RESURGENT TUBERCULOSIS ? THE CASE OF POST - WAR ONTARIO

by

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in partial fulfillment of
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Master of Arts

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ABSTRACT

Tuberculosis (TB) - a long forgotten disease - has over the past decade resurfaced worldwide as a major health issue. According to the World Health Organization (WHO) one-third of the world's population is infected with the disease. TB kills three million people each year and it is estimated that more adults die from TB than from any other infectious disease. The magnitude and seriousness of the modern TB epidemic led the WHO to declare a "global emergency" on the disease in 1993.

This study, using data from the Ontario Vital Statistics Reports from 1949 - 1989, examined the spatio - temporal patterns and trends in TB mortality at the county scale. Standardised Mortality Ratios (SMR) show a persistent pattern which reflects social and economic disparities, mainly a North/South dimension. Allometric analysis showed that the counties with the highest levels of TB mortality improved the most rapidly. At the end of the period there is still a distinct geography of TB mortality, despite significant regional convergence.

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Chapter One

INTRODUCTION

1.1 Overview

This thesis examines the geography of tuberculosis (TB) in Ontario since the Second World War, largely within the conceptual framework of the epidemiological transition model (ETM). The ETM is not simply one meta-statement, nor is it intended to be a theory capable of supporting specific or local predictions. It is nonetheless a useful way of organising what manifestly has happened in the rich, industrialised, urbanised countries. The model was originally developed for national populations, and there have been few regional studies of the ETM. This thesis links spatio-temporal trends in the social and medical geographies of post-war Ontario to changes in the geography of TB. It also explores empirically the possibility that there may be a new ETM era, the return of infectious disease. The hypothesised geography of TB is tested using mortality data at the scale of the census division or county. Since the upswing in diagnosed cases of TB is recent, and because the disease can be very slow in developing, morbidity is likely to rise before an upturn in mortality. Reliable and consistent morbidity data for any disease are notoriously difficult to obtain over any extended time or for a multi-jurisdictional space, such as a (very large) province. Thus, mortality data will, of necessity, be used.

The thesis is organised as follows. Chapter one presents a general overview, stating the problem, developing the conceptual framework, and broadly evaluating the literature.

Chapter two deals with the biological aspects of TB, describing the various types of the disease as well as the sites affected and modes of transmission. Reasons underlying the resurgence of the disease are also developed in this portion of the thesis. Evidence demonstrating the resurgence of the disease, though sporadic and scattered, will also be introduced here. Chapter three focuses on the historical trends of TB in Canada and specifically describes the situation for Ontario. The broad trend of infectious diseases in general is analysed. The fourth chapter outlines data sources and analytical methods used in this thesis. Chapter five presents the results of spatio-temporal and allometric analyses of the data on TB in Ontario, calculated as standardised mortality ratios (SMR) for the counties. The final chapter deals with the weakness and strengths of this research and develops some recommendations and conclusions.

1.2 Context

This research fits within population geography which is largely theorised in terms of three macro models of spatio-temporal change: the demographic transition (Thompson, 1929, and Notestein, 1945), the mobility transition (Zelinsky, 1971), and the epidemiological transition (Omran, 1971). The demographic transition portrays the basic process of population growth through natural increase, the mobility transition describes the nature and scale of movements typically associated with stages of socio-economic organisation, and the epidemiological transition model describes changes in the regimes of mortality and suggests that they are related to technological, scientific and social changes.

The world's population is fast approaching 6 billion, growing at a rate of 1.5 - 1.8% per annum. Globally life expectancy at birth is 78 years for a woman and 72 years

for a man. Forty years ago, at the end of the Second World War, there were 2.5 billion people in the world, the annual growth rate was between 2 and 3%, and expectancy of life at birth was 55 years for a woman, 50 for a man. Clearly more people are living longer, long enough to have children, albeit at a lower rate on the average. There are, of course, very marked differences between the rich and the poor countries of the world. Most future growth will occur in those countries least able to provide the social and material infrastructure to give their people a chance of a healthy and productive life. Demographers and population geographers largely agree in ascribing these changes to declines in cohort mortality rates rather than increases in fertility. We have grown accustomed to life expectancy increasing, and to specific causes of mortality being reduced, so much so that the eventual scientific conquest of disease is probably an expectation in many people's view of the future. In rich countries like Canada most parents expect their children to survive to adulthood, and childhood diseases are regarded more as nuisances than threats to life. Here the apparent success of rising living standards, improved nutrition and scientific medicine in controlling and almost eradicating many diseases has led to confidence that the environmental aspects of infection and human health can safely be ignored. Indeed, some recent work in medical geography (Curtis and Taket, 1996) interprets health as entirely socially-constructed, effectively denying any causal role to the biotic environment. However, this confidence and the extreme identification of health with social construction and inevitably, deconstruction, may be unjustified. Recent evidence is fragmentary but it suggests that new and resurgent diseases are unlikely to remain in their regions of origin: along with social, cultural and economic globalisation we should expect

the globalisation of infectious diseases, possibly as pandemics which kill millions. However, not all diseases will come from elsewhere: many have never actually disappeared from the rich countries, they have simply dropped from public view. One of these is TB.

There is a common misconception that TB affects only the world's poor, the developing nations, or - in the developed nations - the homeless, and the disadvantaged. Although these groups obviously are affected, it should be realized that when it comes to TB everyone is at risk. Despite the categorisation of some groups as high-risk and others low-risk, the chances of any person contracting and (depending on his/her immune system) further developing TB still remains high. One can contract TB by just riding on public transport or merely by talking to or breathing the contaminated air around an infected person. The micro-organisms that cause TB are easily liberated in the form of invisible aerosol droplets when a person with an active case of the disease coughs, speaks, or sneezes. Thus close contact with an active case, especially if indoors for a long time, can have profound consequences if one's immune system is even slightly compromised. Furthermore, a person with an active case may not be aware of the disease until it has progressed to the fatal stage.

A classic example of this was reported in the October 18, 1992, edition of the New York Times. In 1989, a man working as a metal grinder in a shipyard in Bath, Maine, unknowingly infected about 417 of his fellow workers within a period of 8 months before doctors were able correctly to diagnose his persistent cough and fever as TB. Thus, contrary to the belief that this disease could only exist in less-privileged inner city districts

such as Central Harlem, where crime, drugs and other social conditions provide a fertile breeding ground, the disease was able to penetrate even the so-called low risk category of people. Also in July 1992, it was reported that two employees working at the World Trade Center, New York, had developed TB (Ryan, 1993, p 393)

Although the causal agents and transmission modes of many diseases - including TB - are now fully known and understood by medical science, before the mid-19th century ideas concerning disease origins were, to say the least, confused (McKeown, 1988). Diseases during this era were variously attributed to miasmas, visitations from the gods, or punishment for immorality, reasons which now sound ridiculous. This was despite the fact that as early as the 4th and 5th centuries BC, Hippocrates pointed out that diseases were not acts of the gods nor attributable to any other intangible reasons, but rather were caused by earthly influences. It was not until the 19th century that this new idea became firmly implanted. Even then, the causes of non-communicable diseases such as cancer, diabetes and the like were still a mystery until the second half of the 20th century when enough evidence was accumulated to replace animistic and theistic explanations in Western scientific societies.

Until the conclusive scientific demonstration of the germ theory in the last quarter of the 19th century by Louis Pasteur in France and Robert Koch in Germany, humanity in general was powerless to directly prevent diseases. Although these scientists were not the first to argue that infectious diseases were caused by germs, their work was of paramount importance in demonstrating the relevance of the theory to infectious diseases (Magner,

1992, p 307). They were able to demonstrate that minute organisms invisible to the naked eye were the immediate cause of such misery and pain

After this conceptual revolution, inquiry into disease causality followed this direction, and this has led to the biological causes of most diseases becoming apparent. Measures have been developed to prevent and sometimes cure human afflictions. Indeed, Magnier suggests that medical science since the end of the 19th century has flourished mostly by following “the gospel of specific etiology”. This is the belief that if we understand the biological causative agent of a disease, or the specific molecular events of the pathological process, we can totally understand and control the disease. However, Magnier points out “that this view fails miserably to take into account the complex social, ethical, economical and geopolitical aspects of diseases in a world drawn closer together by modern communications and transportation, while simultaneously being torn apart by vast and growing differences between the rich and the poor” (Magnier, 1992, p xi)

Poverty, squalor, genetic variation, organ malfunctions, social-deprivation, homelessness, overcrowding, congestion, malnutrition and undernutrition, poor hygiene and sanitation, drugs, prostitution and a host of other social factors stimulate or facilitate the transmission of diseases. In other words, despite the obvious success of medical science and modern technology in controlling, preventing and curing some human infections one should not be over confident in light of the resurgence of “old” diseases like TB. Scholars like McKeown take this debate a step further. He argues that medical science especially in the case of Europe did not do much to curb infectious diseases. As will be argued later in the discussion of the ETM, infectious diseases (pandemics and

epidemics) were already on the decline or receding (following their natural course to oblivion) before medical technology had an effective role to play. He further states that improvements in hygiene and living standards were more responsible for the drop in the incidence of infectious diseases than was medical knowledge. However there is still ample evidence that medical science played a significant role in reducing the incidence of infectious disease especially in the case of developing countries. In these countries the provision of effective vaccines and other treatment procedures led to a drastic reduction - and in some cases the eradication - of diseases like smallpox, although others like TB still remain a major health problem. These arguments may best be assessed within the framework of the ETM.

1.3 The Epidemiological Transition Model (ETM)

The ETM focuses historically on the changes in the health, disease patterns and problems in population groups that came with economic and social development. Omran (1971) pointed out that many countries have experienced a significant change or transition from high to low mortality accompanying either social development (typical of Western societies beginning with the Industrial Revolution) or a combination of medical advancement and early social change (which was the case in many developing countries when antibiotics, insecticides, sanitation and other medical technologies were introduced after the Second World War). Omran goes on to assert that common to all these countries is a clear shift in the kinds of disease, health and causes of death that are prevalent at a particular time. Thus as time passes the "old world" epidemics of infection are gradually replaced by degenerative and man-made diseases as the main causes of morbidity and

mortality. He explains these patterns by suggesting three ETM models which illustrate the influences and consequences associated with mortality decline.

The first model is the classical (Western) model, typical of the developed nations. This model describes three main successive stages of transition from high to low mortality, as disease regimes change. Each stage is named after the major determinant of death prevailing at the time. The first stage - typical of high mortality - is the Age of Pestilence and Famine, which actually is an extension of the pattern that prevailed in the Middle Ages and continued in Europe through most of the 18th century. In this stage life expectancy at birth is low and variable, fluctuating between 20 and 40 years. Also prevalent in this stage is high childhood mortality as well as a high rate of fertility. Society at this stage of its development is predominantly agrarian, depending upon labour intensive methods of production. Invariably, living standards are low and living conditions are grossly unsanitary. At this juncture the leading community health problems are epidemics, famine, malnutrition, childhood diseases and maternal death in child birth. These problems are further aggravated by poor environmental conditions such as contaminated water and food supplies, poor housing and a general lack of proper personal hygiene. During this era, people relied on all kinds of remedies. Indigenous healing, witchcraft and magic were often used in the absence of scientific knowledge.

The second stage, which is made up of an early and late phase is known as the Age of Receding Pandemics. The early phase which occurred in Europe during the 18th and 19th centuries, marked an era where mortality still remained high but showed signs of declining as fluctuations became less pronounced. Birth rates remained high as population

increased and life expectancy at birth increased steadily from about 30 to 50 years. Society was becoming urbanised, largely as a consequence of rural to urban migration. Also the development of transportation and communication networks further boosted urbanisation directly and via being a catalyst to industrialisation. The leading causes of death at this stage were industrial diseases as well as continuing epidemic scourges and childhood diseases. With improvements in agriculture, malnutrition became somewhat ameliorated, but as in the first stage the same environmental problems persisted or worsened within the cities due basically to overcrowding and poor hygiene. Additionally industrial health problems now began to emerge. In the late phase of the Age of Receding Pandemics, mortality began to decline gradually and for most of this period population growth was very rapid. Society modernised at an increasing rate, with economic growth punctuated by cyclical down-turns. The migration of people from rural to urban areas became even more pronounced, resulting in the creation of very large urban centers. The benefits of continued economic growth stimulated scientific discovery and enhanced environmental control. Likewise there were improvements in personal hygiene and nutrition. Eventually epidemics and famines receded while childhood diseases also began to disappear. At this stage infectious diseases declined as the leading causes of death. For Europe this late phase happened during the late 19th and early part of the 20th century. The final stage of the Western model is the Age of Degenerative and Chronic Diseases, in which mortality declines rapidly (late 19th century) until it reaches stability at a relatively low level (early 20th century). Slowing population growth and continued long-term economic development are the major correlates of this downward trend of mortality.

Science and technology are able to devise more decisive medical therapies some of which are readily available to all via public health developments. Heart diseases, cancer, stroke, diabetes, gastric ulcer and the like, together with increased mental illness, accidents and diseases due to industrial exposure at this point displace infectious diseases and become the leading causes of death. The average life expectancy at birth during this era rises gradually until it exceeds 70 years. More striking is the fact that at this stage fertility levels remain generally low. It should be noted that the transition from one age to another is gradual, rather than discontinuous.

Omran's second model is the Accelerated ETM. This model describes the transition that occurred for nations that went through a slow process of modernisation prior to the drop in mortality in the 20th century. Mortality levels here followed similar patterns to those of the Classical model. However the main distinction between the two is that the changes occurred over a relatively shorter time period than in the Classical model. Improvements in living standards as well as medical advances were the main contributing factors to the decline in mortality. In countries such as Japan, and to a lesser extent China, concerted governmental programs affecting education, old age security, employment, infant mortality and contraceptive means and knowledge have resulted in lowered rates of fertility under agrarian conditions (Meade et al, 1988, p 106).

These national and individual policies favored a controlled rate of population increase and provided the motivation needed to reduce fertility and mortality in a relatively shorter time period.

Omran's third model is the Delayed ETM. This mainly applies to the transition currently being experienced by Developing countries. Thus, like the Advanced countries, Third World nations appear to pass through these same shifts in health and disease patterns. But for them the shifts began late (only in the 1940s after World War Two) and for that matter are not yet complete, hence the name Delayed model. Rapid mortality decline evident during this era is basically due to the impacts of imported medical science. Thus, although late to start, the change in disease pattern in this model is initially much faster than in the Western model, due to the effective use of modern technology and science. In other words, unlike the Western model which was largely socially determined (although medical science played a limited role), this transition is predominantly medically determined. With the introduction of medical technology came public health programs particularly with the help of the World Health Organization (WHO). These programs were able to reduce infectious diseases considerably and consequently to increase life expectancies. However, in lowering the mortality rate, fertility rates were left unchecked at high levels. This has ultimately led to astronomic population growth often without comparable economic growth, putting a strain on Third World economies and hence leaving them grappling with both economic problems and rapidly expanding populations not commensurate to the resources of these nations. The model is summarised in table 1.1 on p 13

The discussion so far reiterates the most fundamental premise of the ETM. This is that with increasing modernisation, causes of mortality and morbidity patterns shift from one where infections and parasitic diseases predominate to one where the leading causes

of illness and death become man-made and degenerative chronic conditions (Omran, 1971, Trovato, 1994). The mechanisms responsible for this transition are partly demographic, fertility being of critical importance.

With modernisation, societies tend to develop a small family ideal that ultimately results in prolonged large scale fertility reductions. As a result of this process, societies go through a fundamental change in their age structures, from a predominantly young age composition to one in which adults and senior citizens represent a growing segment of the population (Trovato, 1994). This tendency is also partly due to the benefits of medical science which enable infants and youth to survive through hitherto fatal diseases now regarded more as nuisances and inconveniences.

1.4 A New Age ? Disease Resurgence

Despite the fact that in the modern era degenerative and man-made chronic diseases dominate as the major causes of death, infectious and parasitic diseases are also resurging as sources of morbidity and mortality. Some of the reasons for this situation will be discussed in the next chapter. For now it is sufficient to point out a major weakness in the ETM with regards to the resurgence of infectious and parasitic diseases in more advanced societies viz, the model assumes all people living in developed nations enjoy or benefit equally from the fruits of modernisation. This is obviously false. There are groups of people within these nations who might be experiencing a different form of the transition similar to that of the developing nations. Thus people who do not form a significant part of the mainstream economic community in these nations and are in effect going through some of the experiences of people living in Third World countries can easily fall prey to

Table 1.1 Illustrating the Epidemiological Transition Model

Profile	Stages in Transition				Possible stage of reduction in degenerative diseases
	Pestilence and Famine	Early phase of receding pandemics	Late phase of receding pandemics	Degenerative and man-made diseases	
Demographic	Cyclical growth. Mortality dominates. High and variable fertility. Population growth constrained. Predominantly young population.	Mortality high but declining and less variable. Net population growth. Proportion of elderly starts to increase. Some migration to towns.	Mortality slowly but progressively declines. Fertility begins to decline. Strong rural-urban migration.	Mortality rapidly declines, then begins to stabilise. Fertility declines to low, fluctuating level. Population ages. Urban residences increase, but urban pressures lead to counter-urbanisation trends.	Population variations to age with low variable fertility. Counter-urban migration variations as well as expansion of urban zones of influence.
Economic	Subsistence economy. Predominantly agrarian, based on manual labour. Labour efficiency reduced by illness.	Improvements in agriculture and landuse and early development of transport, communications, industry.	Sustained economic growth and industrialization.	Initially high economic growth, then tapering off. Production shifts to the service sector. Public welfare and leisure grows.	Post-industrial economy with service sector very dominant. Concern over sustainability of capitalist modes of production. Developed countries become less economically competitive than developing countries in manufacturing.
Social	Traditional, rigid hierarchical society. Strong family structures. Subordinate role for women. Low living standards. Poor unreliable food supply, especially affecting women and children.	Upper middle classes begin to adopt rising expectations. Strong family structures persist. Low but improving living standards. Some improvements in food supply.	Rising expectations throughout society. Extended family begins to weaken in urban areas. Public hygiene and sanitation improve, but still problematic in city slums. Improved agriculture. Better food supply.	Rational-purposeful life styles expected. Tendency towards greater bureaucracy and depersonalisation. Nuclear families become the norm. Women increasingly emancipated and better educated.	High living standards threatened by over-population, urbanisation, reduction in economic growth. Social inequalities remain marked in spite of emphasis on equal opportunities for women and minorities.
Health	Life expectancy low (<20 yrs). Child and infant mortality high. Mortality highest in urban areas. Main cause of death is infectious epidemics, exacerbated by malnutrition. No biomedical care systems. People rely on traditional medicine.	Life expectancy rises. Infant and child mortality still high. Urban mortality still high. Main causes death - endemic parasitic and deficiency diseases and epidemics. Industrial disease increases. Some improvement to personal hygiene.	Life expectancy rises 40-50. Infant child and maternal mortality improve. Pandemics recede. Infectious diseases still important but non-communicable diseases increase. Medicine and environmental health become better established.	Life expectancy reaches 70+. Childhood and infant mortality decline to low levels. Heart disease, stroke, cancer are leading causes of death. Most infectious diseases controlled. Problems of chronic illness grow. Medicine highly developed.	Life expectancy is further extended (towards hypothetical biological limit to life). Mortality from some degenerative diseases (especially heart disease) reduced. Compression of morbidity may result. Other diseases may increase (e.g. Alzheimer's).

Source: Curtis and Taker (1996 p 82).

the resurgence of diseases like TB. It is hypothesised here that there may be a regional pattern to this. Such disparities are clearly epitomised by the incidence rates of TB between aboriginal and non-aboriginal Canadians. The rate is 43 times higher among status Indians than the rest of the Canadian population. The rate (according to *The Globe and Mail*, November 30, 1994, citing a Statistics Canada Health Report) stood at 81.3 cases per 100 000 status Indians, in 1992 and is believed to be even higher than the rates of infection in some of the poorest countries in the world. This is in contrast to the rate of 1.9 per 100 000 among other Canadians who are not Indian.

Public awareness of new and resurgent infectious diseases is poor. Despite TB being rated as the leading killer of adults by the WHO (1993), (it kills more people each year than malaria and AIDS combined) little media attention or coverage is given to this old enemy. In fact movies such as *Outbreak* gave far more coverage to the present global resurgence of infectious diseases than the news media, and Dustin Hoffman made more money playing the role of a disease control scientist than the combined annual budgets for the U.S. National Center for Infectious Diseases and the U.N. Program on AIDS/HIV (Garrett, 1996, p. 79). Apart from journalists like Laurie Garrett, author of *The Coming Plague: Newly Emerging Diseases In a World Out of Balance*, no mention is made of resurgent diseases, except in medical journals and specialized magazines and publications which have a limited audience. As rightly said by Dr. Kevin Kain, (Picard, 1995, p. 1) advanced countries (including Canada's) public-health systems have become dangerously complacent and ill-prepared for the "crisis in infectious diseases sweeping the planet right now".

There is the public notion in these nations that if these diseases are really coming back, they will show up in other parts of the world, especially in Africa and Asia and nowhere near us. This is the disease equivalent of NIMBY. Yet these diseases do not recognise or respect international boundaries. Emphasising this point, Dr. Kain also stated that in 1994 the Toronto General Hospital (the largest health-care institution in Canada) treated more patients infected with malaria than people with HIV or AIDS. What makes the situation even worse is that in about 60% of cases initial diagnosis had been wrong.

The problem of resurgent diseases is quite recent (the last five to seven years), and it has not yet caught the attention of academics in the social sciences as compared to the those in more traditional health fields. Many social scientists, including geographers, have moved away from the realism that science presupposes, and have embraced an overtly social constructionist perspective. This is a move towards esoteric criteria of relevance which are insensitive to the physical and biological worlds. There is a very small disease research literature in Canada from social science perspectives. Although there is scant literature on this issue in the field of medical geography and in the form of dissertations, there are a few treatises on TB in Canada. These, particularly Wherrett's "*The Miracle of the Empty Beds*" (1977) deal mainly with the progress that was made in conquering TB throughout Canada, telling the story from when the disease had no cure and behaved like the present AIDS epidemic, to when it became a curable disease. Wherrett presents a story of how Canada so successfully attacked and controlled TB that these efforts became a model for less fortunate countries to emulate. This spanned a period of almost 150 years from before confederation when Canada was basically a poor rural nation. It follows

through to when poor immigrants started arriving from Europe, and on to when the disease reached its peak in the aboriginal population. The era when sanatoria became the norm in the treatment of TB is extensively documented. The book also gives an account on the optimism and euphoria that followed the discovery of the Bacillus-Calmette-Guerin (BCG) vaccine and the technique for taking chest x-rays, which immensely helped in diagnosing TB. The book also gives an account of the services that were available to TB sufferers in the various provinces as well as describing how several voluntary organisations were set up in that period to deal with the "white plague", as the disease was then called. Similarly, Brink's (1965) "*Across the Years : TB in Ontario*" gives a very brief account of how knowledge was acquired on TB in the early periods of Canada's history, and describes how control programs evolved and were run in Ontario. As a member of the voluntary associations that were formed to deal with the disease Dr. Brink also summaries the activities of these societies, focusing especially on fund raising. Other literatures that were consulted were official government documents which gave an account of the state of the disease in the country at various time periods and which documented how campaigns were progressing. Acts of parliament and legislation which were promulgated to aid the fight against TB are also discussed in these government documents. Also the numerous Health Reports published by Statistics Canada and likewise those of the Lung Association of Canada were reviewed. The most helpful one at this scale was "*A statistical chronicle of TB in Canada*" a (1992) joint publication of these two organizations. It gives an account of TB through to when a national data bank on TB was developed and when it became compulsory to report TB cases anywhere in the

country. The national database began in 1937. This publication tries to explain why TB is resurgent and also contains graphs depicting TB rate incidence patterns and trends.

The scholarly literature on TB in Canada is sporadic and scanty. To offset this problem it became necessary to rely heavily on articles and papers from specialised medical journals, WHO publications and books that dealt with TB in general. Geographical literature on TB is almost non-existent. This thesis develops an analysis of regional patterns of TB mortality, within a context largely set by medical and social histories. It is therefore hoped that this thesis might combat the public ignorance by showing that medical geography can report on and interpret the situation.

This chapter has portrayed the research problem, the context into which this piece of research falls, the conceptual framework and the general layout of this dissertation. The next chapter will provide us with an overview of what TB is, its mode of transmission and also discuss some of the reasons why the disease is resurging.

Chapter Two

THE NATURE OF TUBERCULOSIS

This chapter provides a general overview of TB, including the nature of the disease, its possible origins, sites of infection, modes of transmission, symptomatic effects and treatment procedures. This chapter also reviews some of the reasons put forward by experts and the WHO about why infectious diseases like TB are resurging. It also assesses the global trend of the disease.

2.1 What is TB ?

TB is a destructive infection caused by the tubercle bacillus, *Mycobacterium tuberculosis*. TB is a form of "rot" in humans which may eventually destroy parts of the various organs it affects, particularly the lungs. Basically the damage that TB does to a human is synonymous with the rot that affects fruits (Stead, 1971).

The disease received its name because of the characteristic formation of lumps on or within the normally soft spongy parts of the lungs. TB can affect almost any part of the body but pulmonary TB is the form of most cases in Canada. The infected areas are firm and resemble the lumps on roots of such plants as potato, which are called tubers or tubercles. The name TB was first suggested for the disease by Johann Schonlein, in 1839 because of this morphological similarity.

2.2 Origins of TB

According to Daniel et al (1994) and Ayvazian (1993), the general belief among palaeopathologists and medical researchers is that TB afflicted animals well before it appeared in humans. This is based on evidence from the examination of the skeletal and fossils remains of fauna from the palaeolithic and neolithic eras. They suggest that the most likely time for the disease to have been passed to humans would have been when humans started domesticating animals. Ayvazian goes on to claim that in Hindu historical literature from about 2000 BC mention is made of a "slow wasting fever" in elephants. He further points out that the ancient civilization of the Nile valley also reported "phthisis" (which literally means "to melt" or "to waste away") among its domesticated cattle. Steele and Ranney (1958) also postulated that TB probably occurred as an endemic disease among animals long before it affected humans. It is their opinion that *Mycobacterium bovis*, the cattle strain of the organism that causes TB, was the most likely infecting organism and the first human infections may have been due to this pathogen (Steele and Ranney, 1958). The pathogens of the human, bovine and avian strains of the tubercle bacillus are thought of as belonging to a period of great antiquity and may have derived from a common stock but it is not actually known when speciation occurred (Ayvazian, 1993). Confirming the idea that TB originated from ancient animals Rossman and MacGregor (1994) suggest that TB is much older than recorded history. It might be that TB occurred as a sporadic and unimportant disease in humans after it had been transferred from animals. But it graduated into epidemic proportions when population densities started increasing. Although it is not exactly known when or how TB began among human populations, Diamond (1992) points out that TB most probably started spreading slowly as an

epidemic when infected Europeans began to colonise distant lands. The question of how the disease arrived in North America and Canada specifically, has not been fully answered. Regardless of exactly when TB first reached North America there is agreement that it was after the settling of North America by Europeans that real rises in TB occurred (Buikstra, 1981, Paulsen, 1987; Manfreda et al, 1993). It is thought that at that time it was only Europeans who could have served as sources of TB infection. Also, because the indigenous North American peoples had not been exposed to TB, they were extremely susceptible to it, since they had little or no herd immunity. In addition, Manfreda et al (1993) argue that the arrival of Europeans profoundly affected the biological basis of the indigenous peoples, their social organisation and culture. This resulted in periods of starvation, chronic malnutrition and epidemics of other communicable diseases which further increased susceptibility to TB. In essence, conditions for epidemic outbreaks of TB in the aboriginal population of North America were created and therefore the disease took its natural course.

2.3 Transmission of TB

Since pasteurization of milk and the slaughter of tubercular cattle became compulsory in Ontario in 1938 and 1922 respectively transmission of TB via these modes has been drastically reduced or has been eliminated (Brink, 1965). Consequently, the most viable current means of acquiring the infection is by inhaling tubercle bacilli into the lungs in droplets produced when a person with active pulmonary TB coughs, sneezes or speaks. These droplets are, however, dangerous only for a few hours when an individual comes into contact with them indoors, due mainly to the fragile nature of the micro-organisms. If contact with these micro-organisms occurs outdoors, there is very little chance that infection can take place because the

droplets rapidly undergo great dilution. Although the lungs are the most frequent site affected by TB, the disease may develop in several other organs or parts of the body. TB that affects other parts of the body excluding the lungs is referred to as extra-pulmonary TB, whilst that which is confined to the lungs is known as pulmonary TB. Extra-pulmonary TB most commonly affects the pleura (the thin membrane lining the thorax and lungs), lymph nodes, spine, joints, genitourinary tract, the abdomen and the nervous system.

It is important to note that an individual does not necessarily go on to develop active TB after he/she has been infected with the micro-organism that causes TB. A person may be infected with the bacilli but may never develop the disease throughout his/her lifetime. The further development of the disease depends on a host of factors, including how strong the immune system of the exposed person is, the virulence of the strain (bacilli) that one came into contact with, and the length/duration of time over which the contact with an active case of TB took place. Those who develop the disease go through the development stages of the disease described below. According to Grzybowski (1983b) the risk of infection and development of TB is highest among infants, adolescents, elderly people, malnourished individuals, diabetics, alcoholics, HIV and AIDS patients and generally any one with a impaired immune system.

2.4 Stages in the Development of TB

Although the disease may graduate straight from the initial implantation state to the chronic phase, there are usually five major cycles in the progression of TB.

The first stage is that of Implantation. This is the initial phase of infection when the bacilli in the form of droplet nuclei are inhaled. Once they enter the respiratory system they go

on to find a resting place in areas of good ventilation, normally around the middle and lower lobes of the lungs. This initial phase is usually referred to as primary lesion.

The second phase of the disease is the stage of Primary TB. At this stage there are usually no signs of illness from the presence of TB bacilli in the body. The initial infection either heals at this stage without even being diagnosed, or begins a course towards chronic TB, which as pointed out above may develop directly, or through a series of stages. The most effective way at detecting the presence of the bacilli at this stage is through a skin test.

The third stage is the Haematogenous Dissemination phase. Before the development of allergies/reactions to the infection, some bacilli may escape from the primary lesion in the middle or lower lobes of the lungs into the blood stream. They then proceed to set up foci in other parts of the body. The most common place is the top of the lungs which, due to the high oxygen concentration, favours the rapid growth of the bacilli. However they may also develop in the brain, spine or kidney where oxygen concentration is relatively high and conditions are therefore ideal for the bacilli to grow. This phase of the disease also coincides with the development of immunity. Where immunity fails to control the further development of the disease, an extra-pulmonary condition of the disease may be the outcome. At this stage TB usually becomes fatal if the disease is not recognised and treatment started promptly.

The fourth stage is the Latent/Dormant phase. During this stage in the development of the disease the primary lesions in the middle or the lower parts of the lungs generally begin to heal. However, some of the bacilli may remain alive particularly at the sites of the scars. Thus the bacilli lie dormant in these scars for a long time, ready to erupt into active TB at any time. The last and final stage of the disease, is the Chronic/Adult phase. This is the most serious and

contagious stage of the disease. This is the stage where the bacilli become present in large quantities and in a liquid medium. Thus in addition to carrying bacilli to other parts of the lungs, this highly infectious liquid may also be sprayed into the air and easily endanger other persons. This process may take several months, years or even decades after the initial infection. The chronic stage is most often triggered when the body's resistance is lowered. Normally, this occurs late in an individual's lifespan in association with other diseases which impair the body's defenses (Stead, 1971).

2.5 Clinical Symptoms and Treatment

TB may present itself clinically in a variety of ways and may vary according to the site of the disease. Common symptoms associated with pulmonary TB include cough, fatigue or malaise, anorexia, weight loss, fever, sweating and or chills at night and a dull aching chest pain or tightness as well as sputum production which may be blood-stained (haemoptysis) (FitzGerald, 1995; Schluger and Rom, 1994; Cohen and Durham, 1995). In extra-pulmonary TB the symptoms manifested will be related to the affected organ. Apart from observing the symptoms discussed above, TB can be diagnosed through a variety of tests like chest x-rays, skin/Mantoux tests, bacteriological experiments, and a number of newly developed molecular biology techniques.

Presently the mainstay of the treatment of pulmonary TB is drug therapy. Drug therapy is very effective when compared to the methods used prior to its introduction although its potency has been reduced with the emergence of drug resistant TB in the past decade. Styblo (1980) exemplified the effectiveness of drug therapy by comparing the mortality and recovery rates prior to the commencement of drug therapy with the then 90-100% scenario of cure

from chemotherapy. He claimed that prior to drug therapy, approximately half of the patients suffering from TB died within 2 years of the onset of the disease. Styblo further asserted that only a quarter of active TB patients went on to recover from the disease, and another quarter barely survived with chronically active TB.

Traditionally, several drugs have been used to treat TB although new ones are being added. Since the introduction of streptomycin in 1944, para-amino-salicylic (PAS) in 1946, and isonicotinic hydrazide (INH) in 1952, these drugs have served as the major "magic bullets" against TB. In the early 1950s, when these anti-TB drugs were introduced, it was quickly realised that if 2 or 3 of these drugs were administered at the same time, the success rate was far greater than when a single drug was used. This led to the modification of drug treatment regimens. Consequently a combination of 2 or 3 drugs administered at the same time became the norm and patients had to take these drugs daily over a long period of time, normally 24-30 months.

In the early 1960s the length of drug regimens started to fall considerably from 24-30 months to 18 months and in 1970 to 9 months. In contemporary times, drug therapy has allowed even further reduction in length of treatment. The standard therapy regimen has now been shortened to 6 months, with an optimal combination of 3 or 4 drugs being administered (O'Brien, 1993). Some of the newer drugs that have been added to the arsenal against TB are rifampicin, ethambutol, capreomycin and cycloserine. Streptomycin and the two other major drugs previously discussed are normally referred to as first-line drugs. This is because they are able to contain the disease by restricting the growth of the bacilli. Other drugs are then used to further reduce, eliminate or kill the bacilli. Streptomycin has to be injected intra-muscularly and

is usually given in a hospital or clinic setting for about 3 months. INH and PAS can however be taken by mouth and they allow patients to be discharged home at the end of the streptomycin course, so long as the drug therapy is continued for at least 6 months.

As mentioned earlier, with present medical knowledge and technology TB is easily curable provided that it is diagnosed at an early stage or even after detection of the disease if treatment is followed meticulously. Non-compliance of patients with a strict drug treatment regimen most often leads to reoccurrence of the disease. This normally happens when symptoms of TB begin to disappear or when patients begin to feel better after starting treatment. This can also lead to the building of resistance in the body to TB drugs. As we shall see in the following discussion this may lead to multi-drug resistant TB (MDRTB).

2.6 Resurgence of TB

The WHO, medical experts and scientists in general have attributed the present return of TB to a number of reasons. Paramount is the emergence of the human immunodeficiency virus (HIV) pandemic during the past decade and the emergence and transmission of multidrug resistant mycobacterium tuberculosis (MDRTB) which is defined as strains resistant to two or more first-line drugs. Common in this category of first-line drugs are the mycobactericidal drugs like rifampicin and isoniazid (Crofton, 1987). Deteriorating social conditions and increasing homelessness in large urban centres worldwide (Barron, 1993) and the general lack of enthusiasm on the part of health authorities and governments in the fight against TB during the past decade have contributed immensely to the resurgence of TB. Immigration, (people moving from TB endemic areas to other parts of the world where the disease is still under control) and to some extent, modern means of transportation - particularly the jet plane - have

also contributed in their own ways to the spread of these diseases especially in the industrialised nations. There is also the possibility that the micro-organisms responsible for causing TB have evolved into new forms less vulnerable to standard medical treatments

It has been clearly recognised by medical authorities and the WHO that the present global TB problem is being fanned by the HIV epidemic. It has also been realised that TB has become the leading immediate cause of death worldwide among people infected with HIV. The immuno-suppression associated with HIV infection makes the HIV-infected person much more susceptible to TB, not only for reactivated cases but also from primary infection (Barnes et al, 1991). This is because the immune cells that are destroyed by the HIV virus are the very same cells that enable the body to fight TB infection. Thus latent TB (an inactive case) progresses very rapidly into an active case as soon as a person becomes HIV positive. In fact according to the WHO, people infected with HIV or full-blown AIDS seem to have a 100-fold or greater risk of developing TB than people without HIV. It has become quite apparent to the WHO that TB and HIV have combined forces. It is estimated by the WHO that as of 1992 the cumulative global number of persons co-infected with HIV and TB was about 4.4 million with almost 3.5 million of them in Sub-Saharan Africa (Snider et al, 1994) where health care delivery systems are generally inadequate. More disturbing and potentially catastrophic is the fact that presence of HIV infection or AIDS makes diagnosing TB very difficult. This results in delayed treatment and increased chances of passing on TB since TB at its very late state is extremely contagious. Additionally, it has been observed that HIV infected persons have a higher frequency of developing extrapulmonary TB which, compared to pulmonary TB, is very difficult to diagnose.

Another alarming aspect of the present comeback of TB is the appearance of Multi-Drug Resistant Tuberculosis (MDRTB). This is a situation where an active TB patient does not respond to the standard drug treatment therapy. Many factors contribute to the occurrence of this problem. Before TB became a curable disease with the advent of antibiotics, treatment was mainly hospital-based with patients being confined in wards. This gave medical authorities the chance to closely supervise and monitor their patients with respect to daily drug regimens. However when the disease became more readily curable, treatment became community based (out patient) where patients, unless in very serious situations, were allowed to stay home and were trusted to take their drugs. Thus the control that nurses and doctors had on their patients to see to it that they took their medications vanished. This in a way has resulted in many patients neglecting to complete their drug therapies. Often as soon as they begin feeling better they discontinue taking their drugs and thereby render the medications ineffective since the disease causing agents are able to mutate and consequently develop resistance to these drugs. Another source of persons not complying with their drug regimens can be found in patients from high risk populations. These groups include drug addicts, individuals with HIV and those who have not received adequate medical treatment. MDRTB can occur in a variety of ways. People can contract a strain of an organism that is naturally resistant even before any drugs are administered (primary), or patients can acquire it from another patient thus spread through the air or through incorrect or badly managed drug regimen programs and as already mentioned through patients not following their therapy to the end. The WHO (1993) has estimated that more than 50 million people may have already been infected with drug-resistant TB bacteria. It has been realised by this same organisation that the cost of treating patients rises astronomically

when dealing with MDRTB. For instance in the US the cost of treating TB patients rises from about \$2000 for outpatients to \$250 000 when it comes to MDRTB patients (WHO, 1996)

Deteriorating social conditions, homelessness, and living conditions in shelters have also played a significant role in the present state of affairs. Poverty, overcrowding, lack of proper nutrition, improper ventilation and a general lack of adequate health care leaves people living in both deprived rural and urban areas very susceptible to the ravages of TB. For instance, a report from a shelter in New York City stated that 42.8% of the homeless men evaluated were infected with TB, including 6% who had active TB (McAdam et al, 1990 , Cohen and Durham, 1995). Among the independent risk factors identified in this study were increasing age, minority group status, length of stay in shelter systems and intravenous drug use (McAdam et al, 1990 ; Cohen and Durham, 1995). Brickner et al (1993) have also estimated that the prevalence rates of active TB among the homeless are 150-300 times greater than in the general population. Basically, TB thrives where socio-economic conditions are poor.

Another important factor is that since antibiotics were introduced not much attention has been paid to the disease, especially in developed countries. Soon after the discovery of the "magic bullets" TB hospitals and sanatoria the world over were earmarked for closure. In addition to this came drastic reductions in funds designated for the TB control programs as well as grants for research. The advent of antibiotics also saw a shift in the focus of treatment from hospital inpatient therapy to community based therapy. In the face of all the monetary cutbacks and reduction in the number of trained TB health workers these community based programs were not properly managed since doctors and nurses lost their power to closely monitor their patients. This gradually led patients to abandon their medications and do

whatever they wished as soon as they began feeling better. Those who migrated in most cases could not be traced until the disease caused a relapse and they were again admitted to hospital. At present in cities like New York some patients who fall into this category are held in hospitals against their will despite continuing legal battles (New York Times, November 21, 1993). In a nutshell, cutbacks in funds for both research purposes and control program plus reductions in staff resulted in an almost complete halt decades ago in the fight against TB and this has resulted in the present state of affairs.

Globally, the present economic conditions, coupled with widespread social unrest, war and civil strife results in major movement of people from poor nations into the developed ones (Martin and Widgren, 1996). In receiving countries it has come to the notice of health authorities that an increasing number of recently reported TB cases are of foreign-born people. In other words many of the people being presently diagnosed with active cases of TB are people who got infected with the TB bacteria in their home countries before moving into their present places of residence. In effect developed countries with substantial levels of immigration have recognised the increasing contribution of foreign-born persons to the incidence of TB in their countries (Orr et al, 1990). For instance in the U.S. studies conducted by agencies like the Center for Disease Control (CDC) and others like Jacobs et al (1993) have concluded that foreign-born persons from six countries accounted for about 63% of all TB cases. These countries were China, Haiti, Mexico, the Philippines, South Korea and Vietnam (Jacobs and Starke, 1993; Cohen and Durham, 1995). In Canada the same phenomenon has been observed. However, the list of countries accounting for this changes slightly. For example in Ontario, persons born in Vietnam, Somalia, India, China, Hong Kong and the Philippines account for

76% of all reported TB cases (Communicable Disease Control, December 1994). It should be noted that although immigrants are screened especially for TB before they are allowed entry into developed countries the majority of the TB cases are reactivated within the first few years on arrival in these countries since proper treatment procedures were not followed. Refugees the world over are also latently infected by the disease since in most cases conditions in refugee camps and shelters are conducive to TB spread. Controlling TB therefore presents a grave challenge among displaced people because they are usually mobile populations without access to traditional health services. It is estimated by the WHO that more than half of the world's refugees may be infected with TB (WHO, 1996).

Another avenue via which TB is perpetuated and silently spread is modern transportation, especially through international travel and tourism. Since the 1970's international travel has increased dramatically with people moving all over the world with relative ease. But what was not at first realised were the implications for public health. It takes only a few minutes to get infected with TB when one comes into contact with an active case. In March 1994, health officials in the U.S. reported the first case of TB transmission between airline passengers and warned that people suffering from infectious TB should avoid travelling on commercial flights. The U. S. National Centers for Disease Control and Prevention reported that in May 1994, four people were infected with TB while seated near an infectious passenger on an eight and a half hour domestic flight from Chicago to Honolulu (The Globe and Mail, March 3, 1995).

Furthermore it is feared that worldwide control of bacterial diseases has been lost and we are heading for a "post-antibiotic" age. This is the main theme of Laurie Garrett's (1994)

"The Coming Plague: newly emerging diseases in a world out of balance". She exhaustively and comprehensively traces and discusses why a lot of forgotten disease agents like staphylococcus aureus, pneumococcus, chlamydia, e. coli bacteria and a host of others are making a comeback. What she discerned after extremely painstaking and arduous research which took her to several developing countries was that the present return of infectious diseases threatens to erode decades of progress. Similarly Dr. Alexander Tomasz, a microbiology professor at Rockefeller University, New York, reiterated at the annual meeting of the American Association for the Advancement of Science that if nothing is done to stop the upsurge of infectious diseases nothing short of a health disaster should be expected in the very near future (The Globe and Mail, February 21, 1994). Neo-Malthusians expect this to happen. This trend in most cases can be attributed to two main factors. Firstly, the bacteria themselves are emerging in new forms that resist antibiotics and secondly, a larger part of the world population is becoming immunodeficient, and thus becoming more susceptible to the microbes because of afflictions like AIDS/HIV and others. Also partly to blame for this situation are the medical and pharmaceutical communities which promoted the overuse of antibiotics both directly through inappropriate prescribing, and indirectly in commercial animal feed. This forced bacteria to respond with more and more complex mutations which increasingly render all standard treatments useless. MDRTB was pointed out as one of the most intricate and troubling examples of the new strains of resistant diseases. It is been claimed by researchers like Garrett that at the present rate we will soon reach a point where strains of most bacterial diseases will become resistant to almost all existing antibiotics.

2.7 The Global Trend of TB

WHO reports state that in the U.S, Eastern Europe and especially Africa TB which was believed to have been eradicated prior to the early 1980's is re-emerging as a potent health problem. This is especially so in the developing world (WHO, 1992 ; Cowley et al, 1992 ; Doherty et al, 1995 ; Raviglione et al, 1993).

From a global perspective the picture is disturbing. It is estimated that one-third (1.7 billion) of the world's population is latently infected with *mycobacterium tuberculosis*. Over 8 million new cases of TB are reported annually with nearly 3 million deaths occurring each year from the disease (Kochi, 1991). It is estimated by the WHO that in the next decade 300 million people will become infected and that 90 million people will go on to develop the disease, of whom 30 million will perish (WHO, 1993). This problem is extremely serious in developing countries where the healthcare delivery system is already compromised due to lack of basic equipment and funds. The tragedy of the problem is that most deaths resulting from TB are still easily preventable, if cases are diagnosed early enough and treatment embarked upon.

The trend and distribution of the disease worldwide is quite varied. As already mentioned rates in most developed countries consistently decreased from 1970 to 1989, with only a few reported cases in the elderly, probably due to reactivation. In contrast to this, during this same period TB cases in developing nations (especially in Africa and South-East Asia) increased. Although the average rate of new TB cases decreased from 60 to 47 cases per 100, 000 in non-HIV epidemic countries it increased from 51 to 64 per 100, 000 in 13 HIV epidemic countries : Burundi, Congo, Cote d'Ivoire, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, Zaire, Zambia and Zimbabwe (Sudre et al, 1992 , p 155 ; Lutwick

1995, p 44). Similarly, in the Andean region of South America and in Haiti, West Pacific, South-Eastern Asia, (including India, China, Thailand and the islands of the Philippines and Indonesia) TB rates were as high as in Africa (Snider and La Montagne, 1994, p 1190). It has been predicted by the WHO that by the turn of the century, South-East Asia will have overtaken Africa in terms of TB incidence and prevalence rates. Incidence refers to the number of new cases developing in a given year. Prevalence on the other hand is the total number of all types of living cases of TB, some of whom may have been known for years. Additionally it can also include the estimated number of known cases plus the unknown. This is mainly because it has been anticipated by WHO that no fewer than 40 million Asians will be HIV positive by the end of the century (Ryan, 1992, p 403).

Another worrisome aspect of TB worldwide is that despite the fact that everyone is at risk of being infected with the disease, fatalities are tilted towards the most productive segments (15- 49 age group) of society, rather than the elderly and youth. There are, of course, marked differences between conditions in the developed and developing nations. It is estimated that in Europe and other parts of the developed world almost 80% of all infected individuals are 50 years or older while in Africa and other parts of the developing world approximately 77% of all infected persons are less than 50 years old. Even worse is the situation in Africa, South-East Asia and the Western Pacific regions where more than 50% of the adult population aged above 15 years is infected with the disease. The percentages are 54%, 52% and 62% respectively (Sudre et al, 1992, p 151).

2.8 The United States of America

Industrialised countries are also experiencing resurgent TB. The debate as to whether TB was ever eliminated in these nations after the introduction of antibiotics is continuing. Probably the disease was never eradicated but rather public discussion about it died with the advent of antibiotics. One such country is the United States of America. Immediately after it became apparent that antibiotics could cure TB, people became complacent and eventually stopped worrying about TB. This attitude has proved futile and costly since TB is presently threatening to erase all the successes made against it. Since 1953 when national surveillance began, through 1984, the U.S. experienced a significant decline in TB cases. Whereas in 1953 a total of 84,304 Americans had contracted TB out of whom 19,707 died, by 1985 the level of new infection had fallen to 22,201 with 1,752 deaths in that year from the disease (Ryan 1992, p 390 ; Raviglione et al, 1995, p 223). This constituted an average decline of about 5.3% per year in TB cases. However, from 1985 onwards this decline levelled off. In fact by 1990 the tone of the CDC had changed drastically from one which in the early part of 1989 envisaged that the goal to eliminate TB from the U.S. by the year 2010 was perfectly on course and was attainable (Garrett, 1994, p 516). This was after a fuller assessment of American TB had been made. It then came to light that the decade of the 1980's had witnessed a rise of 28,000 cases of TB. It was then realised that the downward slope that TB had been following since 1953 had plateaued in 1984 and 1985 and actually climbed steadily to the extent that by the end of the decade the U.S. had almost as many cases of the disease as had been seen in 1980 (Garrett, 1994). As expected the rise in TB cases affected American society disproportionately along specific racial/ethnic and geographic lines.

According to CDC (*Morbidity and Mortality Weekly Report*, 40, 1991) the biggest increase in TB cases was among the inner-city African-American population where it grew by 1,596% between 1985 and 1990, although Hispanics and Asians also went through a similar trend. It was also reported that between 1985 and 1991 there was an overall 18.4% increase in TB cases in the U.S., most of them attributable to the HIV epidemic (Elnar et al. 1993 ; Sunderam et al. 1986). Additionally, foreign-born cases accounted for about 60% of all the total cases in America.

2.9 Canada

Canada's experience has not been as dramatic as that of the United States. In essence the situation in Canada is far better and much more stable than the situation in America. According to Dr. Jure Manfreda of the University of Manitoba, Faculty of Medicine, (personal communication) and as further reiterated by Dr. Donna Holton, of the Laboratory Center for Disease Control (LCDC) a branch of Health Canada in Ottawa (*Macleans*, May 24 1993, p 52) the rate of increase in TB cases in Canada has been far less spectacular. Despite this trend public health officials are still worried about the fact that after an overall eight-year decline that began in 1980 when there were 2,751 new cases the downward trend ended after bottoming out at 1,947 in 1988. Since 1991 the number of new cases has risen to 2,012 and health officials are afraid this trend of affairs is on the ascendant in the light of the fact that more than 35,000 Canadians are infected with HIV. For the whole of Canada between the period 1987 and 1992 the rate of diagnosed TB per 100,000 people hovered around 7.2 and 7.4. However since 1993 it has dropped to 6.9 per 100,000 (Statistics Canada, 1993, 1995). This makes Canada one of just a handful of countries in the world whose TB rates are below 10 (The

Globe and Mail, November 30, 1994). Although the picture looks good on the whole, when it comes to disaggregation into the various sections of the populace, things look much different. Among the various groups of the Canadian population the highest rates exist among the aboriginal people at approximately 81 per 100,000 followed by immigrants at 50 per 100,000 with the bulk of cases appearing in immigrants of Asian origin. The rate for European immigrants stood at 10 per 100,000 while that of Canadian-born non aboriginals was 3 per 100,000 (FitzGerald et al, 1993 ; FitzGerald, 1995). Obviously, there are marked differences among these rates. Socio-economic disparities among the various groups are most likely be the source of these dissimilarities in Canada. Moreover, the HIV epidemic and MDRTB has so far not reached the alarming proportions seen in the United States. Nevertheless, aboriginal people for instance account for 20% of all new TB cases although they represent only 3% of the general population. The executive director of the Canadian Council on Social Development, David Ross, concluded that the staggering TB rates in aboriginal people reflect the abominable living conditions of this group of people (The Globe and Mail, November 30, 1994).

Basically, "high risk" groups are aboriginal Canadians, immigrants from countries where TB is endemic, residents of areas with low socio-economic status in both rural and major urban Canadian cities and the elderly. However people with HIV/AIDS have the highest risk of contracting TB. Although no national data exist in Canada on the relationship between TB and HIV/AIDS, provincial reports confirm the fact that some AIDS patients also have TB (Brackner et al., 1992). On a regional basis the northern regions of the country have the highest incidence rates of TB as compared to the south, with the Yukon and Northwest Territories topping the list (see table 2.1 and 2.2).

In conclusion, although the TB problem in Canada is not as bad as in the United States, efforts must be taken to prevent the situation from getting out of hand. This is essential in the face of the present austerity measures being implemented at both the federal and provincial governments levels (particularly Ontario) where government funding for social programs is being dramatically reduced. Also the closure of health care facilities, downsizing, and drastic reductions in welfare benefits might create a lot of unemployment and poorer social conditions that may be conducive to TB. In Ontario, with its large urban population and concomitant

Table 2.1 Number of new active and reactivated cases of tuberculosis, Canada and the Provinces and Territories, 1980-1990.

Year	Canada	Nfld	PEI	NS	NB	Que	Ont	Man	Sask	Alta	BC	Yuk	NWT
1980	2761	89	7	83	59	808	764	172	137	241	371	2	28
1981	2529	79	8	83	72	651	742	151	122	216	370	8	27
1982	2472	72	2	59	42	649	730	154	110	203	414	3	34
1983	2356	63	4	35	58	618	662	208	118	189	363	6	32
1984	2356	57	4	43	39	587	686	182	115	221	397	5	20
1985	2144	34	1	31	38	586	643	144	145	178	334	1	9
1986	2145	56	3	36	20	503	657	136	152	209	346	4	23
1987	1972r	34	1	30	24	432r	645	126	156	205	298	1	20
1988	1947	65	4	26	18	423	635	111	149	176	300	4	36
1989	2035	42	5	30	29	420	711	100	216	133	288	5	56
1990	1996	29	1	23	34	412	727	92	223	157	265	10	23

r = revised

Source: Health Canada (1992) "Recent Trends In Tuberculosis incidence in Canada 1980-1990" Canada Communicable Disease Report, Sept. 1992, volume 17-18.

large number of immigrants, if the right preventive and control measures are not taken now we should expect to see the resurgence of infectious diseases like TB.

The present magnitude and seriousness of the global TB problem has rekindled interest in the disease but unfortunately not among medical geographers. TB has once again become a

Table 2.2 TB rates per 100,000 population, Canada and the Provinces and Territories, 1980-1990.

Year	Canada	Nfld	PEI	NS	NB	Que	Ont	Man	Sask	Alta	BC	Yuk	NWT
1980	11.5	15.4	5.6	9.7	8.3	12.8	8.9	16.7	14.1	11.6	14.1	9.3	65.0
1981	10.4	13.9	6.5	9.8	10.3	10.1	8.6	14.7	12.6	9.7	13.5	34.6	59.0
1982	10.0	12.6	1.6	6.9	6.0	10.0	8.4	14.9	11.2	8.8	14.8	12.6	72.1
1983	9.5	10.9	3.2	4.1	8.2	9.5	7.5	19.9	11.9	8.0	12.8	26.9	66.1
1984	9.4	9.8	3.2	4.9	5.5	9.0	7.7	17.2	11.4	9.4	13.8	22.9	40.5
1985	8.5	5.9	0.8	3.5	5.3	8.9	7.1	13.5	14.2	7.6	11.5	4.4	17.7
1986	8.4	9.7	2.3	4.1	2.8	7.6	7.2	12.6	14.9	8.7	11.9	17.9	44.7
1987	7.7 _r	6.0	0.8	3.4	3.4	6.6 _r	7.0	11.7	15.4	8.6	10.2	4.1	38.7
1988	7.5	11.4	3.1	2.9	2.5	6.4	6.7	10.2	14.7	7.3	10.1	15.8	68.8
1989	7.8	7.4	3.8	3.4	4.0	6.3	7.4	9.2	21.4	5.5	9.4	19.7	104.9
1990	7.5	5.1	0.8	2.6	4.7	6.1	7.5	8.4	22.3	6.4	8.5	38.5	42.6

r = revised

Source: Health Canada (1992) "Recent Trends in Tuberculosis incidence in Canada 1980-1990"
Canada Communicable Disease Report, Sept. 1992, volume 17-18.

featured topic in many health programs, public forums, conferences and national workshops. The seriousness of the problem led the WHO in the April 1993 to declare TB as a "global emergency", the first declaration of its kind in the history of the organization (WHO, 1993).

This chapter has given us an overview of what TB is, its origins, modes of transmission and forms of treatment and some of the reasons why the disease may be increasing once again. In the next chapter we shall see how TB has evolved throughout the years in Canada and Ontario.

Chapter Three

HISTORICAL OVERVIEW OF TB IN CANADA

This chapter describes the course of TB in Canada, and in Ontario in particular. Specifically, this chapter traces the course of the disease from the time when there was no known cure, through to the arrival of antibiotics, taking into account the social and economic conditions that affected its distribution, control, and persistence.

3.1 Overview

The "captain of the men of death", "the white plague", "consumption", "phthisis", "going into a decline" have historically been some of the names used to describe TB. Contracting the disease at the beginning of this century was the equivalent of a death sentence, much as AIDS is at the present time. This was because during that era there was no cure or palliative treatment. TB's impact on the Canadian population cannot be overstated. It is believed that TB killed at least one out of every 1000 people, perhaps more, since not all cases were accurately diagnosed or reported (Grygier, 1994 ; Brackner, et al, 1992).

Before the turn of the century, TB had a great impact on the health and lives of many families in Canada, both rich and poor, and was the cause of death for many, due to its infectious nature and usually long gestation period. Literally all that families and physicians could do was to watch helplessly a patient's downward path to death during

which time other family members and friends frequently also became infected and followed the same trend to the grave (Brackner et al, 1992, p 104).

The earliest attempts at TB control involved the isolation of those with active cases of the disease. In the early 1900s sanatoria were established to care for large numbers of patients over long periods of time. The rationale behind the establishment of sanatoria was to prevent the spread of infection and to provide rest, fresh air and a good diet for patients. It was thought that this therapy would probably help revitalise the immune system of TB patients since there were no drugs to perform that function. The first sanatorium in Canada was opened at Muskoka in 1897 (Brink 1965).

In the 1920s numerous chest clinics were established, followed by the massive TB surveys of the 1940s and 1950s (Grzybowski, 1983a). The rate of TB infection steadily declined from that period onwards but the case mortality rate remained around 50 percent until the discovery in the 1950s of the anti-microbial treatments that rendered TB curable (Grzybowski, 1983a). This decline most probably was due to the isolation of active TB cases from the public.

The incidence of TB in Canada continued to decline steadily and became even more rapid during the 1960s and the 1970s. By the early 1980s, TB had become an uncommon disease in Canada (Brackner et al, 1992). The general improvement in social conditions and quality of life may have contributed significantly to the decline of TB in Canada. This led to a common misconception that the disease had been completely eliminated from Canadian society and to the belief that there was little or no need for further attention to TB control measures (Tuberculosis Committee, 1994).

The degree of apathy and complacency by the public and health authorities is further highlighted by Dr. George Jasper Wherrett in his book " The Miracle of the Empty Beds " (p 163)

" The public has lost its fear of the disease (referring to TB) and has become complacent and the knowledge we have gained is not always being used in an intelligent approach to the problem. There is the fear that this complacency will lead to toleration of the disease and that it will remain for many years to come, a source of infection with its ups and downs and at best, there will only be a truce with the disease rather than a victory over it ".

Contrary to public perception and opinion, after declining for many years cases of active TB diagnosed in Canada increased by 4.5 percent between 1988 and 1989 before declining again by 1.5 percent between 1989 and 1990. However, between 1990 and 1991, the number of newly diagnosed cases increased again by 1.5 percent (Brackner et al, 1992 , FitzGerald, 1995).

3.2 Historical Account of TB in Canada

At the beginning of this century it was clear that TB was among the greatest killers of humans throughout the Western world. It was also realised that if nothing concrete was done to eradicate TB the disease could have crippling effects upon future economic and social progress

In Canada, the situation was no different. TB was a disease for which there was no cure and which therefore had a great negative effect on the population. According to

Grygier (1994) the disease was particularly prevalent in slum areas and among the poor immigrant populations of Canada's rapidly growing cities

The social and economic conditions during the early 1900s helped greatly in the propagation of TB in Canada. Firstly there was a lack of organised public health services during that era. Thus there was no body or organisation responsible for the monitoring or issuing of guidelines on public health matters as well as on the general hygiene of the environment within which the community lived. In effect, anyone suffering from the disease had to bear the brunt of its effects individually with their families. In a situation where people did not have enough funds to seek medical help they quickly succumbed to the disease, dying shortly after contracting it.

The major process here was the massive immigration of poor Europeans to Canada. The sheer numbers and the rates of movement made it impossible for officials to screen migrants carefully before entry was permitted. This was mainly because the country was relatively poorly developed and therefore did not have the necessary infrastructure and qualified personnel to screen migrants, as is the case today. In addition one of the principal priorities of the then government was increasing the size of the country's population as fast as possible in order not to feel so threatened by the size and power of Canada's aggressive and more mature southern neighbour (Wherrett, 1977).

Furthermore, Canada during this era was basically a vast reserve of natural resources, with a dispersed rural population and primary production serving as the main sector of the economy. The country therefore did not have either the technological basis or the medical expertise to effectively restrain or impede the spread of TB. This played a

major role in hampering the control of TB during the early part of the country's history. In trying to obtain accurate figures for the trends in the prevalence of TB (and thus the actual number of people suffering from the disease at a particular time) in Canada during the period in question one is faced with a very difficult task, as the basis of notification to Statistics Canada - or its forerunner, the federal Dominion Bureau of Statistics - has varied over the years (Wherrett, 1977 ; Grygier, 1994). This is because at first figures were based on the reporting of new cases and on the number of patients in sanatoria and hospitals.

Later, reactivated cases and patients treated outside sanatoria were included. It is worth noting that the number of reactivated cases which were reported as new cases in 1961 amounted to an overstatement of about a quarter. As this was not the case in the 1930s or 1940s it is therefore quite difficult to estimate the trends of the disease over the time frame in question. Also lacking are reliable data sources on disease trends in the various provinces. This stems from the fact that it took quite a long time for people to realize the importance of keeping accurate information about the disease. In the early years of the history of this country people were reluctant to reveal vital information about themselves probably due to ignorance or attitudes of mistrust towards governments in their "old countries". Indeed, when one goes further back to the period around and immediately after confederation, it becomes clear that national mortality data on TB did not exist at all. However, data for Montreal and Toronto from as far back as 1880 are available. Wherrett (1977) and Brackner et al (1992) have argued that if an average of the rates for these two cities are taken as rough indicators of the overall urban Canadian TB

mortality rate, then the data suggest that the rate was around 200 deaths per 100 000 population in 1880 and probably did not decrease during the next 20 years.

While it was in 1865 that TB was first shown to be a communicable disease, confirmation would have to wait until 1882 when Robert Koch discovered the tubercle bacillus. It was also around this time that the link between poor living conditions and TB came to light. Until this discovery was made, consumption, as TB was then known was considered a consequence of a variety of causes including heredity, evil spirits, the miasma theory and germ infection. Treatment according to Wherrett (1977) and Brackner et al (1992) consisted of a variety of measures, some of which were very desperate indeed. Hypnosis, purging and blood-letting were all tried as part of the treatment. The discovery of the bacillus and the proof that it could be transmitted to others brought a terrible stigma to consumptive patients. They were now regarded as "lepers" with whom no one wanted contact or association. Despite these tendencies, it was also around this time that the first major organised public measures to control TB began.

According to Grygier (1994) public agitation and demand for action of some sort made politicians realise that TB was in fact a major problem and was not going to go away without significant action on government's part. He also stressed that an additional stimulus to tackling the issue was provided by the extent to which TB was devastating particular sub-groups of the Canadian population, most notably aboriginal people. Despite the efforts of the politicians and government in creating awareness and passing public health acts like the Quarantine Act of 1794 (Brink, 1965, p 17) much of the early progress made against TB was mainly due to the efforts of voluntary associations of doctors and

concerned citizens. The enactment of this law was specifically meant to prevent immigrants suffering from infectious diseases from entering Canada.

The attack on TB at the turn of the century was generally focused on removing sources of infection by means of early diagnosis and the isolation and treatment of infected people. Improvements in the social conditions that helped spread the disease were also a matter of great priority. The development of a vaccine to help prevent infections and specific drugs to kill the tubercle bacilli were also considered to be the ultimate goal in the fight against TB.

In 1896 the National Sanatorium Association was formed, and a year later the first sanatorium in Canada was opened. The establishment of the Muskoka Cottage Hospital was rapidly followed by the formation of several other associations for the amelioration of consumption and other forms of TB. The Toronto and Ontario chapters of the association were formed in 1898 and 1900 respectively. The Canadian association was formed in 1901, since it was realised that if a successful campaign against TB was to be mounted it had to be at the national level. After their formation the initial emphasis of these organisations, particularly the Canadian association, was towards educating the public and the politicians on TB, hygiene and living conditions. The officers of these associations therefore embarked on widespread anti-spitting campaigns, and also organised public lectures on the disease. Fund raising activities in aid of sanatoria, and the publishing of pamphlets on TB were also part of their activities.

3.3 The Era of Sanatorium Treatment

The commencement of this era in Canada was marked by the building of the first sanatorium and as described by one of the pioneers in the fight against TB, "they became beacons in the darkness that demonstrated the value of rest, fresh air and good nutrition in arresting TB, in some instances and which stimulated interest in creating similar conditions for thousands who were unable to find such havens" (Wherrett, 1977).

Sanatoria became enormously popular in Canada after their introduction, and it was thought that the country had enough sanatoria beds to treat every case of TB. From 9000 beds in 1938, the bed complement rose to a peak of 19,000 in 1953, and in the same period the number of sanatoria and special TB units in the country rose from 61 to 101 (Brackner et al, 1992, p 109). In such provinces as Saskatchewan, Manitoba and Alberta there were enough beds for all TB patients, but this was only achievable in the rest of Canada when drug therapy began. Although the patient incarceration in sanatoriums was laborious and depressing they were still popular due to the extensive publicity they received and the hope they offered patients. A patient's normal stay - at their own expense - in a sanatorium during the peak of the sanatoria era ranged between 6 and 24 months. In view of this, the building of new sanatoria and the adding of more beds to accommodate everyone needing treatment became the order of the day and it is not really surprising that the numbers of sanatoria continued to rise during that era.

The x-ray technique, which was discovered by Roentgen in 1895, became an invaluable tool in the diagnosis of internal diseases like TB. The new technology was quickly adopted in Canada for screening TB sufferers. This led to the advent of massive

routine chest x-ray surveys and examinations of persons admitted to hospitals, clinics and dispensaries. Mobile fleets of buses equipped with x-ray units were also used to screen people in remote areas of the country. All these efforts helped enormously in the early diagnosis of the disease and therefore significantly increased the number of patients being admitted into sanatoria.

Sanatoria during this era were usually built in the countryside, away from the distractions of city life, visitors and the polluted air of urban centers. Since the main focus of treatment in these institutions was fresh air, bed rest and good nutrition their founders felt that the rural milieu, with its less polluted air and verdant surroundings, was best suited to the achievement of these goals. They greatly believed in the "healing power" of the countryside and therefore established these places of rest far from the urban residences of most of their patients. A lot of skepticism and doubts were raised about this rationale, with opponents of this idea arguing that removing patients from family support and affection did more harm than good. As time wore on, the trend changed and sanatoria began to be located near large medical centers and general hospitals. This new form of locational strategy is still largely in place in Canada and most TB sufferers are now normally treated as out-patients. Despite the predominance of rest therapy in the era of sanatoria, surgical interventions were also carried out. Techniques such as the collapsing of the lungs by injecting air into the pleural space and other methods were widely used but by 1960 they became very unpopular. It was believed that these techniques would allow the tuberculous lesions to heal quickly, since they restricted the movement of the lungs. Brink (1965) and Brackner et al (1992) claim that between the late 1930s and early 1950s,

one in three patients with pulmonary TB had such collapse treatment. As portrayed below in table 3.1, surgical treatment for TB declined quite rapidly from 1950 onwards

Although reservations had been expressed about the efficacy of institutional treatment (rest therapy) including collapse therapy, before the advent of drug treatment, it is nonetheless widely believed that this form of care achieved a lot by isolating sources of infection, thereby greatly reducing the prevalence and incidence of the disease and hence having a positive effect on Canadian society at large.

As time wore on sanatorium treatment later became free for all patients. This was first introduced in Saskatchewan in 1929, with Alberta following suit in 1936

Table 3.1 Types of Surgical TB Treatment in Canada: 1950-60

Surgical Procedure	Year		
	1950	1955	1960
pneumothorax established	518	14	2
pneumoperitoncum established	451	115	24
thoracoplasty performed	411	67	15

Source : Brink , 1965, p 72

Shortly thereafter, programs to allow patients to care for themselves were introduced in Ontario, Manitoba, British Columbia and Quebec (Grygier 1994). Then immediately after World War Two, New Brunswick and Nova Scotia also made treatment free. In 1948 the federal government, clearly swayed by the activities of TB prevention associations, started to transfer payments to the various provinces on condition that free treatment and the latest drugs in treating TB would be made available to all patients. This practice is still the norm today. It has become mandatory since the beginning of transfer payments to provide free and obligatory treatment to every TB patient in the nation.

3.4 The Search for a Vaccine

The battle against TB entered a new phase in the early 1920s when Drs. Albert Calmette and Camille Guérin embarked upon the task of developing an anti-TB vaccine. The aim here was to raise the resistance of humans to TB. An attenuated virulent bovine tubercle bacillus was to be used for that purpose. After a series of experiments the Bacilli Calmette-Guérin (BCG) vaccine was produced amid enormous controversy in 1924. The confusion was centered upon the use of a vaccine based on a live bacillus. The critics doubted the efficacy of using such a method in producing a vaccine. Despite all the initial problems the vaccine was adopted first in France and then in most Scandinavian countries (Mason, 1977 ; Grygier, 1994). Later on other countries joined the trend.

Historically, as happened with the discovery of x-rays, Canada was one of the first countries to try this new method. The vaccine was initially tried on cattle. These experiments were repeated several times to determine if the vaccine was safe and effective in preventing bovine TB. In 1926 after the desired results had been achieved and under the auspices of the National Research Council, the vaccine was tried on the newborn babies of high-risk groups. These groups were mainly made up of Native Indians and Inuit. By 1949 the outstanding success of these trials when compared to unvaccinated babies led to widespread adoption of the vaccine throughout the country. It was extended to school-children, and later on to health-care workers and especially nurses, because of the high rates of infection within the wards where they worked. Despite the profound success of the vaccine it is believed that only two provinces, Quebec and Newfoundland, adopted

BCG vaccinations on a universal scale with the other provinces catching up much later (Wherrett 1977).

3.5 The Breakthrough: Drug Therapy is Introduced

The search for drugs that could cure TB began as far back as the 1880s when Koch's identification of the bacillus had been accepted by the medical and scientific community of that time.

In 1944, Professor Waksman and his colleagues in the United States developed streptomycin from a soil fungus and it became the first drug to kill the tubercle bacilli (Hawkins, 1950; Grygier, 1994). As expected, this discovery had a tremendous effect on the hitherto incurable disease. This drug was made readily available for the treatment of TB in Canada and by 1953, 77% of TB patients were taking streptomycin, up from an initial figure of 7.2% in 1948 (Brackner et al, 1992, p 110). The discovery of streptomycin provided the first of many anti-TB drugs.

In the early phases of the introduction of streptomycin there were dosage problems, as well as toxic side-effects and a tendency for the bacillus to develop resistance to the drug. However, after a series of trials, the beneficial effects of taking the drug in combination with the other TB drugs soon overcame the initial setbacks. This strategy was adopted in Canada and soon TB patients began taking two or three TB drugs at the same time. By the mid-1950s, (and even at present) the standard drug therapy involves taking at least three or four TB drugs simultaneously. Drug therapy in Canada has really proved beneficial. Not only was it possible to be cured of TB, but also the duration of in-patient treatment was shortened considerably. All of this eventually led to a slow and gradual

decline in the incidence of TB, which in turn caused a surplus in the number of beds needed for the disease's treatment. In the 10 years following 1953 (the year when TB drugs came into widespread use in Canada) the number of treatment beds had been halved from 18,977 to 9,722 and amazingly the average length of stay of patients had also fallen from 18 to 24 months to about 7 to 8 months (Brackner et al, 1992, p 110)

Chemotherapy also had a significant effect on TB mortality rates, which started dropping rapidly after streptomycin was introduced. While the rate declined slowly, 3% annually on average between 1926 and 1946, it fell by 12% yearly over the next five years, when TB drugs were first introduced in the country. Rates dropped even more sharply, by an average of 20% each year, between 1951 and 1956 when the use of anti-TB drugs became the norm (Brackner et al, 1992, p 110). Despite the potency of these drugs in curing TB, sanatoria remained in existence until as late as 1970, when the authorities started converting them into institutions for the elderly and mentally challenged. This remarkable story of the rise and dramatic fall in the number of sanatoria after the introduction and adoption of TB drugs in Canada led anti-TB crusader Wherrett to publish the well-known but premature book "The Miracle of the Empty Beds".

3.6 Ontario : A Pioneer in the Fight Against TB

The history of TB in Ontario since the early 1900s has been until very recently nothing but that of progress. This is underscored by the fact that the province consistently had the lowest rate of TB in Canada over this entire time period (Wherrett, 1977, p 15). In addition, compared to the average mortality rates in the rest of Canada, those of Ontario have been consistently lower. For instance, from about 1905 to 1908 the national

mortality rate stood somewhere around 165 per 100,000 while that of Ontario was 120 per 100,000 (Crombie, 1935, p 486 , Wherrett, 1977, p 15). This relatively low rate was achieved through organised efforts to control the disease. According to accounts from anti-TB pioneers like Wherrett and Brink, it was in this province that the organised campaigns to control TB started. Invariably the province has over the years been at the forefront of the fight against TB. Not surprisingly, it is also in this same province that many of the breakthroughs against the disease were first made.

Unlike its present state of advanced technology and numerous industries, Ontario during the early and mid 1900s was basically rural with agriculture as the main activity. Coupled with this was the fact that there was a constant flow of poor, mainly European immigrants. This resulted in Ontario emerging with a growing population concentration which augured well for the spread of TB. This was particularly true since at that time there was no public health infrastructure such as we are accustomed to in present times. With poor sanitary practices, lack of personal hygiene, and a large population density coupled with a relative lack of medical knowledge about TB, the disease was widespread. Indeed it was even thought that the British were removing people from their sanatoria and sending them to Canada due to the extremely large numbers of these immigrants who were suffering from the disease (Wherrett, 1977, p 5). However it was later realised that most of these people had actually contracted TB here in Canada. This was basically due to the appalling living conditions and the lack of proper medical care. There is a clear indication in the literature on this early period that an organised effort to deal with TB in Canada began in 1896. This was when Sir William Gage founded the National Sanatorium

Association for the purpose of building sanatoria for the treatment of TB patients. This was thought of as a step in the right direction, since there were no such facilities in Canada at the time, which forced TB sufferers to seek sanatorium treatment outside of the country. As already stated, these efforts culminated in the building of the first sanatorium in the country in Ontario. The formation of this association served as a springboard for the establishment of several other similar organisations in Ontario. Some of the most vibrant groups apart from those mentioned above were the Heather Club Chapter of the Imperial Order of the Daughters of the Empire (1909) which focused its attention on the care of children, the Samaritan Clubs (1912), the Ontario Laennec Society (1916) which served basically as the medical wing of the voluntary associations and a host of others (Brink, 1965, p 29). The main aim of most of these groups was basically to educate the public about TB and to provide treatment beds through the construction of sanatoria and treatment centers.

As already mentioned compared to the present era, it is quite interesting to note that there was no official government involvement in Ontario's anti-TB campaign right from the late 1890s until the 1930s. Consequently much of the initial work on TB rested on the shoulders of concerned and generally wealthy individuals and, as stated by Wherrett (1977, p 198)

"typical of the early volunteers were wealthy and socially prominent men who had sufficient drive to enlist others to their cause and who used their influence to encourage the press to bring discussion of TB into the open , a necessary step in public education."

Two of the major philanthropists who really contributed both financially and with a lot of effort to the anti-TB movement were Sir William Gage and Sir Adam Beck. These two individuals, apart from providing the much needed funds to run these organisations, also set up incentive schemes in the form of medical training programs that went a long way to securing the personnel and support staff that were needed to run the numerous diagnostic and treatment clinics as well as sanatoria. The period following the opening of the first sanatorium was characterised by a rapid increase in the number of these institutions, as well as the operation of a number of clinics and mass x-ray programs in Ontario. The campaign to control and prevent TB in Ontario was given greater attention and effort, unlike anywhere else in Canada, resulting in relatively lower mortality rates for the province. Compared with the national mortality rate of 80.5 per 100,000 population in 1925, that of Ontario was 59.2 per 100,000 population. Again in 1935, Ontario's mortality rate was much lower than the national rate which was 61.4 per 100,000 compared with 36.4 per 100,000 for the province (Wherrett, 1977, p. 255). This trend was quite consistent until the early 1970s, when the difference between the rates became quite trivial.

The periods after each world war saw considerable increases in the number of deaths caused by TB. This could be attributed to the extent of government involvement in the war in terms of funds and attention, as well as the unsanitary conditions and extremely long hours in which people had to work in factories and the deplorable state of social amenities like health care services. However, the period after the end of World War Two saw TB mortality rates in Ontario begin falling drastically. For instance in 1948 the rate

was 19.3 per 100,000 population compared with a national rate of 38.1 per 100,000 (Wherrett, 1977, p 255)

Although several reasons have been put forward to explain the decline or downward trend of the disease, including the advent of antibiotics, improved standard of living and sanitation, as well as better public health education, it should still be noted that the initial campaign to control TB in Ontario which began in 1896 with the building of the first sanatorium in the country contributed in a very important way towards the achievement. This is both because of the impetus and momentum it created at that early period when there was no help from the official/government agencies and also for the fact that most of the institutions that were formed back then have in many cases continuously served as the main forums for the continued assault against the disease (an example being the Lung Association of Canada).

The 1950s were generally a period of economic prosperity in Ontario as in the whole of Canada. Coupled with this was a considerably higher standard of living with all the benefits that accrue from it. During this period most parts of the country witnessed TB mortality rates that hovered around 26.8 per 100,000 population with Ontario falling as low as 13.1 per 100,000 during the same period and by 1960 falling to 2.6 per 100,000 in contrast to 4.6 per 100,000 in the country as a whole (Wherrett, 1977, p 255). These rates continued to fall, reaching about 2.1 per 100,000 population for Canada as a whole and 1.1 per 100,000 for Ontario. At this point the rates began to level off until the mid 1980s.

Figure 3.1 below compares TB mortality rates between Ontario and Canada.

3.7 Present Trends in the Occurrence of TB Across Canada

The relative importance of TB as a cause of death, as with all other infectious diseases in present day Canada, has become quite negligible. TB has now been replaced by the various cancers and cardiovascular diseases as the major cause of death in the country. According to Statistics Canada, TB rates across the country hover around 7.5 per 100,000 population in 1992 compared with 200 per 100,000 population in 1880 (Statistics Canada, 1993). Obviously things look much better now than before. But if the necessary precautions and control measures are not taken as discussed in chapter two, TB can become a real threat again.

The situation in some American cities like New York and Atlanta is a good example from which some lessons could be learned.

In terms of regional trends, TB mortality rates have essentially leveled off throughout the country since 1926. However, there are two exceptions to this. The first is the initial high level and phenomenally rapid decline in TB mortality rates in the northern regions from the mid-1950s to the mid-1960s. Brackner and her colleagues assert that within this 10 year period, rates in the North fell by 90%, compared with only a 30% decline for all Canada (Brackner et al, 1992). For Canada, excluding the North, steep declines had occurred earlier, from 1947 to 1957, a period for which reliable data for the North were not available. The second exception is the converging of the levels for all regions except for the North in the last decade. Throughout the five decades from 1926 to 1976, TB death rates in Quebec and the Maritimes far exceeded those in Ontario and the Prairie provinces. Also in recent years, rates for all regions except the North have reached a low plateau, with rates in the Northern regions persisting at about six times the average Canadian rate. In terms of incidence or notification rates Brackner and others are of the opinion that the northern regions have in the last two decades witnessed a far steeper decline rate than the rest of the country. Their claim is due to the fact that in the 1960s rates in this part of the country were 13 times higher than the Canadian rate. However this disparity has narrowed over the period in question to a five fold difference.

This discussion has given us an account on the historical course of TB in Canada and Ontario in particular, and provides a historical context for analysing the present pattern of the disease. In the next chapter we shall see how the data for this project were derived and the methods that were used to analyse them.

Chapter Four

DATA SOURCES AND METHODS

This chapter discusses the data sources and methods used in this thesis. The derivation, limitations, and selection of the data are described, as is the period covered, and the analytical methods. The selection of the province of Ontario as the study area for this project is explained.

4.1 Sources of Data

Secondary data in the form of the Ontario Vital Statistics Reports (Registrar General of Ontario, 1949 to 1989) served as the main data source for this thesis. The section of these reports that deals with *causes* of death by *sex* and by *place* of residence for the counties, districts and regional municipalities (including cities, towns and villages) of Ontario was used. This section was either table 21, 22 or 24, varying according to the time period. Most recently (1979-89) data with respect to causes of death by sex and place of residence in Ontario have been table 24.

Mortality data were used to build the dataset as compared to morbidity data. The latter refers to the number of people who have fallen sick from TB. Using mortality data, the emphasis is on the number of people who have actually lost their life to TB. In terms of the epidemiological transition and our theorisation morbidity data would have been better, but they simply are not reliably available for small areas and long periods. Medical

geographers are often compelled to use mortality data because they are comprehensive and relatively reliable, being taken from individual death certificates.

The vital statistics (table 24) data has been categorized into numerous causes of death, ranging from infectious and parasitic diseases, through neoplasms to endocrine, nutritional and metabolic diseases and immunity disorders, mental disorders, and external causes of injury, following the International Classification of Diseases (ICD). For this project the main categories of data that were used were (1) the total of the deaths attributable to TB, (2) deaths due to all infectious and parasitic diseases and (3) deaths arising from all causes. These are nested sub-sets. These were further disaggregated into male, female and total, although as we will see later (chapter 5) disaggregation by sex was eventually dropped. The information on the causes of death due to infectious and parasitic diseases was included in the analysis to help capture the general trend of these types of disease as compared to the other types in the province and also to assess whether these trends conform to the parameters of the ETM. The total number of deaths from all causes was needed as relative context for the proportion of deaths that are due to infectious and parasitic diseases. The data base relating to TB does not need any extensive commentary. It provides information on TB deaths for both sexes in the entire province over a long period, data that cannot be derived from anywhere else. Thus the absolute level, rate and spatial variation of TB mortality is placed within the context of the major cause of death group (infectious and parasitic diseases) to which it belongs, which is in turn put in the context of general patterns of mortality.

The data covered the time period 1949 to 1989, which marked the last year when such data on causes of death was widely published. The reason why 1989 marked the last year for the publication of these reports is unclear. This also coincided with the relocation of the division responsible for these publications from Toronto to Thunder Bay. The reason for the abandoning of these reports is most probably due to financial constraints imposed by the provincial government.

The 1949-1989 time period was chosen because it coincides largely with Ontario's era of great social and economic change. At the beginning of the 1940s Ontario was basically rural, with farming, forestry and resource exploitation as the backbone of the economy. However in the period after World War Two the province was transformed into an urban-industrial society. This period captures a time frame extending from when infectious disease was the major cause of death to when it was relegated to the background. Data from before 1949 conform to earlier and largely incompatible revisions of the ICD. Also the modern welfare state, including universal health insurance, developed in Canada during this period. Given the importance of social change in the prevalence and incidence of infectious diseases, this period is the most relevant for this analysis.

The Ontario Vital Statistics reports were used, because they date from as far back as the 1920s and are easily accessible. The data from these Vital Statistics reports are - until 1989 - public domain, are published annually and are essentially "free". Moreover the reliability of these reports is high. The reports are comprehensive, reliable and continuous ; there are no gaps in the record.

Ontario started collecting vital events information - in agreement with the federal Dominion Bureau of Statistics - in the 1920s and has continued to do so despite the publication of these reports being discontinued. This provides data which is sequential and continuous. Also this helps reveal trends, on a year to year basis, without gaps.

Furthermore the Vital Statistics provide a broad spatial coverage of the whole of the province, at a useful scale. The data is published at county level. Counties in Ontario conform to Census Canada's census divisions, an attribute essential for the calculation of standardised mortality ratios (SMRs). The scale at which the data is published at the county level makes it potentially possible to identify regions with persistently higher than expected rates of TB mortality. Moreover by using SMRs it may eventually be possible to locate more precisely the settlements within those counties where mortality rates are high. The SMR is the index commonly used to standardise the differences that occur between categories (like different age groups) and mortality or other demographic factors (Jones and Moon, 1987 ; Jones, 1990 ; Curtis and Taket, 1996). These ratios are calculated as the ratio of observed deaths to one hundred expected deaths in the population being considered.

$$SMR = \frac{\text{observed deaths}}{\text{expected deaths}} \times 100$$

Observed deaths here refers to the number of deaths actually occurring in the study population over a given time period, while the expected deaths are the hypothetical number which would have occurred if the pattern of death in each age and sex group corresponded to that occurring in a "reference" population. Usually the information for

the reference population corresponds to national or international averages (Curtis and Taket, 1996).

Where the SMR is 100, the mortality observed in the study area corresponds exactly to the expected number. However when the ratio is less than 100, mortality is said to be lower than expected, and higher when the rate is above 100. It is, therefore a relative measure of excess or low mortality.

Finally it should be noted that the data set conforms completely to the criteria laid down by WHO. The Ontario Vital Statistics reports conform to the ICD, the system by which all diseases are supposed to be categorised in the world. The reports used the sixth (1949), seventh (1955), eighth (1965) and ninth (1979) revisions of the ICD. Compared to earlier versions of the ICD, for instance the fifth edition and earlier, later versions have a lot in common and therefore do not pose any compatibility problems.

Despite all the merits of the Ontario Vital Statistics reports there are a few limitations that need to be pointed out. Deaths that are recorded from the various counties do not pinpoint the exact location of the usual residence of the deceased. Thus there is nothing to show if the recorded deaths occurred evenly across a county or were concentrated in a particular part of the county. It is impossible to do any localised research on this data set. Another issue is that the various county boundaries have, over the years, undergone a series of changes which limit the comparison or inferences that could be drawn from the data. County or municipality boundaries have over the past 40 year period undergone changes such that much spatial stability has been long gone. In such a scenario if the period of time for comparison or analysis is stretched too far back the results might

not be very useful. For example the county of York that we know today is completely different from what existed in the 1940s. This problem could however be overcome by deriving a standardised set of areas. Using a standardised set of areas would imply using the size and boundary limits or shape of these counties from an earlier period (1920, 1930 or 1940) as a superior yardstick for analysing the present county boundaries limits. Thus despite the recent obvious changes in size and boundaries those of an earlier period could be superimposed on the contemporary shape and then analysis could be done on the areas that conform to the shape of the earlier period. However, delineating these boundaries is virtually impossible since it involves a lot of tedious, time-consuming work beyond this thesis and therefore it was decided that the analysis would be done without using standardised sets of areas. Table 4.1 below provides a summary of the county changes.

Table 4.1 Summary of County Changes in Ontario (1949-1989)

Year	Changes
1953	Addington became part of Lennox and was renamed Lennox and Addington. Kenora was sub-divided into Kenora (1) and Kenora (Patricia Portion), and due to these changes the District of Patricia ceased to exist.
1969	The county of Carleton ceased to exist with the creation of the region of Ottawa-Carleton.
1970	The counties of Welland and Lincoln become defunct. The county of Niagara is created.
1971	Kenora (1) and Kenora (Patricia Portion) reverts back to its original name Kenora. Toronto Metropolitan Area is created.
1973	Sudbury Regional Municipality appears
1974	The counties of Haldimand and Norfolk are amalgamated to become Haldimand - Norfolk. The county of Hamilton-Wentworth appears. The county of Ontario ceases to exist.

Source: Compiled by author from Ontario Vital Statistics reports 1949-1989.

4.2 Method of Analysis

The data set for this thesis spans 1949 to 1989. Deaths attributable to TB and those due to other parasitic and infectious, and all causes of deaths for male, female and total in all the 53 counties and regional municipalities of Ontario were put into Excel spreadsheets. The basic data set is one spreadsheet for each year. Subsequent analysis involved these individual sheets being aggregated and linked. The final sets are in Appendices A and B. After this initial step the spreadsheets for each of the years in the forty year period were compressed into a single large spreadsheet. It became obvious at this point that the small numbers problem would continue to affect the analysis in the rural and low density areas. In essence, continuing to disaggregate by sex would only further aggravate this problem, so only the total data were used from this point on. This is not a serious loss, as there is little reason to expect a sex-based pattern in TB mortality. Neither sex is biologically or socially more susceptible to TB. The next step was to calculate percentages of TB deaths with regards to the totals from all causes of death and also the proportion of deaths due to other infectious and parasitic diseases relative to all causes of death.

After all the above mentioned steps had been taken SMRs were then calculated, to control for differences in population growth and aging in the population. It also then becomes possible to directly compare the SMRs of the various counties since they all would have been arrayed around the 'reference' value of 100. Although SMRs might not be particularly important when it comes to TB (unlike diseases such as various cancers which clearly affect certain age groups more than others), it was necessary to include them

in the analysis, since without them no comparisons either between province and county or between counties could be done on the data.

Further analysis in terms of allometries were also calculated from the data. Allometry is the study of size and its consequences, specifically the study of relative growth, where changes in size of one part of a system are measured in terms of the size of the whole system (Dutton, 1973 ; Berry et al, 1974 ; Fleagle, 1985). Here the emphasis is on change rather than uni-directional growth. The allometry relationship holds that when the growth of one part of a system (Y) is compared with the growth of another part or with the system itself (X), it can be mathematically expressed as follows

$$Y = bX^{\alpha}$$

α (alpha)

The alpha value, indicates the allometry of the part to the whole, that is, the ratio of their specific growth rates. Where (α) is less than one, the part grows more slowly than the whole and the allometry is said to be negative. The reverse is the case if the alpha value is greater than one. Allometry is said to be positive and this implies that the part grows faster than the whole system. On the other hand if the allometry of all the components is one it means the parts grow at the same rate as the whole.

The technique was used here to ascertain how the various counties in Ontario are faring in eradicating TB compared to the progress of the whole province. The (X) in the formula above could be used to represent the Ontario average while (Y) could be substituted each time to represent any of the counties in Ontario. Using TB mortality rates per 100,000 population allometries were then calculated for all the counties using the

Ontario experience as the yardstick to ascertain the rate at which counties were making progress in eradicating TB. In effect counties that go through similar experiences like that of the province are said to be progressing and therefore might not need a lot of resources as compared to the other counties that lag behind. The purpose of this analysis is basically to determine the relative change. In order to achieve this objective and also maintain conventional practices the 1989 Ontario figures were used as the base year. Changes in county boundaries precluded one simple analysis. Only those counties which existed unchanged throughout the period could be used in the first step.

A series of charts and graphs were then produced using Excel. The first two graphs showed the trend of TB for the 40 year period 1949-1989. As already pointed out, graphs and charts for the years after 1989 were not compiled since data for those years are not available in the statistical reports. Although it would have been preferable to have data for the 1989-1995 period, the trend in the graphs produced shows that TB mortality rates since 1980 have begun to rise, though not significantly. Additional graphs were subsequently produced for the purpose of carrying out allometrical analysis.

4.3 Why Ontario ?

The province of Ontario was chosen as the study area for several reasons. Most important is the fact that Ontario throughout the post-war era has undergone great social change, from a rural, technologically unsophisticated society into a modern highly industrialised society. This change has had far-reaching effects upon the health of Ontario's population, with a particularly interesting case being the effect on TB mortality rates. During the early stages of the history of the province, health care, public hygiene

and sanitation systems were inadequate and even sometimes not present at all in some parts of the province. The lack of proper health care and basic hygiene gave great impetus to the spread of infectious diseases like TB. Considering the level of technology during that time period it is quite understandable that TB devastated the population.

However, with the transformation expected under the terms of the ETM (discussed in Chapter One), infectious and parasitic diseases like TB (generally regarded as diseases of the poor) would have a reduced chance of thriving in an advanced society such as Ontario. However, with the advent of HIV the reverse has been the case, suggesting that international boundaries or differences in wealth among nations do not really matter when it comes to TB. The continuing presence of TB in Ontario despite modernisation is intriguing.

Another factor that led to the choosing of Ontario as the study area is the fact that the province possesses good records, facilitating extensive research. In short the existence of numerous volumes of well documented material, some dating as far back as 1880 meant that problems with respect to information gaps or lapses were minimised. Coupled with this was the issue of free unrestricted access to these data sources. This could be attributed to the immense emphasis that the early pioneers in the anti-TB campaign placed on keeping good records. Presumably these pioneers felt the only way they could really assess and eventually stop the spread of TB was to gather accurate information that could help them take effective measures against the disease.

The next factor was the urge to find out how the present global resurgence of TB was manifesting itself in Ontario, a province that has over the years chalked up enormous

successes against TB. In contrast with some of Canada's other provinces, Ontario has for decades waged a largely successful battle against TB, making it the province with the lowest rate of TB mortality, despite its large population and attractiveness to immigrants. It was therefore felt that it would be interesting to assess the extent to which this situation was remaining stable or changing for the worse.

Historically, Ontario has long been one of the most (if not consistently the most) populated province in Canada. With such a population concentration, conditions are created for infectious diseases to spread quickly, stemming mainly from the problem of overcrowding, combined with inner city neglect and decay. Another issue which makes Ontario quite appropriate for this research is immigration. The province has a large immigrant population, many of whom come from countries where TB is endemic.

Chapter four has dealt with how and where the data for this thesis was derived, why certain decisions were taken with respect to the dataset and it has explained why Ontario was chosen as the study area. The methods that were used to analyse the data set was also discussed. The next chapter describes the results of the analysis outlined above.

Chapter Five

RESULTS OF ANALYSIS

This chapter focuses on the analysis and interpretation of the TB mortality data set. It constructs and describes recent mortality patterns in Ontario and in Canada in general, so as to assess whether they conform to the ETM. The counties where mortality trends - as expressed in SMRs - depart markedly from the province as a whole are identified. Allometric analysis is also used to investigate regional patterns of relative change.

5.1 Overview

The most fundamental premise of the ETM - the conceptual framework on which this thesis is based - states that with modernisation, morbidity and mortality trends change. The changes that occur with increased modernisation are shifts in the main causes of illness and death from a situation where infectious and parasitic diseases predominate as the major causes of morbidity and death, to one where human-made and degenerative chronic conditions become the norm. Studies show that the processes responsible for this transition are to some extent demographic, among which fertility decline is of major importance (Omran, 1971, 1977 ; Trovato, 1994). With modernisation, societies tend to develop a small family ideal that ultimately results in prolonged large-scale fertility reductions (Trovato, 1994). Eventually this process culminates in significant changes in

the age structure of societies, from a young age composition to one in which first adults and then senior citizens represent a growing segment of the population

Another reason underlying the transition is the change in risk factors that predispose people to injury, diseases and death (Frenk et al, 1991). Frenk and his colleagues have argued that as the process of modernisation intensifies, a gradual shift emerges in the modes of production from an agrarian system to an urban industrial economic system. Accompanying this trend are significant improvements in the standards of living (improved hygiene and better living conditions) which in turn result in a lowering of the risk of infectious and parasitic diseases in the population (McKeown, 1976, Trovato, 1994). Although a reduction in infectious and parasitic diseases may occur it should be noted that modernisation and an urban lifestyle also come at a price, since this process has its characteristic related health problems and fatalities.

In addition to these factors, improvements in health care and medical technology in treating and managing diseases have enabled people with even serious chronic ailments to live longer in contemporary times than they used to. Thus, partly due to better health care systems and advances in treatment and medical technology, many people - especially in the developed countries - are able to prolong their lives. This phenomenon has led researchers like Olshansky and Ault (1986) to argue that the industrialised nations have entered a new phase of the epidemiological transition. They have proposed a fourth stage to the ETM, "the era of delayed degenerative diseases". Using the experience of the United States - although countries like Sweden and Japan seem to be in far more advanced stages of the transition than the United States - these researchers have come to the conclusion that

through: " *the development of new drugs and antibiotics and improved methods of diagnosing and treating degenerative diseases and their complications, the health care community has increasingly been successful in postponing deaths from degenerative diseases by slowing the rate of chronic disease progression and by reducing case-fatality rates* " (Olshansky and Ault, 1986, p 359).

Indeed, in the industrialised nations the era of delayed degenerative diseases has begun manifesting itself with the large number of senior citizens who live well beyond their eightieth birthdays. Despite these developments others - such as Manton (1982, 1989) - are skeptical about the gains. They argue that longer life for the elderly is almost always accompanied by worsening health. In essence the " quality " of life in these extended years is often poor.

5.2 The ETM and Mortality Patterns in Canada

Consistent with the postulates of the ETM, Canada has witnessed a shift in its cause of death structure, from one characterised by the predominance of infectious and parasitic diseases, to one characterised by a predominance of human-made causes and degenerative diseases (Trovato, 1994, p 57). Mortality patterns between the 1920s and 1990 show that Canada has experienced a dramatic change in causes of death and illness. According to Brackner (1992, p 113), by 1990 infectious and parasitic diseases accounted for only 1% of all deaths in Canada. This is definitely a different picture from the early 1920s when TB and other infectious diseases accounted for about 12% of all deaths. Figures 5.1 and 5.2 (below) depict major causes of death in Canada for 1926 and 1990 respectively, showing quite vividly the features of the ETM. This can be seen in Fig. 5.2

which shows that cardiovascular diseases and cancer are the major causes of death in Canada. Furthermore, as depicted in Fig. 5.1 in 1926, TB and cancer were each responsible for 7% of all deaths. However by 1990 cancer had risen to 27% while TB and other infectious and parasitic diseases combined accounted for only 1% of all deaths in Canada. This trend has been repeated in all the provinces, Ontario being no exception. Since (1949 the time when this study begins) until 1989, Ontario has witnessed a consistent downward trend in the percentage of deaths due to infectious and parasitic diseases. As will be seen later in the discussion of the SMRs for the various counties in the province, almost every one of them follows the general downward trend. The main difference is the relative rates at which they fall. A downward trend is, of course, a good thing. Less is better.

Figure 5.1 Major causes of death, in Canada (1926)

Note: Excludes Newfoundland, the Yukon and the Northwest Territories in 1926.

Figure 5.2 Major causes of death, in Canada (1990)

Source: Figures 5.1 and 5.2 were derived from Brackner et al (1992) p 113.

In light of the data limitations - already discussed in the fourth chapter - the prediction of where in Ontario we should expect TB to resurface must be tentative. Obviously, the whole of the province is now experiencing an improved health status over that found in the 1920s, but it is to be expected that there will still be differences between counties. These differences might be due to lifestyle, living environment, income levels and most of other socio-economic factors which it is beyond the scope of this thesis to document. Efforts were directed more towards identifying and measuring the relative changes in the prevalence of TB in the various counties. This was done initially by analysing the trends of the SMRs of TB in the counties from 1949-1989. Counties that showed evidence of a relatively slower downward trend in SMR figures during the 1949-

1989 period were considered as the most likely places where TB could once again start to increase.

5.3 Trends of Infectious and Parasitic Disease Mortality in Ontario (1949-1989)

The relative importance of infectious and parasitic diseases as a major cause of death in Ontario has declined considerably since 1949.

Source: compiled by author from data derived from Vital Statistics Reports.

As shown in fig. 5.3, this downward trend had begun at least as far back as 1950. In 1949 infectious and parasitic diseases accounted for about 32% of all deaths in Ontario. However by 1950 this category had dropped to approximately 22% and by 1958 parasitic and infectious diseases accounted for only 10% of all deaths in Ontario. By 1960 the figure had fallen to about 7% of all deaths. This trend stabilised and hovered between 5-7% for most of the 1960s through the 1970s to the mid-1980s. A different picture

emerged after 1985. The era between 1986 and 1989 witnessed an increase in the percentage of deaths caused by parasitic and infectious diseases. The figure rose from 7% to about 12% in 1989. The last three years which the data cover point to the start of an upward trend in infectious and parasitic disease mortality.

With regards to TB deaths as a proportion of all infectious and parasitic diseases, the data revealed a pattern similar to that of infectious and parasitic diseases as a proportion of all mortality. Mortality from TB over the time period (1949-1989) has generally been declining in Ontario although as shown in fig. 5.4 in certain years there were upward "blips". In 1949, TB accounted for about half of all deaths ascribed to infectious and parasitic causes (fig. 5.4). The situation changed quite dramatically the following year. In 1950 mortality from TB as a proportion of infectious and parasitic diseases had risen to 60%. After this initial increase the picture changed again. The proportion of infectious disease mortality attributed to TB started declining steadily from 1951 onwards until it reached 45% of all infectious and parasitic disease mortality in 1953. From 45% in 1953 the figure rose to approximately 53% by 1954. Between 1954 and 1959 the percentage of TB deaths from all infectious and parasitic diseases began to decline. The decline between 1954 and 1956 was quite gradual, followed by a slight increase in 1957 after which the figure fell to 41% in 1959. The three year period between 1959 and 1961 saw the proportion of TB mortality stabilise at the 1959 figure. However, from 1961 to 1965 there was a gradual increase in percentage of TB mortality of about 6%. During this period the percentage of TB deaths compared to other infectious diseases

Fig 5.4 Total Tuberculosis Deaths as a % of Infections and Parasitic Disease Mortality
Ontario, 1949-89

Source: compiled by author from data derived from Vital Statistics Reports.

rose to about 48%. It then went down by 1% the following year, and then continued to rise again between 1966 and 1968. This rise brought the figure back to the 1949, 50% mark. The situation as can be seen in fig. 5.4 changed quite dramatically between 1968 and 1969. This era witnessed an almost 20% drop in the share of TB mortality from other infectious and parasitic diseases. By 1969, it had fallen to 30% of all deaths by infectious and parasitic diseases. Why this sharp fall occurred within such a short period is uncertain although it might be possible that other infectious diseases became more plentiful. Later in this chapter reasons for the general downward trend will be discussed. This downward trend continued from this period onwards with the only exception being that things were quite gradual this time unlike the example of 1969. The ten year period between 1969 and 1979 saw the proportion of TB deaths rise slightly but eventually fall until it reached 12%

in 1979. The drop within this ten year period compared to the drop from 1968 to 1969 was minimal. Thus after reaching the tenth percentile range there was essentially no more room for improvement. This can be thought of as analogous to the law of diminishing returns. The percentage reached its lowest level ever in 1981. It now accounted for only 9% of deaths ascribed to infectious and parasitic causes and this category had, itself declined. The next four years after 1981 experienced a slight increase in the proportion. The figure by 1985 had risen to 12%. This trend was however short-lived since the subsequent three year period saw the share of TB mortality from other infectious and parasitic diseases fall again to its 1981 level. Nineteen eighty eight saw TB deaths compared to other deaths from infectious and parasitic causes fall back to 9%.

During the years 1988 and 1989 - which marks the last year in the data set - the trend of TB deaths seems to be heading upwards. The mid-1980s increase in infectious and parasitic diseases including TB, according to Brackner et al, (1992, p 112) stems from the emergence of HIV and AIDS infections. HIV and AIDS disables the immune system and therefore makes the body more susceptible to diseases.

During the course of analysing the data it was realised that comparing TB deaths to all causes of death - as was originally intended - would raise serious statistical problems and for that reason this comparison was left out of the analysis. This stems from the fact that the number of TB deaths compared to all causes of death after the late 1950s was so small that just a single death from TB in a year dramatically changed the rate and the trend. For instance a single death in counties with generally low TB mortality led to an

almost 100% rise in the time series graphs for such counties, an over reaction to the leverage of a few cases. This is the small - numbers problem with a vengeance

It is difficult if not impossible to account for the details of the year to year changes in the proportion of infectious and parasitic diseases discussed above. To some extent they are random fluctuations around a general trend. However, with regards to the overall downward trends in the course of these diseases a few possible reasons can be advanced

Although TB mortality rates started dropping with improvements in living standards the most profound influence on these rates in Ontario was probably due to the introduction of antibiotics. TB mortality rates started dropping when the use of antibiotics such as streptomycin and pyrazinamide became the norm in treating TB. As discussed in previous chapters these rates dropped even more rapidly when isoniazid was added in 1952 to the arsenal. Furthermore advances in medical science and technology associated with improvements in treatment and diagnosis procedures as well as screening programs played a significant role by controlling TB mortality rates. Coupled with this was the introduction of universal health care coverage in Canada (in the late 1960s and early 1970s) which made health care more easily accessible to the general population

Moreover the economic prosperity and improved standards of living that were experienced in Ontario in the 1960s and 1970s meant that more people were living in healthier conditions. Improved sanitary and housing conditions inhibited the continued existence and spread of TB in the province.

All the above factors played major roles in reducing the rate of new cases of TB. Simultaneously these factors combined to cut the supply of active TB carriers which in the long run results in reduced infection rates and ultimately lower mortality rates from TB.

5.4 The County Scale : A Summary of SMR Results (1949 -1989)

As explained in chapter four SMRs adjust for the effects of population age structure. They also permit direct comparisons of the rates since they have all been adjusted to a common reference value. The results of these calculations are shown in table 5.1 below. The difference between the results shown here and the conventional way of calculating SMRs is that these rates have been averaged through time for four periods (1949-1956, 1957-1966, 1967-1976, 1977-1989) and they are referenced to the beginning of the data set (1949) instead of the last year (1989). That is, the age specific TB mortality rates for Ontario in 1949 were applied to the county age structures derived from the census central to each period, giving the expected TB mortality for one year. This figure was multiplied by the number of years in the period to yield an estimate of expected TB mortality. The actual TB mortality for each county in each period was calculated from the annual data shown in appendix (A). The reason for doing this was the relatively low TB mortality rates that have persisted in Ontario in the 1980s as compared to the 1940s. It should be pointed out that this procedure requires that we assume the age structure is constant over many years, whereas this is unlikely to be the case very often. But due to the fact that age structure data cannot be derived annually there was no choice but to make this assumption. Because the SMR's were calculated using the first - and usually the highest - TB rates as the basis, in all but the first period they cannot be compared to 100

Table 5.1 SMR Results Ontario (1949-1989)

County	SMR 1949-56	SMR 1957-66	SMR 1967-76	SMR 1977-89
ADDINGTON				
ALGOMA	82.26	24.48	5.53	2.90
BRANT	47.97	20.93	5.63	2.00
BRUCE	59.03	11.42	3.84	1.37
CARLETON	68.85	20.27		
COCHRANE	190.46	49.46	15.09	3.94
DUFFERIN	26.92	13.76	2.29	1.45
DUNDAS	45.93	23.24	5.36	2.09
DURHAM	13.76	2.98	1.76	1.35
ELGIN	39.25	8.24	4.24	1.16
ESSEX	49.03	16.45	7.23	1.34
FRONTENAC	54.70	19.34	7.18	2.74
GLENGARRY	134.29	36.18	10.35	5.84
GRENVILLE	61.19	17.79	3.97	0.00
GREY	33.36	9.53	2.07	4.11
HALDIMAND	38.01	10.28	5.67	
HALDIMAND-NORFOLK			20.45	2.29
HALIBURTON	20.55	6.77	0.00	3.03
HALTON	25.70	8.11	2.40	0.56
HAMILTON-WENTWORTH			4.64	3.21
HASTINGS	42.69	15.91	3.10	2.12
HURON	30.18	6.32	4.41	2.79
KENORA	159.32	16.73	10.27	9.24
KENORA (PATRICIA)	1059.63	196.14		
KENT	36.18	10.93	11.00	2.34
LAMBTON	32.22	17.80	5.92	2.14
LANARK	57.16	12.51	4.48	1.69
LEEDS	55.01	10.72	3.84	1.45
LENNON				
LENNON-ADDINGTON	13.92	14.90	7.01	1.29
LINCOLN	33.03	17.98		
MANITOULIN	127.09	27.20	4.38	10.62
MIDDLESEX	56.88	25.20	8.74	1.35
MUSKOKA	32.45	18.52	11.65	1.94
NAGARA			6.94	2.01
NIPISSING	73.48	19.39	10.56	1.67
NORFOLK	26.62	9.70	3.62	
NORTHUMBERLAND	27.98	5.38	3.00	1.20
ONTARIO	45.40	10.55	4.35	
OTTAWA-CARLETON			6.13	2.11
OXFORD	21.53	12.45	4.25	0.00
PARRY SOUND	59.72	19.99	4.67	6.70

Note : The blank spaces correspond to changes in county formation between 1949-1989.

Source: compiled by author from data derived from Vital Statistics Reports

Table 5.1 continued

PEEL	24.38	10.11	2.72	1.75
PERTH	23.00	6.78	1.52	0.61
PETERBOROUGH	28.71	10.44	5.11	0.78
PRINCE EDWARD	51.68	5.60	11.38	0.00
RAINY RIVER	83.99	25.47	9.94	3.70
RENFREW	35.12	18.34	6.92	2.38
RUSSELL	89.84	16.26	3.21	2.09
SIMCOE	43.90	10.03	3.53	0.75
STORMONT	77.01	31.20	10.19	1.33
SUDBURY DISTRICT	98.91	23.88	8.39	3.58
SUDBURY RM				2.13
THUNDER BAY	104.85	27.31	10.74	3.17
TIMISKAMING	107.22	39.50	14.43	7.98
TORONTO			5.59	3.40
VICTORIA	26.10	3.49	1.31	0.78
WATERLOO	28.18	8.27	3.53	0.74
WELLAND	42.15	16.00		
WELLINGTON	41.69	12.54	2.17	0.66
WENTWORTH	44.69	13.52	17.63	
YORK	47.92	14.40	42.04	0.75
Average SMR	55.71	19.81	7.14	2.47

Note: The blank spaces correspond to changes in county formation between 1949-1989.

Source: compiled by author from data derived from Vital Statistics Reports.

as the "expected" level, so in each period the county rates are compared to the average SMR of *that period*, and not to the fixed value of 100 based on 1949. Using the averages for the various periods the counties were sorted according to whether they were performing below average or were above average. This is shown in table 5.2, below. Counties shown in this table have, throughout the entire period of the study, had above average SMRs, with the most extreme case being Kenora (Patricia Portion) which since 1971 has been incorporated into Kenora. Almost all the counties have SMRs that exceed the average SMR for the four different time periods. The most extreme case is Kenora (Patricia Portion), which during the 1949-1956 period had an SMR which was more than 20 times higher than the average for that period. This is not a data error - it is real. This

alarming occurrence changed quite significantly in the 1957-1966 time period. Although it was a great improvement from the first 7 year period it is still high compared to the average SMR.

Table 5.2 Counties with above average SMRs Ontario (1949-89)

County	SMR 1949-56	SMR 1957-66	SMR 1967-76	SMR 1977-89
ALGOMA	82.26	24.48	5.53	2.90
COCHRANE	190.46	49.46	15.09	1.94
GLENGARRY	134.29	36.18	10.35	5.84
KENORA	159.32	16.73	10.27	9.24
KENORA (PATRICIA)	1059.63	196.14		
MANTOULIN	127.09	27.20	4.38	10.62
PRESCOTT	87.06	28.86	11.24	4.23
RAINY RIVER	83.99	25.47	9.94	1.70
SUDBURY DISTRICT	98.91	23.88	8.19	1.58
THUNDER BAY	104.85	27.31	10.74	1.17
TIMISKAMING	107.22	39.50	14.43	7.98
Average SMR	55.71	19.81	7.14	2.47

Source: compiled by author from data derived from Vital Statistics Reports

Although the conditions are not as alarming as in the counties shown in table 5.2 the counties of Metropolitan Toronto, Grey, Haliburton, Hamilton-Wentworth and Parry Sound have, over the 1977-1989 time period, experienced above average SMRs. It is perhaps significant that three of these counties are heavily urbanised.

Furthermore table 5.2 revealed a regional pattern. Apart from the counties of Glengarry and Prescott which are in the Eastern part of Ontario all the other counties with high TB mortality rates are located in Northern Ontario. These northern parts of Ontario are disproportionately populated by aboriginal peoples; high proportions of their total populations are residents of Indian reserves. Consequently, the high TB mortality rates in this part of the province are regrettably not surprising in the sense that studies have consistently shown the correlation between poor social and living conditions on Indian reserves and other health and pathology indicators. For instance, Trovato (1994, p. 53) is

of the opinion that while the whole of Canadian society is experiencing the "era of delayed degenerative diseases" the aboriginal groups in Canada and in other parts of the world have yet to reach that stage. Thus although infectious and parasitic disease deaths are in general receding, in Canada they still account for a large proportion of deaths in the aboriginal communities. It is therefore likely that if TB is to once again become common in Ontario and Canada in general then we should expect it to happen in these places in particular.

With regards to the counties in the eastern part of Ontario, the explanation for the high TB SMRs is elusive. The obvious explanation may be due to relapses of inactive cases. This is quite possible because most parts of eastern Ontario are rural and economically depressed, with a significant over-proportion of senior citizens. Moreover most of these seniors lived through a time when TB was a major killer and may have been carrying the tubercle bacillus until aging compromised their immune system so much that they could no longer fight the infection. However, since SMRs are supposed to even out the differences in mortality rates among age groups the high TB SMR rates may be due to other factors which could not be identified in this thesis.

The situation in the large urban areas like Metropolitan Toronto which have within the 1977-1989 period witnessed above average SMRs may be due to HIV infection and AIDS, homelessness, unhealthy living conditions and international migration where people from countries where TB is endemic contract the disease at their origin but develop the active phase of TB in their new places of residence. Non-compliance to medical

treatment regimes which in many cases leads to MDRTB may also partly account for this pattern

The geography of TB shows the same persistently "worse-off" trend characteristic of infant mortality rates (IMR) in the province Bennett (1985, p 87 , 1990, p 434) concluded that the experiences and pathways typical of counties like Kenora, Prescott (and to a lesser extent York, after the creation of Metropolitan Toronto) have over the years been markedly and consistently different from the other counties According to Bennett, environmental rather than strictly biomedical factors seem to be the main cause of these differences It is likely that these same factors - largely social in origin - are responsible for the (above average) SMRs TB in table 5 2 This suggests that social deprivation and poor living conditions especially among Canada's native peoples might be the most plausible explanation, which is in turn exacerbated by poor access to the health care system (Bennett, 1990, p 435)

5.5 SMR z-scores

To determine the pace of change in the province over the study period histograms were constructed using z-scores calculated from the SMRs The z-scores were derived by expressing each county in terms of its distance from the average in units of standardised variation Figures 5 5 to 5 8 below show the results Figure 5 5 shows that over the 7 year period 1949 -1956, 14 counties out of 56 counties at that time had SMR z-scores over the average Fig 5 6 even showed a much more improved situation During that 9 year period

Fig 5.5 Frequency distribution of SMR z-scores, 1949-56

Fig 5.6 Frequency distribution of SMR z-scores, 1957-66

Fig 5.7 Frequency distribution of SMR z-scores, 1967-76

Fig 5.8 Frequency distribution of SMR z-scores, 1977-89

the number of counties with above average SMR z-scores had fallen to 8 out of 56 counties. However the situation was a little different during the 1967-1976 period when the number of counties with SMR z-scores over the average rose to 16 out of 56 counties. Although this might be considered bad it must be noted that at this time TB mortality rates had fallen so much that a slight increase in mortality absolute numbers was magnified when expressed as a rate. The 12 year period 1977-1989 portrayed almost the same picture as in the previous time period. Although this period in comparison to the other three periods was much longer the number of counties with above average SMR z-scores did not increase. The histograms show the range of conditions and how often they occur. The general trend is for a smaller variation when TB mortality was declining fastest, with a greater range of values in the most recent period when the average was at its lowest.

5.6 Allometric Analysis

As explained in chapter four a major objective of this analysis was to determine relative change in the performance of the counties when compared to Ontario as a whole. The analysis revealed that those counties previously classified as having above average SMRs in table 5.2 were the same counties that had allometry values greater than one, showing a positive allometry between the two entities. The greater the alpha value the faster conditions get better in the counties, relative to the entire province and vice versa where the alpha value is less than one. When the allometry value equals one conditions in both county and province are getting better at the same rate. Tables 5.3, 5.4 (highlighted counties) and figures 5.9 - 5.19, show allometry values that are greater than one. Conditions are relatively worse (at the beginning of the study period) in these counties but

Table 5.3 Allometries of Territorially - Stable Counties Ontario (1949-89)

COUNTY	ALLOMETRY 1949-1989
ALGOMA	1.0856
BRANT	0.7657
BRUCE	1.2268
COCHRANE	2.6796
DEATH RIVER	0.4133
DUNDAS	1.1164
DRUMHURST	0.2484
ELGIN	0.7166
ESSEX	0.7877
FRONTENAC	0.8656
GLENGARRY	2.7785
GRANVILLE	1.2613
GRIFFIN	0.6771
HAMILTON	0.2556
HATTON	0.1911
HASTINGS	0.7751
HURON	0.5415
KENORA	2.7464
KJIKI	0.614
LAMBTON	0.5085
LANARK	1.2223
LEEDS	1.2278
MANITOULIN	2.0504
MIDDLESEX	1.028
MISSISSAUGA	0.4551
NIPISSING	1.264
NORTHUMBERLAND	0.5269
OXFORD	0.4099
PARRY SOUND	1.0189
PEEL	0.3885
PERTH	0.4055
PETERBOROUGH	0.4556
PRESCOTT	1.2209
PRINCE EDWARD	1.2677
RAINY RIVER	1.1222
REDFRUIT	0.6367
RUSSELL	1.3961
SIMCOE	0.8605
STORMONT	1.253
SUDBURY	1.3376
THUNDER BAY	1.8433
TIMISKAMING	1.6637
VICTORIA	0.5824
WATERLOO	0.4825
WELLINGTON	0.8623
YORK	0.7399

Note: these are counties that have remained unchanged throughout the whole period

then tend to get better at a faster rate than the province towards the end of the period. With the exception of the highlighted counties and those having allometry values of one, all the remaining counties shown in table 5.9 have allometry values that are below one. This means that these counties have negative allometry relationships with the province and therefore experience relatively slower improvement rates than the province. The reverse is the case when it comes to counties with allometry that equals one. A classic example is portrayed in fig 5.9 which depicts the county of Middlesex. In such counties conditions improve at the same rate as in the province. Using the rationale of relative change, trends are expected to react in the same manner should conditions begin to deteriorate. In such instances it is expected that conditions will worsen at a much faster rate in counties with allometries greater than one. On the other hand where allometry equals one, the rate of change will be the same in the province and counties. The results of the allometric analysis have revealed that the counties shown in fig 5.9 - 5.19 have high allometry rates. Although these rates are considered high they are falling at a fast rate which implies that conditions are getting better relatively faster than the provincial rate.

Table 5.4 Allometries of non - Territorially - Stable Counties Ontario (1949-89)

COUNTY	ALLOMETRY 1949-1989
HALDIMAND-NORFOLK	0.5466
HAMILTON-WENTWORTH	0.7661
KENORA (including PATRICIA)	6.9609
LENNON AND ADDINGTON	0.6782
NIAGARA	0.7254
OTTAWA-CARLETON	1.2147
METROPOLITAN TORONTO	0.7426

Note : these counties did not exist unchanged throughout the entire period.
The first four counties resulted from amalgamations while the others started from different time periods.

The discussion in this chapter has centered on reporting and explaining the results derived from the data analysis. In the next and final chapter the findings and conclusions of this piece of research as well as its shortcomings and recommendations will be discussed.

Fig 5.9 Allometry, TB rates, Middlesex and Ontario, 1949-1989

Fig 5.10 Allometry, TB rates, Algoma and Ontario,
1949-1989

Fig 5.11 Allometry, TB rates, Cochrane and Ontario,
1949-1989

Fig 5.12 Allometry, TB rates, Glengarry and Ontario,
1949-1989

Fig 5.13 Allometry, TB rates, Kenora and Ontario,
1949-1989

Fig 5.14 Allometry, TB rates, Manitoulin and Ontario, 1949-1989

Fig 5.15 Allometry, TB rates, Prescott and Ontario, 1949-1989

Fig 5.16 Allometry, TB rates, Rainy River and Ontario, 1949-1989

Fig 5.17 Allometry, TB rates, Sudbury District and Ontario, 1949-1989

Fig 5.18 Allometry, TB rates, Thunder Bay and Ontario, 1949-1989

Fig 5.19 Allometry, TB rates, Timiskaming and Ontario, 1949-1989

Chapter Six

SUMMARY AND CONCLUSIONS

This chapter summarises the research, presents the findings and conclusions, and discusses its weaknesses and strengths. The chapter also recommends issues and themes which require further investigation.

6.1 Summary

Chapter one spelled out the research problem, described its context, developed the conceptual framework and outlined briefly the data that were used. It hypothesised a possible return of TB, reviewed the scanty literature on TB in Canada, and specifically on Ontario, and introduced the structure of the thesis. Chapter two described the nature of TB, its possible origins, sites of infection, modes of transmission and treatment procedures. Chapter two also discussed some of the reasons put forward by experts and WHO as to why TB is resurging and assessed the contemporary global trend of the disease. In chapter three the emphasis was on the historical course of the disease in Canada in general and Ontario in particular. The discussion here centered on the trend of the disease throughout the forty year time period of this study, from when there was no known cure upon the arrival of antibiotics in 1952 to 1989. The present trend of the disease across Canada was also described here. The fourth chapter discussed in some detail the data sources, and the analytical methods. The limitations of the data sources were explained. These limitations steered the possible analysis away from the ideal.

Chapter four also outlined the reasons for choosing Ontario as the study area and the fifth chapter presented the results of the data analysis.

6.2 Findings and Conclusions

This thesis has documented that, on a global scale, TB is resurging at alarming rates especially in the developing countries of South-East Asia and Africa. Although this phenomenon is occurring worldwide the literature on TB seems to suggest that it is not yet as much of a problem in the developed as in the developing nations. In the developed nations this problem has surfaced mainly in deprived inner city districts, although occasionally in certain unexpected places. The resurgence seems to be more widespread in the third world. The seriousness and magnitude of the TB problem led the WHO to declare its first ever "global emergency" on any disease in 1993.

Some of the reasons responsible for the resurfacing of TB range from complacency on the part of governments in providing enough funds for TB eradication programs, to the present scourge of HIV and AIDS, poor social and living conditions, through to patients not following to their treatment programs. Finally, there is the declining efficacy of the drugs (antibiotics) used to "cure" TB sufferers.

Due to the limitations of the time span for which the data were available, it was not possible to show if TB is reappearing strongly in Ontario. Evidence since 1986-1989, though scanty, seems to suggest that it is. Since resurgent TB surfaced only quite recently, it will take a while for the broad morbidity picture to emerge in patterns of mortality. Present morbidity trends in TB in Ontario will need more time to be translated into clear mortality patterns.

In Canada and Ontario in general, the most recent specialised literature on TB (medical journals and reports) seems to suggest that the problem of resurgent TB is minor, as yet. Moreover, reported TB outbreaks in Canada have been sporadic. Recent outbreaks in places like Pukatawagan, Manitoba (Paul, 1995), although not yet reaching the alarming situations found in American urban centers show that there is the possibility of conditions deteriorating if we become complacent. An attitude of "it cannot happen in Canada" is unjustified.

This study has not clearly shown that the hypothesised era of resurgent infectious and parasitic diseases like TB is upon us. Although some evidence seems to point towards this, it is not convincing enough to affirm that TB is resurfacing in Ontario as a significant cause of death.

Furthermore the analysis has revealed that out of the present fifty-seven counties in Ontario, ten have over the past forty year period always had high TB mortality rates relative to the provincial average. These counties are Algoma, Cochrane, Glengarry, Kenora (including the District of Patricia), Manitoulin, Prescott, Rainy River, Sudbury District, Thunder Bay and Timiskaming. Although the rates might not be alarming when compared with TB mortality rates from other parts of the world, they are still considered beyond the norm relative to the provincial rates.

Moreover this study revealed - via allometric analysis - that although conditions in the counties with relatively high TB mortality are bad these conditions have been improving at much faster rates than in the entire province. If conditions happen start to deteriorate it is likely that they will worsen in these places at rates significantly faster than

those in the rest of the province. In other words if TB was to re-emerge in Ontario, among the most likely places for this to take place would be in these counties. This prediction is based heavily on the past forty year performance of these counties.

A regional dichotomy was also demonstrated, at least at the scale of the county. Apart from Prescott and Glengarry in eastern Ontario all the counties are situated in the northern parts of the province where there is a high proportion of aboriginal peoples and where average levels of income are low. This trend is in line with the historical fact that social conditions and other environmental factors play a major role in perpetuating TB. Also, between the 1977 and 1989 time period, urban centers like Metropolitan Toronto have been experiencing rising numbers of TB mortality. It is likely that these rates have an intra-urban geography, but given the coarseness of the scale of analysis here this must remain conjectural.

With regards to the ETM it was apparent that parts of the province were experiencing entirely different phases of the model. This tendency again could be explained by environmental factors. It was clear that groups of people who do not fall into the mainstream of economic activities in the province were passing through an earlier phase of the ETM. In short although the discussion revealed that Ontario and Canada were on the whole experiencing the latter phases of the ETM the (" age of delayed degenerative diseases ") parts of the province were still passing through earlier stages of the ETM.

6.3 Recommendations

Although this study did not come out with any dramatic revelations a few lessons can be drawn from its findings. As stated earlier, resurgent TB at present is not a major or widespread problem in Ontario. However it is important for us to take the necessary measures to prevent it from emerging before it does escalate into a health issue in Ontario. Here are some suggestions about those measures.

Public awareness and education on the dynamics of TB, defusing some of the misconceptions about the disease will help in preventing conditions from getting worse. This is because if people become well acquainted with the facts of the disease they will most likely seek medical help immediately they suspect the symptoms. According to Dr Kain of Toronto General Hospital, the majority of recent TB cases were mis-diagnosed in their early stages. It is however not surprising that even some medical doctors are failing to recognise the symptoms of TB. Over the past decades the disease has become so rare that it is possible that its symptoms are confused with other ailments because many Canadian-trained physicians have no direct experience with TB. Moreover there is a general perception that TB affects only the poor. Although this may be largely true, the disease could strike anywhere due to its mode of transmission. A persistent cough may be considered normal in society with no folk-memory of TB. Something like the attention and resources currently focused on AIDS may be necessary.

Constant monitoring of TB morbidity could also prevent the disease from becoming a health problem in Ontario. Research in the form of developing more effective and less expensive treatments and drugs would enhance the fight against TB. Although

treatment regimes have been considerably shortened from 24 months at the turn of this century to 6 months in contemporary times there is still the need to further shorten the treatment period. If this could be done a lot of MDRTB cases could be averted since patients will find it easier to cope with relatively short treatment programs

New drugs and treatment procedures should be less expensive and should be made available worldwide, especially in developing nations. This stems from the fact that with international travel and migration TB could be transferred to any part of the world in a matter of hours. This is particularly true when it comes to the evacuation of refugees and famine victims. In such emergencies screening is quite minimal since the immediate goal is to save life now, and to worry about the consequences later, if at all.

Constant and random screening of the general populace in Ontario would help in monitoring the disease so as to prevent outbreaks. If programs like these are maintained and properly and continually funded we may be a step ahead when TB strikes.

Adequate and continued funding of TB eradication screening and monitoring programs is another pertinent issue that should be seriously considered. In the era of provincial and federal government reductions, in spending, more thought should be exercised in deciding where to cut. Prevention programs find few advocates and lose out against the lobbying of hospitals and health consumers. As already stated the current resurgence of TB in some parts of the United States could be partly blamed on cuts in funding TB programs over the 1970s and 1980s. This was because US politicians turned down a request for a \$35 million surveillance program in the 1970s. Partly as a result of this, in 1994 TB cases soared to 39,000 with a tab of \$550 million to the health-care

system (Picard, 1995, p 1 & 5) In short, if we do not want to repeat such grave mistakes here in Ontario, then we should be careful and extremely selective in trimming costs. In addition provincial and federal spending cuts should be carefully planned so that their effects would not increase social deprivation especially in already depressed areas. This is because there is a clear and strong correlation between poverty and TB. All things being equal, deprived areas are likely to have more cases of TB than economically vibrant areas.

Improvement in the social and economic conditions of relatively disadvantaged groups such as aboriginals could also help control the spread of TB in Ontario. Better living conditions and the provision of adequate social amenities on - especially better housing - native reserves would probably considerably reduce the spread and incidence of present and future TB.

On a broader scale, there should be more international cooperation among nations in an effort to control and eventually eradicate TB. Modern modes of transportation have reduced the world to a "global village". Diseases can easily be transferred from endemic areas to others parts of the world. The ease with which a passenger arrived at Toronto's Pearson airport from ebola stricken Zaire is a clear example of how easily diseases could be transferred world wide (Bryden, 1995, p 2). International efforts could be in the form of rich nations providing funds for research, sharing research findings and making new treatment drugs readily available at affordable prices to poor nations or by making TB eradication programs part of the process.

Lastly more emphasis should be placed on WHO TB programs like Directly Observed Treatment, Short-Course (DOTS) (WHO, 1996, p 12). The focus of this

program is to monitor TB patients so that they would complete their treatment regimes. A health worker or a trusted family member is put in charge of making sure that TB sufferers take their medication until treatment is complete. By doing this the burden of making sure patients are following their treatment procedures is equally shared by the patient and the health care system. This initiative is a step in the right direction in the sense that most TB patients, especially the destitute, neglect taking their medications which in most cases results in relapses of TB and eventually MDRTB. The DOTS program in effect is able to monitor and ensure that patients comply to their treatment programs. According to the WHO 1996 Report on TB the DOTS program has produced an almost 95% cure rate in places such as New York City, London, Tanzania and Pakistan - where it is being used (WHO, 1996, p 12).

This study, although it has limitations, has merit in that it could serve as an educational and informational source to the general public about a problem which most people have forgotten exists. In addition, since the data for the project was based on a reliable source, the results are a clear indication of what is happening in the province. On the other hand one of the major weaknesses of this study lies in the fact that it does not include data for the 1990s, although this was due to inaccessibility problems. Also the data covers a wide areal extent and therefore makes it difficult to pinpoint exactly where TB deaths took place. Finally since the data set does not include morbidity data it is impossible to determine or comment on the present morbidity pattern of TB.

With regards to future research projects it is suggested that micro level analyses should be done in remote communities and big cities, focusing on morbidity. Investigation

should include the lifestyle, behavioural and environmental conditions in the counties shown here to have persistently high levels of TB mortality. This piece of extensive and quantitative research could direct our attention to places where intensive qualitative work could illuminate the causes, experiences, and consequences of TB suffering.

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Appendix A: TB Mortality (Absolute Numbers and Rates/100,000 Population) and Total Populations, (Four Censuses), For Counties Which Had Stable Boundaries Throughout The Period 1949-89

[illegible]

[illegible]

Appendix A. TB mortality (Absolute Numbers and Rates/100,000 Population) and Total Populations, (Four Censuses), For Counties Which Had Stable Boundaries Throughout The Period 1949-89

[illegible]

[illegible]

Appendix B : TB Mortality (Absolute Numbers and Rates/100,000) and Total Populations, (Four Censuses), For Counties Which Had Unstable Boundaries Throughout The Period 1949-89

	Population 1951	Population 1961	Population 1971	Population 1981	1949	1950	1951	1952	1953	1954	1955	1956
HALDIMAND-NORFOLK	66946	78670	86750	99475	Number	3	9	6	21	3	1	2
					Rate	4.49	13.46	6.89	2.99	4.49	1.50	2.99
HAMILTON-WENTWORTH	269083	368837	401875	411435	Number	34	20	25	28	15	21	4
					Rate	12.78	7.52	9.40	10.52	5.64	7.89	1.50
KENORA	39212	51474	53225	59430	Number	43	42	32	24	13	5	7
					Rate	109.68	107.11	61.61	61.21	33.15	12.75	17.05
LENNOX AND ADDINGTON	16544	23717	28370	30045	Number	2	1	3	1	0	0	2
					Rate	10.23	5.12	15.35	5.12	0.00	0.00	10.23
Niagara	212989	281415	347325	366280	Number	27	22	12	11	10	10	6
					Rate	12.70	10.35	5.64	5.17	4.70	4.70	4.23
OTTAWA-CARLETON	242247	363902	471925	546945	Number	40	45	39	24	26	17	11
					Rate	16.51	18.58	16.10	9.91	10.73	7.02	6.19
METROPOLITAN TORONTO			208810	2137365	Number							464
					Rate							

Appendix B : TB Mortality (Absolute Numbers and Rates/100,000) and Total Populations, (Four Censuses), For Counties Which Had Unstable Boundaries Throughout The Period 1949-89

	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
HALDAMAND-NORFOLK	1	1	3	0	2	1	4	0	1	0	1	0	1	0	0	2	3	0	2	2	1
HALMILTON-WENTWORTH	127	127	381	000	254	127	508	000	127	000	115	000	115	000	000	231	348	000	231	231	115
	6	9	13	10	6	1	7	10	9	5	10	6	7	3	2	4	4	7	2	2	1
KENORA	223	251	362	279	167	028	196	279	251	139	249	199	174	075	050	100	174	050	050	024	
	4	6	4	6	3	5	6	5	1	1	2	0	1	3	2	3	1	1	1	0	1
LENNOX AND ADDINGTON	777	1186	777	1186	583	971	1186	971	194	194	376	000	188	584	376	584	188	188	000	188	
	0	1	1	0	1	0	2	1	0	0	0	0	0	1	1	0	1	0	1	0	0
NIAGARA	000	422	422	000	422	000	843	422	000	000	000	000	000	352	352	000	352	000	352	000	000
	16	9	7	2	8	6	9	11	6	3	4	1	5	0	0	0	0	0	0	0	0
OTTAWA-CARLETON	549	309	240	069	275	206	309	377	206	103	115	029	144	000	000	000	000	000	000	000	000
	19	16	8	9	13	15	6	4	6	9	13	11	6	6	7	4	6	1	5	3	3
METROPOLITAN TORONTO	538	538	227	255	388	425	170	113	227	255	275	233	127	170	127	148	085	127	021	108	055
															31	21	23	23	26	10	13
															149	101	110	110	134	048	061

Appendix B : TB Mortality (Absolute Numbers and Rates/100,000 and Total Populations, (Four Censuses), For Counties Which Had Unstable Boundaries Throughout The Period 1949-89

	1976	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
HALDIMAND-NORFOLK	1	0	0	0	1	0	0	0	1	0	0	1
	1.15	0.00	0.00	0.00	1.15	0.00	0.00	0.00	1.15	0.00	0.00	1.15
HAMILTON-WENTWORTH	4	2	4	3	2	2	1	6	1	1	3	2
	0.97	0.49	0.97	0.73	0.49	0.49	0.24	1.46	0.24	0.24	0.73	0.49
KENORA	2	1	1	0	0	2	0	1	0	3	0	0
	3.37	1.68	1.68	0.00	0.00	3.37	0.00	1.68	0.00	5.05	0.00	0.00
LENNOX AND ADDINGTON	0	0	0	0	1	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NIAGARA	0	0	0	0	0	0	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
OTTAWA-CARLETON	3	0	2	1	1	1	1	5	2	3	2	2
	0.56	0.00	0.37	0.18	0.18	0.18	0.18	0.91	0.37	0.56	0.37	0.37
METROPOLITAN TORONTO	16	11	13	6	12	9	16	11	14	14	19	20
	0.75	0.51	0.61	0.37	0.59	0.42	0.75	0.51	0.66	0.66	0.89	0.94