILDREN'S SANATORIUM

STANNINGTON . NORTHUMBERLAND

Information for Incoming Patients . .

1. Patients must present themselves at 66, Percy Street, Newcastle, at 2-0 p.m., on alternate Fridays, or as arranged. Arrangements will be made for a conveyance to meet the Patients at 66, Percy Street, Newcastle, or as arranged.

2. LIST OF CLOTHING.

In order that a complete change of every item of apparel may be made, if necessary, the following list, *wherever possible*, is recommended :—

GIRLS

Two Warm Dresses, or Jerseys and Skirts.

Two Pairs Strong Boots.

One Warm Overcoat.

One Pair Bedroom Slippers.

Two Pairs Combinations, or Two Warm Vests.

Two Warm Nightdresses.

Two Pairs Knickers.

Three Pairs of Stockings.

Hair Brush and Comb.

Tooth Brush.

Dressing Gown.

BOYS

Two Suits of Clothes, or Two pairs Trousers and Two Jerseys.

Two Pairs Strong Boots.

Two Warm Vests or Two Pairs of Combinations.

One Warm Overcoat.

One Pair Bedroom Slippers.

Two Warm Shirts.

Two Pairs of Pyjamas or Night Shirts.

Three Pairs of Stockings.

Hair Brush and Comb.

Tooth Brush.

Dressing Gown.

P.T.O.

STANNINGTON SANATORIUM

Report on Discharge of Patient

Admitted on ... Discharged on :

Name : ..... Case No.

Address : ..... Age : Sex :

.....

	Admission	Discharge
Height :		
Weight :		
Mantoux :		
B.S.R. :		
Sputum :		

Clinical Record :

X-Ray Report :

Classification :

Reasons for Discharge :

Recommendations as to subsequent treatment :

Appendix F

Stannington database

Copy of limited database supplied on CD

The categories included in this database (saved as **limited database.xls**) are:
Sex, age, rural/urban origin, year of admission, weight at admission (in stones, pounds and ounces), weight at discharge (in stones, pounds and ounces), time in sanatorium (in days), result of treatment, contact, type of TB, side affected, bones affected, radiographs taken, drugs given, surgery, tuberculin test and treatment.

What is **not** included in this database:
Date of birth, address, date of admission and discharge, details on contact/family history, personal/TB history, part affected, radiography report, consent for surgery, reason for discharge and where they were admitted from. This complete database with be held at the Northumberland Record Office or the Northumberland Health Authority

Appendix G

Glossary of terms

The definitions found in this glossary were provide by Black's Medical Dictionary 38th edition (Macpherson 1995), the online medical dictionary (http://cancerweb.ncl.ac.uk), the online dictionary (www.hyperdictionary.com), or in Counting the Dead (Waldron 1994)

Abscess:
Localised collection of pus.

Acetabulum:
Cup-shaped socket on the pelvis in which rests the head of the femur, the two forming the hip joint.

Acme:
The top or highest point – in medicine the crisis or height of a disease.

Adenectomy:
The surgical removal of all or part of a gland.

Adenitis:
Inflammation of a gland.

ADNA:
Ancient Deoxyribonucleic Acid.

Allergen:
Is the term applied to any substance, usually a protein, which, taken into the body, makes the body hypersensitive to it.

Ankylosis:
Is a term meaning the condition of a joint in which the movements are restricted by fibrous bands, or by malformation, or by actual union of the bones.

Antigen:
Virus coded cell surface antigens that appear soon after the infection of a cell by a virus, but before the virus replication has begun.

Apicolysis:
Surgical collapse of the upper portion of the lung by the operative detachment of the parietal pleura allowing a medial displacement of the pulmonary apex.

Arthrodesis:
Is the operation for fixing a joint in a given position from which it cannot be moved.

ARTI:
Annual risk of tuberculosis infection.

Artificial pneumothorax:
Pneumothorax produced by the injection of air, or a more slowly absorbed gas such as nitrogen, into the pleural space to collapse the lung.

Attested:
To certify validity.

Auscultation:

The act of listening for sounds within the body, chiefly for ascertaining the condition of the lungs, heart, pleura, abdomen and other organs.

Bacteriocidal:

Capable of killing bacteria. Some antibiotics are either bacteriocidal or bacteriostatic in their action.

Bacteriostatic:

Inhibits the growth or multiplication of bacteria.

BCG:

Bacille Calmette-Guérin an attenuated strain of *M. Bovis* used in the preparation of the BCG vaccine that is used for immunization against TB and in cancer therapy.

Bp:

Base pairs. Two nitrogenous bases (adenine and tymine/ guanine and cytosine) held together by weak bonds. Two strands of DNA are held together in the shape of a double helix by the bonds between base pairs.

Bronchial washing:

Nebulized saline solution is inhaled for 45 minutes and then the patient expectorates into a sterile jar.

Bronchospasms:

Spasmodic contraction of the smooth muscle of the bronchi as occurs in asthma.

Cachetic:

Disease which leave you in a feeble state.

Cancellous:

Is a term applied to loose bony tissue as found in the end of long bones.

Capsule:

Thick gel-like material attached to the wall of gram-positive or gram-negative bacteria, giving colonies a smooth appearance. May contribute to pathogenecity by inhibiting phagocytosis.

Caseation:

The central part of a diseased area, instead of changing into pus and so forming an abscess, changes to a firm cheese-like mass which may next be absorbed or may be converted into a calcareous deposit and fibrous tissue, and so healing results with the formation of a scar.

CDC:

Centre for Disease Control and Prevention. The American agency charged with tracking and investigating Public Health trends. Its stated mission is to promote health and quality of life by preventing and controlling disease, injury and disability.

Cervical:

Pertaining to the neck.

Chemoprophylaxis:

Drug treatment designed to prevent future occurrences of disease, treatment may be chemotherapy as far as an individual is concerned but chemoprophylactic for the population as a whole.

Chemotherapy:

Is the treatment of disease by chemical substances.

Chromosome:

The self replicating genetic structures of cells containing the cellular DNA that bears in it protein.

Clinical percussion:

Invented by Auenbrugger, consists of taping the chest with fingers and listening to the sounds to detect any abnormalities – precursor to auscultation.

Consumption:

Another term for tuberculosis (no longer in use) – obsolete term for wasting of the tissues or body.

Contact tracing:

When a tuberculosis case is discovered, the testing of all people who have been in contact with this original contact and those discovered to have been infected are treated with chemotherapy.

Conveniences:

Houses which at the time would have had a separate flushable toilet, running water, heating (coal or gas) and electricity or gas lighting.

Crepitations:

Is the name applied to certain sounds which occur along with the breath sounds, as heard by auscultation, in various diseases of the lungs.

Cystic:

1-Relating to urinary bladder or gall bladder, 2- relating to cyst (any closed cavity or sac that is lined by epithelium, often contains liquid or semi-solid materials.

Cytokines:

Non-antibody proteins secreted by inflammatory leukocytes and some non-leukocytic cells that act as intercellular mediators.

Deamination:

Is the process of removal of the amino group NH_2, from amino-acids not required for building up body protein.

Debridment:

The surgical removal of foreign material and damaged tissue from a wound.

Depurination:

The N glycosidic link between purine bases and deoxyribose in DNA, has an appreciable rate of spontaneous cleavage in vivo, a lesion that must be enzymically repaired to ensure stability of the genetic information.

Disease:

In adults tuberculous disease is recognised when the signs, symptoms or radiographic manifestation appear. In children this is very difficult to evaluate as in only 30-50% of children with tuberculosis is bacteriological proof obtained.

Dispensaries:

A place where medicines are prepared and dispensed; especially a place where the poor can obtain medical advice and medicines gratuitously or at a nominal price.

Distal:

Away from the centre of the body, opposite of proximal.

DNA:

(Deoxyribonuclaic acid). DNA is the molecule that encodes genetic information in the nucleus of cells. It determines the structure, function, and behaviour of the cell. It is a double stranded molecule held together by weak bonds between base pairs of nucleotides. The four nucleotides in DNA contain the bases adenine (A), guanine (G), cytosine (C) and thymine(T).

DOT:

Directly Observed Therapy.

DOTS:

Directly Observed Therapy Short Course.

Empyema:

accumulation of pus within a cavity, the term being generally reserved for collections of pus within one of the pleural cavities.

Endocranial:

Situated inside the cranial cavity.

Endoplasmic:

Referring to endoplasm (inner granule rich cytoplasm of amoeba (genus of protozea)).

Enumerated population:

All persons who spent census night in the household (whether private or communal) as well as persons who usually live in the household but were absent on census night.

Epiphyses:

Is the spongy extremity of a bone attached to it for the purpose of forming a joint with the similar process on another bone.

Epithelioid cells:

Characteristic cells of granulomatous hypersensitivity. They appear as large, flattened cells with increased endoplasmic reticulum. They are believed to be activated macrophages that have differentiated as a result of prolonged antigenic-simulation. Further differentiation or fusion of epithelioid cells is thought to produce multinucleated giant cells.

Erythema nodosum:

A disorder characterised by the formation of tender, red nodules on the front of the legs. Eryhtema nodosum primarily affects women and has been associated with certain infections like TB.

Ethambutol:

Is a synthetic drug, often included in the treatment regimes of tuberculosis.

Exchequer:

The funds of a government or institution or individual (synonym:treasury).

Excision:

Means literally cutting out; the removal of any structure from the body.

Exogenous:

Developed or originating outside the organisms, as exogenous disease.

Exposure:

implies a recent and substantial contact with an individual who has pulmonary tuberculosis.

Fibrosis:

Means the formation of fibrous or scar tissue, which is usually due to either infection or deficient blood supply.

Formalin:

Powerful antiseptic, and has the power of hardening tissues. Made up of 34 to 38% of formaldehyde in water.

Gastric lavage:

Is a technique of washing out the stomach with warm water or saline to remove the contents.

Genome:

Is a complete set of chromosomes derived from one parent, or the total gene complement to one set of chromosomes.

Gram-negative:

A common class of bacteria normally found in the gastrointestinal tract that can be responsible for disease in man.

Gram-positive:

Bacteria that retains the stain or that are resistant to decolourisation by alcohol.

Granulomatous:

Having the characteristics of a granuloma (chronic inflammatory lesion characterised by large number of cells of various types) some degrading and some repairing the tissue.

Haematogenous:

Is an adjective applied to a biological process which produces blood or to an agent produced in or coming from blood.

Haemopoietic:

Refers to an agent or process that affects or promotes the formation of blood cells.

Haemoptysis:

The spitting up of blood from the lower air passages.

Heliotherapy:

The treatment of disease by exposing the body to the sun's rays, the therapeutic use of sunbathing.

HIV:

Human Immunodeficiency Virus. A type of retrovirus that is responsible for the fatal illness acquired immunodeficiency syndrome (AIDS).

Hybridization:

The process of joining two complimentary strands of DNA or one each of DNA and RNA to form a double stranded molecule.

Hyperlordosis:

Extreme lordosis (accentuation of the lumbar curvature of the spine).

Hypersensitivity:

Is the abnormal immunological reaction produced in certain individuals when re-exposed to antigens that are innocuous to normal individuals.

Iliac:

(singular to ilium) is part of the three bones forming the pelvis (ilium, ischium and pubis).

Immunization:

A process that increases an organism's reaction to antigen and therefore improves its ability to resist or overcome infection.

Incidence:

Describes the number of measures of new events occurring in a population within a specific time .

Induration:

The quality of being hard, the process of hardening.

Infection:

Tuberculosis infection is first detected by a reactive skin test and if positive means that the person has contracted tuberculosis (but does not mean that they have active disease).

Inoculation:

Introduction of material (usually a vaccine) into the tissues. Mode of entry of bacteria into the body.

Inoculum:

Cells added to start a culture, or in the case of viruses, viruses added to infect a culture of cells. Also for biological material injected into a human to induce immunity (a vaccine).

Insidious:

A disease existing, without marked symptoms, but ready to become active upon some slight occasion; a disease not appearing to be as bad as it really is.

Intercurrent infection:

A new infection occurring during the course of another, not related to the primary disease process.

Interleukins:

Are of the lager class of T-cells products which are now more frequently considered as cytokines. The interleukins of which there are 12 identified to date modulate inflammation and immunity by regulating growth, mobility and differentiation of lymphoid and other cells.

Isoniazid:

(INH) is one of the anti-tuberculous drugs.

Jarman Index:

Used to quantify deprived areas.

Lavage:

Is the name applied to the washing out of the stomach.

Levant:
Area representing Lebanon and the Middle East.

Lung resection:
Excision of a portion of a lung (in part or in whole).

Lymphocytes:
Are white cells of the blood that are derived from stem cells of the lymphoid series. Two main classes are recognised: T-lymphocytes which are responsible for both cell-mediated immunity and for stimulating B-cells and B-lymphocytes which when activated are responsible for the production of antibody.

Lymphokines:
Are soluble protein factors generated by activated lymphocytes that affect other cells, primarily those involved in cellular immunity.

Lytic (lesions):
Destructive lesions. In radiography, localised areas of reduced attenuation in bone resembling holes or cut-out areas. Associated with a moth-eaten appearance

M. bovis:
(*Mycobacterium bovis*) bovine variety of the tubercle bacillus.

M. tuberculosis:
(*Mycobacterium tuberculosis*) human variety of the tubercle bacillus.

Macrophages:
Are relatively long lived phagocytic cells of mammalian tissue derived from blood monocytes which play an important role in killing bacteria.

Mantoux:
Test for tuberculin reactivity.

Mass miniature radiography:
MMR. Is a method of obtaining radiographs of the chests of large numbers of people at the rate of around two per minute. It was widely used in the fight against tuberculosis.

Medial:
Side of the body or body part that is nearer to the middle or centre of the body.

Memory helper T-cells:
A T-cell that bears receptors for a specific foreign antigen encountered during a prior infection or vaccination. After an infection or vaccination, some of the T-cells that participated in the response remain as memory T-cells, which can rapidly mobilize and clone themselves should the same antigen be re-encountered during a second infection at a later time.

Menarche:
Is the term applied to the beginning of the menstrual function.

Meningitis:
Is an inflammation affecting the membranes of the brain or spinal cord, usually both. The term is however restricted to inflammation due to a bacterium or virus.

Menses:
Menstrual discharge, a periodic flow of blood or bloody fluid from the uterus.

Mesenteric:
Pertaining to the mesentery: a membranous fold attaching to various organs of the body wall.

Metaphyseal:
The extremity of a long bone where it joins the epiphysis.

Monocyte:
One of the three types of white blood cells. Monocytes are precursors to macrophages.

Morbidity:
The condition of being diseased. The morbidity rate is the number of cases of disease occurring within a particular number of the population.

Mortality:
Actual death from morbidity.

mtp40:
Is a gene thought to be lacking in classical *M. bovis* strains.

Multi-drug resistant tuberculosis:
Also know as MDR TB. A form of tuberculosis which is resistant to both INH and rifampicin (two anti-tuberculous drugs).

Multiple intercostals neurectomy:
Excision of multiple nerves between the ribs.

Mummification:
Bodies preserved either by the ancient Egyptian technique or due to chance under favourable climatic conditions.

Mycobacteria:
A gram-positive rod-like genus of aerobic bacteria, some species of which are harmful to man and animals.

Mycolic acids:
Long-chain cyclopropanecarbolixylic acids (C19-C21), further substituted by long-chain (C24-C30) alkanes containing free hydroxyl groups, found in certain bacteria; these waxy substances appear to be responsible for the acid-fastness of the bacteria that contain them.

Nebulize:
To reduce (as a liquid) to a fine spray or vapour.

Necrosis:
Means death of a limited portion of tissue, the term being most commonly applied to bone when, as a result of disease or injury, a fragment dies and separates.

Neurological:
Pertaining to neurology (nervous system).

Neurectomy:
Excision of a segment of a nerve.

Neurotoxicity:
Toxicity (being poinsonous) to nervous tissue.

Nitrogenous:
Of, pertaining to, or resembling nitrogen.

Notification:
Informing by words (act of giving official notice or information to the public or to individuals).

Nubia:
Ancient region of northeastern Africa (Southern Egypt and Northern Sudan) on the Nile, much of Nubia is now under Lake Nasser.

Oligonucleotides:
Polymers (compounds formed by the joining of smaller, usually repeating units linked by covalent bonds) made up of a few (2-20) nucleotides (the basic building blocks of nucleic acid).

Os coxae:
Hip bone.

Osteoarthropathies:
A condition which describes the broadening or thickening of the tips of the fingers (and toes) with increased lengthwise curvature of the nail and a decrease in the angle normally seen between the cuticle and the fingernail. Often this finding on physical examination can be quite subtle and easily overlooked. Clubbing may be seen in a wide variety of conditions (including TB) – most of which result in a decrease in blood oxygen.

Osteoarticular:
Tuberculosis of the bones and joints.

Osteosclerosis:
The hardening or abnormal density of bone, as in eburnation and condensing osteitis.

Papilloedema:
Swelling of the optic disk specifically due to raised intra-cranial pressure.

Paratracheal:
Nodes along the sides of the trachea in the neck and in the posterior mediastinum.

Parietal:
Of or pertaining to the walls of a cavity; pertaining to or located near the parietal bone.

PAS:
Para-amino salicylic acid, one of the early anti-tuberculous drugs.

Patch test:
A test of skin sensitiveness.

Pathogenic:
Means disease-producing, and is a term, for example, applied to bacteria, capable of causing disease.

Pathogenecity:
The ability of a parasite to inflict damage on the host.

Pathognomonic:
Is a term applied to signs or symptoms which are specially characteristic of certain diseases, and on the presence or absence of which the diagnosis depends.

Paucibacillary:
made up of, or denoting the presence of, few bacilli.

PCHA:
Poor Children's Holiday Association.

PCR:
Polymerase chain reaction.

Periarticular:
Around the articulation.

Perifocal:
Surrounding a focus; denoting tissues, or the blood that they contain, in the vicinity of an infective focus.

Periosteal:
Situated around bone; of, or pertaining to the periosteum.

Periosteum:
The membrane of a fibrous connective tissue which closely invests all bones except at the articular surfaces.

Periostitis:
Means the inflammation on the surface of a bone affecting the periosteum.

Phagocyte:
Cells, including white blood cells and macrophages, that envelop and digest bacteria, cells, cell debris, and other small particles. These cells are a vital part of the body's defence system.

Phagocytosis:
Endocytosis (uptake of material into a cell) of particulate material, such as microorganisms or cell fragments.

Phrenic crush:
Where the nerve supply to one diaphragm is cut and the diaphragm remains paralysed in a relaxed phase higher in the chest thus restricting movement of the lung and decreasing its volume permitting it to rest.

Phrenic evulsion:
Where the nerves attached to the diaphragm would be cut to depress the diaphragm.

Pleura:
Is the name of the membrane which, on either side of the chest, forms a covering for one lung.

Pleural effusion:
A collection of fluid (or blood) in the pleural space (in one side of the chest cavity around the lung).

PncA gene:
Pyrazinamidase – gene encoding *M. tuberculosis.*

Pneumolysis:
Seperation of the lung and costal pleura from the endothoracic fascia.

Pneumoperitoneum:
Deliberate introduction of air into the peritoneal cavity (space enclosed by the peritoneum (smooth serous membrane which lines the cavity of the abdomen)).

Pneumothorax:
A collapse of the lung due to an abrupt change in the intrapleural pressure within the chest cavity.

Pott's disease:
Is a name often applied to the angular curvature of the spine which results from tuberculous disease.

Prevalence:
is the proportion of the population with a specified condition at any one time.

Promizole:
Sulphone derivative used as an anti-tuberculous drug, not very effective and abandoned quickly because of its toxicity.

Proximal:
Is a term of comparison applied to structures which are nearer the centre of the body or the media line (opposite of distal).

Psoas:
Is a powerful muscle which arises from the front of the vertebral column in the lumbar region, and passes down, round the pelvis through the groin to be attached to the inner side of the thigh-bone not far from its upper end.

Psoas abscess:
Is a localized collection of pus in the psoas muscle.

Pyrazinamide:
A pyrazine that is used therapeutically as an anti-tuberculous agent.

Quiescent:
Marked by a state of inactivity or repose.

Radiolucent:
X-rays shine right through things that are radiolucent. Radioluent structures appear black on exposed x-ray film.

Reticulonodular:
A somewhat net-like chest radiographic pattern, with nodular thickening at the intersections of the lines.

Reticulum:
The second stomach of ruminants, in which folds of the mucous memebrane form hexagonal cells.

RNA:

RNA is the abbreviation for ribonucleic acid, which is one of the two types of nucleic acid that exist in nature, RNA plays a role in trans ferring information from DNA to the protein forming system of the cell. It has ribose as a sugar and uracil replaces DNA's thymine.

Sacral:

Adjective pertaining to the sacrum, the lower part of the vertebral column.

SAD:

Seasonal affective disorder. Is a disorder in which an affected individual's mood changes with the seasons. Those affected are commonly depressed in winter, picking up again in spring.

Salpingitis:

Is inflammation situated in the Fallopian tubes.

Sanatorium:

An institution for the treatment of chronic disorders and a place for recuperation under medical supervision.

Sanocrysin:

A drug used in the early 20th century in the treatment of TB, not very effective.

Sequestrum/Sequestra:

Is the name given to a fragment of dead bone cast off from the living bone in the process of necrosis.

Silica:

Is a major constituent of the earth's crust. Its main danger to health arises from free silica, present mainly as quartz and flint and as important constituent of granite sandstone and slate.

Silicosis:

Constitutes the most important industrial hazard in those industries in which silica is encountered. It diminishes the efficiency of the lungs, which manifests itself by slowly progressive shortness of breath. The main danger of silicosis is that it is liable to be complicated by tuberculosis.

Spoligotyping:

Is a method where the direct repeats (DR) are used as targets for in vitro DNA amplification and in which the variation of the spacers is exploited to obtain different hybrization patterns of the amplified DNA with multiple synthetic spacer oligonucleotides, which are covalently bound to a membrane.

Sputum:

Means material spat out of the mouth. It may consist of saliva from the mouth, of mucous secretions from the throat or back of the nose, but is generally expectorated by coughing from the lower air passages.

Steep:
Soak or bathe in liquid.

Streptomycin:
Commonly used antibiotic in cell culture media.

Subarachnoid space:
Is the space between the arachnoid and the pia matter, two of the membranes covering the brain.

Subchondral:
Beneath or below the cartilage.

Sulphonamide:
A drug having the sulphoniamde grouping SO_2NH_2.

Suppuration:
Means the process of pus formation. When pus forms on a raw surface the process is called ulceration, whilst a deep-seated collection of pus is known as an abscess.

Synovectomy:
Excision of a portion or all of the synovial membrane of a joint.

Synovium (synovial membrane):
The inner of the two layers of the articular capsule of a synovial joint, composed of loose connective tissue and having a free smooth surface that lines the joint cavity. It secretes the synovial fluid.

Tay-Sach's disease:
Fatal genetic disorder in which harmful quantities of a fatty substance called ganglioside GM2 accumulate in the nerve cells in the brain.

T-cells:
A class of lymphocytes so called because they are derived from the thymus (the lymphoid organ in which T-lymphocytes are educated).

Thoracolumbar:
Relating to the thoracic and lumbar portions of the vertebral column.

Thoracoplasty:
Involves the surgical removal (resection) of rib segments.

Townsend Index:
Measures multiple depravation by area (unemployment, overcrowding, non car ownership and non home ownership).

Tuberculin:
A preparation derived from the tubercle bacillus intended for the diagnosis of tuberculosis.

Tuberculosis:

Is the general name for the whole group of diseases associated with the presence of the *Mycobacterium tuberculosis*, of which pulmonary tuberculosis is the most important.

Valgus:

Means literally knock-kneed and is a bending inward at the knees (genu valgum) or at the ankle, as occurs in flat foot (pes valgus).

Varus:

Meaning bow-legged, is the term applied to a bulging condition at the hip (coxa vara), at the knee (genu varum) or at the ankle (talipes varus).

Viscera:

The general name given to the larger organs lying within the cavities of the chest and abdomen.

Viscus:

Viscus is the term applied individually to the organs which are part of the viscera.

White Paper:

An educational report made available to the public that expounds on a particular industry issue.

WHO:

World Health Organisation. A United Nations agency dealing with issues concerning health and disease around the globe.

Ziehl's stain:

Is a technique using a carbol-fuchsin solution of phenol and basic fuchsin used to demonstrate bacteria and cell nuclei.

Ziehl-Neelson stain:

Is a method for staining acid-fast bacteria using Ziehl's stain, decolorising in acid alcohol, and counterstaining with methylene blue, acid-fast organisms appear red, other tissue elements light blue.

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"More bugs, more drugs!"

(Starke 1999:131)

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