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The Strangling Angel

Diphtheria in Hamilton

D. Ann Herring, editor

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1

The Strangling Angel in Hamilton

D. Ann Herring

She took refuge in the throats and hearts of the unprepared. The Strangling Angel—diphtheria—found comfort on the boots of German soldiers as they marched across Europe in the 1940s. Even though she visited over one million people in Europe at the time, she was forgotten and her lessons were lost (Meadows 2013:1).

Diphtheria is known as the Strangling Angel because of the way in which it kills by asphyxiation, and kills mostly children. It is an ancient disease, feared for centuries. Although it is still very much present in the world today, diphtheria has essentially faded from memory in Canada. *The Strangling Angel* tells the story of how the disease flourished and then was eliminated in the small city of Hamilton, Ontario. Set in the late nineteenth and early twentieth centuries, this book encompasses a period of dramatic social and medical change within which diphtheria was transformed from a deadly disease for which there was no effective treatment to one that was preventable and curable. The people of Hamilton played an important role in this transformation.

Written by fourth-year Honours Anthropology students studying the anthropology of infectious disease at McMaster University, *The Strangling Angel*

draws on a rich body of cultural artifacts that bring the struggles with diphtheria back into view. Our book sets Hamilton's experience against the ancient history of diphtheria, explores changes in how the disease was identified and understood, and examines medical efforts designed to treat and prevent it. Diphtheria became a major threat to public health in the 1920s; this is the story of how cooperation between the people of Hamilton, medical professionals, and brilliant researchers studying bacteria, led to the elimination of the Strangling Angel from Hamilton, and later, all of Canada.

We hope this book will remind the people of Hamilton of the significant contribution the city made to medical history, a contribution no less vital because knowledge of it has faded with time and memory.

History and Conceptualization of Diphtheria

Our book begins with Emma Mitchell's reflection on the spiritual roots of the idea of the Strangling Angel and how this dreadful image came to represent the disease of diphtheria (Chapter 2). The earliest beginnings of the human experience with diphtheria are still beyond our grasp because only fragmentary evidence exists for its presence in the past. Katherine O'Donnell (Chapter 3) makes the case, however, that bioarchaeological evidence suggests the Strangling Angel has affected human societies for thousands of years. Tracing its history is also impeded by the various names given to diphtheria at different times and in different cultures, and by changing conceptions of the disease itself. Kelly Day takes up this problem in Chapter 4 by exploring debates among nineteenth-century physicians about the cause, symptoms, and treatments of diphtheria during a time in which the dominant medical paradigm was shifting toward germ theory.

The fundamental philosophy underlying the understanding disease affected the remedies physicians used to treat diphtheria. Emily Liu (Chapter 5) discusses the most common methods used by nineteenth-century physicians, before the germ theory of disease became the dominant medical paradigm. She notes that many patients suffering with the disease experienced worse effects, even death, at the hands of their physicians during this time. Rachit Srivastava (Chapter 6) explains the new treatments for diphtheria developed by researchers after *Corneybacterium diphtheriae* was identified (in 1883) as the cause of

diphtheria; the brilliant discoveries of antitoxin, toxin-antitoxin, the (Ramon) toxoid, and antibiotic treatments made it possible, at last, to eliminate the Strangling Angel.

The Strangling Angel in Hamilton

Despite the apparent antiquity of diphtheria, it is difficult to find much information on its presence in Hamilton until the late nineteenth century. How serious was the disease and how did the toll it took compare with that taken by other diseases? Samantha Atkins (Chapter 7) studies the statistical record for diphtheria cases and deaths in Hamilton from 1905 to 1935, viewing them against important events for this period, such as World War I, the 1918 influenza pandemic, and the massive influx of immigrants through which the city grew. Diphtheria was only one of many dangerous infectious diseases that affected children in Hamilton. Isabel Krysa (Chapter 8) asks how diphtheria ranked in terms of severity, relative to other diseases such as influenza, typhoid fever and smallpox.

Public Health Initiators and Initiatives

The observations that diphtheria often occurred in cycling epidemics, that its spread was tightly connected to unsanitary living conditions and poverty, and that it was caused by *Corneybacterium diphtheriae* spurred medical and social reformers alike to try to curb its fatal effects. The early twentieth century was a particularly important period in which major discoveries led to effective methods to detect, treat, and prevent the Strangling Angel. The Schick Test (named after its inventor, Béla Schick), developed in 1913, remains a key diagnostic tool for identifying people who are susceptible to diphtheria today. Saima Tufail (Chapter 9) tells the story of how the Schick Test was developed and underscores its lasting significance to the study of immunology.

The Schick Test was but one of a battery of medical initiatives put into practice by public health officials in Hamilton in their campaign to eradicate diphtheria. One figure looms large during the diphtheria epidemics of the 1920s: Dr. James Roberts, the Medical Health Officer for Hamilton. Antonija Vistica (Chapter 10) explains how Dr. Roberts, a larger-than-life, energetic leader, made

Hamilton the first city to immunize its children against diphtheria. Although Dr. Roberts is accorded most of the credit for the stunning achievement of eliminating diphtheria from the city, he did not work alone. Spencer Bernacci (Chapter 11) reminds us that other physicians and nurses, most of whom have been forgotten, helped eradicate the Strangling Angel. Examining the life and contributions to these efforts of Dr. J. Edgar Davey, School Medical Officer for Hamilton, Bernacci asks why some figures are remembered while others fade from memory.

Unhealthy environments were understood to produce unhealthy citizens, and Hamilton's public health officials had worked for decades to improve a host of deleterious sanitary conditions in the city, such as water quality, milk purity, and nutritional hygiene. Sarah Thompson (Chapter 12) contends that Hamilton's clean milk and pasteurization initiative was a key element in the eradication of diphtheria and had a lasting impact on child health in the city. Vigorous educational campaigns exhorting parents to vaccinate their children were conducted through pamphlets, newspaper articles, and schools. As Elizabeth Carmichael shows in Chapter 13, many pamphlets contained shaming statements that blamed parents, especially mothers, for their children's illness, revealing a moral agenda cloaked in medical information. Ultimately, Jeffrey Coffin argues (Chapter 14), diphtheria was eradicated through a multi-pronged process that required close collaboration between medical professionals, various levels of government, public health organizations, private laboratories, school officials, and researchers studying bacteria.

Diphtheria Today

If diphtheria was eliminated from Hamilton in the 1920s, where does it occur today and why does it persist? Priyanka Gogna (Chapter 15) contends that a comprehensive answer to this question can only be found if both its biology and cultural context are fully investigated. Even with this knowledge, diphtheria cases can emerge unexpectedly, even when the sufferer has not been in contact with an infected person. Jacqueline Meijer (Chapter 16) explains how asymptomatic carriers can spread the disease, despite being healthy. Carriers also can be blamed for the eruption of epidemics (as in the case of Typhoid Mary), a symptom of the deep-seated fears that surround diseases of unknown origin. David MacDonald (Chapter 17) takes up the issue of health literacy, noting that medical jargon is

often more confusing than helpful for patients struggling with a diagnosis, however well-educated they may be. Chloe Rondeau (Chapter 18) suggests that if we are to understand why diphtheria persists today, it is necessary to examine the role played by social inequalities in creating barriers to effective treatment and health care in general. Finally, Taylor Noble (Chapter 19) considers the threats posed to the health of Canadians by international and local health practices surrounding diphtheria.

Acknowledgements

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2

The Strangling Angel Personified

Emma Labrosse Mitchell

It suffices to say that at some point in time, I will be standing over you, as genially as possible. Your souls will be in my arms. A colour will be perched on my shoulder. I will carry you gently away (Markus Zusak 2005:4).

Angels. They are everywhere: from religion, to art, to pop culture. The world is surrounded by these mythical creatures. These figures are so deeply woven into everyday life that it is hard to avoid them. The idea of angels has even crept its way into everyday vocabulary. Every time a mother calls her child "my sweet angel" or when a friend is expressing gratitude for a favour, these creatures are being invoked. Angel imagery is also found in discussions of disease: diphtheria was dubbed the Strangling Angel. Before exploring the role played by angels in this child killing disease, it is important to discuss the roles angels play more broadly in society. This chapter explores how angels and diphtheria came to be connected.

Angels are present in many different religions, including Judaism, Islam, and Christianity. Though there are many religions that incorporate angels, the focus in this chapter is on Christianity because among Christians, angels are not

seen as glorified humans or representing a job after death; angels are distinct entities. Angels are important to the Christian faith because they are God's messengers, and do His bidding. They deliver his messages and enact his will

There are two schools of thought about angels. The first holds that they are kind, benevolent creatures that bring good tidings. The other view sees angels as uncaring creatures, void of emotions. According to Edwards (2014:40), "Throughout the world, beliefs about angels cover a wide spectrum, from one extreme (regarding them as nice but purely figurative ideas) to another extreme (regarding them as major preoccupations and objects of quasi-worship)". Angels simply follow the will of God: "On Judgement Day, it is said, Uriel will unfurl his prodigious wings and escort the dead before the throne of God" (Fioravanti 1991:75). This passage demonstrates the indifferent nature of angels: they simply do what they are told. Angels deliver news, whether it is good or bad. One of the best known examples of an angel delivering the word of God to a mortal is found in the story of the Virgin Mary, how she was impregnated and the angel Gabriel brought the news. In discussing the Book of Twelve, Conrad (1997:74) explains how the angel Zechariah brings God's answers to humans who pray for guidance. In this role, the angel is merely the agent through which God delivers guidance.

Angels inspire awe and wonder in humans. They are most commonly depicted with beautiful wings. This is a very interesting phenomenon as in much of scripture, angels do not have wings (Edwards 2014:40). The incorporation of wings into the depiction of angels was a visual expression of their mobility, their power to move great distances in short amounts of time (Edwards 2014:40). As "administrative assistants of God" (Fass 2008:1), angels are beings of immense power. They represent the second coming of God. Angels play a great role in the celestial heavens. They are the connection between God and mortals on earth; they are the communication link to God. As the mediators between prayers and answers, angels are vital to communication between the heavens and earth. Angels are able to travel between the planes of existence.

Benevolence versus Indifference

As mentioned above, angels are seen in two different lights within Christianity. The first is a benevolent light. When angels are seen as kind and merciful, the most common example that comes to mind is Gabriel delivering the happy news

of a baby to Mary. This same image can be twisted into a much more sinister encounter. When painted in a dark light, this iconic scene is depicted as the celestial rape of Mary. It was God's will for the Virgin Mary to be impregnated with Jesus and so it came to pass. Depending on the situation, therefore, angels can be depicted as beings of hope or figures of terror.

Figure 2.1: Angel of Death (Oldag 2010).
Image used by permission 2015, courtesy of Eric Oldag.

The character of Castiel on the television show *Supernatural* is a lovely example in popular culture of angels depicted as indifferent associates of God. The angel Castiel is neither good nor bad. He simply acts in the interest of God. The character is gradually transformed into a 'caring' angel and attempts to save the Winchester brothers on several occasions. This illustrates the fluidity of the way in which angels are depicted: they can change from indifferent to helpful. When angels bring good news, people rejoice and angels are the heroes. When a child is saved, the angels have brought a miracle. But when things go wrong, angels are villains. Angels are evil. This explains the idea of fallen angels and angels of death. When things go wrong, people believe they are being punished and the angels appear to deliver their sentence.

Angels and Diphtheria

Now that the stage has been set, the concept of angels can be applied to the infectious disease, diphtheria. Diphtheria got its nickname, The Strangling Angel, because of the way the infection forms white puss around the throat and resembles angel wings. The infection cuts off air from the lungs and strangles the sufferer to death. The disease is imbued with angel imagery. The white pus, which resembles angel wings and cuts off the airways, is a very literal explanation for the name Strangling Angel. Though physiologically the patient dies of strangulation caused by a membrane of wing-shaped pus, on a metaphorical level, the Strangling Angel is a way of giving a face to the evil. By calling the disease the Strangling Angel, the crisis is depicted as an enemy against which people can unite. By using the familiar religious figure of an angel, it is possible to rationalize the pain of death and, at the same time, see diphtheria as punishment.

It is especially interesting that public health agencies in the early twentieth century used strangling angel art in posters created to alert the public to the dangers of the disease. Many of the posters and illustrations used in diphtheria prevention campaigns involved imagery of children. Although the disease primarily affected children, another more fundamental reason for depicting them in public health posters is that children are considered to be the vulnerable members of society. Children depend on their parents for survival and so when a disease as deadly as diphtheria attacks children, panic sets in.

When an adult becomes ill with diphtheria, it is easy to take personal responsibility for the situation. When a child falls ill, adults are blamed because they are considered to be responsible for the wellbeing of their child. This is the cruelest form of punishment any parent could endure. Public health pamphlets made use of this emotional response to persuade parents to vaccinate their children. They used blaming words and language that direct the fault on to the parents (Chapter 13). They paired such language with images of children, often infants, to evoke an emotional reaction from parents. Both the beholder and the artist bring their own set of experiences and biases to viewing representations (Nodelman 1966:92), such as the Strangling Angel imagery attached to diphtheria. A very dark picture is evoked by this evil designation. Here we see the vision of angels as dark, emotionless characters. These angels acted without feeling, taking lives according to God's will. This depiction gave the disease a clear, identifiable face and a way to rally people against a common enemy.

In the End

The Strangling Angel is a tragically beautiful image of a deadly infection. In giving the infection a character, by personifying the evil disease, people were able to find a way to cope and fight against it. Angels closely resemble the human form. It only makes sense that people would find a way to link diphtheria to a tangible image. Many significant events have been documented through visual art, just as many every day activities were depicted through cave drawings. Art offers a medium through which to make social commentary, a way to demonstrate the effects of a certain event, and to make sense of tragedy (Plattner 2003:17). In the case of diphtheria, labeling it the Strangling Angel served to personify a deadly disease and create the sense that it could be defeated.

3

Global Distribution of Historical Diphtheria Epidemics

Katherine O'Donnell

The first distinct description of a form of malignant sore throat is found in the writings of Aretseus, who lived about the time of Galen, under the name of Egyptian or Syrian ulcer (R.T. Trall 1862:76).

There is some evidence for the origins and spread of diphtheria. The distinctive membrane that forms in the throat helps trace it through ancient and historical records (Hammonds 1999:20). However, evidence for this bacteria does not preserve well in the human remains that make up the archaeological record; it is rarely possible to extract preserved bacterial DNA. However, whenever evidence is found in ancient writings, as well as in more recent historical medical texts, this information helps us understand how the disease spread across the world and, at the same time, provides insight into historical epidemics. This chapter provides an overview of that evidence and presents a chronology of known or presumed outbreaks of diphtheria.

Ancient Diphtheria

When studying the history of diphtheria, the first questions often asked are: how old is the disease, and where did it come from? Archaeological records are the most useful sources for answering these questions as this evidence dates back much further than written records. The earliest evidence for diphtheria seems to be as old as the Ancient Egyptians. Researchers identified biological evidence for the disease in an ancient Egyptian mummy, dated to 1550-1080 BC. Abscesses in the mummy's teeth yielded the DNA of *Corynebacterium diphtheriae* (Zink et al 2001:267). This pushes the historical context of diphtheria far back in human history and represents our starting point for tracing the movements and frequency of the disease through time.

Diphtheria itself has probably existed far longer than we can see through the archeological record, but we can be certain of its existence in Egypt at least 3000 years ago. The biological evidence for diphtheria is further supported by written records by peoples who interacted with the Egyptians around this time. R. T. Trall discusses writings by Aretseus who around the second century AD described a sore throat which he labelled Egyptian or Syrian ulcer (Trall 1862:76). This is among the oldest evidence for diphtheria (The Editors of Encyclopaedia Britannica 2015). This observation suggests that this disease attracted sufficient attention to be described in ancient historical documents. Although we cannot be certain, these writings also imply that the disease was unique to places such as Egypt and Syria at the time, and places the context of the disease outside the Greek/Roman homeland of the early chroniclers (The Editors of Encyclopaedia Britannica 2015). This raises the possibility that the disease was not present in Europe in the ancient era but rather was found in south Eastern Europe and Egypt. The disease may have spread via Greek and Roman contact with these early disease centers.

Historical Timeline of Diphtheria Epidemics

Turkey 400 BC: Little is known about an outbreak in Turkey in 400 BC, but scholars postulate that it may have been caused by diphtheria, influenza, or whooping cough (Kohn 2001:407). If the disease was in fact diphtheria, this helps fill in the gap between its presence in ancient Egypt and the historical record.

Epidemic: a large spike in the number of cases of a disease.

Endemic: a disease constantly present in an area.

Box 3.1: Epidemic versus endemic (dictionary.com 2015).

Paris France 1576: This is the earliest definite epidemic of diphtheria, identified and accurately diagnosed by Guillaume De Baillou. De Baillou was able to observe the membrane that grows across the throat from the autopsy of a 7-year old boy who had unfortunately died of the disease (Kohn 1995:234-235). His research also led him to conclude that the disease may have been endemic in France since the middle ages (Kohn 2001:252-253). Although he accurately diagnosed the disease, De Baillou's research was not widely circulated and much confusion surrounded the diagnosis of this disease for hundreds of years.

Spain 1583-1618: Known as 'angina maligna', this epidemic began in Seville and spread across Spain in the late sixteenth and early seventeenth centuries. As the disease moved, it gained yet another name, 'garrotillo', which makes tracking the disease more difficult. This epidemic was devastating and emerged in waves, some more deadly than others, over a period of 35 years (Kohn 2001:318). It may be more correct to say that the disease was problematic and cycled through epidemic and endemic phases across the country. Because this endemic/epidemic cycle received much attention it is possible that this marks the first introduction of diphtheria to Spain.

Italy 1618: This epidemic was identified as diphtheria. It erupted in the city of Chiana and traveled to Naples, killing some 8,000. There is a local word for diphtheria as well, which is 'male in cana' (Kohn 2001:170-171).

Europe 1770s: Possible descriptions of outbreaks of sore throats with rashes, different from scarlet fever (which was also problematic), were described in England and Scotland in 1739. Physicians writing a decade or so later (1748-1752) describe the membrane, typical of diphtheria, in patients' throats. The disease was called throat distemper and was epidemic in England in the 1700s (Andrews et al 1923:22). There was also a dangerous outbreak of the disease in Sweden from 1760 to 1770, but may have been 'croup' which has the same dangerous throat membrane (Andrews et al 1923:27). Diphtheria may have been endemic in these areas, but these small scale accounts were not necessarily epidemics but show up in the historical records as instances of the disease.

New England 1735-40: This eighteenth-century epidemic was identified at the time as throat distemper, and may have been diphtheria or scarlet fever. It began in New Hampshire and moved to Massachusetts and Connecticut. The disease may have persisted for so long because physicians did not realize that it was passed from person to person and therefore no quarantine measures were put in place to prevent disease spread (Kohn 2001:234-235). People had little contact with each other and yet the disease continued to spread in small towns (Caulfield 1939:221). As it turns out, the disease was spread through contaminated milk, and many families got their milk from the same supplier (Caulfield 1939:261). This epidemic lasted five years and killed around 5,000 people, mostly children, and threatened the success of small colonial towns (Caulfield 1939:219-221). It is one of the earliest accounts of the disease in the Americas, where it did not seem to be endemic beforehand (Andrews et al 1923:21). However, there seems to be a research bias toward studying the spread of disease in the British colonies rather than in native populations.

Cremona, Italy 1747-48: This outbreak proved very deadly, resulting in the deaths of over 1,000 people, again mostly children. There had been similar outbreaks in 1616 under the name 'angina maligna' and the disease was known to be contagious. However, no quarantines were put in place so most children in an infected family contracted the disease (Kohn 2001:69). This is another instance in which diphtheria was most likely endemic to the area for a long time but due to a lack of consistency in naming it, the knowledge of earlier epidemics was lost.

Tours, France 1818-1820: This outbreak, mainly among soldiers, was heavily studied by a French physician, Pierre-Fidele Brettonneau. Yet another name was attached to this disease, 'scorbutic gangrene'. The differences between croup and diphtheria were still poorly understood, so some of Brettonneau's cases may not have been diphtheria (Kohn 2001:347).

Europe and the World in the late 1850s: A large scale epidemic of diphtheria started in Britain in the mid-nineteenth century and spread across the world to Australia, North America, and Asia. Even though this disease was recognized as diphtheria, there was still confusion with 'scarlatina', another name for it (Kohn 2001:97). Many of the places affected by it were new colonies and remote regions, thus there was some confusion in determining whether the disease travelled with the British to the colonies or if diphtheria was already there. For example, the disease could have been endemic to China before the British arrived or before it was documented. A local word for the disease, 'quinsy', was identified by the British as possibly diphtheria (Davidson 1892:510). The disease was more deadly in places such as Australia and it was not present there before European colonization (Davidson 1892:556-557, 565). Although diphtheria was present in many parts of the world, the British colonial project appears to have introduced it to many places.

Alexandria/Cairo, Egypt 1882-86: This epidemic, called 'cynache' in Cairo and Alexandria, resulted in a death toll of about 3,500 people and was most devastating in Cairo. The disease may have had a longer history of endemics under this name rather than diphtheria. We do know it was present in this area in ancient times from the evidence found in the aforementioned Egyptian mummy. The disease recurred years later in 1932 and had a high patient mortality rate of 48% (Kohn 1995:45).

South Africa 1938-43: This long lasting epidemic ravaged South African communities. Many children caught diphtheria at school or through the consumption of infected milk. The Schick test (Chapter 9) confirmed the presence of diphtheria, but epidemics continued because it was impossible to contain or treat large masses of people at this time in this area (Kohn 2001:308).

Israel 1950-51: This epidemic seems to have been brought on by mass immigration to the area after political changes in the area. The epidemic received little attention and predated implementation of mandatory diphtheria vaccinations. After this epidemic, however, there was a huge push for people to get vaccinated to prevent another devastating epidemic (Kohn 2001:167).

Russia 1992-93: This epidemic resulted from social transformation. "Prior to the arrival of vaccines, diphtheria was an endemic childhood disease associated with poor living standards [in Russia]" (Kohn 2001:285). Russia enforced vaccinations programs, although they were relaxed after initial success. Propaganda in the late 1980s claimed that the vaccines were compromised and people were encouraged not to vaccinate their children. These factors allowed the disease to reach epidemic levels, leading to many deaths, mainly among children. During the epidemic, the UN was able to help by supplementing more vaccines, and the disease was brought under control (Kohn 2001:285). The Russian epidemics show how social and political factors can contribute to an outbreak.

Other ways to Track the Spread of Diphtheria

The spread of diphtheria can also be traced through its modes of transmission. Diphtheria can spread through the consumption of contaminated cow's milk, thus the archaeological record is a source of information on the origins of dairy production in areas known to have a long history of endemic diphtheria (Kohn 2002:308). If we establish contaminated milk as the primary way in which people became infected, then we can look at the archaeological record for the so-called 'secondary products revolution' (Fall 2002:446).

People started to use cattle for milk production around 6000-7000 BC (Evershed et al 2008). As noted above, the earliest evidence for diphtheria is found in an ancient Egyptian mummy, dated to 1550-1080 BC (Zink et al 2001: 267). It is certainly feasible that this mummified Egyptian person could have caught diphtheria from milk contamination. Cattle were domesticated in 8000 BC in the near east, in modern day Turkey and Syria. It is found in 6000 BC in Eastern Europe, and perhaps as early as 7000 BC in the near east, in the Fertile Crescent north east of Africa. This innovation moved to Britain where the first use for milk is found in 4000 BC (Evershed et al 2008). Perhaps coincidentally,

these areas are places where diphtheria has no clear origin and appears to have been endemic for a long time (Figure 3.1). The gray areas in Figure 3.1 are placed where I have proposed endemic diphtheria in early historic and ancient times. The ovals indicate general areas of agricultural innovation leading to milk consumption. The second earliest case seems to be from Turkey itself. More research could be conducted on this phenomenon and a clear correlation could be teased out through archeological evidence.

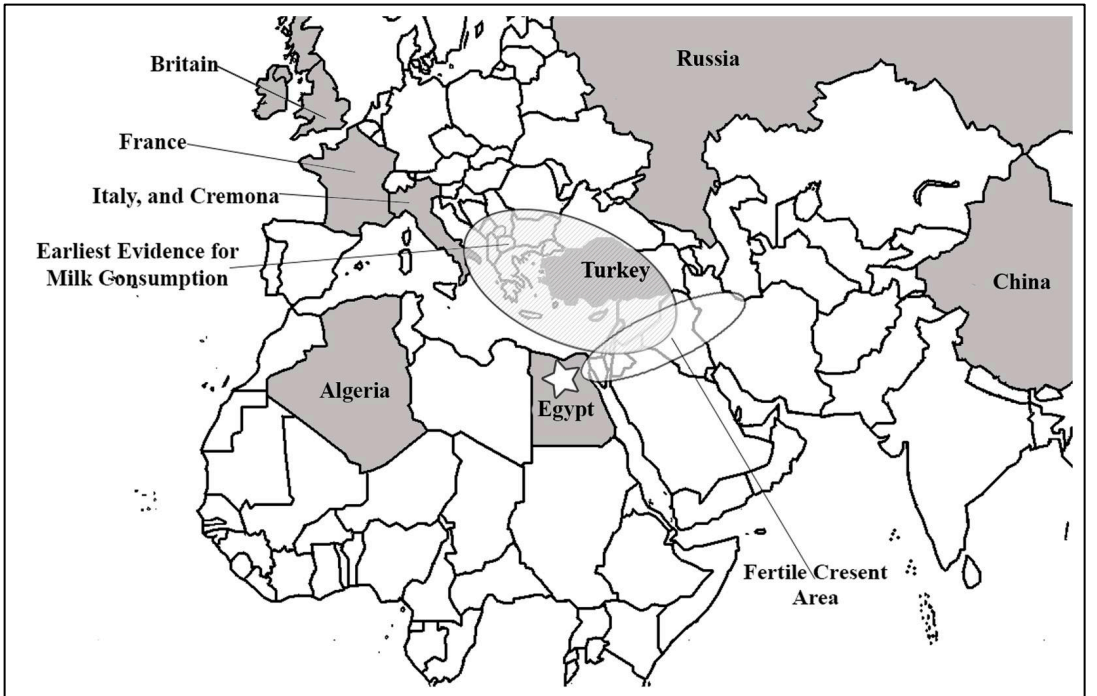


Figure 3.1: Areas with proposed endemic diphtheria and the location of early milk consumption (Evershed et al 2008).

Distinguishing Diphtheria from Croup

The study of diphtheria is complicated by the multiple terms used for the same disease, over time and cultural space. Diphtheria is categorized by a set of throat symptoms which are none too specific. The diagnostic membrane associated with diphtheria is hard to differentiate from other throat. In 1855 the term 'Diphtherie' was coined by Bretonneau to denote diphtheria as a disease identifiable by the membrane which forms in the throat. However, diphtheria was often confused with croup before it was distinguished by its causative agent, *C. diphtheriae*, through germ theory. Before this, "Practitioners… apply the term diphtheritic for all inflammations which occur as local manifestation of the specific disease known as diphtheria and to such inflammation only, whatever may be their form" (Hammonds 1999:20). Consequently, there are conflicts in the medical documentation of epidemics in the pre-germ theory era. However, in 1894 there was a push to diagnose the disease through bacterial analysis instead of simply observing the throat. This made the diagnosis of diphtheria more reliable and the presence of epidemics, and their spread, easier to track (Hammonds 1999:85).

Future Research

Very little research has been conducted on tracing the history of diphtheria. There are several circumstances that make this a difficult endeavor, beyond distinguishing between epidemics of croup and diphtheria. The variety of names applied to the disease, reflecting the different cultural contexts and medical traditions in which diphtheria epidemics occurred, complicates identifying epidemics. There is also a research bias towards the study of Europe, and an absence of studies of Indigenous groups and people living in other regions of the world. It is evident that diphtheria was present in China and Egypt, and most likely in other areas in trading relationship with these places, and perhaps in regions with domesticated cattle. Diphtheria is not a hot medical topic into which research dollars are being poured. However, the available evidence suggests that diphtheria is an ancient disease, that it moved around the world during colonial times, and that it was most likely introduced to remote areas from Western Europe. A lot is known about the disease from the 1600s to the present, but more research is needed to understand its origins.

4

Bile to Bacteria and Changing Conceptions of Diphtheria

Kelly R. Day

Before the nineteenth century a disorderly collection of facts and opinions and a multiplicity of names served but to confuse the mind with regard to the conditions which were popularly called throat distemper (Andrewes et al 1923:20).

In the study of medicine there are innumerable examples of words whose meanings have changed and ideas that have evolved with the passage of time and increased knowledge (Cohen 1953:155). This chapter addresses how medical and public knowledge of infectious diseases has changed, with a particular focus on advances in knowledge about diphtheria in the nineteenth century. During this time diphtheria became recognized as a significant killer of children and, as a result, began to receive more attention in the medical literature. The nineteenth century was also a period of conflicting views and debates among medical authorities, enhanced by the introduction of germ theory. This chapter explores how the understanding of the cause, symptoms and treatment of diphtheria changed, and how this reconfiguration of the disease relates to a broader shift in the understanding of infectious disease and medicine in the nineteenth century.

Early Medical Theories

From the earliest time humans have recognized illness as feelings of pain or discomfort. However our understanding of what disease really is, and what causes it, continues to evolve. Until the nineteenth century a number of theories were used to explain the etiology of infectious diseases, theories that reflected ideas about how the world worked (Duffin 2005:3). Many of these concepts were based on the notion that disease was an external entity acting on or invading the human body, thereby creating illness.

Blood, Phlegm, and Bile

Figure 4.1: "Four humors" (Author unknown 1574).

The humoral system dominated the study of disease for several thousands of years. The humoral system is based on the belief that the human body is comprised of four main humors: blood, phlegm, yellow bile, and black bile (Figure 4.1). The essential function of each part of the body is based on the balance of these humors. Each humor is associated with specific elements and qualities. These elements are air, water, earth, fire, and the qualities are hot, cold, moist, and dry (Siegel 1968:196-198). When these external elements and qualities act on the body, a surplus or deficit of the associated humor would occur which, in turn, would cause a person to become sick.

Early accounts of diphtheria explain that the irritation and membranous tissue in the throat resulted from consuming a substance that was either too hot or too cold in quality (Andrews et al 1923:15). However, diagnoses were made based on observations of certain parts of the body associated with particular humors. This attention to symptoms,

many of which were similar in different diseases, means that what is now recognized as a single disease might under the humoral system have received different diagnoses and treatments. Fevers, for instance, were believed to be caused by the rising heat of a decomposing humor, phlegm, yellow bile, or black bile (Siegel 1968:201). Fever and sore throat are symptoms of diphtheria, but physicians employing the humoral system would not have thought these symptoms were caused by the same disease.

Bad Air and Decaying Filth

In the late eighteenth and early nineteenths centuries, anatomy and physiology had become more integral to the study of medicine and disease (Cohen 1953:157). The main theories of infectious disease during this time centred on ideas of contaminated air. While people were now beginning to understand that diseases like diphtheria were contagious and could be spread from the sick to the healthy, very little was understood about their etiology. For one, medical professionals still could not explain why some diseases could spread without direct contact between healthy and sick individuals. Because of this, infectious diseases were believed to come from a more generalized and atmospheric source (Tomes 1998:6). One of these sources was bad air, referred to as miasma (Figure 4.2). Miasmic theory was based on the belief that sickness was caused by inhaling contaminated or foul smelling air from decaying animals or food waste (Hughes 1977:1).

Figure 4.2: Representation of cholera (Seymour 1831).
Courtesy of U.S. National Library of Medicine.

Another popular explanation was the zymotic theory of disease. This theory explained disease agents as chemical ferments emitted into the air by decaying filth and waste (Tomes 1998:27). People became ill by coming into contact with fermented particles through direct contact or inhalation. The zymotic theory also stressed that under the right atmospheric circumstances these disease-

causing agents could generate spontaneously (Tomes 1998:27). Many medical professionals explained the spread of diphtheria with atmospheric infection theories, even though the disease was being spread through droplets in the breath and saliva of sick individuals. McDonald believed diphtheria to be a disease caused by poisonous substances in the body, which acted through the blood and were seen in the throat (Trall 1862:78).

Because there was no known direct cause of infectious disease at this time, diagnosis was still primarily observation-based. Diseases were frequently identified not by their pathogenic cause, but rather by particular changes to a particular organ or part of the body (Carter 1980:265). Diseases that exhibited multiple symptoms, like fever and sore throat, were thus identified as different diseases, and diseases with similar symptoms to one another were lumped together under one name. Diphtheria was often used interchangeably with croup and scarlet fever to describe several diseases with similar symptoms, such as irritation in the throat. Because of the observational nature of disease identification, diphtheria was known by several different names: croup, because of the hoarse cough patients experienced; angina maligna, because of the damage that occurred to the heart from the bacterial toxin; and morbus sufficans, which translates to the strangler, because many suffocated to death (Lax 2005:67).

Germ Theory

By the middle of the nineteenth century there was growing evidence for the pathogenicity of microorganisms (Hughes 1977:11). The accumulation of this evidence resulted in the development of the germ theory of infectious disease (Box 4.1). Germ theory is based on the principle that unseen microorganisms play

1850's/1860's: Louis Pasteur's work established fermentation and putrefaction as microbial processes resulting from the activity of specific organisms.
1876: John Tyndall discovered that tuberculosis could be transmitted from humans to animals through inoculation
1877: Robert Koch was able track the complete life cycle of the anthrax bacillus both inside and outside of a host.

Box 4.1: The road to germ theory (Hughes 1977:6).

a central role in the cause and spread of infectious disease (Tomes 1998:5). This new concept of disease initially met with resistance and the previously mentioned miasmic and zymotic theories still prevailed for many years, well into the late nineteenth century. In 1888, for instance, J. Lewis. Smith wrote that he believed that the majority of children who became sick with diphtheria caught the disease from inhaling infected sewer gas (Park 1931). This opinion is reminiscent of miasma theory. However, these older theories of atmospheric infection did eventually give way to a more scientific understanding of pathogens and disease.

Diphtheria has gone by a number of names, including throat distemper, croup, and malignant sore throat. In the early nineteenth century Pierre Bretonneau was the first to refer to the disease as diphtherite (diphtheria). This name described the main characteristic of the disease, the diphtheric membrane. Diphtheric is derived from the Greek word diphtheria which means leather or hide. The membrane that forms over the throat received this name for its leathery appearance.

By the middle of the nineteenth century, *diphtherite* began to be replaced with *diphtheria*. Medical words ending in *ite* or *itis* in English refers to inflammation of a specific organ. The ending *ia* refers to the irregular condition of part of the body. This small change in the ending of the word reflects a shift in the understanding of how diphtheria affects the body.

Box 4.2: What's in a name? (Lax 2005:67).

The introduction of germ theory in the late 1870s was a fundamental development in the way people understood and studied infectious diseases, as well as how they approached treatment and prevention of those diseases. Germ theory ushered in an era in which the specific causes of many different diseases, as well as the means by which they spread, could be discovered; it also disproved previous theories of spontaneous generation of disease or that one source (such as infected sewer gas) could be the cause of several different diseases. Physician William H. Mays summarized germ theory as follows: "I hold that as an oak come from and oak, and a grape from a grape, so does typhoid fever from a typhoid germ, and diphtheria from a diphtheria germ" (Tomes 1998:27). The introduction of germ theory also modified the way in which diseases were identified and

diagnosed; instead of relying solely on symptoms, specific microorganisms were identified.

The medical and public perception of diphtheria was greatly influenced by this increase in specificity in the study of infectious diseases. The establishment of diphtheria as an independent disease with a specific name (Box 4.2) was pioneered by Pierre Bretonneau in 1826. He was the first person to consistently refer to this disease as diphtherite, later changed to diphtheria. A disease is born when it is given a name, even if the associated illness and symptoms have been recognized for some time; through naming, the disease takes on a life of its own, distinct from other diseases (Duffin 2005:11). Diphtheria occurs most commonly among young children; however, prior to the identification of the disease and the bacteria that cause it, no one knew what was causing their children to die. Once diphtheria was identified and named, it became an enemy, often referred in medical literature as the scourge of childhood (Lax 2005:65).

The same inoculation process employed by Tyndall was also used to confirm the infectious nature of diphtheria. In the 1880s the work of Edwin Klebs and Friedrich Loeffler contributed to the identification of the pathogenic bacterial cause of diphtheria, *Corynebacterium diphtheriae* (Lax 2005:68). The identification of diphtheria and *C. diphtheriae* bacteria had a significant impact on conceptions of the disease. Previously, few worried about the daily hazards of infection outside of epidemic periods (Tomes 1998:4). Now medical professionals connected the spread of diphtheria to seemingly harmless behaviors such as coughing, sneezing, sharing dishes, and not washing one's hands (Tomes 1998:4). The conception of diphtheria changed from an external entity beyond human control to something that could be prevented or, at the very least, managed.

A Disease is Born

The understanding and perception of diphtheria has changed and evolved over time in relation to larger trends in the study of medicine and infectious diseases. The nineteenth century was a time of significant change in medical thinking, stimulated by the introduction of germ theory. This development greatly influenced the history of diphtheria and how it was understood by physicians and ordinary people. Previously lumped together with other diseases such as croup and scarlet fever based on physical observation of symptoms, it became possible

for diphtheria to be identified as a specific disease caused by specific bacteria: *Corynebacterium diphtheriae*. Until this radical transformation in thinking occurred, diseases were believed to be caused by atmospheric forces. The discovery of the microorganism that caused diphtheria placed the disease within the natural order and thus made it controllable by human action.

5

Treat the Disease, Aim for a Cure

Emily P. H. Liu

Medical reasoning is unlike all other reasoning. It seems to disregard all the ordinary rules of logic…remedies have a power over the vital functions, and that they are capable of controlling morbid actions; and when a patient recovers, the remedies employed are accredited with the cure. But suppose the patient dies? What then? Do these medical logicians charge the killing to the medicine? Never. The patient dies in spite of it (R.T. Trall 1862:105).

Many nineteenth-century physicians in North America and Europe commonly published medical findings on how to treat the various stages of diphtheria, often adapting and making mention of publications from other parts of the world. These publications and case reports nevertheless display an alarming similarity: there was no single, standard method for treating diphtheria. As a result, many patients suffered greatly at the hands of experimenting physicians who wished to find the most effective cure for the disease. This chapter explores treatments prescribed by physicians prior to the development of inoculation techniques and the eventual creation of the vaccination (Chapter 6).

I discuss three treatment categories that encompass the most commonly employed methods used in the nineteenth century: medical treatments, water

treatments, and invasive treatments. Focusing primarily on medical reports, memoirs, and lectures from the 1800s, I highlight conflicting points of view prevalent among nineteenth-century medical men. In particular, I draw attention to the ways in which physicians understood the various treatments and their efficacy. Reference is made to many European and North American physicians who pioneered and experimented with treatments, such as Bretonneau, Daviot, and Trall, among others.

Medicine in the Nineteenth Century

The Age of Enlightenment marked a time in history in which religion was overturned in favour of science. Although the exact date of this period is contested, it is often situated in the 1700s, a time in which physicians believed illness resulted from disharmony in the body (see Williams 2003).

The practice of medicine underwent many changes during the mid-nineteenth century, although many physicians continued to rely on traditional theories for understanding the body. The body was believed to be made up of four substances ("humours") and the healthy body was understood to be in a state of humoural balance. Too much or too little of a humour would throw the body into a state of imbalance; in order to restore the body, balance would need to be regained. Physiology, the study of bodily functions, did not appear in the medical curriculum until 1880, and even so, was not considered important for treating the body (Shortt 1983:57). The various ways in which physicians treated diphtheria reflect the need to restore the balance of humours. Treatments for diphtheria and other diseases, therefore, involved bleeding, sweating, cutting and other attempts to remove illness from the patient's body. These methods were believed to be effective, as long as a physician could witness changes in the patient's general wellbeing, such as pulse rate or skin colour (Shortt 1983:60).

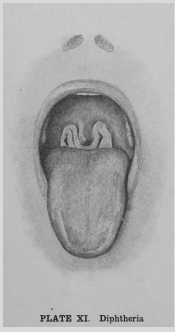
Diphtheria? Diphtheritis? Diphtherite?

William M. Edwards, a Baptist missionary who travelled throughout New Brunswick, gave a lecture in 1882 summarizing the origins of the term 'diphtheria'. Diphtheria can be traced to ancient Greek and signifies skin; 'diphtheritis' translates to inflammation, and 'diphtherite', a term created by

doctor Pierre-Fidèle Bretonneau (who coined the term diphtheria, meaning membrane), was used to classify any diseases that formed false membranes (Edwards 1882:3).

Diphtheria was commonly understood to be an inflammation of the throat, accompanied by a fever; physicians reported seeing a "pellicle", a patch of opaque grey tissue that developed near the tonsils and downward, in some cases blocking the airways and resulting in breathing difficulty (Trall 1862:11-19). Many nineteenth-century physicians considered the terms 'diphtheria' and 'croup' (a cough similar to the sounds of a barking seal that may lead to difficulty breathing) to be interchangeable; others argued that the presence of the false membrane signified a case of diphtheria (Box 5.1). The troubling inconsistencies in the diagnosis and medical terminology employed by various physicians (Chapter 17) gave rise to different methods for treating the illness.

The term 'false membrane' describes a growth that appears on the tonsils, or near the back of the throat, in patients with diphtheria. It became the identifying symptom of diphtheria. As the disease progresses in an individual, the membrane grows and turns gray; in severe cases, it grows downwards into the windpipe, eventually obstructing the airways.



Box 5.1: The false membrane (Rossiter 1913:Plate 11).

The absence of a single, all-encompassing remedy for diphtheria meant that physicians studied a patient's symptoms, all the while consulting "the rules established by our teachers" (Daviot 1859:371). Paradoxically, these physicians often discredit previous treatments developed by these very same teachers; in the *Dictionary of Medical Sciences*, for instance, states that earlier treatments were "powerless" solutions against a disease like diphtheria (Daviot 1859:365). Generally, treatments focused on removing the false membrane (Trall 1862:105) while combating the effects of the disease throughout the body.

Medical Treatments

Blood-letting

Intentional bleeding was a common treatment for a variety of illnesses. Its efficacy resided in the belief that in order to maintain and control inflammation, blood had to be withdrawn from the affected area. Inflammation of the throat is a symptom of diphtheria, and thus the neck became the site for controlling inflammation. Leeches were attached to the area, or cuts and blisters were made on the patient. Leeches produce profuse bleeding in the neck region, which resulted in blood loss that was "extremely difficult to arrest" (Trall 1862:198). Physicians disagreed on the number of leeches required to treat diphtheria. Dr. Bouchut recommends three to four leeches and in proportion to "the loss of blood to the strength and the age of the patients" (1859:282); however, he also states that "[b]leeding at the arm is preferable to bleeding by leeches" (1859:282). Dr. Bretonneau reports applying eight leeches to a five-year old child shown to have "large grey spots" covering the tonsils (Bretonneau 1859:10). Although Bretonneau later states "I had already recognized the inefficacy of blood-letting", he justifies his use of the treatment on the basis that it rapidly reduces inflammation (1859:41). Dr. Daviot experimented with blisters: "I was compelled, in spite of my reluctance, to apply one. This blister, after the disappearance of the original disease, very nearly destroyed the life of my patient" (1859:370) and he warns against experimental use of this procedure.

Mercury

Mercury was believed to diminish the false membrane and the cough of patients suffering with diphtheria (Bouchut 1859:282). The use of mercury and its efficacy was the subject of great debate in the nineteenth century and it is known today that exposure to mercury can result in mercury poisoning, amongst other adverse health effects. Using mercury as a treatment for diphtheria was thus as dangerous as the disease itself. There are no records of the amounts of mercury deemed safe and some physicians suggested using "mercury in large doses" (McGahan 1893:770). Many physicians applied mercury either directly to the false membrane or to the exterior of the neck, even though they were aware of the

potential dangers of this poisonous substance. Bretonneau utilized mercurial treatments and states that the "chemical nature of the preparation, the temperature of the air, and the habits and age of the patient" (1859:85) contribute greatly to the risk of mercury poisoning; he does not provide any further details. Dr. Daviot also treated patients with mercury but notes unsuccessful results: "these medicines often caused a diarrhoea which exhausted [patients] more rapidly" and states that mercury is "an agent which has theoretically and experimentally been recognised to be hurtful" (1859:369).

Hydrochloric Acid

Hydrochloric acid is a corrosive substance which lends itself to the production of many fertilizers and dyes and is used heavily in the textile and rubber industries (United States Environmental Protection Agency 2000). Hydrochloric acid was applied to the false membrane via a sponge (often in combination with mercurial treatments applied externally) to dissolve, detach, or shrink it (Bouchut 1859:284). Hydrochloric acid was commonly mixed with a few drops of honey to dilute and weaken its harmful effects. The solution was a known irritant and disturbed the membrane more than dissolved it, leaving an "unpleasant taste in the mouth" and inducing "violent efforts of vomiting" (Daviot 1859:284). Despite these negative effects, hydrochloric acid was a popular treatment for diphtheria. Varying outcomes were reported and Bretonneau treated many patients, with mixed results. He reports a case of "two young peasant girls…treated and cured by applications of concentrated hydrochloric acid" (1859:15). Bretonneau finds that applying hydrochloric acid is not worth the risk as the dose was applied every twenty-four hours (1859:42). He then contradicts himself by applying concentrated hydrochloric acid, and two leeches, to an eight-month old "for three days, and the applications of concentrated acid were repeated night and morning without the cough becoming more frequent" (1859:76). The child died on the sixth day and Bretonneau suspects "that the applications of hydrochloric acid had been too frequent and too strong" (1859:76).

Water Treatments

Water treatments were commonly practiced by North American physicians among whom there was a common understanding that treatments should be "mild, not meddlesome" and that there should be no "tortur[ing] the little one with blisters, and gargles" (Nichol 1884:17). In North America, physicians considered treating diphtheria with water to be the most promising remedy and the "vehicle by means of which all the nutrient materials of the body are transported to the various structures" (Trall 1862:232). Dr. Lewis A. Sayre, an American physician, noted that any discharge resulting from diphtheria that fell onto hard surfaces became a "tough pellicle"; however, if the discharge fell into "warm water, it remained liquid and limpid, like ordinary thin lymph or mucus" (Trall 1862:49). Physicians began creating a hot and humid atmosphere for diphtheria patients using a heated flat-iron suspended over a water pail. Dr. Sayre recommends a temperature of 80° Fahrenheit (equivalent to 26.67° Celsius) and noted that the membrane was being "expelled in liquid form through the nose and mouth" (Trall 1862:49). North American physicians strongly discouraged the use of any treatments that "lower[ed] the powers of life" (Trall 1862:198) and criticised physicians who practiced invasive treatments as not knowing "when to let the patient alone" (Trall 1862:247). European physicians acknowledged the possibility of resorting to water as a treatment, noting that they too had seen the membrane dissolve in cold and hot water; however, they justify their use of acids and solutions as a quicker method for hardening the membrane as well as helping it to shrivel and eventual detach (Bouchut 1859:273).

Invasive Treatments

Invasive treatments were resorted to only when medical treatments failed to halt the growth of the false membrane or when the growth of the membrane began to interfere with a patient's ability to breathe. Anaesthesia was rarely used even though it had been introduced into medical practice in the 1840s (Shortt 1983:58) and many patients suffering from diphtheria required surgical intervention to unblock their airways from the membrane.

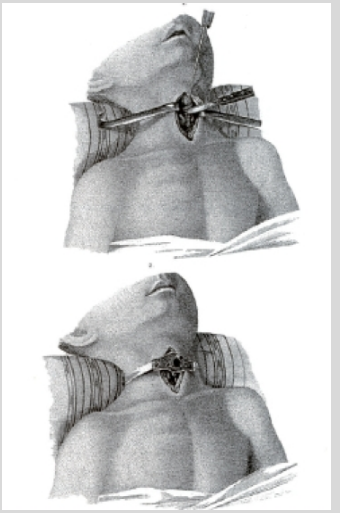
Forced Membrane Removal

Physicians who attempted to forcibly remove the false membrane by means of forceps or any other tool were considered "inexperienced" as it was "a procedure which is to be mentioned only to be condemned" (Hammonds 1999:25). While this procedure met with harsh criticism from many recognized physicians, others also claimed to have tried it themselves or state that they had at the very least observed the procedure. Trall states that while mercurial and hydrochloric acids treatments seemed to be ineffective for detaching the membrane, forceful attempts to do so would aggravate the area and possibly cause another membrane to form in its place (1862:189). Dr. Empis also found it difficult to detach the membrane using forceps, stating that the "adhesion to the tissues is such that we are rarely able to detach them without causing the raw part, covered by them, to bleed in some measure" (1859:322). Physicians concluded that forcibly removing the false membrane only aggravated the disease and the surrounding tissues.

Tonsil Removal

A practice commonly referred to as the "ablation of tonsils" (Daviot 1859:374) was justified in the belief that removal of the tonsils would prevent diphtheria from progressing – no patches or membranes could be formed near the tonsils if they did not exist. Dr. Daniel D. Slade (1864) advises against this and states that it is likely the membrane will form once more if tonsils are removed, coupled with the risk of "severe haemorrhage" (145). Slade considers the possibility of removing the tonsils of adults if they have obstructed the airways (1864:145), but only as a last effort (Daviot 1859:374).

Tracheotomy



After the incision line is traced a cut is made with a surgical knife – the knife separates the muscles by using the blade and forceps help to separate the two sides. Careful notice is taken when cutting the cellular tissue that unites the veins in this area and separating them with another pair of forceps. The incision is continued downward until the trachea is reached, described as hard due to the false membrane (Trousseau 1859:290). A small puncture is made in the trachea and cut up and down by a blunt knife (Trousseau 1859:290). Blood, mucous, as well as portions of the false membranes will escape the incision; the tracheal dilator is then introduced and applied by taking the cannula, a tube that keeps the hole open, once air is heard passing through the cannula the dilator is to be removed and strings of the cannula tied behind the neck, thus declaring the end of the operation (Trousseau 1859:290).

Box 5.2: Tracheostomy in a child suffering from diphtheria (Kramp and Dommerich 2011:3).

Surgical intervention to treat diphtheria was a highly debated practice that resulted in varying rates of success. Referred to by many as the absolute "last resort" (Trall 1862:258, Buchanan 1880:554) and the "ultimatum of the therapeutics" (Bouchut 1859:287), tracheotomy was resorted to when all other treatments had failed and when the patient demonstrated difficulty breathing or when the possibility of death by suffocation was imminent. The procedure was practiced successfully for the first time in 1782 in London by physician John André; after subsequent unsuccessful attempts by other physicians, tracheotomy was forbidden by France's Académie de Médicine (Hamilton 1881:89). Tracheotomy (Box 5.2) was performed to open up an alternate air passage through the trachea (windpipe), a tube that allows for the passage of air.

This operation is very rarely practiced today. A less-invasive solution was created in 1881 by New York physician, Dr. Joseph O'Dwyer, who introduced an intubation method to keep the throat open in severe cases of diphtheria (Hammonds 1999:27). O'Dwyer's method involved inserting a small hallow tube into the throats of patients and became recognized as one of the "most effective surgical interventions in the treatment of diphtheria" (Hammonds 1999:27).

Varying Treatments, Varying Survival Rates

The varying success rates for diphtheria treatments reported by nineteenth-century physicians show that they were guided by their own beliefs, experiences, and observations of the methods of their medical predecessors. The absence of a single, standard treatment meant that physicians were reduced to treating the symptoms that arose as the disease progressed – inflammation was believed to subside if blood was extracted from the inflamed site, coughs had to be subdued, the growth of the membrane had to be stopped, and obstructed airways needed to be opened once all possible methods of treatment had been exhausted.

The progression of the disease was often so quick that post-mortem examinations of the body were inconclusive on whether the patient died from the disease or from the treatments; physicians speculated endlessly on this subject. Today, untreated diphtheria is fatal in up to half of cases, though many cases are likely unreported and unrecorded (Centers for Disease Control and Prevention 2014). Can this mortality rate be attributed solely to untreated diphtheria or to poor treatment options that may have harmed the patient more than the disease itself? Although medical innovations in the twentieth century drastically changed the ways in which physicians treated diphtheria, these innovations developed out of nineteenth century treatments – not only were some of them unsuccessful (and therefore ruled out from modern medicine), many proved to be fatal.

6

Fighting Diphtheria with Diphtheria

Rachit Srivastava

When I noted the four children from one family, the thought ran through my head-"Four out of one family-how many are going out in pine boxes?" The thought ran through my mind-"I wonder if there is anything new on Diphtheria? (Reynolds 1894).

This chapter introduces the history and development of various medicinal treatments for diphtheria from 1890 to the present. In particular, I discuss and compare the development timeline, efficacy, and the way various treatments work. I explain antitoxin, toxin-antitoxin, the (Ramon) toxoid, and antibiotic treatments. Understanding how these treatments work allows us to better understand why they were successful in preventing and treating large populations. Unlike humoural treatments covered in Chapter 5, the biomedical treatments discussed here had a standardized manufacturing process, distribution, and dose administration, which allowed them to be used effectively and successfully in numerous populations with the same result. It is only due to this standardization that allowed for public initiatives and campaigns to work effectively as they did in stopping diphtheria across the globe (Chapter 19). I also discuss socioeconomic

factors that play a role in diphtheria prevention and treatment in developing countries today.

Key Terminology

It is important to define key terms used to explain immunization and treatment (Box 6.1). The terminology can be confusing, since some words (like toxin and toxoid) appear to be similar, yet refer to very different biological phenomena. It should be noted that the word 'host' is applicable to humans and animals.

Toxin – refers specifically to poisonous substances produced by living cells or organisms. For example, the toxin secreted by the bacterium *Corynebacterium diphtheriae* causes diphtheria in humans.
Vaccine – a biological dose designed to provide protection (immunity) against a specific pathogen. The vaccine may take the form of a weakened pathogen that does not harm the host, but confers long-term immunity.
Vaccination – a carefully designed course of vaccine(s) that result in long-term immunity in the host upon the completion of the course.
Antitoxin–substance that protects the host against a specific disease by neutralizing the toxin. Antitoxin (also known as antibodies) is produced by hosts in response to vaccination. Antitoxin is used for treatment.
Toxin-antitoxin – a mixture containing the toxin along with the antitoxin, which is supposed to provide the host with long-term immunity. Toxin-antitoxin can be used for both treatment and prevention.
Toxoid – modified toxin that has been inactivated and cannot harm the host, however, still retains its ability to provide protection (immunity) to the host against future exposure to the same toxin. Toxoid only has preventative effects.
Adjuvant – material added to vaccine that results in the production of more antibodies/antitoxin and longer-lasting protection.
Antibiotics–substances that kill or prevent the growth of the bacteria itself. These are used for treatment only.

Box 6.1: Key terminology in understanding diphtheria prevention and treatment.

Early Experimentation: Serum Therapy and Antitoxin

The first biomedical treatment for diphtheria was developed by Shibassaburo Kitasato and Emil Von Behring in 1890, who inoculated guinea pigs with heat-treated diphtheria toxin (Behring and Kitasato 1890:138; Centers for Disease Control and Prevention 2015:110). Kitasato's earlier work on tetanus in rabbits and mice helped provide a theoretical model for immunity (Behring and Kitasato 1890:138). They were able to show that the blood (serum) of inoculated guinea pigs contained a 'substance' that could counter the negative effects of the diphtheria toxin when the guinea pigs were exposed to the toxin again. They later showed that the extracted serum of an immunized animal could be used to treat diphtheria in another animal (Behring and Kitasato 1890:138-139). The 'substance' extracted from the serum was called antitoxin (or antibodies). Antitoxin acts to neutralize circulating toxins and prevents further progression of the disease (Centers for Disease Control and Prevention 2015:110).

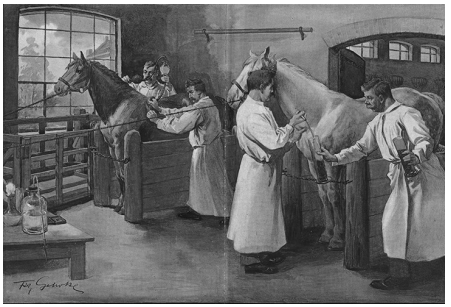


Figure 6.1: Recovering the diphtheria serum from horse blood in Marburg, Germany (Gehrke 1890).
Image courtesy of U.S. National Library of Medicine.

Von Behring considered this development to be "one of the most important contributions that has been made to medicine by microbiology," as it opened up the "possibility of specific therapy for diseases through the injection of immune system" in the future (Behring and Kitasato 1890:140). This paper marked the beginning of the science of serology (Behring and Kitasato 1890:140). Von Behring was later awarded the Nobel Prize in medicine in 1901 for his research on diphtheria.

In order to produce large amounts of antitoxin for human use, Von Behring and Kitasato targeted large animals, such as sheep and horses, for extracting sufficient blood serum. To ensure that the production of antitoxin was regulated, its purity and potency had to be strictly monitored. The goal was to find the optimum amount of toxin that could be successfully injected into animals, which would subsequently yield the maximum amount of antitoxin. New York City was one of the most important locations for

early research and clinical trials in North America. William Hallock Park was a leading figure in New York, and would go on to make his own improvements to the antitoxin method.

Limitations of the Antitoxin

Antitoxin was very reliable in producing immunity for a short time (Park et al 1923:24). However, the fact that the diphtheria antitoxin was not a product of human cells, but rather a product of the cells of an animal (horse/sheep), meant that the antitoxin (along with the immunity) would leave the human body over a course of few weeks (Park et al 1923:24). If needed, the antitoxin injections could be repeated, however, these subsequent antitoxin doses would be flushed out twice as fast. Thus, the injections would be needed roughly every ten days if treatment were still required (Park et al 1923:24).

Antitoxin was also used to prevent diphtheria among people suspected of being in direct contact with cases or outbreaks of diphtheria, for example, in a family where a child might have developed diphtheria or at public institutions like schools (Park et al 1923:24). The antitoxin was far more efficient as a treatment, however, because it could be used as soon as a case was discovered, whereas it could only be used for prevention when diphtheria exposure was suspected to have taken place (Park et al 1923:25). Nonetheless, the use of antitoxin reduced diphtheria by a factor of one-seventh (Park et al 1923:25).

By the late 1910s, the improvement and benefits initially observed for antitoxin had begun to wane as diphtheria began to rise in the United States (Park et al 1923:25). It was time to consider options that could provide active immunization, rather than the passive and fleeting immunization of antitoxin (Park et al 1923:25).

William Hallock Park's Modification: Toxin-Antitoxin Mixture

In 1914, William H. Park began to extend Von Behring's work. He studied the use of toxin-antitoxin mixtures for producing active and long lasting immunity in animal subjects, and eventually in humans (Park and Schroder 1932:7). The purpose of this mixture was to have the toxin component provide long-lasting immunization, while the antitoxin component provided protection against the

toxin. This safe and controlled exposure to the toxin resulted in the production of antibodies that would provide long-term immunity. The goal was to create an overall mixture that was slightly toxic, so that the body would recognize the toxin and produce antibodies in response to it. These antibodies last, protecting the body against future contact with harmful diphtheria toxin. If the overall mixture were weak or non-toxic, then the body would not be as effective in producing antibodies.

In the 1910s, William Park experimented with doses that varied in strength, potency, and the number of vaccines in the course of treatment. In New York City he had great success with a three-injection, one-week apart, course; 85% of the children were successfully immunized, and 80% of them sustained that immunity even after ten years. This later iteration of the drug was also better than previous versions at retaining its immunizing abilities.

The next improvement came when Alexander Glenny and his colleagues showed that formalin could reduce the toxin's toxicity (Park and Schroder 1932:9). Formalin is an aqueous solution that can kill bacteria and inactivate their cells. Adding formalin meant that the toxin used in the toxin-antitoxin could be much stronger than before (but still safe) and that antibody production and the immunization rate improved.

The toxin-antitoxin was primarily used in the United States and Germany (Fitzgerald et al 1932:25; Park and Schroder 1928:1455). It was adopted by both private physicians and public agencies in the United States (Schwartz and Janney 1930:504). It was used on a moderate scale in Canada until 1925 in the provinces of Ontario and Saskatchewan (Fitzgerald et al 1932:25).

By 1928, there were two toxin-antitoxins in use: the nearly neutralized toxin with a trace of antitoxin produced in horses, and the toxin nearly neutralized with antitoxin produced in goats (Park and Schroder 1928:1455). Occasionally, toxin-antitoxin caused an allergic reaction (Schwartz and Janney 1930:507). To reduce this, it was strongly recommended to use toxin-antitoxin that was not prepared from the serum of horses (Schwartz and Janney 1930:507). Sheep serum was strongly favoured (Schwartz and Janney 1930:504).

Gaston Ramon's Toxoid

In 1923 Gaston Ramon, a veterinarian, developed the diphtheria toxoid at the Pasteur Institute in France (Centers for Disease and Prevention 2015:113; Fitzgerald et al 1932:25). Alexander Glenny, in London, was doing similar work. Ramon's goal was to inactivate the diphtheria toxin, so it could be directly inserted into the body without the need for antitoxin (Park and Schroder 1928:1455). By treating the diphtheria toxin with heat (370°C) and processing it with formaldehyde formalin, the toxin molecule was inactivated and could not cause toxicity in the body (Fitzgerald et al 1932:25; Fraser 1939:470; Park and Schroder 1928:1455; 1932:9; Schwartz and Janney 1930:508). This inactivated form of toxin is called the toxoid. While the toxoid did not cause any harm in the body, it still retained its ability to trigger the production of antibodies and long-term immunity. This was the simplest method developed to date, as it was quite readily prepared with just the potent diphtheria toxin and did not require additional antitoxin from animal serum (Fitzgerald et al 1932:25).

Alexander Glenny was further able to improve the effectiveness of the diphtheria toxoid by treating it with aluminum salt, which increased the antibody response and the duration of immunity. Early trials in Canada were held in Hamilton, Windsor, and Brantford, Ontario with overall positive results (Fitzgerald et al 1932:25).

Toxin-Antitoxin versus Toxoid

Gladys Dick and George Fredrick compared the effectiveness of the toxin-antitoxin and the toxoid in susceptible adults (Greengard 1931:228). They found that toxoid had a 94% immunization rate in comparison to toxin-antitoxin's 82% immunization rate.

Greengard (1931) provided a summary of multiple studies among children and compared the use of toxin-antitoxin with toxoid. Toxoid was found to be the better immunizing agent in children, as had been the case for adults. He also suggested that toxoid be administered by the end of the first year of the child's life (Greengard 1931:228). This is because at this age toxoid produced no harmful reaction, whereas toxin-antitoxin sometimes resulted in adverse reactions due to the presence of horse serum (Schawartz and Janney 1930:509).

Modern Immunization with Toxoid

Toxoid was not widely used until the early 1930s (Centers for Disease and Prevention 2015:113). By the 1940s, diphtheria toxoid was combined with the tetanus and pertussis vaccine (Centers for Disease and Prevention 2015:113). Toxoid is still used today and is the recommended method for preventing diphtheria (Centers for Disease and Prevention 2015:113; Fraser 1939:471). The modern toxoid course of 3 to 4 doses, plus boosters, is approximately 97% effective (Centers for Disease and Prevention 2015:113). Children usually receive the vaccine for diphtheria with vaccines for other diseases in the same shot. These range from tetanus, acellular pertussis, hepatitis B, and polio.

By combining several types of vaccines into fewer doses, the chance of successful immunization against several diseases becomes higher (Hadler 1994:415). If administered separately, the likelihood of missing doses would increase, especially in developing countries where the medical infrastructure may not allow for flexibility in receiving immunization. Additionally, combining multiple vaccines reduces administrative costs by limiting the total number of immunization sessions (Hadler 1994:415).

Antibiotic Treatments

Modern treatment of diphtheria involves antibiotics that can kill the diphtheria bacteria, along with antitoxin that can neutralize the toxins. Patients are isolated for up to 48 hours, which allows sufficient time to stop the spread of infection.

Penicillin G is commonly used, as penicillin kills gram-positive bacteria, such as *Corynebacterium diphtheriae* (Centers for Disease Control and Prevention 2015:107; Tipper and Strominger 1965:1133). Penicillin works by killing cells. It does this by preventing the growth of the cell wall, which is responsible for protecting and structurally supporting the cell. Without a functioning cell wall, the bacteria cannot survive.

Erythomycin is an antibiotic that appears on the World Health Organization's List of Essential Medicines as it treats diphtheria and many other bacteria-related diseases (Centers for Disease Control and Prevention 2015:111). Erythomycin works by inhibiting the growth of the bacteria, especially when the bacteria is at higher concentration.

Clarithromycin is also offered as a substitute to erythromycin. The benefit of clarithromycin is that it can be taken orally due to its tolerance of high gastric acidity in the stomach. Clarithromycin works by crippling important bacterial functions, such as hormone activity, functional support, growth, cell regulation, and cell communication.

Cost of Diphtheria Vaccine and Treatment

The price for diphtheria vaccine includes the price of the actual vaccine dose and the cost of administering the vaccine (Ekweume et al 2000:799). In North America, the cost of the vaccine is based on what is contained in the dose (diphtheria, tetanus, polio, pertussis, hepatitis B) and whether the patient is covered under a private or public health coverage plan (Ekweume et al 2000:799). The prices listed by the Centers for Disease Control and Prevention (CDC) for various diphtheria vaccines range from $16.04 to $54.38 per dose.

Funding diphtheria immunization is not only beneficial for the population who will not have to live through the symptoms of diphtheria, but also has economic advantages (Ekweume et al 2000:797). Immunization against diphtheria prevents the cost of subsequent hospital admittance and administration, physicians, and treatment of sick patients.

The majority of the vaccines currently in use around the world are produced in developed countries (Mahoney and Maynard 1999:647). To recuperate the huge cost of research and development needed to make the vaccine, the companies price the vaccine higher in developed countries (Mahoney and Maynard 1999:647). The Expanded Program on Immunization (EPI) sponsored by WHO allows developing countries to buy vaccines in bulk, at a fraction of cost. For example, UNICEF can buy the same vaccine that costs $10 in Europe or United States for $0.10 for developing countries (Mahoney and Maynard 1999:650). This price is very close to the actual cost required for producing the vaccine.

However, even with the ability to obtain relatively cheap vaccines in developing countries still does not guarantee that the population will be well vaccinated. There are other economic and social barriers preventing people from being vaccinated. Successful vaccination programs require the presence of medical infrastructure, sufficient resources, and educating the public the

importance of vaccination (Chapter 13). India is an example of a developing country that continues to have problems with mass immunization due to these socioeconomic barriers.

Case Study: Diphtheria Prevalence in India

Studies on diphtheria incidence in Hyderabad, India show that diphtheria is most prevalent among children between the ages of 5 and 19, girls and women, and the Muslim population (Bitrangunta et al 2008:1145). The coverage of initial primary vaccination was adequate in the city, however booster coverage was low. The booster shot ensures that immunity is retained. Low booster coverage could have contributed to decreased herd immunity and increased the prevalence of diphtheria in Hyderabad. Poor booster coverage has also been found in countries, such as Russia, where diphtheria has resurged (Chapter 18). When researchers asked Hyderabad community members about the vaccination status of their children, the record of the child's immunization status was based primarily on the mother's recollection (Bitrangunta et al 2008:1146). Booster coverage can be improved by using written immunization documents, kept by mothers, to track the child's vaccination history and to schedule booster shots.

Primary vaccination coverage was the same for Muslim and non-Muslims in Hyderabad; however, booster coverage was low among Muslims. This drop in immunization could be attributed to "lack of awareness, misconception, avoiding immunization for trivial reasons, migration, declining enthusiasm regarding routine immunization due to repetition of pulse polio immunization campaign" (Khan et al 2007:434).

There are several barriers to improving immunization coverage in India. India's universal immunization programme requires six primary vaccines for infants. The booster shot is included in this schedule, but there is no provision for future scheduling of the shot or monitoring of whether it has occurred (Murkhekaret al 2009:195). Additionally, the Hyderabad health system is overworked due to insufficient numbers of field staff (Murkhekar et al 2009:195). There is not enough time for overworked health workers to adequately discuss with mothers when the next dose should occur. Even though mothers receive a printed immunization card with a suggested schedule and see messages on the walls of the health center about booster shots, many mothers are illiterate. Health

providers need to do a more effective job of communicating information about the importance of vaccinations to families (Bitrangunta et al 2008:1146).

Conclusion

The development of the diphtheria antitoxin, toxin-antitoxin, and toxoid were critical in reducing the spread of diphtheria around the world. Their ability to be mass-produced with high consistency and efficacy allowed for rapid and pre-emptive widespread control. Vaccination programs in Canada and other developed countries have been successful due to adequate funding and infrastructure, public outreach, and medical coverage. This still remains a problem in developing countries like India where despite having the vaccinations, other socioeconomic factors prevent mass immunization. Another problem which persists in both undeveloped and some developing countries is that people are not getting booster shots to retain their immunity. This has resulted in outbreaks in areas where diphtheria was previously under control. Thus, an integrated approach between the medical, governmental, and social outreach sectors is required to maintain vaccination against diphtheria.

7

Diphtheria during Turbulent Times in Hamilton

Samantha P. K. Atkins

Here lies a grave so short and small, 'Twould touch a mother's heart! (The Hamilton Spectator 1901:4).

The Great War, the Spanish Flu, and large-scale urbanization and vaccination movements were some of the major events that left their mark on Canadians during the early part of the twentieth century. Each of these events had far-reaching consequences and an impact on everything from population size to the price of a loaf of bread. By looking at diphtheria rates during this turbulent period, it is possible to see both the direct impact of the disease and the influence of larger historical and cultural events on the people of Hamilton.

Statistics are a valuable source of information for anyone studying history, as they can summarize vast amounts of data and at the same time give context to larger social trends. This chapter takes a mixed-methods approach to diphtheria by analyzing statistical data in Hamilton in the early twentieth century from a socio-cultural perspective. To do so, I examine diphtheria incidence and mortality rates from 1905 to 1935 and attempt to make sense of them within the large historical and cultural events of the period.

The Numbers –A Measure of Grief

Before attempting to understand the larger picture of changes in disease patterns from a social perspective, it is necessary to understand what the figures show and, more importantly, what the numbers say. When examining any data, it is necessary to know the source of the information and, in particular, what possible biases may influence the integrity of the data.

For this study, statistics on diphtheria cases and deaths were collected from the Public Health Reports of Hamilton written by Dr. James Roberts, the Medical Health Officer of Hamilton from 1905 to 1940 (Chapter 10). Rosemary Gagan (1981:82) suggests he may have manipulated some of the reported figures in order to produce the lowest overall mortality rates for the city. Underreporting of cases and deaths from diphtheria also likely occurred, as it is widely recognized that minority populations are not always accurately represented in reported data (Freeman 2001:90).

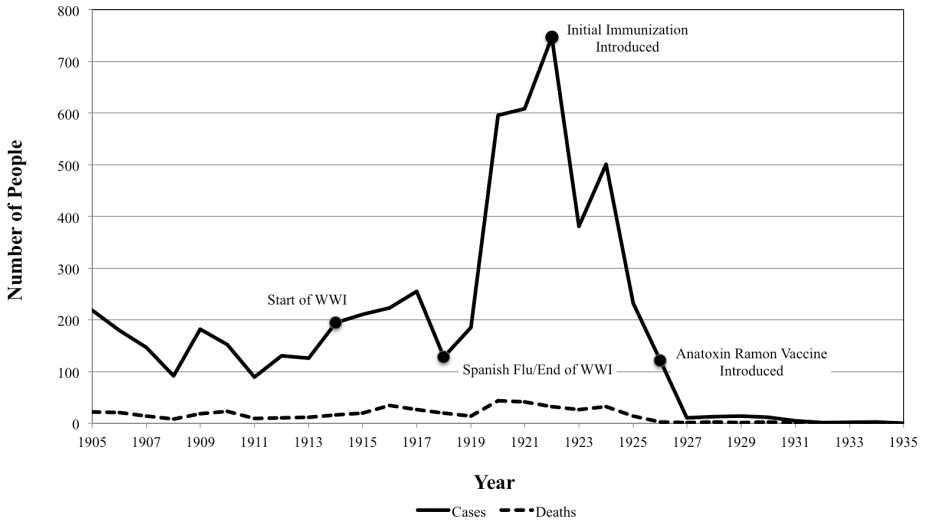


Figure 7.1: Diphtheria cases and deaths in Hamilton from 1905 to 1935 (Hamilton – It's Commerce and Industries 1933:17).

Figure 7.1 shows both the number of cases and the number of deaths resulting from diphtheria from 1905 to 1935. The annual number of cases of diphtheria varied extensively, even more than the number of deaths, and ranged anywhere from 92 (1908) to 747 cases (1922). By and large, cases of diphtheria generally ranged between 100 to 200 cases until the early 1920s, then increased dramatically afterwards. The high diphtheria case rates start to drop by the mid 1920s and by 1931 there are no reported cases of diphtheria.

Diphtheria mortality is relatively consistent, generally ranging between 10 to 25 deaths per year. Even when the number of cases spike during the early to mid 1920s, the number of deaths only increase slightly and range between 25 to 45 deaths. By the end of the 1920s the number of deaths drops off to less than 5 per year, and by 1931 there are zero deaths from diphtheria.

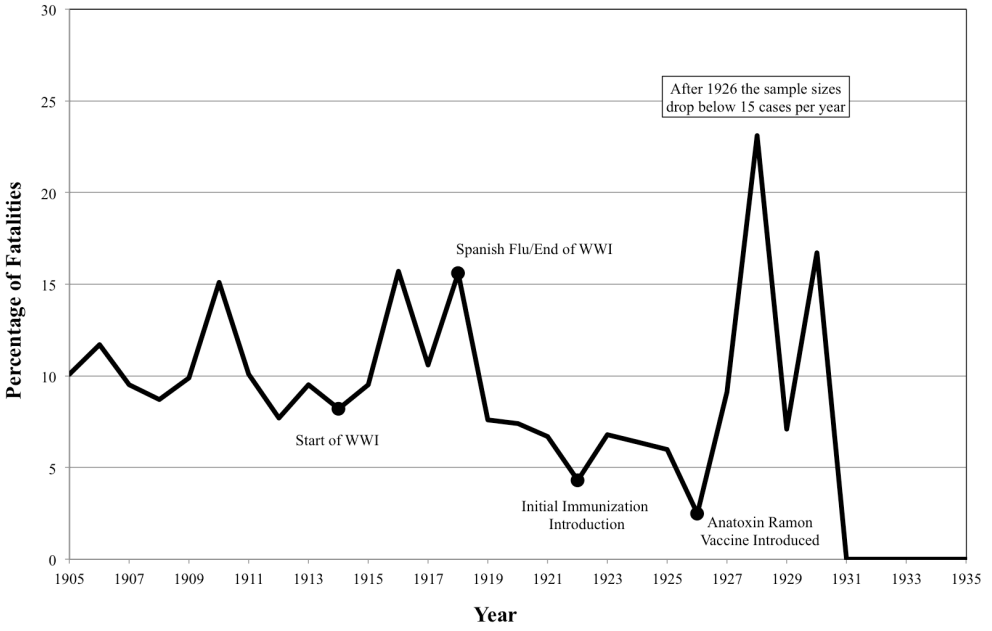


Figure 7.2: Case fatality rates for diphtheria in Hamilton from 1905 to 1935 (Hamilton – It's Commerce and Industries 1933:17).

Figure 7.2 shows the case fatality rate for diphtheria, which is the percentage of people diagnosed with diphtheria who died from the disease. This information is important because it can indicate how dangerous the disease was at any given point in time**,** and can highlight periods of stress in the overall population that could lead to higher fatality rates. It is important to note that there may have been more undiagnosed cases of diphtheria than were listed in the public health records, along with people with asymptomatic diphtheria (Chapter 16). Figure 7.2 shows that fatality rates for diphtheria were relatively consistent from 1905 until the early 1920s, generally ranging from 7 to 15 percent. During the early 1920s, the fatality rates drop and hover between 4 and 6 percent. Fortunately for the people of Hamilton, from 1926 onwards, the sample sizes are too small to make the fatality rates reliable.

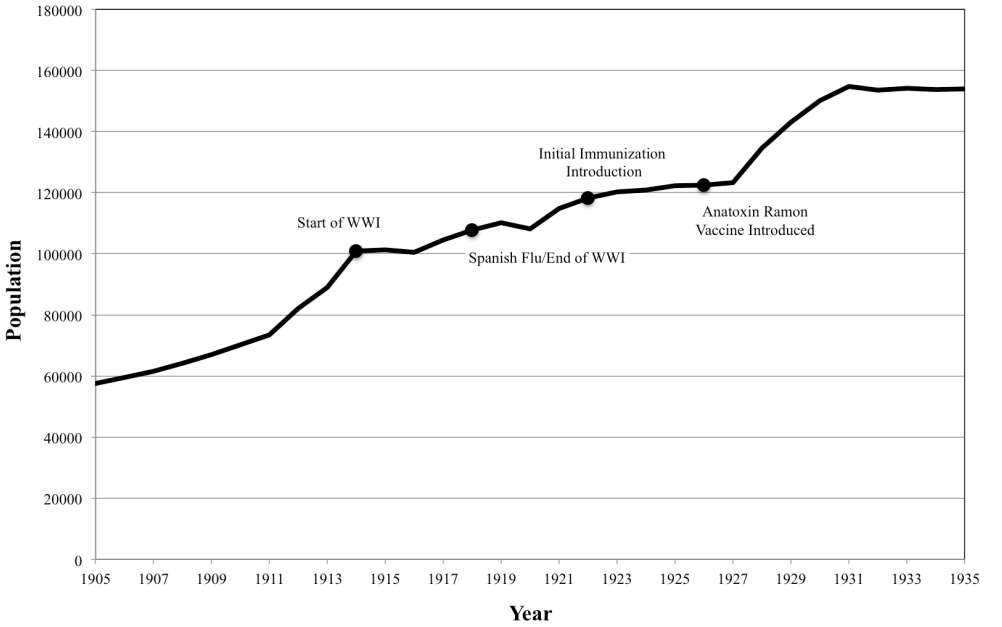


Figure 7.3: The population of Hamilton from 1905 to 1935 (Hamilton – It's Commerce and Industries 1933:17).

Figure 7.3 shows the overall population size of Hamilton from 1905 to 1935 plotted against major social and medical events. It clearly demonstrates that Hamilton underwent a period of rapid population growth from 1911 to the early 1930s. In less than ten years the population nearly doubled, jumping from 60,000 people in 1905 to just over 100,000 in 1914. After the start of World War I, population growth tapered off, before starting to climb again by 1916. By 1927, the population sat at just over 120,000 people and, after another population boom, by 1930 over 150,000 people were living in Hamilton.

Urbanization – A Story of Immigration and Migration to the Big City

City Is Threatened With the Slum Evil

That Was the Statement Made by the Medical Health Officer To-Day

Crusade Is To Be Started Shortly Against the Over-Populating of Homes

That the dreaded slum evil, which is such a perplexing problem in other cities, is fastening its hold on Hamilton and must be dealt with at once, was the statement made this morning by Dr. Roberts the medical officer here, in the course of a conversation on the lessons of the national housing conference, from which he has just returned…He said that here he had found that the habit of people renting houses and subletting them in sections to boarders was beginning to get common in the poorer sections of the city. He told of one instance that came to his notice recently where the mother, father and children were all living in one room, one of the children having scarlet fever. The parents could not isolate the child in another room as lodgers occupied the rest of the house.

Box 7.1: City Is Threatened With the Slum Evil. The Hamilton Spectator (June 10, 1911:1).

Before the turn of the twentieth century, Hamilton had shifted from being a small city near the metropolis of Toronto to an important center for manufacturing (Weaver 1982:94). This shift brought many new factories to Hamilton, which changed the demand for labour from skilled craftsman to unskilled labourers (Freeman 2001:88). To meet this new demand, thousands of immigrants came to Hamilton and found employment working for the lowest wages, doing the hardest jobs (Weaver 1982:93).

This influx of immigrants helped to accelerate the increasing gap between the rich and the poor. This widening socio-economic gap greatly affected the living conditions of the poor and immigrant populations of Hamilton, among whom overcrowding, poor sanitation, and limited access to health care created a breeding ground for all types of infectious diseases (Janjua 2009:20). A 1911 census taker visiting the poverty-stricken areas of Hamilton mentions one house where twenty-eight family members plus boarders lived together, and described the living conditions as "more or less deplorable" (Freeman 2001:89). It is easy to see how extreme overcrowding could quickly lead to the spread of many diseases, diphtheria included. It is also likely that impoverished and immigrant groups lacked access to doctors, contributing to underreporting of the number of cases and deaths from diphtheria recorded in Figure 7.1.

Diphtheria cases generally numbered between 100 and 200 per year until World War I. It is likely that the many economic and social changes during this period contributed to the variability in diphtheria rates. Surprisingly, the pre-war fatality rates for diphtheria, like the case rates, do not rise in association with the huge influx of immigrants to Hamilton. This may reflect the under-reporting of cases, and perhaps exposure to diphtheria in Europe prior to migration.

"Germany is Prepared to Fight The World" - The Hamilton Spectator (August 4, 1914:1)

Monstrous Vanity Embroils Europe

Never Was War So Righteous as That Against Germany

H. G. Wells, the noted author and scientist, in a remarkable analysis of the European conflict, says: "At last the intolerable tension is over and Europe is at war... A victory for Germany will mean the permanent enthronement of the war god over all human affairs; the death of Germany may open the way to disarmament and peace throughout the earth… Never was war so righteous as the war against Germany now: never any state in the world so clamoured for punishment… First, we have to save ourselves and Europe, and then we have to stand between the German on the one hand and Cossack revenge on the other."

Box 7.2: Monstrous Vanity Embroils Europe. The Hamilton Spectator (August 4, 1914:6).

The start of World War I on August 4, 1914 was greeted with excitement by the people of Hamilton. When recruitment for the war started on August 8, Hamilton had the highest enlistment rate, contributing 10,000 of the 30,000 men who signed up from Canada on the first day of enlistment. The citizens of Hamilton also contributed upwards of 4.5 million dollars to the war effort. Despite this ambitious beginning, Hamilton quickly turned into a place of social unrest fuelled by concerns that the large immigrant population would cause trouble, as many of them were from countries that were now enemies of Canada (Freeman 2001:112).

On top of social unrest, in 1913 Hamilton was plagued by an economic depression and it was not until 1915 that work returned to the factories (Weaver 1982:107). By 1916, the lack of available men created a labour shortage, and this ushered in a new work force made up of women (Freeman 2001:122). An unexpected side effect of the war was a new emphasis on the importance of children, which led to concerted efforts from the Board of Health to improve the health standards for children (Rose 2008:85). Unfortunately, the data in Figure 7.1 and 7.2 do not reflect any direct improvement in diphtheria rates during the war, which suggests health care efforts were mostly ineffective. By the end of the war, the 1918 influenza pandemic had hit Hamilton and a massive recession left many of Hamilton's returning soldiers unemployed (Freeman 2001:120).

Before World War I, the number of diphtheria cases never exceeded 200 per year, but once the war started cases increased each year and peaked by 1917 at 255 cases. During the last year of the war, the number of cases dropped dramatically, in association with the emergence of the 1918 influenza pandemic (Spanish Influenza). Case fatality rates also show a general increase during the war years, starting at 8 percent in 1914 and ending at 15 percent by the end of the war in 1918. These fluctuations in case and fatality rates occurred in a population that did not increase by more than 8,000 people during the war, possibly due to the departure overseas of Hamilton's eligible young men.

"Spanish Influenza Rages in Canada" – The Hamilton Spectator (October 12, 1918:1)

Week's Toll of Influenza Five Hundred Cases
Besides Many Which Have Not Been Reported

In the grip of the Spanish influenza epidemic for one week, the total number of cases under the observation of the heath department up to noon-to-day was 507.

Box 7.3: Week's Toll of Influenza Five Hundred Cases. The Hamilton Spectator (October 12, 1918:1).

World War I ended in November of 1918 but thousands of sick and wounded soldiers had already been sent back to Hamilton, some of whom suffered from influenza. Some of the earliest cases of the flu occurred among the Hamilton military population (Meyer and Mayer 2006:47). The epidemic was worse from September to December, and deaths from influenza peaked in November with 194 deaths (Persaud and Venus 2006:33). This flu pandemic was unique in targeting young adults, unlike previous influenza strains that affected children and the elderly (Chan and Kluge 2006:57). Even though health care officials understood the need for an organized health care system to reduce communicable diseases, it was not until the influenza pandemic that real change occurred (Janjua 2009:21). These changes included increased funding to the Board of Health and health care institutions, which lead to a notable decrease in overall mortality rates for Hamilton (Manning 2006:193). This emphasis on improving health care also created more interest and funding for vaccinations, contributing to the introduction of the first diphtheria vaccine in 1922 (Manning 2006:195; Deadman 1933:138).

The end of the war and the Spanish Flu in 1918 were associated with a drop in the number of cases of diphtheria. By 1919, the number of cases began to increase and by 1920 they had skyrocketed to 596. Diphtheria cases remained high from 1920 to 1922, possibly related to the severe recession Hamilton experienced during these years. The recession also appears to coincide with the dip in population and high unemployment rates in Hamilton, suggesting that the recession inhibited population growth. Despite the dramatic rise in diphtheria

cases at this time, fatality rates declined rapidly and continued to decline until the introduction of the first diphtheria vaccine in 1926. This reduction in fatalities may be related to the major health reforms triggered by the Spanish Influenza (Janjua 2009:21). By the time the war and Spanish Flu had passed, the population of Hamilton was on the road to recovery.

Vaccination - Freedom From the Menace of Diphtheria

Dr. Roberts is Smiling - Has Succeeded in Stamping Out Diphtheria in the City

Dr. Roberts announced this morning that there was not a single case of diphtheria in the city at large.

Box 7.4: Dr. Roberts is Smiling. The Hamilton Herald (April 5, 1910:1).

Before the development of the diphtheria vaccine, the disease was a leading cause of death for children aged one to fourteen (Gagan 1981:106). Due largely to the turbulent events of the first two decades of the twentieth century, the focus of the Board of Health shifted from disease containment to the eradication of infectious diseases, and to improving the general health of the people of Hamilton. Dr. James Roberts is often credited with leading the charge in disease prevention and educating the public, particularly parents, on proper health procedures (Gagan 1981:193).

The first immunization for diphtheria, a toxin-antitoxin serum, was introduced in 1922 and Figure 7.1 shows that cases of diphtheria drop by almost 50% the following year (Deadman 1933:138) (Chapter 6, 14). Cases increased again in 1924, but the graph clearly shows that from this point onward the threat of diphtheria is nearly over. The experience of diphtheria changes again in 1926 with the introduction of the new "anatoxin Ramon" vaccine (Chapter 6), and the number of cases and deaths drop off continuously thereafter (Deadman 1933:138). This new vaccine effectively brought an end to diphtheria in Hamilton, such that by 1933 there were zero cases and zero deaths. What is even more telling is that by 1937, the Annual Health Report no longer lists diphtheria as a communicable disease, indicating that the people of Hamilton no longer had to fear this terrible disease (City of Hamilton 1937).

Turbulent Times Are Over

The early twentieth century was a time of great change for Hamilton, with many major socio-cultural transformations. Increased urbanization and immigration, World War I, the Spanish Influenza, and the introduction of life saving treatments and vaccinations all left their marks on the people of Hamilton. By looking at diphtheria rates during these turbulent times, it is possible to see both the direct effects of this terrible disease on families, as well as the impact major events had on disease rates. While it may not be considered one of the most significant historical events in the city, the complete eradication of diphtheria in Hamilton should be recognized as an impressive achievement that stopped the suffering of thousands of children and their families.

8

The Leading Causes of Death in Hamilton in the 1920s

Isabel Krysa

Mortality statistics should appear in local newspapers with as much regularity as records of the weather bureau, - not as headlines to appear only when there is an epidemic of some disease, but in such a way that the reader would come to look at these rates as a matter of course, and notice whether the figures were high or low (George Porter 1989: 161).

Pediatric diseases, also known as "infectious childhood diseases", have been a disease category since the 1800s. They often affect children between the ages of one and eight. There were many pediatric disease outbreaks in Hamilton throughout the years, such as tuberculosis, measles, and mumps, however, some were more deadly and dangerous than others, and took the lives of thousands of children. In this chapter I discuss three diseases that affected children in the 1920s: influenza, typhoid fever, and smallpox in order to provide an understanding of the parts of the body they affect, their symptoms, and how they are similar or different from diphtheria. The social and economic state of Hamilton during the 1920s provides insight into why deaths from these diseases differed, depending on the year under scrutiny.

One of the aims of this chapter is to determine whether diphtheria was the most deadly disease for Hamilton's children in the 1920s. I explore diphtheria's rank in comparison to these other three diseases using Public Health Reports from 1920-1929 (City of Hamilton 1920-1929)**.** A second aim of this chapter is to examine which age groups were most affected by these terrible diseases. Since childhood diseases are a great worry for parents, a third aim of this chapter is to consider the emotional reaction of parents to diphtheria, in view of the fact that their child could contract it at any time.

Influenza, Smallpox, and Typhoid Fever

Influenza, small pox, and typhoid fever were frequently occurring diseases in Hamilton's Public Health Reports from 1920 to 1929 (City of Hamilton 1920-1929). Influenza typically occurs during the winter months and is a contagious infection of the throat, lungs and nose. Symptoms often include vomiting, coughing, sore throat and fever. Shockingly, the presence of a sore throat in influenza sufferers can be mistaken for a case of diphtheria and therefore the two diseases are difficult to distinguish. Influenza spreads in tiny droplets coughed and sneezed into the air. Much like diphtheria, influenza is also most common in children (Harper et al 2004:1). Smallpox is a serious, contagious and sometimes fatal disease caused by the variola virus. Small, pus-filled blisters form on the external surface of skin. Like diphtheria, smallpox is contagious and affects the internal organs. Smallpox was eradicated by the WHO in 1980 but diphtheria is still present today. Typhoid fever is a bacterial fever that causes red spots on the chest and abdomen. Like diphtheria, it is very contagious and affects mostly children.

Diphtheria

The rise in diphtheria cases in Canada began in the 1920s. From 1921 to 1924, diphtheria was the most common cause of death in Canadian children 2-14 years of age (Fitzgerald et al 1932:26) and in 1924, 9,057 cases were reported in Canada. One in ten of those who contracted the disease died (Munford et al 1974:1891). In 1920, the attack rate was 151 cases per 100,000 population

(147,991 reported cases). From 1921-1924, diphtheria ranked first as a cause of death in Canadian children (Fitzgerald et al 1932:26).

The picture was similar for Hamilton. A total of 148 deaths from diphtheria were reported in the 1920s, compared to 182 from influenza, 17 from typhoid fever, and 16 from smallpox (Table 8.1). With the exception of cases of influenza in 1920, 1922 and 1925, diphtheria deaths exceeded those from influenza, typhoid fever and smallpox from 1920 to 1929. Diphtheria was prevalent throughout the 1920s, with some 300 to 500 cases reported annually until 1925. In 1924, 501 cases were reported (an increase of 120 over the previous year), which Dr. Roberts attributed to "dirt, overcrowding, and lack of clean and well-fitted appliances [which] are factors in the spread of respiratory and other forms of diseases" (City of Hamilton 1924:24).

By 1925, however, the cases and deaths from diphtheria had decreased dramatically to 47 cases and 14 deaths. By the end of the 1920s, only 14 cases were reported with one death of a 6-year old boy (City of Hamilton 1929:10). This reduction is directly related to the public health initiative introduced in the late 1920s in which 1,852 school and 1,788 preschool children were immunized, and due to better health and sanitary inspections. The City of Hamilton (1920:11) promised that "The Sanitary Inspection of the City will be more systematic and thorough throughout the years and will continue through the 1930s."

	Diphtheria	Influenza	Typhoid Fever	Smallpox
1919-20	44	120	9	0
1921-22	32	1	1	0
1922-23	26	42	2	0
1923-24	32	1	1	0
1924-25	14	5	1	0
1926	3	13	0	0
1927	1	N/A	0	0
Total	152	182	14	0

Table 8.1: Number of deaths from communicable diseases from 1920-1929, Hamilton, Ontario (City of Hamilton 1920-1929).

Influenza

According to the Public Health Report for 1920-21 from the City of Hamilton, "120 cases have been notified from influenza and out of these, 114 deaths occurred in February and March". These were the two months in which the influenza epidemic was at its height: 3,956 cases were notified in these months, for a total of 4,008 cases in 1920 (City of Hamilton 1920:5). Six influenza cases were reported during 1922, with only one death, as compared to 23 cases and 7 deaths in 1921; this shows a slight improvement. During the months of January and February in 1923, a small outbreak of influenza occurred: 11 cases were reported in January and 103 cases in February. In all, a total of 115 cases were reported with 42 deaths (City of Hamilton 1923:16). Due to the increase in influenza cases, 355 children were sent to Fresh Air Camp in Burlington where they could be examined for diseases.

Influenza seemed to be most prevalent in 1920, with a total of 120 deaths. It decreased dramatically a year later with only one reported death. In 1923, deaths increased in the winter months due to individuals staying indoors and overcrowding schools, easily spreading the bacteria amongst one other and bringing it to other homes. Influenza tends to increase and decrease from year to year, however, deaths are not dramatically high after 1923. This can be attributed to precautions taken by public health officials to make Hamilton a cleaner city. No information is provided on influenza for the years 1928 and 1929.

Small Pox

Smallpox cases occurred throughout 1920. In 1922, only 14 cases were reported, of which seven occurred in June, and no deaths were reported. Ten cases were reported in 1923, which is lower than the previous year, and no deaths occurred (City of Hamilton 1923:17). No cases or deaths from smallpox occurred in 1924. In 1925, only one mild case was reported (City of Hamilton 1924:17). From 1926 to 1928 only a couple of smallpox cases were reported, and all were contracted outside of the city (City of Hamilton 1928:78). Overall, smallpox declined from 1920 onward and no deaths occurred throughout the 1920s because the cases were relatively mild.

Typhoid Fever

In 1920-21, 59 cases of typhoid fever were reported, 35 of which were contracted outside the city while citizens visited friends or temporarily resided elsewhere. The sources of infection for the 24 cases contracted in the city were not known (City of Hamilton 1920:10). In 1922, 21 cases were reported with only one death recorded. Dr. Roberts states that typhoid has its origins in water, milk, or other foods or by contact with an actual case or a carrier of the disease. The relatively small number of cases of typhoid in Hamilton suggests that the milk and water supplies were satisfactory (City of Hamilton 1922:15). In 1923, thirteen cases of typhoid fever were reported with only one death. Of the thirteen cases reported, six of them were contracted outside of Hamilton. This is a slight improvement over 1922, in which two deaths were reported (City of Hamilton 1923:16). In 1923, two deaths were caused by typhoid fever. Thirteen cases of typhoid fever were reported in 1924 with one death. The number of cases of typhoid fever improved throughout the years because milk and other dairy products were pasteurized, killing the typhoid-causing bacillus (City of Hamilton 1924:16). In 1926, ten cases of typhoid fever were reported, seven of which were contracted outside of the city; no deaths were recorded. Only three cases of typhoid fever were reported in 1927. This reduction in typhoid fever may be connected to chlorination of the city's water supply (City of Hamilton 1927:78).

Who Was Most Affected?

Children were most affected by diphtheria, especially young ones attending school. *Corneybacterium diphtheriae* could spread easily from child to child, especially since the schools were considered to be unsanitary and overcrowded (City of Hamilton 1921:18). Statistics for Canada as a whole indicate that the highest attack rates from diphtheria occurred among children aged one through nine years of age. Diphtheria accounted for over 15 per cent, or 1 in every 7 deaths, in that age group. The annual mortality rate per 100,000 population varied from 14 to 23. The number of deaths in a year varied from 1,281 to 2,072. It is highly significant that approximately one-quarter of the cases and one-half of the deaths occurred in children under 5 years of age (Fitzgerald et al 1932:26).

Table 8.2 shows the childhood age groups affected most by diphtheria in Hamilton. Male and female deaths were similar in each age group. Children aged 2-3 years of age had the most deaths (46), followed by children aged 4-5 years of age (45). Dr. Roberts attributed these deaths to poor sanitary infrastructure, deficient water supply, and inadequate housing. In particular, he identified defective or absent drains and sewers; defective sewer traps; defective waste pipes and traps; lack of water supply; defective, dangerous or absent eaves troughs and rainwater leaders. Together, these defects caused damp conditions in homes or dirty walls, ceilings and floors, which affected children living in those homes (City of Hamilton 1924:19). Children aged 4-5 were also heavily affected by poorly equipped and crowded schools which were unsanitary and needed repairs, especially closets, sinks, washbasins and urinals (City of Hamilton 1921:18).

Child Age Groups	Male	Female	Total
Under one year	14	9	23
1-2 years	13	13	26
2 to 3 years	23	23	46
3 to 4 years	20	12	32
4 to 5 years	21	24	45
5 to 6 years	18	16	34
6 to 7 years	13	13	26
7 to 8 years	17	18	35
8 to 9 years	4	10	14
	143	138	281

Table 8.2: Childhood deaths from diphtheria, by age, Hamilton, Ontario, 1922-1923 (City of Hamilton 1922-1923:11).

Was Diphtheria Frightening?

In the 1920s, public health officials blamed parents for not taking the proper precautions to protect their children against diphtheria. Dr. Roberts advised parents to “confine children to their own premises and let them know playing on the streets is unnecessary and very dangerous” (Hamilton Spectator 1922). In 1921, Dr. Roberts announced an immunization program for diphtheria, and stated it is the “only safeguard”; “parents who neglect to take this precaution have

themselves to blame if their children should be numbered among the victims". He warned that "parents who refuse to protect their children through a mistaken feeling of compassion, are not acting with kindness but the reverse" (Hamilton Spectator 1921). These strongly worded warnings suggest that diphtheria may not have been as frightening to parents as one might think.

Although I was unable to locate accounts of parents' anxiety and worry about diphtheria, Bretonneau (1859) shows just how fast and gruesome deaths can be from this disease. He describes how a child who was eight years old and who had complained about a sore throat a few days earlier was brought into an infirmary with a "pale complexion, sunken eyes, foul breath" and "with soft parts in the back of the mouth grey tint colour" (Bretonneau 1859:11). This child was thought to be completely recovered, when he complained of a feeling of suffocation. Bretonneau states the child described his own death, saying "he uttered some piercing cries and died, saying that a beast was devouring his inside" (1859:12).

Although parents may not have taken proper precautions to protect their children, perhaps they were unaware of how terribly quick and gruesome death from this disease can be. Even though diphtheria was not the major killer of children in the 1920s, it was certainly a horrible experience for parents and children who suffered from this disease.

Final Words

Diphtheria has been regarded as one of the most dreadful diseases that can fall upon children; not only is it dangerous to life, but its after effects on patients who do not succumb to the disease are frequently very serious, causing damage to the body and generally impairing health (City of Hamilton 1922:14). In the 1920s, diphtheria was ranked the second major killer out of four diseases presented. Influenza ranked first with 182 deaths, diphtheria ranked second with 152 deaths, typhoid fever ranked third with 14 deaths, and smallpox ranked fourth with 0 deaths. The childhood age group affected most by diphtheria was 2-3 years of age. One can conclude that despite its ranking, diphtheria was a frightening and painful disease that should have galvanized parents into action.

9

Béla Schick's Work Saved Millions

Saima Tufail

Children are our future. The more I have studied the child, the more I have admired nature for accomplishing this miracle of creation (Béla Schick 1923 as cited in Pasquale 2006:2).

Diphtheria, one of the most prevalent childhood diseases in the early 1900s, was ranked second in 1901 and tenth in 1911 on the list of infectious disease killers. It frequently occurred in cycling epidemics, predominantly in developing industrial regions (Freeman 1932:271, Galazka et al 1995:95). Unsanitary living conditions and cramped spaces facilitated the transmission of this disease, which spread though droplet secretions from the nose or mouth (Freeman 1932:271, Galazka et al 1995:95). In 1904, the mortality rate from diphtheria was approximately 4.1 per 10,000 (Gagan 1981:161). The threat of diphtheria grew significantly during the late nineteenth century and became one of the major causes of death. Although diphtheria was mostly associated with the poor and was a particular threat to children, it did not spare or discriminate by class and age and its cause, route of spread and cure remained a mystery until the last part of the nineteenth century.

This chapter explores the use of the Schick test in the quest to develop a way to provide immunity against the deadly disease of diphtheria. I focus on the

20-year period between 1910 and 1929, when diphtheria was most prevalent in Hamilton and Béla Schick invented the Schick test. I provide a history of the inventor of the test whose personal story highlights the social and medical climate of the period. I also discuss the steps involved in performing the test, and the overall role the Schick test played in immunization against diphtheria. The ultimate goal of the chapter is to provide a discussion and appreciation of the overall value of the Schick test in the history of immunization.

The Children's Doctor

Béla Schick, a premature infant, was born at Boglár, Hungary on July 16th 1877 to Jacob (a grain merchant) and Johanna Pichler Schick. Quoting the Talmud at a young age, "The world is kept alive by the breath of children", Schick convinced his father to allow him to attend medical school and pursue pediatrics rather than enter the family grain business (Pasquale 2006:6). After earning his M.D. at Karl Franz University in Graz, Austria, he began a medical practice and joined the medical faculty at the University of Vienna (Pasquale 2006:6).

Béla Schick served in the Austro-Hungarian army for approximately six months and then returned to Graz where he became a voluntary assistant in the clinic of Professor Theodore Escherich. In 1902, after Professor Escherich left Graz to accept the chair in pediatrics in Vienna, Dr. Schick was asked to accompany him. In Vienna, Dr. Béla Schick was appointed to work with an assistant known as Dr. Clemens von Pirquet at the Children's Clinic of the University. They immediately began conducting research on serum sickness. In 1905, Schick and von Pirquet defined the concept and treatment of allergy, previously known as "serum sickness", based on the body's antigen-antibody response (Pasquale 2006:6). In 1902, Schick and von Pirquet (Box. 9.1) observed that a few children suffered severe reactions to the new antisera for infectious disease, which was derived from the blood of animals (mainly horses). Schick observed a young boy's reaction to antiserum for scarlet fever. He became very ill and developed generalized itching seven days after receiving the injection. After his second injection of diphtheria antiserum fifty days after his first dose, another child vomited within fifteen minutes and showed signs of swelling on his face.

In the early 1900s, Béla Schick and Clemens von Pirquet were conducting research on the natural history of infectious diseases and the reactions caused by vaccination. They faced several clinical challenges in treating their patients during a diphtheria epidemic in the pediatric wards in Vienna. Children treated with antiserum for diphtheria developed severe systematic reactions, including fevers, rashes, diarrhea, falling blood pressure, enlarged lymph nodes, joint pains and breathing difficulties which began 8-12 days after injection of the horse serum. This serum therapy consisted of injecting *hyperimmune heterologous serum* (antitoxin) into human subjects suffering from a particular disease. The serum was produced in animals, usually horses (equine), and contained antibodies against only one antigen. The physicians noted that the incidence and severity of the reaction caused by the antiserum following the injection depended on the amount of serum employed. They began to understand that the disease itself required the development of hypersensitivity to the foreign serum and did not depend on the intrinsic toxicity of the serum.

In 1905 in a classic monograph titled "Die Serumkrunkheit" or "Serum Sickness", Béla Schick and Clemens von Pirquet coined the word "allergy". They provided a detailed description of human serum sickness to designate the illness which was often seen after the therapeutic administration of horse serum containing diphtheria antitoxin. Béla Schick subsequently translated this monograph into English and provided remarkable clinical features of the disease as well as great details of its pathogenesis.

Box 9.1: Dr. Béla Schick and serum sickness (Zweifach et al 2014:651).

Building on this research on antigen/antibody reactions, in 1913 Schick developed a simple method for determining susceptibility to diphtheria using toxin from diphtheria organisms. This method became known as the Schick test. In 1923, Schick became a leader in the public health campaign to vaccinate children against the disease (Pasquale 2006:6). That same year, he left Vienna for the United States, where he became pediatrician-in-chief at Mount Sinai Hospital in New York City and a professor of disease of children at Columbia University (Pasquale 2006:6).

Dr. Schick also conducted important research on scarlet fever, tuberculosis and the nutritional needs of newborn children. He introduced

isolation cubicle for infants as well as extended opportunities for promising female physicians. Schick helped Mount Sinai become a training ground for women who went on to pioneering careers in medicine. In his 1932 guide to child rearing titled *Child Care Today*, Schick argued against spanking and provided evidence for the lasting effects of early trauma on children. Along with several other physicians, he founded the American Academy of Pediatrics and received many honors for his work, including the Medal of the New York Academy of Medicine and the Addingham Gold Medal. On December 6th 1967, Schick died at Mount Sinai Hospital in New York City (Pasquale 2006:6).

What Is the Schick Test and How Is It Performed?

In 1913, pediatrician Béla Schick introduced a clinical test capable of dividing a population into people susceptible and non-susceptible to diphtheria. The test involves the introducing an antigen between the layers of the skin and then observing the reaction to the injection. A diluted diphtheria toxin is injected into an individual's forearm and the same amount of heat-inactivated toxin is then injected into the other arm (Zingher 1917:392)

Figure 9.1: Schick test (Sharrer 1915).
Image courtesy of G. Terry Sharrer, Ph.D. National Museum Of American History.

In order to be immune to diphtheria he/she should present a negative reaction to the test and have about or more than 1/30th of a unit of the specific antitoxin per c.c. in his/her blood. Individuals who have Schick-positive results possess a serum antitoxin level of more than 0.01 AU/mL (Zingher 1917:392). In non-immune individuals, the diphtheria toxin creates an area of redness in roughly eighteen hours that grows in size and intensity in three to five days; a

central area of necrosis may develop. Injections of antitoxin give protection from diphtheria for up to seven years.

Diphtheria in Hamilton

Studies of diphtheria deaths in Hamilton reveal that it was a major cause of child mortality. Coreil and colleagues (1997) assessed child deaths recorded in the death records for Hamilton for 1901 (Government of Ontario 1901) and found a total of 211 child deaths divided into some 56 diverse causes of death. In 1911, 328 child deaths were documented, along with roughly 83 different causes of death. Diphtheria was the second largest cause of death among children in 1901 and was ranked number 10 for the year 1911 (Coreil et al 1997:154-55). During diphtheria epidemics, school closures often took place to exclude sick children, yet this did not solve the problem or prevent future outbreaks (Sutherland 1976:41). For example, following an outbreak of diphtheria, Victoria Avenue School was closed on June 15, 1905 (The Hamilton Spectator June 15, 1904:5). The outbreak took the lives of numerous students, including a seven-year old girl named Hilda Watson, whose death prompted the school's closure (The Hamilton Spectator June 15, 1904:5). Several children with diphtheria had been sent home only to return untreated, one even with a doctor's note affirming that the child was "perfectly fit to attend school" (The Hamilton Spectator June 15, 1904:5).

Hilda Watson's sore throat had gone unnoticed by parents and teachers, leading to her unfortunate death The Hamilton Spectator June 15, 1904:5). Clearly, school closures were not an effective approach for preventing disease from spreading from one student to another. As a result of high mortality rates from diphtheria, the Hamilton Board of Health in conjunction with Hamilton Board of Education began to implement new strategies, including the Schick test, aimed at reducing disease transmission and improving the overall health of children in schools.

The Schick Test and Immunization

The Schick test was part of an early public health campaign in which several of radio stations and newspaper outlets asked the general public "Have you been Schicked?" (Rosen 1958:377). Diphtheria immunization was routinely done on

children near the end of the first year of infancy. Although diphtheria antitoxin was available to treat patients once the disease had been diagnosed and had proved to be effective, it was not until 1913 that the Schick skin test was developed to determine immunity to diphtheria.

The first large scale immunization programme for school children was implemented and carried out in New York City in 1920 to lower the high mortality rate from a diphtheria epidemic (Rosen 1958:337). Diphtheria was believed to be preventable by the universal use of the Schick test and diphtheria toxoid (Lawley et al 1985:129). Thousands of children were tested, which allowed a deeper understanding of the epidemiology of the disease (The British Medical Journal 1967:750). The test was not only used to indicate the immunity of the children but it was also of great value in active immunization with diphtheria toxin-antitoxin (Zingher 1917:392).

In 1941, the Air Council approved routine Schick testing and subsequent immunization of all susceptible air force personnel (Feasby 1953:34). This action followed severe outbreaks of diphtheria during which Schick tests on large numbers of trainees showed that susceptibility was much higher than expected (Feasby 1953:35). The decline in mortality from diphtheria was attributed to the effectiveness of antitoxins and later to immunization programs (McKeown 1975:275). This illustrates how large-scale Schick testing and preventive inoculation in communities lead to an overall decrease in mortality rates from diphtheria.

During the diphtheria epidemics between 1901 and 1910 in Hamilton (with a population of 175,000 people), not a single case was diagnosed after large scale Schick testing was implemented. In Quebec, where these general preventive measures were not adopted, deaths from the disease were more numerous. Following the adoption of general testing and preventive inoculation in New York, cases of diphtheria dropped from over 8,000 in 1929 to 1,143 in 1936, and the number of deaths fell from 463 to 35. In Toronto, where between 1926 and 1930 there were never less than 50 deaths a year from diphtheria, no deaths occurred between 1934 and 1937 (The Hamilton Spectator May 5 1939:12).

The Legacy

The development of the Schick test was an important milestone in the goal of providing immunization against diphtheria; it also helped shape medical history. Additionally, it was the most accurate way of determining one's susceptibility to the disease and thus quickly came into widespread use. The Schick test was widely used throughout the ensuing decade until, in 1923; scientists developed an anti-toxin with fewer side effects that could be given safely to all babies during their first year. The Schick test is prone to error, due either to inaccuracy in the measurement of small amounts of undiluted toxin or to improper technique in mixing the toxin and saline. Diphtheria immunity is a relative and not a "solid" immunity; however the universal performance of immunization affords tremendous protection against diphtheria. The test was an important milestone during the epidemic of diphtheria as it allowed doctors to take special precautions for susceptible individuals and protect them before it was too late (Wright 1917:265).

None of this would have been possible without the work and dedication of Béla Schick. Throughout his life, he was admired for his art as a clinician, his discoveries in theoretical science, his ability to translate his theoretical studies into clinical skills and social action, and for spearheading public health policies.

10

Dr. James Roberts, Hamilton's Faithful Servant

Antonija Vistica

I must admit that I personally measure success in terms of the contributions an individual makes to her or his fellow human beings (Mead 1979:249).

The Medical Health Officer is notably one of the oldest and most crucial components in the modern system of public health administration. Although the position and status of these officers varied between locations, these individuals played vital roles in society. The Medical Health Officer, or M.H.O, was defined as the "man close to the people" (Roberts 1920:349). The M.H.O was heavily involved in keeping the public informed on its conditions and made decisions on how and when to act regarding health concerns. The primary task of health officers was to control epidemic outbreaks and contagious disease, although their practice was not strictly limited to work in the preventative field. The responsibilities of the M.H.O went beyond the field of medicine, as hygienic education became a fundamental aspect of keeping the public aware of the management and prevention of disease (Roberts 1920). One of the most prominent public health figures in Hamilton during the diphtheria epidemics of the early twentieth century is Medical Health Officer Dr. James A. Roberts. This

chapter highlights the work of Dr. Roberts and his impact on the field of medicine and on the fight against diphtheria.

Born in 1877 at Woodhouse, Ontario, James Roberts grew up on a farm alongside the members of his large family. According to his successor, Dr. J. Edgar Davey, Roberts was a "self-made man" (The Hamilton Spectator 1952). Roberts worked his own way through school, leading him to study medicine at McGill University. Due to his upbringing, Roberts took a special interest in and sympathized with disadvantaged people. As a result, part of his work within the public health sector focused on providing aid to the less fortunate within the city. Roberts was recognized as "highly cultured", a man who travelled, read a great deal of literature and possessed a retentive memory (The Hamilton Spectator 1952). Dr. Roberts began practicing medicine in the Muskoka district in 1900. Ultimately, he moved to Hamilton to work as a senior physician and in 1905, at the age of 28, accepted the position of Medical Health Officer (M.H.O) for Hamilton. He focused much of his work into reconstructing public health care and within his 35 years as medical health officer, he greatly improved Hamilton's living conditions. After suffering from a heart ailment for several years, Roberts passed away from a severe attack in 1940 at the age of 64 (The Hamilton Spectator 1940). Dr. James Roberts is recognized as one of North America's leading public health reformers (Benn 2006:128) and he is remembered for his strong personality, one that never quite followed the rest of the "herd" (Gagan 1989).

Shifts in Public Health Practice

Dr. Roberts's efforts to improve healthcare in Hamilton was reflected in the ways in which he approached his position as M.H.O Originally, the duties of Hamilton's health officer were limited to recording and isolating contagious diseases that affected the public. However, Roberts took alternative approaches to develop the public health movement. Initially, the work of the medical health officer remained a private practice due to an inadequate annual salary (Gagan 1989). The issue of funding and the imperfect organization of the urban M.H.O became an obstacle to the progress of health work within Hamilton (The Hamilton Spectator 1922). Roberts declared in 1919 that his income – which had been issued by the municipality – was "unfair and unreasonable" (The Hamilton

Spectator 1919) and demanded a salary increase to $5000 a year. In 1923, Roberts reported that the adjustment made after his 1919 statement was not reflected in his income and claimed he was not being paid for his work. Dr. Roberts voiced these concerns as fellow health officers working in cities such as London, Windsor, Ottawa and Toronto were receiving annual salaries ranging from $5,000-$8,000, individuals who had less experience than Roberts in terms of the number of years of service in Ontario (The Hamilton Spectator 1923). Dr. Roberts actively worked for the improvement of services and acknowledged that the lack of administrative bodies prevented him from doing so (Roberts 1922). By 1927, Roberts was awarded an annual income of $7,500 in recognition of the increasing responsibilities of the medical health officer (The Hamilton Spectator 1927).

As a practitioner of medicine in the early twentieth century, Dr. Roberts was profoundly influenced by new theories in public health. In an article written in 1922 for the Hamilton Spectator (1922), he addresses transformations in the understanding of disease. Whereas once great emphasis had been placed on environmental determinants of disease, now epidemiological and laboratory studies prevailed. Modern theories of infection stressed the influence of person-to-person contact, the interaction of bodily fluids/excretions, and the transmission of pathogens through direct and indirect means. Additionally, sanitation practices had shifted to correspond with these new perspectives. The control of

1907: The start of medical inspection in schools
1912: First housing survey in Canada commenced
1916: Pasteurization of milk advocated by Dr. Roberts
1921: Health center established
1922: Immunization for diphtheria begins
1924: Mental health clinic established
1927: Chlorination of water established
1928: Pasteurization of milk now mandatory in Hamilton
1933: Filtration plant built
1934: School medical services and health department join together
1938: Testing for tuberculosis begins in secondary schools

Box 15.1: Achievements according to Dr. J. Davey (The Hamilton Spectator 1952).
Image of Dr. James Roberts (1935) courtesy of The Hamilton Spectator.

communicable diseases was executed through new methods of sewage and water maintenance, clean milk initiatives, school hygiene, public health education, industrial hygiene and supervision of housing conditions (Roberts 1922).

Roberts understood public health through more than just a medical standpoint – he was concerned about emerging socioeconomic issues pertaining to Hamilton's urban growth (Gagan 1981). He recognized that overcrowding, poverty and unsanitary conditions were a danger to the health of its citizens, noting "…the last decade has witnessed a marked improvement in the sanitation of rural homes with regard to essential features, but in many sections the earmarks of progress are still sadly lacking. Respiratory infections from neglect of personal hygiene and circulatory disturbances from exposure and overwork, are very prevalent" (Roberts 1922).

From 1910 onward, Roberts dedicated more of his time towards inspecting sanitary conditions in Hamilton. He believed that the physical expansion of the city required "constant watchfulness" in order to avoid epidemics and high death rates (Gagan 1981:174). Roberts did not limit the focus of his work to the homes of Hamiltonians; instead, he continued his improvement of overall public health by taking on the hospital board. Dr. Roberts argued the hospital was a source of multiple cases of cross-contamination and he accused his predecessor, Dr. Walter Langrell, of neglect. Roberts argued it was necessary to record all instances of contagious disease treated at the hospital, sparking debate with Langrell. Langrell opposed this process, while a member of the board declared Roberts as "lacking understanding in many areas" (Gagan 1981:162). Still displeased with the conditions, Roberts campaigned for a new isolation hospital separate from the city hospital. This campaign emerged from Dr. Roberts's primary interest in the treatment and recovery of patients, and in the consequences of illness. More specifically, Roberts understood that social and economic stresses were made worse when a member of a working class family was affected by sickness:

> The bread winners in all of these instances with other members of the family, who contribute to the weekly income, were compelled to submit to the inconvenience, the hardships and the monetary losses of seeking homes or boarding houses elsewhere. Let me tell you that the weekly incomes of the bread winners, even when augmented by additions from an older boy or girl, are not sufficient

> in a large percentage of cases to stand any avoidable strain, especially in these strenuous times. (cited in Gagan 1981:163).

Roberts had been one of the few to recognize and identify illness as a factor that had the potential to jeopardize a family's ability to survive. The cooperation of each member of a family allowed them to endure the pressures of day-to-day living (Gagan 1981). Lastly, the concept of "mental hygiene" became an important aspect in the future program for public health. Dr. Roberts acknowledged that many physicians "did not recognize the importance of considering these two departments, physical and mental hygiene, as inseparable and representing two phases of one great problem" (Roberts 1922). He argued that the spirit of health greatly relied on the mind; health went far beyond the scope of physical disease control. Roberts hoped to not only achieve a reduction in infection but also to ensure all individuals led long and happy lives (Roberts 1922).

The Fight Against Diphtheria

Diphtheria prevention was one of the many tasks with which Dr. Roberts concerned himself from 1905 to 1914. After his death in 1940, obituary reports praised Roberts for this aspect of his life's work (Gagan 1981). In April of 1910, Dr. Roberts announced, for the first time in his career as M.H.O., diphtheria had been eradicated from Hamilton. However, this statement proved to be false by the end of 1910. With 152 cases of diphtheria reported and a death rate of 15.1 percent, the disease was still prevalent and efforts to eliminate it carried on. Roberts was involved in several initiatives to reduce the threat of diphtheria, including an increase in lab testing for *C. diphtheriae* and education programs for parents about 'proper childcare' (Gagan 1981). Dr. James Roberts continuously battled for the "modernization of his department" (The Hamilton Spectator 1925). In order to better provide clinical services to the public, Roberts pushed to relocate the health department into the old public library. By 1921, a new health clinic was established, providing education and medical service to the parents and children of Hamilton. The establishment of this clinic was followed by a considerable increase in children receiving toxin-antitoxin treatment for

diphtheria. Pamphlets were circulated to Hamilton homes, enlightening citizens on topics such as the Schick test (The Hamilton Spectator 1925).

His efforts went further. In 1921, Hamilton had recorded 608 cases and 41 deaths from diphtheria. In 1922, Dr. Roberts campaigned for and introduced immunization to the city. Until Roberts initiated a collaboration between the health department and school health service, the two remained separate entities. This newfound partnership allowed immunization to be carried out among all schoolchildren. Through an active education program and spread of immunization for diphtheria, death tolls gradually reduced until the disease became virtually nonexistent in Hamilton (The Hamilton Spectator 1939; The Hamilton Spectator 1940).

Recognition for Dr. Roberts's role in eradicating diphtheria was not limited to Hamilton alone. Impressed by the Hamilton health department and their achievements in preventing diphtheria, Dr. James Kerr decided to have models created depicting the decrease of diphtheria and its results through the years presented at the Edinburgh hygiene exhibition in Scotland (The Hamilton Herald 1932). Another physician from Scotland, Dr. John Hunter, reflected on Dr. Roberts's influence on the control of diphtheria through immunization. Hunter praised Roberts for establishing the "practical application of knowledge" in Hamilton's laboratories, and attributed the successful campaign against diphtheria to Roberts' enthusiasm towards its eradication and prevention (The Hamilton Spectator 1940). His outstanding service as a medical health officer was recognized even after his death; his work to improve the overall health of the public was known worldwide. Roberts made Hamilton the first city on the continent to begin immunization. What once was characterized as a dreaded scourge upon children now held no threat to the public. It is this contribution to the city that became one of Roberts's greatest accomplishments.

11

Dr. J. Edgar Davey, Our Forgotten Hero

S. R. Bernacci

He was a very quiet—a very gentle sort of person (Numbers 1982).

The history of diphtheria in Hamilton is largely forgotten today. When it is remembered we recall that Hamilton was Canada's first city to become immunized against the disease; the general public remembers little else about the efforts to combat this fearsome epidemic. Those with knowledge of Hamilton's involvement in eradicating diphtheria foreground the efforts of Dr. James Roberts, Hamilton's Medical Officer of Health at the time (Chapter 10). However, in emphasizing the work of Dr. Roberts, much is lost, such as the struggles undertaken by other medical officials and nurses who labored as tirelessly as he did to protect our city. In this chapter I examine the life of Dr. James Edgar Davey, and explain his contributions to the immunization program against diphtheria. My aim is to address the question: "Why do some figures become engrained in social memory, while others are forgotten?"

The Life of Dr. James Edgar Davey

James Edgar Davey was born 15 May 1873 and was the son of a Methodist minister in Jerseyville, Ontario (Scott 1995:200). Davey received his education at the University of Toronto, earning his medical degree in 1902 (Bailey 1999:68). In 1903 he worked as an intern in the Erie County Hospital, Buffalo. However, upon completing his internship Davey returned to Canada in 1904 to marry Jennie Eldora Flatt of Hamilton, with whom he had two children: a son, Earl, and daughter, Jean (Scott 1995:200). That same year he opened a medical practice where he worked until 1915 when he joined the Canadian Army to fight in WWI (McKee 2009). During the war, Davey served as Lieutenant Colonel in command of the 19th Field Ambulance Unit (Scott 1995:82). From 1916 until his return home in 1917, he served in both Belgium and France in charge of Canadian Casualty Clearing Station no.2. Dr. Davey was awarded the Distinguished Service Order, and upon his return, took charge of Brant House, a military hospital located in Burlington (McKee 2009).

In 1922 Davey was appointed School Medical Officer in Hamilton – a post he would hold for nearly three decades – tasked with overseeing the health of the city's children in the school system (Scott 1995:142). One of the initial challenges he faced was the citywide epidemic of diphtheria, which had resulted in 32 deaths the previous year (Department of Health 1921-1922:14). Through his collaboration with the Department of Health, namely its Chief Medical Officer of Health, Dr. James Roberts, diphtheria immunization was administered to city youth for the first time. Davey instituted clinic rooms within Hamilton schools, so that regularly visiting nurses could more efficiently look after the children's health (Bailey 1999:47). In 1923, 3,859 children received immunization against diphtheria through the school system, a strikingly higher number than the 843 who visited the city's public Health Centres (Department of Health 1924).

In 1934 the school medical program merged with the city Health Department; Dr. Davey became Assistant Medical Officer of Health (Department of Health 1935-1936). In 1940, upon the death of James Roberts, Dr. Davey was appointed Hamilton's new Chief Medical Officer of Health. He held that position until his retirement in 1946 (Scott 1995:200). Davey died on 14 July 1969 and was buried next to his wife, Jennie, in the Hamilton Cemetery (McKee 2009).

Social Memory

When discussing the notion of social memory it is imperative to recognize that the concepts of 'memory', 'remembering' and 'forgetting' are closely intertwined on both an individual and a collective level (Erll 2011:8) 'Memory' and 'history' are two terms often used interchangeably; thus, it is important to define 'social memory'. Fentress and Wickham (1992) define social memory as an expression of collective experience. Social memory is used to identify a group, giving its members a sense of its past and define its aspirations for the future. This is not to say, however, that social memory is not the opposite of history, or even individual remembering. Rather, it is the sum of a group's individual memories combined to create a sort of scrapbook of social memories they all share. This scrapbook is then used as a tool by that society to interpret history. We must keep in mind, nevertheless, that memory, whether individual or collective, is constructed and reconstructed through the processes of remembering and forgetting (Climo and Cattell 2002). Why, then, are some events or figures remembered while others are lost? More specifically why does Hamilton's social memory of the diphtheria epidemic recall Dr. James Roberts and not Dr. James Edgar Davey?

According to Niklas Luhmann, memory acts as a stabilizing factor within societies (Erll 2011:60). For Luhmann, memory's function is to select what is remembered based on its coherence with reality, or rather, what our previous memories have constructed to be reality (Erll 2011:60-61). From this perspective, memory is not something that recalls past events or stores them away, but instead acts as a control mechanism that sorts out relevant from irrelevant information. To Luhmann, therefore, *forgetting* is the main function of memory. Similarly, John Barnes (1990) formulates the concept of 'structural amnesia'. Though his work was done primarily with societies without writing, I believe this concept can be applied to all societies, especially where social memory is concerned. According to Barnes, only the relevant aspects of culture are passed on from one generation to the next. All other facets of cultural memory are thus lost in an 'amnesic regression' as a new generation replaces the older one who experienced the passed on memories (Barnes 1990).

Taking both of these theories into account, what is not forgotten by society then can only be attributed to profound and highly public acts of remembering. Yet, meaning is largely given priority over truth when memory is

used to reassert history (Climo and Cattell 2002). This is due to the fact that even though social memory is cumulative and continuous, it is also shifting, temporary, malleable and dependent upon emotion (Climo and Cattell 2002). Memories are not impartial images of the past, but are instead an expression of the needs, desires and interests of the person or group doing the remembering (Erll 2011:8). At the same time, in order to be part of the historical or social collective, a memory must leave behind a visible reminder to have any effect (Crane 1997).

I thus suggest that diphtheria is not recalled by Hamiltonians because the epidemics no longer hold any significance to them in their daily lives. Since the majority of people who experienced the epidemic are no longer alive, there are few left to trigger our collective memory of its existence.

I further suggest that Dr. Roberts is remembered far more than Dr. Davey due to two major factors. First, Dr. Roberts was a much more prominent public figure than Dr. Davey during the immunization campaigns of the 1920s. Newspaper reports both during and after this period identify Dr. Roberts as the key figure in Hamilton's successful combat against the disease. In contrast, Dr. Davey is hardly ever mentioned, even less so by name, therefore leading public opinion to believe Dr. Roberts was essentially the sole protector of the city. Second, Dr. Roberts left behind the annual reports from the Department of Health, in which he recorded the efforts he made in the immunization process. In contrast, Dr. Davey made no such reports, at least none that still exist, for the Board of Education or Department of Health, thus limiting the knowledge of his contribution to the elimination of diphtheria from Hamilton to the people with whom he worked.

Furthermore, Climo and Cattell (2002) state that when cultural memories are forgotten or lost, a reconstruction process naturally arises in order to create a sense of continuity. Hence, when the recollection of diphtheria surfaces social memory seeks to attribute ownership of the immunization movement to someone. Since Dr. Roberts is already remembered in connection with the era, and in city documents and newspaper accounts, he is naturally given that honour. Due to this fact no further investigation is done on the part of the social collective to uncover the works of others in the immunization process, leaving the contributions of Dr. Davey – as well as numerous others – unrecognized. However, as Cheryl Natzmer observes "it is not only the memories expressed and contested that shape how

history will be remembered but also those that are absent, ignored or forgotten" (2002:175).

Figure 11.1: Dr. James Edgar Davey School.
Image Used by Permission 2015 © Spencer Bernacci.

Legacy

Even though he lacked the renown of Dr. Roberts, James Edgar Davey has still been recognized for his dedication to the city of Hamilton. During his lifetime, in 1962 Davey was named Hamilton's "Citizen of the Year" (Scott 1999:200). Shortly after his death, in 1971 the Board of Education opened *Dr. J. Edgar Davey School*, which remains a lasting tribute to Dr. Davey's work in the 1920s to guard the wellbeing of school children. Furthermore, I hope that this chapter may serve as a memorable dedication to the tireless work of one of Hamilton's less recognized heroes. I feel that highlighting Dr. Davey's labors, not only in the immunization of diphtheria, is vital to Hamilton's local history. This is not only due to the fact that in comparison to Dr. Roberts he has been forgotten, but also as a reminder to Hamiltonians that there are many individuals involved in solving any crisis. Thus, although Dr. James Roberts is seen as the leading figure in the process of immunizing the people of Hamilton against diphtheria, as a community we must remember that there existed a great number of others who stood behind him. Dr. Davey is one of those people. And as a "quiet…very gentle sort of person" I believe he is not better remembered simply because he did not want to be: for Dr. James Edgar Davey his work alone was enough.

12

Public Health, Milk and the War against Diphtheria

S. E. Thomson

Something was lurking in the milk, something unseen to adults but deadly to children (The Hamilton Spectator 1923).

This chapter focuses on the Clean Milk Initiative (CMI) instituted in Hamilton in response to rising rates of diphtheria between the years 1889 and 1928. I explore the role and impact of the CMI and the pasteurization law that emerged from it. I also delve into the backlash by local dairy farmers when faced with the new law. Finally, this chapter concludes with a discussion of the lasting impact the CMI had on rates of diphtheria in Hamilton.

History and Background

Between 1889 and 1928, public health initiatives in Hamilton expanded into an array of dental and maternity services, the dispensary and nutrition campaigns, and improvements to the public wards of the city's hospitals (Toth 2001:15). It was recognized that unhealthy environments produced unhealthy individuals and thus more attention was paid to antenatal care and infant health. Medical consultations were extended from infants to all students in elementary school, and

milk and food sanitation increased. Food cleanliness, and public eating and drinking establishments throughout the city, became objects of careful inspection. Restaurants were inspected not only for cleanliness but also to evaluate the wholesome of food served, its preparation and handling, and the cleanliness of employees (The Hamilton Spectator 1939).

You purify society, when you purify the home. The welfare of the family underlines the welfare of the city – Mrs. Adelaide Hoodless (The Globe Magazine 1960).

Mrs. Adelaide Hoodless was one of the pioneers who helped orchestrate the social hygiene movement in Hamilton. A local resident of Hamilton, she sought to change the understanding of what it meant to be sanitary and what sanitation could do for the population of Hamilton (The Hamilton Spectator 1945). Mrs. Hoodless became a driving force behind the initiative towards clean milk after the death of her infant son who died in 1889 as result of impurities in unsterilized milk (The Globe Magazine 1960). She blamed her child's death on her lack of knowledge about sanitation, the lack of clean milk delivery and "the lack of knowledge of the dirtiness of milk" (The Globe Magazine 1960). Hoodless was determined that no other Canadian babies should experience a similar fate, and so she began a crusade to educate young women to better understand food hygiene, the scientific care of raising children, and to raise the general standard of life. Her achievements included the Women's Institute, which became to be known as the mother's institute of Canada and in 1894 she sponsored a resolution asking Canadian schools to produce a training manual for girls in domestic. Domestic science was not just a matter of cooking and sewing but taught the value of pure air, proper food, care of children, civic sanitation and disease prevention. Mrs. Hoodless believed that if women were to obtain better living and social conditions, they must unite (The Hamilton Spectator 1945).

Box 12.1: Adelaide Hoodless oil on canvas (Forster, J.W.L: circa 1909).
Image presented by the Women's Institutes of Ontario, 1912, University of Guelph Collection at the Art Gallery of Guelph.

The Boards of Health also undertook to inspect houses for structural soundness, overcrowding and health hazards because many of the epidemics affecting Hamilton during the nineteenth century were exacerbated by damp, crowded living conditions. By 1889, dwelling inspections were well underway in Hamilton (Toth 2001:16). The medical health officer and public health inspectors were given power and authority to exercise measures against unhealthy conditions, which could endanger the public.

The Process of Inspecting Milk

It was known that tuberculosis could be acquired from drinking diseased cows' milk, and that clean milk would be vital for stopping the spread of diphtheria in children (Chapter 15). The result was "the milk question", which entailed "Questions about the quality of milk being supplied to the public especially from cows kept in crowded diseases stables and fed on the worse kind of food" (The Hamilton Spectator 1888). The initiative to provide clean milk for babies and families was also spurred by reports of babies dying of stomach and intestinal problems due to the unavailability of clean milk and improper feeding (The Hamilton Times 1909). In 1882 the Public Health Act of Ontario suggested local boards inspect all foods, such as milk and meat to be sold for human consumption, to stop the spread of disease and to improve health standards overall (Gagan 1981). "The Hamilton Health Board carried the suggestion to a motion which would adopt the regulations by the Provincial Board of Health for the inspection of dairy milk and in 1889 a milk inspection by-law was approved by the Hamilton Board" (Toth 2001:28).

The health department then became responsible for the food and dairy division in Hamilton charged with inspecting and protecting the purity, wholesomeness and handling of food and dairy products (The Hamilton Times 1909). This process is notably detailed and requires some explanation. "More than 700 dairy farms which compose the milk system in Hamilton need to be regularly inspected" (The Hamilton Spectator 1926); the dairy depots had to be thoroughly examined with cow inspection sterile tools and a nurse stationed at the farm to ensure quality care at all levels of milk processing (The Hamilton Times 1909). "All dairymen and vendors of milk [were] required to have once a year registration with a

medical health officer and provide all information regarding their dairying operation such as the number of cows in their possession, how much milk is being produced and sold and the kinds of food being supplied to their cows for consumption" (The Hamilton Spectator 1926). The dairymen or milk vendor had to comply with the health acts to be licensed and were required to give notice of any contagious animals or family members that could affect milk processing (The Hamilton Spectator 1888).

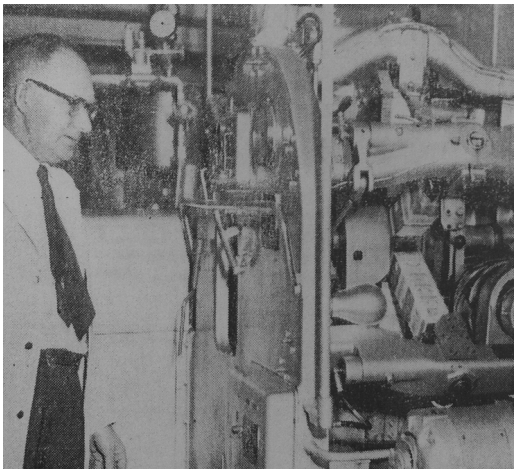


Figure 12.1: Milking process at local dairy farm (The Hamilton Spectator 1958). Image (1958) courtesy of The Hamilton Spectator.

There were five essential factors in the production of milk (Figure 12.1) with a low bacterial count: sterilized utensils, clean cows, a small top pail and milk kept at a low temperature (Department of Health 1922). Lastly, the personal cleanliness of the employees was considered to be vital; they had to be free of communicable disease and not be carriers of diphtheria, typhoid or scarlet fever (Department of Health 1922). The decision as to whether dairy premises were maintained at a suitable standard rested with the dairy inspector.

Great improvements in milk sanitation, which resulted from these regulations, contributed to improved health for children and adults (Gagan 1981:167). By 1916, there were 5,000 inspections of dairy farms annually, 1,178 milk samples tested for butter/fat content, and 313 milk samples tested for dirt and sediment (Madison 2008:92). This lessened the infant death rate by at least 30 percent since 1908 (The Hamilton Times 1910).

Hamilton was not the only city in Ontario to point the finger at contaminated milk to explain childhood diseases. Interestingly, a fellow McGill graduate of Dr. Roberts's and head of Paediatrics and Child Health and Dean of McGill Faculty of Medicine, Dr. Alexander Blackader, worked tirelessly in

Montreal to promote the establishment of milk depots and identify other underlying causes of infantile death rates associated with impure milk and unsanitary conditions. In Montreal, Dr. Blackader campaigned to educate mothers about the importance of regulated, sanitary milk depots (Blackader 1912:369).

> A supply of pure milk for the infant's use must be brought within the reach of the very poorest mothers. While all milk entering within the city limits should be tested for its purity its freshness, and for the extent of its contamination by bacteria, and all that does not come up to a certain standard should be forbidden to be distributed (Blackader 1912:370).

Blackader (1912:370) argued that milk should be fresh, pure and obtained from dairies with the most careful sanitary precautions. Milk depots should be established in the various wards or parishes of the city under the charge of competent nurses, or better still, under the superintendence of an enthusiastic physician with competent nurses to assist him.

Obtaining milk from the depots, however, added burdens to mothers and took away some of their autonomy. They were required to attend the depots every week, have their babies weighed, and also attend conferences or lectures. Although not implemented in Hamilton, these Montreal measures also required mothers to obtain a physician's prescription to even receive milk for their children. The Montreal milk depots provided instruction to dairymen and to young mothers generally about the value of good milk and how to obtain it (Blackader 1912:371).

I Think Pasteurization Could Be The Key!

As greater importance was placed on clean milk because cow's milk was increasingly viewed as a fundamental nutrient, milk inspections were taken a step further. Many of the dairy farmers under the jurisdiction of the board were reported not meeting the regulation standards. In 1910, Dr. Roberts (Chapter 10) reported that many farms were improperly ventilated and lacked sufficient light and that these conditions were ideal for spreading disease. "The ability to obtain a clean raw milk supply a moderate cost is absolutely necessary for the public, the protection of milk from infection by scarlet fever, diphtheria, typhoid and

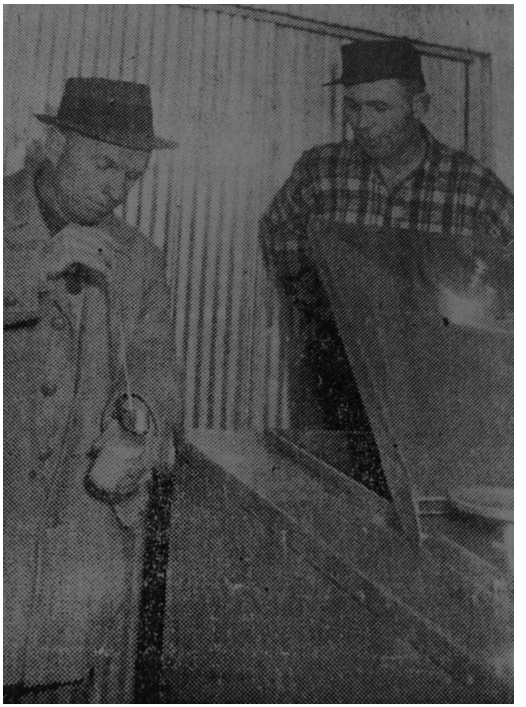


Figure 12.2: Clean milk initiative (The Hamilton Spectator 1926).
Image (1926) courtesy of The Hamilton Spectator.

tuberculosis can save many lives" (The Hamilton Spectator 1923). Close to 8,000 cases of typhoid, scarlet fever, septic sore throat and undulant fever had been traced to milk since 1912, including 688 fatal cases (Rutty and Sullivan 2010**).**

Pasteurization (Figure 12.2) was found to be the best method for preventing the spread of infectious diseases. The flash method, which was cheap and fast, involved heating milk to 160° Fahrenheit for 30 minutes and then cooling it. The method became so popular that in 1928, seven pasteurizing plants supplied approximately two-thirds of the city's milk (The Hamilton Spectator 1923). Inspectors were responsible for checking all equipment and making sure the pasteurization process was followed and strict cleanliness was observed (Department of Health 1922). It was impossible to produce uninfected milk unless the vessels were comparatively sterile; the cows were as clean as possible, and the milker's hands and clothes clean (Toth 2001).

Despite these regulations and recommendations, a law requiring milk pasteurization did not come into effect until 1928, when the Hamilton Board of Health called for the compulsory pasteurization of milk. All milk sold, distributed, or consumed by people in Hamilton had to be pasteurized (Campbell 2007).

Backlash to Pasteurization

As an entirely new system for testing dairying was being legislated by the government, many small dairy farmers began to worry about negative consequences for their operations. Only milk from tested animals was acceptable under the new regime, so dairy farmers had few options or outlets for their milk and butter if they did not agree with the new terms of milk testing (The Hamilton Spectator 1926). The dairymen also faced thousands of dollars in losses because the new system required "all the animals which fail the test must be slaughtered" (The Hamilton Spectator 1926). Often the heaviest milk producers had the most diseased cattle, and dairymen were faced with a heavy loss of cattle, which needed to be replaced. "They will have to fill their stables with tested cattle and there is likely to be active buying for a time" (The Hamilton Spectator 1926).

Milk inspection laws were not the only impediment faced by dairy farmers. With new strict laws of pasteurization, farmers were faced with a by-law that forced farms to be refitted with pasteurizing methods and plants that conformed to the law. Controller Jutton protested on behalf of the smaller milk dealers:

> A small milk dealer cannot afford the fancy new machinery, the pasteurizing plants which the law would now require. Those who cannot afford to install will be compelled to sell their products, their farms and their cattle to the big dealers at whatever price the big fellows fixed creating a monopoly (The Hamilton Spectator 1920).

Hamilton's citizens also objected to the CMI and the resulting pasteurization of milk. Many doubted the scientific basis for the initiative and whether clean milk would lower diphtheria rates. "The germs that induce diphtheria are still with us and probably always will be so it must be accepted that it has been the health department's campaign of initiatives that has reduced the number of cases of diphtheria" (The Hamilton Spectator 1925). These sceptics or raw milk advocates were characterized by public health officials as little different from anti-vaccinationists or opponents of obligatory school attendance and child labour laws. As a Canadian Public Health Journal editorial noted, "Some of these people are undoubtedly affected by purely selfish motives, some are misinformed,

but, in the main, this opposition would appear to be based upon the inherent dislike of the Anglo-Saxon to all measures which are designed to restrict the right of personal choice" (Rutty and Sullivan 2010).

Why is This Important?

The CMI was part of larger social projects conducted by the Ministry of Public Health, which focused on a variety of issues such as sanitation, public education about cleanliness and raising standards of living. Fostered by increasing disease rates, the CMI gradually grew into strict laws requiring milk inspection and pasteurization still practiced in Hamilton today. Although the ability to obtain clean milk was often steeped in criticism of mothers and small milk farmers, and anti-initiative individuals questioned the value of the policy at the time, the CMI was a step towards a new Hamilton, which attempted to protect its citizens from the dangers of infectious disease. In this way, experience with diphtheria and other infectious diseases in the late 1880s eventually led to the establishment of Hamilton's milk by-laws and pasteurization.

13

The Duty of Parents to Immunize their Children

Elizabeth Carmichael

Mothers of Ontario! You owe it to yourselves and to your children to know something about diphtheria. It is a dangerous disease. During the year 1922, there were 410 deaths from diphtheria in this Province. Think of the pitiful scenes and the saddened homes as these loved ones were taken away. Yet most of these deaths were preventable (Provincial Board of Health of Ontario 1923:5).

By the 1920s, medical researchers had developed effective methods to treat and prevent diphtheria, including the Schick test and the toxin-antitoxin immunization. In order to provide these treatments to the public, health officials set up clinics and utilized schools where parents could have their children tested and treated for diphtheria. However, while many school aged children could be tested and immunized in schools by government health officials, pre-school aged children and children treated by private physicians could not be reached this way (Hammonds 1999:191). In addition, officials also faced the problem of parents refusing to have their child immunized. Therefore, it was important to educate parents on diphtheria and its treatments.

In this chapter I examine the public health campaign to educate parents on diphtheria between the 1920s and the 1940s as health officials put more resources

into promoting immunization. This chapter begins by explaining why health officials began to launch these public health campaigns. I primarily focus on the role of schools in immunizing children and the realization that a large portion of children were not being reached. Then, I examine the means by which these campaigns informed parents and the content provided, in order to gauge what parents were being taught and how the information was presented to them. Finally, I consider the purpose served by these campaigns to highlight how health officials saw the role of parents and how they believed diphtheria was a preventable disease. I also explore what public health officials valued and how they saw ordinary people. In doing so, this chapter examines whether or not there was a moral agenda to this campaign and who government health officials stigmatized through the campaign.

Immunization in Schools

In the Department of Health reports from Hamilton during the 1920s, diphtheria is featured prominently as a dreaded but preventable disease. An important point of discussion for these reports is how to get more children tested and immunized for diphtheria. The establishment of clinics for this purpose seemed to provide the solution to this problem. In early Department of Health reports, stress is placed on a new clinic that opened on January 1, 1922 at the Health Center under the direction of the city bacteriologist, Dr. W.J. Deadman, who was assisted by Dr. J.C. MacGregor, Dr. T.L. Eaton and Dr. G.R.D. Farmer. This new clinic would be responsible for the application of the Schick test and administration of the toxin-antitoxin treatment. This clinic opened on Monday and Thursday afternoons at 4pm. Deadman's report for the first year of the clinic noted that 325 Schick tests were performed with 30% testing positive, after which clients were immunized accordingly (City of Hamilton 1922:21).

Subsequent health reports only mention this clinic and school clinics. It is not until the health report for the year ending October 31, 1926 that mention is made of changes in the operation of clinics. Termed a "minor change," immunization was thereafter carried out in all Hamilton clinics, instead of in one clinic dedicated to this specific purpose (City of Hamilton 1927:19). The report additionally notes how these new clinics were opened at "centres convenient of access to several populous districts hitherto not served, and already the attendance

at each is very gratifying" (City of Hamilton 1927:25). This change highlights the need for more clinics in order to reach more children, as the location or availability of the original immunization clinic was inadequate to treat all children. This need also appears to be greatly fulfilled by schools.

Other than housing clinics to which parents could bring their child, schools were an important institution for diphtheria prevention and treatment. It appears that schools were more successful in immunizing children than immunization clinics, evident in the statistics given for the number of children immunized for diphtheria, which are consistent from year to year. Table 13.1 demonstrates that only 650 tests and 486 treatments were conducted at the Health Centre (clinic). In comparison, 1,130 tests and 1,005 treatments were conducted in schools. The 1925 health report notes that 8,676 children were immunized, with 6,919 of these immunizations given at school clinics (80%) while only 1,757 were given at the Health Centre (City of Hamilton 1925:11). In 1926, 1,265 pre-school and school age children were immunized at the Health Centre (32%) compared to 2,740 who were immunized in schools (City of Hamilton 1927:38).

Diphtheria Immunization Work				
Schools	Schick Reading	Positive Schick	Completed Treatments	Percentage of Positive Schick Tests Completed
Murray	99	26	26	100%
Fairfield	203	36	31	86%
Memorial	465	233	201	86%
Queen Mary	363	157	153	97%
Lloyd George	Schick not done		222	-
Gibson	Schick not done		372	-
Health Centre	650	236	486	100%
Total Treatments			1,491	

Table 13.1: Performance of Schick test and treatment at public schools and health centre, Hamilton (City of Hamilton 1923:30).

The relationship between the Department of Health and Hamilton public schools can first be seen in the Department of Health Report for Hamilton 1921-

22. This report discusses how the Department of Health obtained permission from the Board of Education and the School Medical Officer to extend the prevention and immunization campaign to children in public schools. By doing so, the Department of Health could use schools as a center to attract children to receive the Schick test and vaccine (City of Hamilton 1922:14).

Subsequent health reports explain how this process worked. In particular, the health report from 1922-1923 discusses the active campaign to immunize children in schools. This report recounts that a discussion of the value of immunizing children for diphtheria took place between health officials (including Dr. W.J. Deadman) and school teachers. The health officials then provided teachers with pamphlets and permission slips to distribute to their students, who took this information to their parents who gave their consent for the vaccine. The signed permission slips were then brought back to school to be collected by the teachers and given to the Health Department nurse.

While there is no mention of school nurses in health reports, there is evidence of the role played by public health nurses in the immunization campaign. Reports by the superintendent of nurses, Annie B. Boyd, indicate that public health nurses served the purpose of referring parents to clinics to get their children immunized during their routine visits (City of Hamilton 1927:91). Nurses also worked in clinics and visited schools to assist with examining children and inspecting classrooms (City of Hamilton 1927:91).The children were then organized into groups based on their classes and taken to receive the Schick test. Any child who tested positive was given the toxin-antitoxin (City of Hamilton 1923:13). The report boasted that 400 children could be tested in an hour and that at the time of publication 5,000 immunizations had been performed at health clinics and public schools (City of Hamilton 1923:14). This method of reaching children was used consistently throughout the 1920s, as evidenced in the 1926 health report that demonstrates children were still being immunized in schools (City of Hamilton 1927:38).

Though these campaigns were effective, they did not necessarily reach everyone. The health reports convey a feeling of frustration with parents, particularly when children got sick due to their parents' refusal to have them vaccinated. The reports stress that early and efficient treatment of diphtheria reduces the mortality rate significantly and that mortality rates remain high because parents do not call the doctor once their child becomes ill. Even the early

health education pamphlets indicate that the Provincial Board of Health of Ontario supplies diphtheria antitoxin, the Schick test and immunizations free to the public (1923:11). There is also no evidence for how much a doctor may have cost in order to perform the treatment or tests at these clinics, so it is not possible to determine whether parents refused treatment for economic reasons. In addition, despite the availability of clinics and schools for immunization, parents did not necessarily agree to have their child vaccinated. Table 13.1 demonstrates that even if a Schick test produced a positive result, the child was not necessarily treated. For example, though there were 36 positive Schick test results at the Murray school, only 31 of these children completed their inoculations. Similar results are also evident at Memorial and Queen Mary schools, and even at the Health Centre. Annie B. Boyd noted in her report from 1927 that parents distrust immunization, despite being advised by nurses and doctors. Boyd further suggests that appropriate literature should be used to explain the use and benefits of preventative treatments for diphtheria, in order to relieve parents' anxieties (City of Hamilton 1927:91). It became a critical objective of public health campaigns, therefore, to educate the public at school and in the home.

Protect Your Child from Diphtheria

In order to educate the public on the dangers and horrors of diphtheria, various government organizations, including the Canadian Welfare Council, the Department of Pensions and National Health, the Division of Public Health Education and Division of Laboratories, produced educational pamphlets for parents. In addition, insurance companies, such as the Metropolitan Life Insurance Company, also helped government organizations create and distribute their own educational material. This relationship is noted in the Hamilton Health Report from 1927 which describes the co-operation and courtesy of the Metropolitan Life Insurance Company in helping public health officials show 88,000 people a film examining the prevention of diphtheria (City of Hamilton 1927:74). These pamphlets were distributed to parents between the 1920s and 1940s in order to help them understand the disease, its prevention and treatment. However, the information presented in pamphlets changed over the years.

During the 1920s, pamphlets emphasized that diphtheria was a dangerous and contagious disease of the nose and throat and was caused by the diphtheria

germ or just germs in general. The only exception to this pattern is a pamphlet released in 1923 by the Division of Public Health and the Division of Laboratories which referred to the cause as the diphtheria bacillus. The terminology was probably simplified to make it easier for parents to understand the cause of the disease; also, while it was necessary to educate the parents into the science behind the disease, it was more important to teach them the right procedures to follow if they suspected their child had diphtheria.

It is not until the 1940s that the terminology changes for the cause of diphtheria. Instead of referring to diphtheria as a disease, it is referred to as an infection caused by a germ known as the Klebs-Loeffler bacillus (Author unknown 1943:5). The change may be due to an accumulation of scientific knowledge; alternatively, the change in language may reflect the recognition that since diphtheria has been around for decades, parents were able to understand the scientific terminology (Chapter 17). However, it should also be noted that, oddly, pamphlets released during the 1930s do not refer to the cause of diphtheria but focus on explaining the various treatment options available to parents. This may have resulted from a sense that parents were sufficiently knowledgeable about diphtheria and that the new goal was to educate parents on prevention.

In addition to outlining the cause of the disease, the public health pamphlets also explained how diphtheria affected the body and how it spread from person to person. All of the pamphlets stress the importance of early recognition and treatment, and calling a doctor. In the 1920s, health officials explained that the germs created sore spots and developed a poison that weakened the heart (Author unknown 1925:1). Some pamphlets go into more detail about what body parts are affected and how the poison, not the bacillus, enters the bloodstream (Provincial Board of Health of Ontario 1923:6).

The after-effects of diphtheria are also occasionally discussed in the pamphlets, including the chances of paralysis and kidney disease due to the circulating poison (Provincial Board of Health of Ontario 1923:6). The symptoms of diphtheria are not discussed in great length during the 1920s, except for sore throat and fever, but the pamphlets make the point that only a doctor can truly distinguish between a cold and diphtheria (Author unknown 1921:1). The same stance is evident in pamphlets in the 1940s: if a sore throat or fever appears, then the parent should call the doctor immediately (Author unknown 1943:6).

Some pamphlets tend to highlight which age groups are most susceptible to diphtheria. For example a pamphlet in 1925 stressed that children between 1 and 5 years old are most likely to die from diphtheria, and that children up to 10 years old should be vaccinated for the disease (Author unknown 1925:2). Information presented in the 1940s concurs with this, stating that 80% of deaths from diphtheria are among children under 5 and that 95% of deaths are among children under 10 (Author unknown 1943:5).

Pamphlets teach parents that diphtheria is spread through contact with children who have the disease or from those who recently had it (Author unknown 1921:1). Pamphlets from the 1920s also stress how children may get diphtheria from spoons, cups, pencils and toys that have not been cleaned properly (Author unknown 1921:1; Provincial Board of Health of Ontario 1923:6). In the 1940s, the term 'carriers' is introduced to explain how diphtheria spreads (Chapter 16), noting that individuals may carry the germ but may appear healthy due to natural or acquired immunity (Author unknown 1943:7). This new information is supplemented with details on different kinds of immunity to diphtheria (Author unknown 1943:8). In the 1940s, milk contamination was linked to the spread of diphtheria (Author unknown 1943:7) and cleaning up the milk supply became an important public health campaign (Chapter 12).

The treatment and prevention of diphtheria constituted the most important topic in the pamphlets. Until 1925, pamphlets gave priority to describing the treatment for diphtheria. They stressed that every sore throat should be seen by a physician to ensure a proper diagnosis (Provincial Board of Health of Ontario 1923:5). Furthermore, "if the doctor says that antitoxin should be used, see that this is done; it may save the child's life" (Author unknown 1921:1). Pamphlets also explain how to take care of a child suffering with diphtheria. Parents are advised to quarantine the child in a sunny and airy room, and to disinfect any dishes, clothes or items the child uses (Author unknown 1921:2). Disinfection required that "all soiled clothes should be soaked for an hour in a tub containing one pound of carbolic acid in five gallons of water" (Author unknown 1921:2). Here the need to protect not only other family members, but also other people's children, is emphasized.

Discussions of preventative measures, such as the Schick test and vaccination, appear near the end of the early pamphlets. This suggests that greater importance was placed on decreasing the spread of disease and on treatment, rather than on preventing the spread of diphtheria through immunization. In 1925, however, this shifts: immunization comes to the forefront and treatments are placed at the end. The concept of immunity and tests for susceptibility are explained. Some pamphlets dedicated entire sections to explaining the Schick test and how it works. The pamphlets also urged parents to heed the advice of their physician and let their child receive the diphtheria toxoid vaccine (Author unknown 1937:2). Diphtheria came to be understood as preventable and the term 'immunizing' began to be used (Author unknown 1921:3; Provincial Board of Health of Ontario 1923:10). In other words, in the mid-1920s there is a distinct shift toward teaching preventative measures in order to wipe it out completely.

Figure 13.1: Protection against diphtheria (Canadian Council on Child and Family Welfare:1937).

Take No Chances with a Sore Throat

"Take No Chances with a Sore Throat, Call in the Doctor – It May be Diphtheria" (1921) was on the title of a pamphlet released by the Metropolitan Life Insurance Company. This message embodied the purpose of the initial health education campaign for parents in the early 1920s; namely, to make parents recognize the importance of calling a doctor at the first sign of a sore throat. A sore throat could no longer be treated as if it were just a cold, it was a sign of danger that could lead to a child's death (Provincial Board of Health of Ontario 1923:5). Health officials emphasized that only doctors knew how to diagnose diphtheria and, if caught in time, it could be treated with anti-toxin. Parents are also warned against alternative treatments because "listening to the advice of quack doctors and anti-vaccinationists results disastrously for the unfortunate child" (Provincial Board of Health of Ontario 1923:7). It appears as if the slogan *it's better to be safe than*

sorry was applied to the early diphtheria campaigns. Better to call in the doctor than to let your child die when they easily could be treated.

The campaign began to change around the mid-1920s and was fully realized in the 1930s and 1940s. The direction of the health campaign switches to preventative measures in the form of immunization with the toxoid vaccine. Here it is stressed that diphtheria can be prevented (Author unknown 1925:3). Immunization is heavily promoted through the use of statistics to show how death rates have dropped in Canada due to the toxoid preventative treatment (Author unknown 1937:1). For example, in 1936 a pamphlet proclaimed that "The deaths from diphtheria in Canada during the year 1932 dropped to 398 and in 1933 to 239; unquestionably this drop can be attributed to the wide use of toxoid" (Author unknown 1936:1). Great care was also taken to explain the process of immunization and to reassure parents that the vaccine would do no harm to the child (Author unknown 1937:2). The differences between toxoid and antitoxin were also explained: "Diphtheria antitoxin is only given to a person who is ill to help him fight the disease or to children in contact with it to protect them until the immediate danger is past" (Author unknown 1936:2). This short-term treatment would only last ten days to two weeks (Author unknown 1936:2), but toxoid treatment would give lasting immunity if the child was not already immune naturally, a condition discernible by a simple Schick test (Author unknown 1943:10). Parents were urged to remember that "Toxoid immunization is lasting. Toxoid immunization is effective. Toxoid immunization is cheap. Toxoid prevents diphtheria" (Author unknown 1943:11).

Neglectful Mothers and Moral Responsibilities

The pamphlets not only provided information on the diphtheria, its treatment and prevention, but also blamed parents for their child's illness. "When a child dies from diphtheria, somebody is always to blame. That fact should be impressed on everyone" (Provincial Board of Health of Ontario 1923:9). Parents who failed to listen to the advice of health officials increasingly came under fire and soon came to be blamed for any child's death from diphtheria. For example, a 1936 and 1937 pamphlet states: "Deaths from diphtheria are practically all due to not giving diphtheria antitoxin early enough – usually because the parent does not call the doctor when the child first becomes ill" (Author unknown 1936:1; Author

unknown 1937:1). These accusations aimed at parents are common throughout the educational literature. Parents were either blamed for not calling the doctor in time or failing to prevent their child's illness by not ensuring they received the toxoid vaccine. Many pamphlets begin with shaming statements, such as "if parents only realized" and "if mothers will have these things done" (Author unknown 1936:1; Author unknown 1921:3), emphasizing that it is a parent's duty to protect their children from diphtheria so that they could have a healthy childhood (Provincial Board of Health of Ontario 1923:11). If parents failed to protect their child, they betrayed a sacred trust and were "morally responsible should one of their children die from the disease" (Author unknown 1936:2). In consequence, a child's death from diphtheria became synonymous with neglectful and bad parenting.

Maternal ignorance was blamed in New York City diphtheria campaigns, rather than the failure of private medicine or the state to provide health care to children (Hammonds 1999:200). Health officials in New York believed they needed to change the attitudes of fearful and uncooperative mothers (Hammonds 1999:198) and language about the neglect of children by ignorant mothers was prevalent (Hammonds 1999:200).

Mothers also became specific targets in Canadian diphtheria campaigns; fathers were never blamed for not having their child immunized or treated with antitoxin. A 1921 pamphlet proclaims: "Diphtheria can be stamped out and many lives saved every year if mothers will have these things done and protect their children" (Author unknown 1921:3). In an Ontario pamphlet in 1923, mothers are similarly chastised:

> Mothers of Ontario! You owe it to yourselves and to your children to know something about diphtheria. It is a dangerous disease. During the year 1922, there were 410 deaths from diphtheria in this Province. Think of the pitiful scenes and the saddened homes as these loved ones were taken away. Yet most of these deaths were preventable. (Provincial Board of Health of Ontario 1923:5).

Accusatory language in educational pamphlets targeted parents, and mothers in particular. In this sense, health officials made immunization and treatment a moral obligation for parents. It became the duty and responsibility of

mothers to ensure that their child was immunized otherwise they were neglectful and failing to provide the necessities of life.

Conclusion

Public health campaigns for diphtheria reveal the relationship between health officials and parents, and culturally constructed ideas about expected roles. These campaigns emphasized that it was the duty of parents to act according to specific behaviours prescribed by health officials. Whether it was to call a doctor at the first sign of a sore throat or to take a child to the clinic to be tested and vaccinated, it was the parent's obligation to do so. It is important to understand these roles to highlight how medical knowledge is disseminated and received by the public. These pamphlets on diphtheria indicate that public health officials were concerned that parents were unaware of the treatment and prevention of diphtheria, or did not comply with advice given by health officials. It was the goal of the campaigns to sway their opinion. This demonstrates how public health campaigns reflect the culture specific values of the health officials who devised them, evident in the blame game that underlies the educational agenda contained in pamphlets. Parents or often times, mothers, who failed to adhere to the advice and values of health officials, and refused to vaccinate their children, were deemed neglectful. In doing so, this campaign charged parents with a moral responsibility to see that their child had the best chance at a long and healthy life; if their child died from diphtheria, they were to blame for the tragedy.

14

Who Led the Charge Against Diphtheria?

Jeffrey Coffin

Seventy years ago Connaught Laboratories led the world's public health war against one of the most dreaded diseases ever known: Diphtheria (Rutty 1996:11).

It is hard for Canadians today to imagine diphtheria as a major cause of death in the country because the disease has been eliminated from Canada for decades, thanks to country-wide immunization. It is also difficult for Canadians to imagine how public health care worked when diphtheria was still present in Canada, because our health care system has evolved so much over the course of the country's history. The development and distribution of diphtheria immunizations actually helped shape Canada's health care system, and early immunization campaigns like it were the beginning of a health care system more like what we have today.

Public health care was largely organized at the Provincial level in the beginning of the twentieth century. The Canadian constitution of 1867 designated health a Provincial responsibility (Lewis 1986:163). The Ontario Board of Health was established in 1882, and many of the other Provinces followed this example in the next twenty years. Despite pleas from many important members of the

medical profession at the time, the Federal government was reluctant to establish a Federal Department of Health. The heads of the Health Branch of the Commission on Conservation, a committee of government officials and university experts established in 1906 to discuss conservation and use of many of Canada's resources, called a special meeting in 1910 of sixteen of the country's leading medical experts and established the Canadian Public Health Association. The association focused on many aspects of public health, and while it had little success persuading the government to establish a Federal Department of Health, it did provide a place for Canada's medical experts to discuss important areas of public health and improve the legislation of Provincial Health Departments (Rutty 2009:169). At the Federal level, health care organization was purely a committee where medical professionals could discuss important topics in health care, but implementing these goals or legislations remained a Provincial responsibility. Many medical professionals in Canada were responsible for shaping the structure and interests of health care in Canada, and with some help from the Provincial governments, they were able to carry out many of their health care plans.

In response to the 1918 influenza outbreak that occurred at the end of the First World War, the Federal Government finally established the Federal Department of Health in 1919. The department's initial goals of education programs, expanded hospitals, and volunteer medical training were meant to prepare the country for another epidemic, but the Federal Department had difficulty implementing its goals because it had to negotiate these plans with the Provincial Departments. Vaccination was also not a major focus for the Federal Health Department in its early stages, because the organization was created in response to the 1918 influenza outbreak, and the limitations of medical science at the time made it difficult to identify a useful vaccine for influenza (McGinnis 1977:127). The responsibilities and authority of the Federal Department grew gradually over time, but it was mainly only responsible for advising and helping to pay for Provincial health programs until the 1940s (MacDougall 2007:955). The Federal Department had very little involvement in the diphtheria immunization campaign, which was largely organized through cooperation of local and provincial departments, and with prominent members of the medical community.

The Beginnings of Connaught Laboratories

At a meeting of the Canadian Public Health Association in 1911, delegates noted that biological products such as vaccines, antitoxins, and other serums were mostly imported; these products were expensive, in limited supply, and lacked standards of quality assurance (Rutty 2009:169). The association wanted to establish a Federal laboratory that would produce these products in Canada and solve these problems, but as usual the Federal government did not accept this request. In response to this need, in 1913 Dr. John G. FitzGerald began producing rabies vaccines and diphtheria antitoxin in his own, small, privately funded laboratory (Rutty 2009:170). He was very quickly supported by several Provincial Health Departments, particularly the Ontario Department. In 1914 Dr. FitzGerald convinced the University of Toronto to establish its Antitoxin Laboratories (renamed Connaught Laboratories in 1917) within the Department of Hygiene, where Dr. FitzGerald was appointed director (Rutty and Sullivan 2010:2.12). The Connaught Laboratories immediately began producing diphtheria and tetanus antitoxins, rabies vaccines, and anti-meningitis serum (Rutty 2009:170).

The diphtheria antitoxin (Chapter 6) offered treatment and temporary protection from diphtheria. It was provided without cost by Connaught Labs in the City Isolation Hospital of Toronto, and by 1915 members of the Ontario Board of Health already began to notice that the death rate within the hospital was very low; 6% compared with the 16% in the rest of Toronto (Lewis 1986:164). Connaught Laboratories was able to produce antitoxin more cheaply than the cost of importing it; by 1915, Connaught had become the source for antitoxin for the Provinces of Nova Scotia, Prince Edward Island, Alberta, Saskatchewan, and British Columbia (Lewis 1986:164). By 1916 the Ontario Board of Health made the Connaught Laboratories the official source of Ontario's public health biological products, which eliminated the competition from external sources as well as commercial firms within the Province (Rutty and Sullivan 2010:2.13).

In the early 1920s, Connaught Laboratories also produced toxin-antitoxin, which provided treatment and immunization to diphtheria (Chown 1921:319) (Chapter 6). However, immunization using toxin-antitoxin was much more prevalent in the United States; in Canada it was only distributed on a small scale in a few cities across Ontario, Saskatchewan, and Manitoba (Chown 1921:319; FitzGerald et al 1932:25). The Schick reaction test was also developed and used

Dr. John Gerry FitzGerald was born in Drayton, Ontario in 1882. He worked in his father's small, rural drug store until age 16, when he began his studies at the University of Toronto. By 1907 he was appointed clinical director at the Toronto Asylum for the Insane. He quickly changed his focus from psychiatry to preventative medicine and bacteriology, and, after marrying in 1910, travelled to Europe to study medicine. At the Pasteur Institute he learned to make vaccines and antitoxins, and decided to open a lab in Canada to provide these to Canadians for free.

When FitzGerald returned in 1913 his idea was rejected by the University of Toronto, so he borrowed some of his wife's inheritance to build a stable and fill it with lab equipment. His success extracting diphtheria antitoxin from horses in which he had developed immunity inspired the University of Toronto to accept his request, and open its Antitoxin Laboratories in 1914.

In the following decades the lab made Canada a world leader in medicine. It became a major producer of insulin, as well as several vaccines and serums, including those for diphtheria. In 1919, FitzGerald helped form the Dominion Council of Health, the advisory committee of the Federal Department of Health. He suggested that Connaught Laboratories should be the official provider of vaccines and antitoxins to the provinces. By the 1930s, Dr. FitzGerald had taken on much more work internationally, and his colleague Dr. Robert Defries took over running Connaught.

Sadly, by the late 1930s Dr. FitzGerald developed symptoms of paranoia and depression, and after battling depression for several years, he took his own life on June 20 1940 at the age of 57. After his tragic death he left behind a wife, two children, and a legacy that saved and improved the lives of millions of Canadians.

Box 14.1: Dr. John G. FitzGerald (FitzGerald 2002).
Image used by permission 2015 by James FitzGerald.

around this time, and was very important for physicians to determine whether someone was immune to the diphtheria toxin, which would indicate whether

further immunization was required (FitzGerald 1936:54) (Chapter 9). Because of its importance to the immunization process, the Laboratories also began producing and distributing the Schick test to the population of Ontario for free (Provincial Board of Health of Ontario 1923:11). The initial production of diphtheria antitoxin at Connaught Laboratories is an excellent example of how health care in Canada was largely shaped by the ideas of the country's leading medical professionals, such as Dr. FitzGerald. The Provincial Boards of Health, which were also mostly composed of important medical professionals, shared this view of health as social welfare, and helped to organize the free distribution of treatment and immunizations to the public.

The Hamilton Health Board and Diphtheria Antitoxin

This chapter has focused on the roles of the Provincial and Federal governments in health care and the treatment of diphtheria; however, the actual application of public health care to Canadian citizens was shaped by the individual Municipal Health Departments. It is thus important to recognize how the Hamilton Board of Health treated its citizens during the early years of diphtheria immunization.

In 1884 the Ontario Government's Public Health Act made it mandatory for cities in Ontario to create a Local Board of Health, which included the mayor and several other representatives chosen by city council. This law led to the establishment of the Hamilton Board of Health and made permanent what had previously been a temporary body formed in response to community health crises (Gray 1986:57). The Hamilton Board of Health now had several permanent members responsible for making legislation dealing with public health, and a civic Health Department responsible for applying the legislation. The Medical Officer of Health headed the Department and was responsible for supervising sanitary work, and keeping and preparing accounts for the Local and Provincial Boards (Gray 1986:57). While the Hamilton Health Department underwent some changes in the following decades, it was Dr. James Roberts who rapidly began to reorganize the Department after his appointment as Medical Officer of Health in 1905. He established the Public Health Laboratory in 1908, which examined diphtheria cultures, among many other important medical tests (Gray 1986:59).

The Hamilton Health Department began its diphtheria immunization campaign in 1922 with the establishment of two weekly clinics to administer the

Schick test and toxin-antitoxin to children (City of Hamilton 1922:14; City of Hamilton 1927:91). This initiative was also inspired by the 1918 influenza epidemic of only a few years earlier because it overburdened the hospitals and required a large number of volunteer nurses. Dr. Roberts saw the need for permanent, trained nurses in hospitals who would help educate and prevent the spread of communicable diseases (Gray 1986:60). While the shipment of antitoxin and Schick tests to health practitioners in Hamilton had already been occurring for several years, this was the first time that toxin-antitoxin was made available. This marks the beginning of the Hamilton Health Department's active campaign supporting mass immunization in clinics (City of Hamilton 1932:7; FitzGerald et al 1938:391).

The Report to the Hamilton Department of Health (City of Hamilton 1922:21) indicates that 325 children were given the Schick test at the clinic before October 31, 1922, and that roughly 30% of them tested positive and were thus treated with diphtheria toxin-antitoxin. The Report (City of Hamilton 1922:14) claims that attendance at the clinic was good, considering the public was not educated on the subject of immunization, but implies that attendance would be much higher if the broader public was better educated on the subject. In the following years the Hamilton Health Department adopted an active campaign to inform the public about immunization against diphtheria. This was carried out by nurses who made routine house calls and informed parents of the importance of having their children immunized, and who taught children in schools the importance of diphtheria immunization (City of Hamilton 1923:12). While production and distribution of diphtheria immunizations was the responsibility of the Provincial Health Department and the Connaught Laboratories, the Hamilton Health Department was responsible for administering them. Through their efforts to open clinics and educate the public to attend them, the Department began an intense local diphtheria immunization campaign.

Discovery, Production, and Distribution of Toxoid

The antitoxin serum was only a treatment and could not actually produce immunity to the disease. While the limited use of the toxin-antitoxin was a promising first step towards immunization, it was quickly abandoned for a more effective vaccine. Diphtheria anatoxinae, more commonly referred to as toxoid,

was discovered between 1923 and 1924 by Dr. Gaston Ramon at the Pasteur Institute in Paris. He found that applying formaldehyde and heat to the diphtheria toxin eliminated its toxicity but allowed it to retain its antigenic properties, meaning that it would no longer cause harmful effects but allow immunity to develop (FitzGerald 1930:179). When Dr. FitzGerald visited the Pasteur Institute in 1924 he was fascinated with the immunizing effects of toxoid. He quickly explained Dr. Ramon's process to Dr. Peter J Moloney at Connaught Laboratories, and asked him to start producing it. After some minor initial difficulties, Moloney produced a large quantity of the vaccine which Connaught was prepared to test in children (Rutty 1996:11). This was the beginning of a large scale diphtheria immunization campaign, and the beginning of the end of diphtheria in Canada.

In 1925, once again with the financial aid of the Ontario Provincial Health Department, Connaught Laboratories began toxoid trials in 7000 preschool children from several different cities in Ontario (Lewis 1986:165). The trials were so positive that by 1926 the Ontario Provincial Health Board issued a Memorandum about the use of toxoid, and offered to provide it and test materials for free to all of the Provinces of Canada (FitzGerald 1930:180). The toxoid was very effective at immunizing people to diphtheria, but there were also some potentially dangerous side effects. However, Dr. Moloney quickly identified these issues and created a test that would determine if an adult or older child would experience a negative reaction to the toxoid, and by 1927 this test was distributed for free as well (Lewis 1986:165). By this time Canada was a world leader in production and testing of the diphtheria toxoid, and demonstrated the effectiveness of the vaccine through the significant decrease in the prevalence of the disease (Rutty and Sullivan 2010:3.14).

The Provincial Health Departments of Canada were very excited by the effectiveness of the vaccine, and vaccination education campaigns were adopted in several Provinces. In Ontario, vaccination campaigns were advertised by the radio and newspapers, and involved educational lessons in schools (Lewis 1986:165). As many as 36,000 Toronto children were immunized with the diphtheria toxoid between 1926 and 1930, and the incidence of the disease among these children was reduced by 90% (Rutty 1996:11).

Dr. FitzGerald and other doctors from the Connaught Laboratories also played an important role in presenting information about the vaccine's success in

Canada, and its relative safety with the pairing of the Moloney test, to other countries such as the United States and Britain, which had not adopted large scale use of the vaccine by the early 1930s (Rutty 1996:11). Because of the cooperation between the Connaught Laboratories and the Ontario Department of Health, over three million people in Canada were vaccinated between 1925 and 1936 (Lewis 1986:163). The early trials for diphtheria toxoid in Canada were so widespread and heavily supported by education initiatives of the Provincial governments and health care professionals that they were actually a major step forward in the campaign to eliminate the disease from the country.

Hamilton and the Eradication of Diphtheria

The Hamilton Health Department was already heavily committed to its anti-diphtheria campaign by 1926 when the toxoid was made available. By October 31, 1926, 14,605 children had been immunized at Hamilton clinics since the beginning of the campaign in January 1922 (City of Hamilton 1927:38). Attendance at clinics had increased rapidly in that time as well, with 9207 people immunized in 1926. In an attempt to reach more children the Department also began conducting immunizations at all of its clinics and immunizing children in schools, rather than just designating a single clinic for this purpose (City of Hamilton 1927:38). The Hamilton Health Reports (City of Hamilton 1927:19) largely attribute the success of the program to the massive strides made in educating the public about immunization.

While diphtheria education in schools was still ongoing, the Department began distributing health educational literature (City of Hamilton 1927:19). The Hamilton Spectator featured many articles about the Health Department and its campaign to immunize citizens against diphtheria. One 1926 article discusses the success of the campaign and encourages people not to forget about immunization just because the disease was less common; citizens could fall into a false sense of security but the only sure security against the disease was immunization (The Hamilton Spectator 1926). The newspapers also identified Dr. Roberts as an important figure in the fight against diphtheria. Roberts himself tried very hard to educate the public about immunization. In 1932 he created a large exhibit outlining the effectiveness and importance of immunization, and even suggested putting posters in store windows to attract the most attention (Roberts 1932:853).

Years	Cases	Deaths
1918-1922	2,264	151
1923-1927	1,246	76
1928-1932	45	6

Table 14.1: Rates in Hamilton (City of Hamilton 1932:7; FitzGerald 1930:181).

The introduction of the vaccine in Hamilton was a huge success, and unlike the initial treatment using toxin-antitoxin, which did not have a very noticeable effect on the number of diphtheria cases, the incidence of the disease dropped dramatically within a couple years of adopting the vaccine (City of Hamilton 1932:7). The incidence of diphtheria dropped from 2264 cases and 151 deaths between 1918 and 1922, to 1,246 cases and 76 deaths between 1923 and 1927, and then to 45 cases and only 6 deaths between 1928 and 1932 (City of Hamilton 1932:7; FitzGerald 1930:181). Before the introduction of the vaccine the numbers of cases and deaths were irregular, but steadily increasing with the population; after the vaccine was introduced the population continued to grow, and the incidence of the disease decreased (City of Hamilton 1932:7). By the time the campaign had become a clear success, the Health Reports (City of Hamilton 1929:5; City of Hamilton 1930:5) began to claim that diphtheria had been banished from the city, arguing that the very small number of cases were all unvaccinated people who had contracted the disease outside of the city. The last recorded death from diphtheria in Hamilton occurred in August of 1930, and after 1933, the first diphtheria-free year in Hamilton's history, there were only two reported cases (City of Hamilton 1936:9; City of Hamilton 1940:7; The Hamilton Spectator 1962).

The major success of the vaccination campaign in Hamilton became a popular example in the field of medicine. The statistics and methods of the Hamilton Health Department were used as pro diphtheria vaccination propaganda all over Canada, as well as in the United States and Great Britain (City of Hamilton 1930:7). Dr. FitzGerald (1930:181) specifically thanked Dr. Roberts and his entire Department of Health for his effective methods of rapidly immunizing the citizens of Hamilton, and providing such valuable statistics. Other doctors from the Connaught Laboratories worked with members of the Hamilton Health Department, and presented their findings to several international medical authorities and conferences, including the Pasteur Institute that first created the toxoid, and the Medical Section of the League of Nations (City of Hamilton 1930:7). In this way, the people of Hamilton were not the only ones to

benefit from their success with diphtheria toxoid. Hamilton benefitted from the vaccines that were shared by the Connaught Laboratories and the Provincial Department of Health, and in return it shared the information with Connaught and medical experts around the world so they could benefit from it.

Shaping Canada's Health Care System

Health care in Canada has undergone many changes over time, but the early twentieth century was a very important time for the unique development of Canada's health care system. Health care in Canada has always been shaped by the charitable views of the leading healthcare professionals who organize it. In the early twentieth century, health care was not organized by government officials but by medical professionals who, like Dr. FitzGerald, attempted to provide Canadians with health care at a cost to themselves. While the government Health Departments were largely organized at the Provincial level at the time, they cooperated with each other and with medical institutions to offer these inspirational doctors the means to provide health care to Canadians. Even today we have free health care and mandatory vaccinations, which were among the goals of Canadian health care in the early twentieth century. Even at the local level there is the example of Dr. James Roberts, hailed as brilliant doctor for revolutionizing health care in Hamilton and defeating diphtheria in the city. His view of public health as a device for helping the citizens of Hamilton is the same caretaking attitude held by FitzGerald and the members of the Provincial Health Department. Because of this mutual cooperation between medical professionals and institutions, the efforts of the Hamilton Department of Health also provided valuable information to other medical institutions within and outside Canada. By examining the history of the diphtheria immunization campaign in Canada it is evident how the Canadian attitude towards health care as a service to the public developed.

15

The Wide Wings of the Strangling Angel

Priyanka Gogna

It is the knowledge of the way in which the disease is propagated that will cause it to disappear (John Snow1854 as cited in Taylor 2010:140).

This chapter discusses the epidemiology of diphtheria: its cause, distribution, and modes of transmission in human societies. I briefly describe the biology of its causative bacteria (*Corneybacterium diphtheriae)* and how this affects its geographical and social distribution. The discussion then shifts to the main modes of transmission of *C. diphtheriae,* the means by which the bacteria spread from person to person. I also explore common modes of transmission in the pre-vaccination era. Finally, I discuss the importance of examining the biology of diphtheria within the context of cultural factors, and adapting a holistic approach characteristic of anthropology in order to better understand and control it.

The Bacteria

In order to understand the prevalence and transmission of *C. diphtheriae*, it is necessary to identify characteristics of the bacteria. The year 1888 marked the discovery of *C. diphtheriae* exotoxin, which is largely responsible for producing

the symptoms of diphtheria observed in humans (Wharton 2004:85). This discovery paved the way for many other studies of the organism.

C. diphtheriae is aerobic, which means it grows well in the presence of oxygen. The bacteria do not survive well at high temperatures and can be killed within ten minutes at a temperature of 58°C or greater. The persistent nature of the bacteria is also well documented, and it can retain virulence on the mucous membranes of patients after all symptoms have been resolved (Northrup 1902:31). The robust nature of the bacteria is a key factor in its prevalence and transmission.

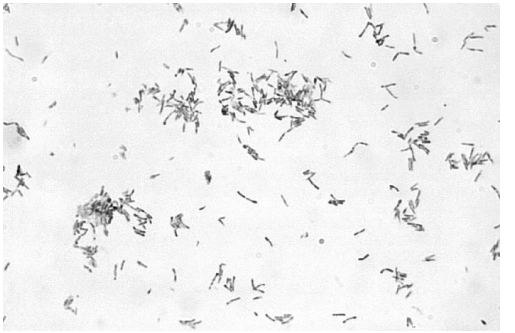


Figure 15.1: Photomicrograph of *Corynebacterium diphtheriae* at 1200x magnification (Centers for disease control and Prevention 2005:1). Image courtesy of the CDC.

Global Distribution

Cases of diphtheria have been documented across the globe; however, the distribution of *C. diphtheriae* changed dramatically with the introduction of vaccination campaigns from the 1940s to the present (Wharton 2004:85). Currently, rates of diphtheria are low to non-existent in developed countries such as Canada and the United States, with Canada reporting only a single case in 2014 (World Health Organization 2015:1). These low frequencies are attributed to the implementation of vaccination-centered diphtheria control programs (Galazka 2000:S3).

Despite the successful control of *C. diphtheriae* in some developed countries, the bacteria continue to be a public health concern in developing

nations (Figure 15.2). The disease and the bacteria are endemic in Sub-Saharan Africa, Brazil, Columbia, India, the Middle East, and parts of Europe (Barroso 2015).

The geographical distribution of *C. diphtheriae* depends on the symptoms associated with it. Cutaneous diphtheria affects the skin of victims, and is known to thrive in tropical climates and spread easily among children. On the other hand, respiratory diphtheria is more common and spreads easily in the fall and winter seasons. This seasonal pattern of spread is linked to increased strain on the respiratory system during colder months, and a tendency for people to remain indoors (Wharton 2006:86; Northrup 1902:20). As is commonly observed with infectious diseases, the incidence of diphtheria has historically been higher in urban areas, and is attributed to overcrowding and an abundance of carriers and hosts in which the bacteria may thrive (Galazka 1995:100). Despite a higher incidence in urban areas, higher fatality rates have been reported in rural areas due to delayed diagnosis and availability of treatment (Galazka 1995:100).

Keep in mind, however, that studying only the biology of diphtheria will never create a clear picture of the reasons behind the distribution of the pathogen. Gaps remain in our knowledge on the distribution of diphtheria, especially regarding the influence of cultural factors, such as social class, politics, and the environment. Although a thorough cultural analysis of the distribution of diphtheria across the globe is beyond the scope of this chapter, the topic has been addressed throughout this book.

Who is Affected by Diphtheria?

Historically, diphtheria has been considered a childhood disease, with epidemics spreading quickly between children (Wharton 2004:86). Before vaccination became widespread, up to 70% of all reported diphtheria cases occurred in children younger than 15 years old. This pattern was exemplified in countries such as the United States, Germany, and England between the years of 1908 to 1937 (Galazka 2000:S3).

Unexpectedly, perhaps, infection among infants (children under one year of age) was not found to be common during this time and was attributed to the passing of temporary immunity from mother to child (Northrup 1902:24) This acquisition of immunity comes from antibodies passed by the mother to the

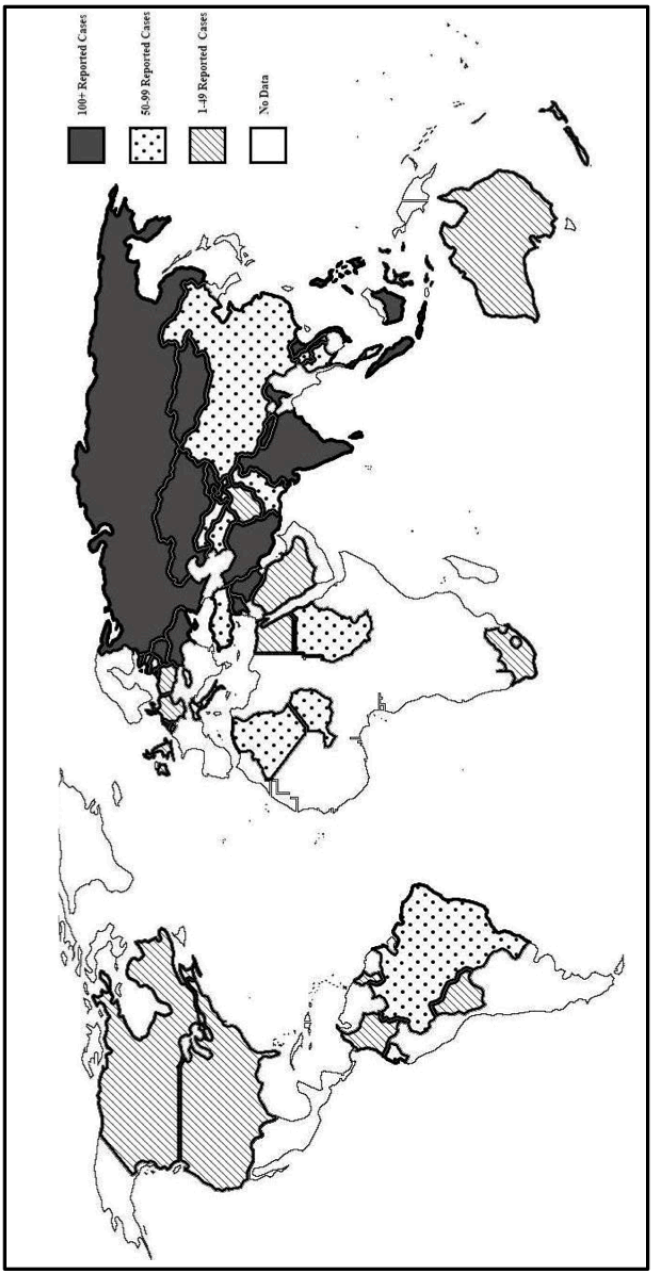


Figure 15.2: Diphtheria cases reported to WHO between 1997-2006 (Public Health England 2006:1).

growing embryo (Hanson 2003:199). Various factors have been attributed to the higher incidence of disease among children in the past, including ease of spread of the bacteria within schools, as well as the naturally acquired immunity present among adult populations in the pre-vaccination era due to exposure to the pathogen during their childhood (Galazka 2000:S3).

An interesting shift in the distribution of the disease has been documented within developed countries in the post-vaccination era, where the number of cases reported in adults has steadily increased after vaccination campaigns. For example, in the years following German vaccination campaigns in the 1940s, cases involving adults increased from 12% to 48%. Galazka identifies two stages in the shift of infection: in the first stage, disease is spread primarily among school-aged children. However, after vaccination campaigns, the transmission shifts to adults, who become vulnerable to the bacteria due to lack of immunity from strains that had been common in the population beforehand (Galazka 2000:181).

This upward shift in affected age groups is related to the fact that immunity acquired from the diphtheria vaccine wanes over time, making 40-50 year olds more vulnerable to diphtheria infection (Galazka 2000:S2). At the same time, vaccination also reduces the number of circulating strains in the environment that help adults maintain their acquired immunity. This explains why vaccinating children increases the rate of infection among adults. The trend to older age at infection with diphtheria is found in developed countries such as the United States, Germany, Australia, England, and Norway (Galazka 2000:S3). For these reasons, 20-60% of adults in developed countries may be susceptible to diphtheria (Barroso 2015).

Furthermore, the World Health Organization (WHO) reports a recent increase in diphtheria cases among children in developed countries such as Spain and Thailand (Barroso 2015). Such cases are usually connected with the anti-vaccination movement, which has gained support among new parents in the past decade. The movement revolves around the idea that vaccines are harmful and may be linked to autism in children. Despite overwhelming scientific evidence that suggests otherwise, the anti-vaccination movement has become a major challenge to public health in developed countries (Novella 2007:27).

These shifts in affected age groups did not occur independently of cultural movements, ideas, and influences. Factors affecting the distribution of *C. diphtheriae* in various groups are discussed elsewhere in this book (Chapter 18).

Main Modes of Transmission

The known modes of transmission of diphtheria are relatively simple. Tracking transmission of the bacteria, however, is still complicated by the resilience of the organism. It is not uncommon to find individuals who have gone through treatment, and are no longer symptomatic, still testing positive for the presence of *C. diphtheriae* in the mucous membranes of the throat. A related condition in which asymptomatic carriers remain positive for diphtheria bacteria also occurs (Barroso 2015, Wharton 2004:92). The carrier state is discussed in detail in elsewhere (Chapter 16), however, it is important to note that 'carriers' are integral to understanding the transmission of the bacteria, and make it difficult to trace sources of infection during epidemics.

The spread of *C. diphtheriae* is tightly linked to the manner in which a person becomes infected. Although various modes of transmission have been described, such as fomites (substances capable of carrying pathogenic bacteria, such as clothes, biofilms, and doorknobs), unaffected carriers, and possibly animals, I focus on the two main modes of spread: respiratory and cutaneous. Respiratory diphtheria is the more typical form of the disease, resulting in a sore throat and pseudomembrane formation (a thick coating that grows on the victim's throat) (Barroso 2015). The spread of respiratory diphtheria occurs from contact with aerosolized droplets expelled from a sick individual, similar to the way in which the common cold or influenza spread (Barroso 2015). This can occur while an infected person is coughing, sneezing, or carrying on a conversation at close range with a non-infected person (Northrup 1902:20).

Cutaneous diphtheria is the lesser-known manifestation of *C. diphtheriae*. Cutaneous diphtheria can cause skin infections that produce ulcers. This form of diphtheria is more commonly seen in tropical climates, where close contact with skin lesions of infected persons can lead to the spread of the disease (Barroso 2015, Wharton 2004:88). Individuals suffering from cutaneous diphtheria rarely see the spread of the bacteria to the respiratory system. These infected individuals

are important reservoirs of the bacteria, and have great epidemiological significance in the spread of the bacteria (Wharton 2004:89).

Despite the fact that *C. diphtheriae* are known to cause diphtheria in humans, it is worthwhile mentioning that *Corynebacterium ulcerans* is a closely related animal pathogen known to spread to humans and cause diphtheria-like illness. Clinically, diphtheria caused by *C. ulcerans* is indistinguishable from diphtheria caused by *C. diphtheriae* (Barroso 2015, Konrad 2015:769).

The relevance of the bacteria has increased in industrialized countries in recent years, as cases of diphtheria caused by *C. ulcerans* have even outnumbered those caused by *C. diphtheriae* (Konrad 2015:768). Due to the post-vaccination shift in human diphtheria rates, and the fact that no medical reports on the distinction between *C. ulcerans* and *C. diphtheriae* can be found prior to 1951, it is hypothesized that *C. ulcerans* cases have not increased, but cases of C. diphtheriae have fallen (Henkiksen 1952:1503). Reported cases have thus far all involve close contact with an animal infected with *C. ulcerans*, and generally lead to symptoms associated with cutaneous diphtheria in affected people (Moore 2015:1100, Berger 2012:539). Animals from which *C. ulcerans* bacteria have been isolated include cats, dogs, pigs, and cattle (Konrad 2015:768, Moore 2015:1102). Cases have also been reportedly caused by ingesting milk from infected animals (Konrad 2015:769).

Box 15.1: *C. ulcerans.*

Historical Accounts of Transmission

The resilient nature of *C. diphtheriae* was described as early as 1902, along with warnings suggesting the bacteria could survive on common household items for extended periods of time (Northrup 1902:38).

The spread of *C. diphtheriae* was documented to occur from the sharing of utensils such as spoons and forks, as well as from other shared household objects such as towels, dishes, clothes, furniture and bedding. In extreme cases, *C. diphtheriae* bacteria were found on children's toys kept in a dark room for up to 5 months (Northrup 1902:31). Such instances of possible transmission would have

made outbreaks of diphtheria among children seem to have appeared out of nowhere, with no apparent origin.

The Milk Theory

Special attention was given to the milk theory of transmission in early nineteenth century historical texts, in which outbreaks of diphtheria were linked back to milk contaminated with *C. diphtheriae* (Northrup 1902:125, Priestly 2014:38). *C. diphtheriae* grows well in milk (Northrup 1902:125). Today, however, transmission of diphtheria from milk is linked to *C. ulcerans* (Box 15.1). Bacteria can spread via fomites; however, spread of *C. diphtheriae* via milk has not been confirmed yet (Barroso 2015, Wharton 2004). It is possible that *C. ulcerans* was confused with disease caused by *C. diphtheriae* in the past (Box 15.1). Milk-men were often believed to be responsible for local outbreaks of the disease, and accused of supplying contaminated milk despite knowing that their animals were diseased (Priestly 2014:38, The Hamilton Spectator 1884). An 1884 article in The Hamilton Spectator states "Dr. Ryall, medical health officer of the city, has inspected and tasted some of the water from the well of the milkman, who is accused of having disseminated the disease in the milk that he sold." The article exemplifies the suspicions placed on milk-men and their products during local epidemics of diphtheria in Hamilton (The Hamilton Spectator 1884:8).

Of course, today, individuals in industrialized countries are unlikely to be concerned about disease transmission by milk, largely due to regulation of milk distribution and pasteurization processes in place. In Canada, pasteurization of all sold milk was made mandatory in 1991 (Government of Canada 2013). Therefore, it comes as no surprise that such modes of transmission are found commonly in historical reports, and articles, but not mentioned in more contemporary accounts of disease spread, as previously discussed (Chapter 12).

The Biocultural Approach to Disease Analysis

As highlighted throughout this chapter, a purely biological understanding of diphtheria distribution and spread is an incomplete understanding. Cultural factors, such as environment, class, race, inequality, habit, and lifestyle, play integral roles in disease expression (Lock 2010:61). It is in the very nature of

anthropological study to address these factors, and combined with epidemiological study of disease, these two fields can expand understanding of the ways human behaviour influences the host-pathogen relationship (Trostle 1996:261).

The role of ethnography – a common form of research in cultural anthropology – has also proven to be useful to the field of epidemiology. For example, a study of factors leading to the spread and control of schistosomiasis (a parasitic disease spread by water, causing intestinal problems) in Cameroon in the 1980s recruited medical anthropologists and epidemiologists alike to conduct research. Epidemiological surveys alone were insufficient to develop effective preventative strategies, and therefore an anthropological study was designed. The structure of the study involved qualitative surveys of households to determine disease understanding and the imagery used by currently implemented health programs. This approach allowed researchers to gauge ways in which a community-centered system to detect and control disease could be implemented. In the final stage of the project, educational messages relevant to the local people, and practical tools deemed usable by the public were developed using the anthropological information collected (Robert 1989:356).

A similar approach can be applied in countries where high rates of diphtheria occur, such as India and Russia (Figure 2.2). The first step would be for anthropologists to collect ethnographic information on social factors that contribute to the spread and severity of diphtheria. Key questions that need to be asked include: why do diphtheria infections continue to rise despite the invention of a successful vaccine, how do local people understand and cope with diphtheria, and what measures are taken by individuals to prevent disease? The answers are best sought through an ethnographic approach instead of via quantitative surveys often employed by epidemiology. Once such research is completed, medical anthropologists would be employed to help bridge the gap between medical professionals, policy advisors, and the local population (Wiley 2009:31). Anthropologists may suggest changes in policy that improve diphtheria education, vaccination, and increased outreach to vulnerable populations. A biocultural approach to prevent and treat diphtheria in countries such as India, Kazakhstan, and Russia has the potential to reduce reported diphtheria cases, and increase the overall health of their populations.

Big World, Small Steps

The argument has been presented that biocultural analysis and research is an important part of developing our understanding of disease, pathogens, and how they spread. The field of medical anthropology is heavily involved in work attempting to decipher the ways in which human behaviour and culture shape disease distribution and spread, and therefore has much to contribute to fields such as public health, epidemiology, and medicine. In concluding this chapter, we are left with gaps in our knowledge regarding the spread of diphtheria, risk factors in human behaviour that may help the pathogen spread more effectively, what social and environmental factors put certain groups at a higher risk for disease, and what modifications can be made to human behaviour to limit spread.

Despite progress within both epidemiology and medical anthropology, there is still ample room for more collaborative efforts, where not only can anthropological research complement epidemiological research, but epidemiological research can spur the creation of new research projects in anthropology (Behague 2008:1702). As suggested in this chapter, the implementation of ethnographic research about local perceptions of disease has vast potential for lowering diphtheria rates and improving the health of humankind.

16

The Silent Grip of the Carrier State

J. Meijer

We look for medicine to be an orderly field of knowledge and procedure. But it is not. It is an imperfect science, an enterprise of constantly changing knowledge, uncertain information, fallible individuals, and at the same time lives on the line. There is science in what we do, yes, but also habit, intuition, and sometimes plain old guessing. The gap between what we know and what we aim for persists. And this gap complicates everything we do (Gawande 2003:7).

In 1949, a rare case of diphtheria emerged in a 33-year old woman in Hamilton after health officials seemingly had a grip upon the Strangling Angel. With only one case of diphtheria in the previous thirteen years, and over fifteen years without a diphtheria-related death, medical personnel began to worry that diphtheria was back. Could diphtheria be present in someone who showed no symptoms? With the identification of the first confirmed case of diphtheria in almost a year and a half, many suspected an unknown diphtheria 'carrier' was spreading the disease. This carrier had to be one of Hamilton's own, as the sick woman had not left the city prior to her illness. Her child had been toxoided and protected from the disease, so health officials began to wonder if they should conduct throat swabs on everyone who might have been in contact with her (The

Hamilton Spectator 1949) – such a large task to find a single individual. Was it even possible to find an individual who had a 'silent case' of diphtheria?

This chapter considers the 'carrier state' in infectious disease and the role played by carriers in the spread of diphtheria in Hamilton during the early twentieth century. Dr. Robert Koch's famous work in microbiology and bacteriology, which led to the discovery of the carrier state, is also discussed. This chapter aims to address the social consequences of the discovery of the carrier state and to reveal how 'othering' emerged from this medical label. The widely known case of Typhoid Mary helps to drive home the connection between medical categories, deeply embedded fears surrounding the mysteries of unknown aspects of infectious disease, and social blame.

What is a Carrier Anyway?

The carrier state refers to infected individuals who do not show symptoms, and remain healthy, yet can spread a disease (Gradmann 2010:232). The carrier state is an important aspect of any infectious disease, as carriers unknowingly facilitate the spread of disease agents. In order to identify carriers of a particular disease, screening methods must be developed and put to use on a mass scale. German physician Dr. Robert Koch is credited with inventing the concept of the carrier state through his work on microbes and their transmission at the turn of the twentieth century (Gradmann 2010:233) (Box 16.1).

Robert Heinrich Herman Koch (1843-1910) was a German physician and microbiologist. He is the founder of modern medical bacteriology and studied mainly anthrax, tuberculosis, and cholera. Koch's main contribution to modern medicine stem from his four postulates which outline a method for linking the cause and effect of an infectious disease. His work helped immensely with the discovery of infectious disease carriers, people who can spread a pathogen but never show symptoms themselves. The notion of the carrier state arose during a screening campaign for military soldiers conducted in 1902 in the German city of Trier, directed by Dr. Robert Koch himself.

Box 16.1: Robert Koch (Unknown Author 1912).
Courtesy of Images from the History of Medicine (IHM).

Carriers and Other Diseases: a Brief Discussion of Typhoid Fever

Typhoid fever is a life threatening bacterial infection also known as *Salmonella typhi*. It often begins with a high fever, accompanied by a headache and abdominal pain. In 1879 Dr. Karl Joseph Eberth discovered the bacterial agent causing the disease, and Dr. William Budd was the first to demonstrate its spread through fecal contaminated water (Marineli et al 2013).

Typhoid fever and diphtheria have a carrier state – both infections can affect asymptomatic individuals who, unwittingly, spread the disease. Typhoid fever ravaged North America during the same time period as diphtheria, during the late nineteenth century. The first effective vaccination was introduced and used in 1896; a steady decline in the disease followed over the next century (Smith 2015). The widely known case of Typhoid Mary (Mary Mallon) exemplifies who and what a carrier is, and illustrates the social stigma faced by individuals who are carriers of a disease (Box 16.2).

Case Study: Typhoid Mary

Mary Mallon (1869-1938) was the first known case of a healthy carrier in the United States. She was born in Ireland and immigrated to the United States in 1883. Mary worked as a cook during her time in the United States. In late summer 1906, six out of

the eleven people at the house where Mary worked contracted and suffered from typhoid fever. A sanitary engineer, George Soper, was hired to investigate the case and later discovered that Mary was a 'healthy carrier' of typhoid fever. By 1909 Mary was tested and found positive for typhoid fever. She was confined and quarantined by health officials. Over subsequent years Mary escaped quarantine several times, continuing her work as a cook, and consequently infecting many who crossed her path. Overall it is estimated that Mary caused over fifty cases of typhoid fever, at least three of which were fatal. Some sources suggest she caused over a hundred cases. Mary died in quarantine of a presumably unrelated stroke or pneumonia in 1938.

Box 16.2: Mary Mallon in hospital (The New York American 1909).

Othering: The Terror Next Door

When the rare case of diphtheria emerged in Hamilton in 1949, with seemingly no evidence of who might have transmitted it to the affected woman, the public began to panic (The Hamilton Spectator 1949). As illustrated by the example of Typhoid Mary, it is clear that disease carriers were not met with welcoming arms. Carriers were shunned, excluded, and stigmatized, and began to be regarded as the 'problem', especially as diseases such as typhoid fever and diphtheria became less prevalent (Marineli et al. 2013).

The idea of 'othering' is fundamentally based on the dichotomy most cultures make between 'us' and 'them'. Edward Said (1978) discusses this dichotomy with reference to Orientalism, a feature of European colonialism in which Europeans (us) considered their culture to be superior to all non-European cultures (them). The arbitrary dichotomy of 'us' and 'them' is the basis for othering (Washer 2010:78-80). The carrier state can be viewed through the lens of othering, society being 'us' and carriers being 'them' (Magner 2009:106). The creation of others is an integral part of the creation of a culture, and in the cohesion of a state (Robins 2006). In the context of disease, a carrier can be stigmatized as a foreign entity, different from a normal, healthy citizen. Peter Washer (2010:107b) suggests that a modern response to infectious epidemics is the recurring notion that 'others' are dirty and have poor hygiene.

Typhoid Mary exemplifies the notion of the other. As a known carrier of typhoid fever, Mary was fired from numerous jobs, and confined in various hospitals and institutions (Marineli et al 2013). She was declared 'unclean', and therefore 'othered'. A Washington newspaper article from 1915 depicted Mary as a "Witch in N.Y." who cast black magic upon the city of New York (her home) (Tacoma Times 1915).

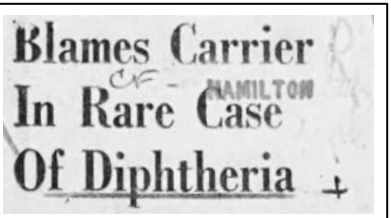

Blames Carrier
In Rare Case
Of Diphtheria

Figure 16.1: Blames Carrier In Rare Case of Diphtheria (The Hamilton Spectator 1949)

How would you feel, knowing one of your neighbours might be transmitting a deadly disease? Would you stay away from a known carrier? Would you meet them with welcoming arms? All these questions must be taken into consideration whilst discussing the notion of othering. When the mysterious case of diphtheria was discovered in Hamilton in 1949, diphtheria carriers were blamed for the reemergence of the disease, as seen in the Hamilton Spectator's headline, "Blames Carrier in Rare Case of Diphtheria" (Figure 16.1). In addition to the provocative title, the article discusses the need for immunization, perhaps suggesting that it is the carrier's own fault for not receiving the vaccine. Hamilton's medical officials were on high alert and undertook a mass-screening program of throat swabbing to identify all diphtheria carriers (The Hamilton Spectator 1949).

Disentangling the Research

During the period between WWI and WWII, the question of how to deal with carriers arose. Various studies were performed on carriers in order to better understand them. Many researchers wished to identify how long a carrier tested positive for *C. diphtheriae*, as well as how they contracted the disease. Virulence also became a significant question – did carriers carry virulent or non-virulent forms of the bacilli? And could non-virulent forms transform into virulent forms?

One experiment published in the British Journal of Medicine found that carriers had various exposure lengths, ranging from one to fourteen years prior to the experiment. Some 160 carriers were tested at varying intervals to identify how long a carrier tested positive for diphtheria: the results suggested carriers could

transmit the bacteria anywhere from a few months to a couple of years. The most significant conclusion drawn from this study, however, was that carriers of non-virulent bacilli are not a menace to society and can therefore live normal daily lives. However, it was imperative that carriers of virulent forms be quarantined in hospitals and undergo treatment (Author Unknown 1921).

The normal antitoxin did not usually rid diphtheria carriers of the disease (Grant 1931:566). Virulence tests were also conducted to determine if the disease was deadly or harmless. In hopes of curing diphtheria in carriers, antiseptics were either painted on the tonsils of throat carriers, or swabbed onto the nasal passage for nasal carriers (Grant 1931:566).

Penicillin was also a widespread treatment given locally; however given systemically, this treatment would fail (Author Unknown 1947:538). Penicillin was used cautiously as several side effects were often dangerous, including stomatitis. Removing the tonsils also proved to be a successful treatment most of the time (Author unknown 1947:538).

It is important to keep in mind that the carrier state narrative was often more complex than can neatly be summarized.

What about us?

How does the carrier state affect us today? Should we worry about diphtheria carriers? Should we worry about other disease carriers? How can we protect ourselves? The final section of the chapter discusses the legacy of the carrier state.

Since the turn of the twentieth century, much has changed in our medical understanding of diseases and microbes. Dr. Robert Koch's discovery of the carrier state still holds true today. Whether we should worry about getting diphtheria depends on where we live; diphtheria prevalence is high in tropical countries (CDC 2009:111). Currently, however, diphtheria and diphtheria carriers are no longer a threat in Hamilton, Ontario, nor are they a threat throughout North America. Children receive immunization against diphtheria in their childhood boosters, which stop infectious diseases before carriers can even emerge. Such immunizations are given in a single shot in a combined booster with tetanus, and boosters are recommended every ten years (CDC 2009:111). According to the Centers for Disease Control, there are various steps to take if a carrier of

diphtheria is detected, including but not limited to contacting the CDC, obtaining proper antibiotics, and identifying close contacts. In contrast to the past, infectious disease protocols today are much more complex. In Typhoid Mary's case, being a carrier resulted in her stigmatization and exclusion from society. However, the current understanding of the carrier state suggests that it is often very treatable and non-threatening.

With regard to the rare case of diphtheria in Hamilton in 1949, it is unclear whether the carrier who infected the 33-year-old woman was ever found. No other cases were identified during that time period. As with other disease carriers, it is difficult, if not impossible, to identify a carrier by appearance alone – tests must be run to determine whether an individual can spread the pathogen.

And therein lies the terror: the unknown.

17

Pseudomembranous Lesions? Medical Terminology More Wordy than Wise

David MacDonald

Physicians often use medical jargon, deliver too much information at a time, and do not confirm patients' understanding of what is discussed (Sunil and Weiss 2006:888).

Diphtheria is an infectious disease that is, for the most part, eradicated in western countries, but still endemic in many areas of the world. The recent epidemic in Russia that began in 1990 (Chapter 18) shows that if not properly controlled, diphtheria can still be a threat. Therefore, it is important not to disregard the cumulative efforts during the past decades to immunize against and control diphtheria (Hadfield et al 2000:S120).

Medical explanations can be quite technical and the words, expressions and concepts can be very hard to understand, even if the public is well educated and literacy rates are high. Thus, this chapter explores the problems with current medical jargon and Consumer Health Literacy (CHL) in Canada and around the world. With reference to diphtheria and other areas of medicine, low CHL is

studied to show its effect on doctor-patient relations and doctor-doctor relations, as well as how it may lead to misdiagnosis and improper treatments.

To provide potential solutions and recommendations for the problematized medical jargon, the final section discusses the steps which health-care professionals, anthropologists and the Canadian public may take in overcoming the health-literacy gap and miscommunication. I explore community-based literacy approaches as well as changes to physician training that help support efficient and effective communication with patients. I begin with an explanation of what diphtheria is and how it makes people sick.

Diphtheria

Diphtheria is an infectious disease caused by *Corynebacterium diphtheriae*. The disease gets its name from the Greek word for 'leather' (Barroso and Pegram 2015). The infection is characterized by its hallmark symptom, a grey, leathery-looking growth often in the throat (Chapter 5, Box 5.1), referred to as a 'pharyngeal pseudomembrane,' where it gets its name. In layman's terms, this means a growth in the throat that looks like a lining that would normally protect an organ or body part (Barroso and Pegram 2015). In the case of diphtheria, the lining does not offer protection, but rather causes difficulty breathing.

How Diphtheria Makes You Sick

Diphtheria attacks the body in two ways: the bacteria invade the area to which they are exposed (generally the throat or another part of the respiratory tract) and colonizing bacteria produce a local lesion. The bacteria grow (by mass reproduction), creating a pseudomembrane that covers the lesion. It is the pseudomembrane that can lead to respiratory trouble and, in some extreme cases, suffocation (Hadfield et al 2000:S117; Todar 2015). Diphtheria also makes people sick by toxigenesis, that is, by poisonous substances that cause the death of tissues and cells in the body (Todar 2015).

There are three strains of *Corynebacterium diphtheriae.* In order of severity they are: *gravis*, *intermedius* and *mitis*; each strain produces the same toxin but at different rates and quantities (Chapter 15). Diphtheria creates a two-

component bacterial exotoxin (DTx); one part binds to cells and the other activates its toxin (Todar 2015). The binding section latches on to the cell while the active section injects the cell with DTx. This process allows the bacteria to insert its own ribonucleic acid (RNA) into the cell to start reproduction and to kill the cell (necrosis) (Collier 1975:79). DTx is only created by an encoding gene in *C. diphteriae* that kills susceptible cells (Holmes 2000:S156).

This very complex, technical language is used by physicians and researchers to understand and discuss diphtheria and permeates the literature on infectious diseases. Medical jargon is very common and continues to create problems in public health. Graham and Brookey (2008:67) argue, "The entire health-care system relies on the assumption that patients can understand complex written and spoken information." Health-literacy skills "are needed for dialogue and discussion, reading health information, interpreting charts, making decisions about participating in research studies, using medical tools … calculating timing or dosage of medicine, or voting on health or environmental issues" (Kindig et al 2004:31). Even among highly educated individuals, medical terminology can be confusing, which may lead to misdiagnosis and improper treatment (Kindig et al 2004:59).

Diphtheria is often wrongly diagnosed (Bonnet and Begg 1999:3). When the public does not have access to the complicated terminology used by physicians, it is difficult for patients to describe their symptoms in a way that leads to proper diagnosis. In addition, when doctors diagnose, explain illnesses and suggest treatments, patients often misunderstand the technical information being conveyed. Examples of the barriers created by medical jargon are illustrated in the following sections.

Doctor-Patient Relationships

Navigating through North American health-care and public-health systems can be quite an arduous task; from bureaucracy, procedures, processes and paperwork, getting health care can be quite difficult (Kindig et al 2004:168). Even highly educated individuals find health-care systems complicated by "official documents, including informed consent forms, social service forms, and public-health and medical instruction as well as health information materials" (Kindig et al 2004:168). They are full of medical jargon and highly technical language,

making forms needlessly difficult to understand and complete properly. Doctors often fail to recognise that they have not properly explained medical diagnoses and treatments to patients, and equally, patients are often too embarrassed or prideful to admit that they do not understand (Campbell 2014). Researchers in England discovered that it was quite common for a parent to be told that their child tested positive for a disease, and interpreted this to mean that the child was healthy rather than what the doctor actually meant; that the results came back positive and the child *does* have the disease being tested for (Campbell 2014). This is very alarming, as a misunderstanding like this could end in improper treatment and even the death of a child.

Figure 17.1: Defining medicine (Potter 2015).

Health Literacy or Consumer Health Vocabulary (CHV) is an index of the ability to which patients understand the materials and advice given by medical professionals (Cambell 2015; Zeng and Tse 2006: 28). Study after study has shown that health literacy and the transfer of knowledge between doctors and patients is quite low. For example, a study by Cherla and colleagues (2012:1653) found that most internet-based education materials on the topic of a minimally invasive endoscopic surgery are written well above the health literacy of the average American (1653). Lerner and colleagues (2000:766) looked at the understanding of medical terminology by emergency department patients and found that many left misinformed or confused, especially young, urban and poorly educated patients. McCarthy and colleagues (2012:2) discovered that many older adults often have difficulty remembering medical advice given during clinical encounters. Farrell and colleagues (2008:243) argue that: "The large number of jargon words and the small number of explanations suggest that physicians' counselling about newborn screening may be too complex for some parents."

Bagley and colleagues (2011:401) suggest that properly educating patients is an important and routine part of medical practice. Graham and Brookey

(2008:67) argue, "The entire health-care system relies on the assumption that patients can understand complex written and spoken information." There are other barriers to effective medical communication. In the United States, 19 million people are limited in English proficiency, which makes medical terminology more difficult to comprehend (Flores et al 2003:6). Countless studies come to the same conclusion: health literacy is low and low health-literacy rates can cause harm, and that it is, in part, the health-care professional's role to help explain and avoid confusion. Medical jargon is a substantial barrier to accessing health information for laypersons, and clearly must be reworked so that health-care professionals can better fulfil their role in keeping people healthy (Zeng and Tse 2006:28).

Although health-care professionals have a responsibility to ensure their patients understand the medical advice and treatment commands, it is also in part the responsibility of government to provide education that helps the public understand medical concepts. It is important for the public to have basic health literacy in order to properly understand and apply the advice from the doctor to their decision making. In the next sections, I show that it is likely not entirely the fault of the doctors, but in fact their tools (medical terminology) that create gaps in health literacy.

A (2008:3) study by the Canadian Council of Learning found that although Canada has one of the most highly educated populations, and public healthcare, 60% of Canadians do not have "the skills needed to adequately manage their health and health-care needs." This means that 6 in 10 Canadians "lack the capacity to obtain, understand and act upon health information and services and to make appropriate health decisions on their own" (Canadian Council of Learning 2008:6). This low score on Canadian Health Literacy is alarming and demonstrates the need to create better physician-patient communication and better public teaching of medical concepts and language.

Doctor-Doctor Communication

Not only does medical jargon impede patient health literacy but as Trall (1862) pointed out over 150 years ago, it also creates barriers to physician-physician communication regarding diphtheria. Trall (1862:7-8) argues that medical literature and jargon "has served to confuse and mystify the subject" of

diphtheria. In his analysis of medical papers on diphtheria, Trall (1862) found many confusing, incorrect and contradictory uses of jargon. He argues that even in 1862, the literature on diphtheria is full of "incoherent expressions of incoherent ideas" (Trall 1862:38). The undefined or vaguely defined concepts which claimed that diphtheria was an inflammation, a fever, or both, could cause unnecessary debate that would distract from the actual problem at hand (Trall 1862:41). He notes that the literature on diphtheria is filled with nonsense terms, such as 'morbid poison.' Trall explains that this is gibberish, and that morbid means something is abnormal; all poisons are considered morbid. Adding the word morbid only increases reading difficulty without adding content; thus, 'morbid poison' is jargon (Trall 1862:120). At the time Trall (1862:163) was writing, medical authors even confused fundamental philosophical medical concepts, referring to a disease "running its course through the patient," which implies that diseases can simply 'pass through' patients.

Although Trall's paper about diphtheria was written over 150 years ago, medical discourse today is still filled with words and phrases that are often vague, unnecessarily difficult, redundant and just plain incorrect. An American survey found that more than 8 million Americans seek health information on the Internet for decisions that directly relate to their health care; an estimated 70% of Canadians did likewise in 2009 (Cherla et al 2012:1649; Statistics Canada 2011). The diphtheria jargon alone, such as "pseudomembranous lesions," shows that the technical language around health is a barrier to health literacy. It is important to use terminology that can be discussed and understood by anyone. When writing anything, it is important to write for one's audience. In this case, the medical explanations provided by physicians exceed the literacy level of the public and are therefore not effective ways of communicating with patients.

How Can We Fix It?

It is quite clear that medical jargon is a major cause of miscommunication within the health-care system. There are three ways to tackle this problem: stop using medical terminology; improve health literacy; or compromise by keeping the terminology but improving it to get rid of overcomplicated jargon and creating a more health-literate public. The third option seems to be the best solution; however, actually implementing this strategy will take a lot of work. The

solutions could be first to rid medical discourse of unnecessary jargon such as the incoherent phrases noted by Trall (2008), while leaving the medical terminology that enables health-care professionals to communicate effectively. We must work toward developing a more health-literate public, which will require a multi-disciplinary approach.

Doctors, researchers, public health, the education sector, Non-Governmental Organizations (NGOs), and others must collaborate in creating a solution to low health literacy. It is important to target each source of miscommunication. For the doctors' offices, a solution may be to "design a standard set of clear, concise leaflets for every condition, so no one can fail to understand what they are being told" (Campbell 2014; McCarthy et al 2012:7). Leaflets, in the patient's first language, also provide reference material for patients who may have trouble recalling what the doctor told them, material they could readily consult at home. Digitized leaflets can provide that information to anyone who has access to a computer. In view of the finding that 70% of Canadians use the internet for health advice, it is also important to make effective materials available online for just-in-time access (Statistics Canada 2011).

Doctors should ensure that each patient has the answer to three questions every time they visit: "1) What is my main problem? 2) What do I need to do? 3) Why is it important for me to do this" (Graham and Brookey 2008:68). The American Medical Association (AMA) has called for greater efforts to prepare physicians for effective communication with patients (Sunil and Weiss 2006:888). This must be done within the medical curriculum as well as in graduate classes. It should be continued and reiterated within each health-care workplace. It is vital that doctors be aware of health literacy and know how to simplify the information they provide to their patients. Educating health-care professionals to use simple and understandable language, instead of perpetuating medical jargon, is an important step in solving the problem.

Adopting a community-based approach to healthcare can also be an effective step in solving the problem. This approach can create an interactive environment between experts and communities. Community-based approaches allow members to choose which questions are asked and to get the answers they seek. These approaches have shown promise in helping to spread health literacy by getting communities interested and knowledgeable about healthcare (Kindig et

al 2004:126). This also provides community members with an opportunity to clear up any misconceptions they may have.

Creating awareness of health illiteracy is also important for counteracting it. Health-care professionals have a duty to ensure proper transfer of knowledge to their patients; however, it is the role of government to provide opportunities to educate its citizens. Implementing a mixture of public-health and education policies can considerably increase health literacy and, in turn, improve the overall health of Canadians.

The most promising approach is the first-generation CHV platform. The CHV advocates teaching medical terminology and concepts at a young age, throughout elementary and secondary school. In this way, increased health literacy develops gradually and can be built upon through doctor-patient relationships without needing to start from the very basics. This curriculum can evolve over time, as basic information becomes common knowledge; health literacy can increase in complexity, reduce health-risk behaviours and prepare people for navigating through the complicated health-care system (Kindeg et al 2004:143).

Medical terminology is often the cause of much confusion, as illustrated by the language used to discuss diphtheria, and ongoing barriers to communication between doctors and patients. Reducing this confusion (perhaps through the CHV platform) and improving health literacy should be a priority for Canadians and for the Canadian government. Raising awareness and providing solutions to these problems can improve health outcomes. As anthropologist and feminist author Emily Martin (1991:7500) argues: “The models that biologists use to describe their data can have important social effects.”

18

Under What Conditions Does Diphtheria Flourish?

C. J. Rondeau

Unequal development in different countries in the promotion of health and control of disease, especially communicable disease, is a common danger (Garrett 1994:457).

This chapter briefly considers the worldwide distribution of diphtheria from a socio-economic perspective and asks how this lens can inform our understanding of diphtheria in Hamilton in the early twentieth century. I discuss the social characteristics of developing and developed countries as well as urban and rural communities to highlight the role of social inequalities in the prevalence rates and the availability of vaccines to prevent it. I also look at different diseases in history in order to analyze the effects of diphtheria biologically and socio-culturally. The aim of this chapter is to explain the factors that allow diphtheria to persist today.

Developed and Developing Countries

The resurgence of diphtheria in any community can be stimulated by social conditions that affect its modes of transmission. Diphtheria can be transmitted through human-to-human contact via the respiratory route (Konrad 2015:769).

This mode of transmission may be common in developing countries as population levels and over-crowding tend to be higher than in developed countries. Social factors that affect the prevalence of diphtheria include the circumstances of life, public health initiatives, rates of immunization, and political-economic situations. Although it is sometimes difficult to identify diphtheria outbreaks, since 1974 most cases have been reported in developing countries (Galazka 1995:97).

Diphtheria outbreaks can be a major problem in developing countries; since 1980, cases of respiratory diphtheria have been reported in Africa, Asia, the Eastern Mediterranean, and Latin America (Galazka 1995:102). Young children are especially susceptible to diphtheria acquired through cuts to the skin that allow *C. diphtheriae* to infect the wound and cause skin sores (Galazka 1995: 101). Pre-school children and the elderly are the most vulnerable to diphtheria due to their weak immune systems. Immunization and vaccine coverage, especially for these groups of people is essential to the control the disease.

Developed countries can display "thirdworldization," exhibiting characteristics of developing countries (Garrett 1994:503). This phenomenon often includes insufficient methods for countering the effects of disease. Social stigma can cause discriminatory behaviour towards the sick, usually owing to a lack of knowledge about the epidemiology of a disease. For example, thirdworldization is evident in the HIV/AIDS epidemic in North America. False information on the epidemiology of HIV/AIDS caused marginalization, discrimination, poverty, and social alienation of the sick (Garrett 1994:474). The social factors involved in the emergence of HIV are similar to those associated with the emergence of diphtheria. Although developed countries have higher vaccination coverage relative to developing countries, diphtheria can still cause epidemic disease. As diphtheria is still prevalent in developing countries, people travelling from these countries are a potential source of infection for developed countries (Garrett 1993:840).

Russia 1990

Outbreaks of diphtheria in the early 1900s in the Russia Federation displayed characteristics of thirdworldization. This ongoing outbreak was one of the largest in the developed world, mostly occurring in St. Petersburg and Moscow (Garrett 1993:841). Over 12,000 cases were reported from the first case in January 1990

until the last in August 1993 (1993:840). As the population of St. Petersburg grew due to the migration of rural people searching for work, cases of diphtheria increased. Many migrants failed to find work and became homeless, accounting for almost half of the total diphtheria cases in Russia. During the last wave in 1993, 6,000 cases and 106 deaths were reported, despite the call for revaccination to contain the spread (Garrett 1994:504). Most cases involved individuals under the age of 14 and thus children were required to have the diphtheria-tetanus-pertussis (DTP) vaccination developed in the 1960s before their first birthdays (1993:840). However, adults may still have harboured the bacteria, making older individuals vulnerable to the disease.

Although diphtheria can be treated successfully with antibiotics, deterioration of the Russian health care system led to an increase of death rates during the 1990 wave (Garrett 1994:504). The vaccination itself can be considered a success worldwide although its protective effects only work for about five years. The worldwide distribution of the vaccine means that most people have never been exposed to the bacteria (Garrett 1994:505). The Russian epidemic remained a problem as other developed countries slowly got rid of the disease. In response to the persistence of the disease, revaccination of nearly all the nations' citizens was called for as a part of a five-year plan. Russia's diphtheria problem was rooted in the inadequacy of its health care system. Other social factors, such as the fall of the Iron Curtain revealed how severe the effects of disease and illness were at the time. It can be argued that conditions may have gotten worse because of the political and economic turmoil in the post-Soviet era.

Urban and Rural in Hamilton

As is the case for developing and developed countries, urban and rural communities offer different settings for diphtheria. Historically, general patterns are found in both contexts, especially during the rural to urban transition. Urban areas were more likely than rural ones to have the conditions in which diphtheria thrives, such as overcrowded households and high fertility rates that allowed for higher transmission rates (Galazka 1995:96). Diphtheria could have been introduced to cities with growing populations through the process of migration. Rural areas, however, could also have experienced high fatality rates, even though the disease may not have been as prevalent due to smaller populations and less

household crowding (1995:102). When fewer people live together in a household, sanitation is generally better. Also, rural labour was not run by industrial companies and was less intense. However, if an individual contracted diphtheria, it was diagnosed late, and often there was no ready access to health care (1995:100).

As the city of Hamilton became more industrialized at the beginning of the twentieth century, the transition from rural to urban setting accelerated. The key for Hamilton was a boom in population growth between 1909 and 1913 (Weaver 1982:92). Population growth affected housing, sanitation, and labour relations (Weaver 1982:92). The demand for more housing resulted in overcrowding, making people living in close quarters more susceptible to disease as bacteria spread via the airborne route is easily spread through coughing, sneezing, and kissing (Northrup 1902:20). Other modes of transmission depend on cultural practices, such as the consumption of milk or the presence of domestic animals that harbour the bacteria (Northrup 1902:21). Urban families were also at risk of contracting diseases in the workplace, where intense labour requirements created environments with longer hours. Economic abundance in Hamilton also brought people to the city in search of work, including European immigrants (Weaver 1982:92).

Diphtheria in Hamilton in the Early Twentieth Century

In 1900, diphtheria and tuberculosis caused 7% of deaths in Hamilton (Gagan 1989:163). In fact, respiratory and nervous system disorders, coupled with increased infant mortality, caused death rates to escalate at this time. After 1910, the overall health of the city improved as shown by a decrease in contagious diseases and mortality rates (Gagan 1989:164). The reduction of deaths from diphtheria between 1900 and 1914 indicates a more positive response to treatments and more accurate diagnosis. The presence of diphtheria in Canada can be traced primarily to settlers who introduced it. Diseases like diphtheria easily spread to Aboriginal populations (Waldram et al 1995).

The general patterns of outbreaks reveals, however, that no single group of people is immune to diphtheria, even though cultural factors, such as religious affiliation, can often affect mortality rates. Northrup mentions, for example, that Jewish individuals were more susceptible to diphtheria relative to other groups

(1902:25), whereas Battles (2013:14) notes that Jewish communities had a lower death rate from polio compared to Catholic communities (2013:34).

Age, however, seems to be the most important factor affecting susceptibility to diphtheria. Initially, the disease affected children and the elderly due to their weaker immune systems (Galazka 1995:97). However, as outbreaks continued, the disease tended to target older children and adults and usually occurred every 30 to 40 years, with the first wave emerging among children. Each subsequent wave affects older ages as the age pattern shifts upwards to target adolescents and adults (Galazaka 1995:102). Working class families with young children were often very poor in 1920s Hamilton (Battles 2013:33). Higher infant mortality rates occurred in these families owing to their lower incomes and poorer living conditions. More affluent families also had greater access to doctors and medical knowledge (Battles 2013:34).

Poverty has a direct effect on an individual's health and on the risk of diphtheria. For instance, diphtheria is sometimes found among adult urban alcoholics because of "underlying skin disease, hyperendemic streptococcal pyoderma, and [the] introduction of new strains from exogenous reservoirs" (Harnisch et al 1989:71). Respiratory and eye infections often occur which eventually lead to their death.

The Impact of Public Health Initiatives

Public health policies play a major role in the epidemiological patterns of diphtheria. How a community decides to approach the problem of a new disease and illness can greatly affect rates of immunization and transmission. Protective measures that should be taken include high immunization coverage for groups at risk, recognition and management of cases, and prevention of secondary cases by identifying close contacts (Galazka 1995:102).

The diphtheria outbreaks in the Russian Federation in the early 1990s illustrate the importance of health care systems in prevention. In Hamilton, the department of health took action in the 1920s under Dr. James by introducing vaccines and immunization projects to control the disease and lower the mortality rate. Public health initiatives and laws are created to keep the public calm and prevent social stigma by disseminating knowledge about disease. The HIV/AIDS epidemic in the 1980s and 1990s, by contrast, caused state emergencies, denial,

and panic as the public had no knowledge of how the disease worked. It is important to recognize the effects of public health for disease control and how vital they are for preventing diphtheria from flourishing.

19

The Aftermath: The Global Persistence and Threat of Diphtheria After 1940

T. Noble

Diphtheria has been in the past, and will be in the future, one of the greatest causes of death among our child population unless, and until parents come to the realization that this is a preventable disease - preventable by immunization (Canadian Welfare Council 1936:1).

After the near eradication of diphtheria in Hamilton and surrounding areas due to the success of vaccination initiatives, worries lessened about the deadly child killer. The daily newspaper, *The Spectator,* reported in 1939 that diphtheria had been eradicated in Hamilton since 1922 (The Spectator 1939:1). Thereafter, the local news only mentioned the disease to generate excitement about how many years had passed since the last case was detected. Local public health initiatives were maintained to ensure children received the proper protective inoculations, and antitoxin continued to be administered to those who became ill (Health Canada 1998:5).While Hamilton seemed to be safe from the disease, the need for diphtheria prevention continued in Canada after the 1940s. This chapter explores

the threats international and local health practices surrounding diphtheria posed to Canadian health and health policy.

In Canada

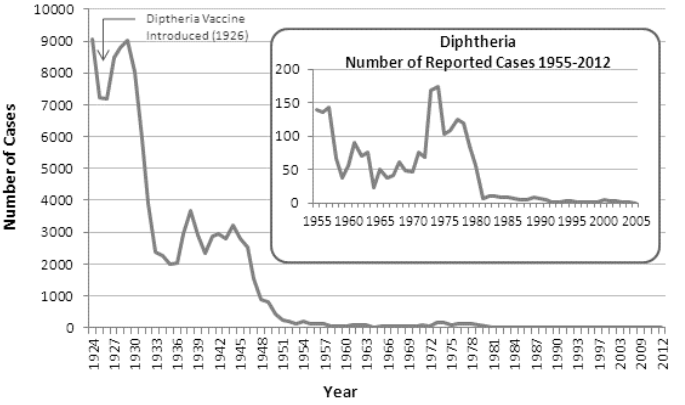


Figure 19.1: Annual number of reported cases of diphtheria, Canada 1924-2012 (Public Health Agency of Canada: 2014). Image © All Rights Reserved. Diphtheria: For Health Professionals. Public Health Agency of Canada, 2014. Reproduced with permission from the Minister of Health, 2015.

Diphtheria prevention strategies continued in Canada on a provincial level. At the federal level, Ottawa's main concern was to understand the perceived threat of the disease and spread awareness to Canadians. Annual statistics on cases and deaths were published by the Canadian Welfare Council in 1936 (Figure 19.1) and later, through the Centre for Disease Control until 1998. The reports focused on two main risks: local cases arising in Canada and imported cases from other countries.

The internal risks were deemed to come from Canadians who refused vaccination and/or medical intervention, or individuals who forgot to continue the vaccination program every ten years (Canadian Welfare Council 1936:2). The external risk was perceived to be the global persistence and foreign exchange of disease (Health Canada 1998:5). Let us begin by exploring a bit of the world's history in order to understand why outbreaks continued to occur.

Creation of Global Health Initiatives

Alongside the persistence of diphtheria disease, the twentieth century also held other misfortunes – the First and Second World Wars. Although Canadians participated and experienced loss of life in both wars, they did not face war on

their home soil; European countries, however, suffered massive destruction. The devastation of WWII led to a movement to create global organizations focused on maintaining peace and supporting equality for services of safety. Thus, the United Nations was born in 1945 in order to promote security and cooperation between countries. While its main concern was global peacekeeping, global access to basic healthcare became an important UN initiative. By 1948, the UN created the World Health Organization (WHO) with a mission to work towards a global healthcare system with equal access independent of financial status (World Health Organization 2006:25). The organization leads the research agenda in healthcare and dictates which health strategies are most important for human health (World Health Organization 2015). This agenda includes diphtheria surveillance and immunization campaigns around the world.

Diphtheria toxoid became especially valuable to the WHO in the 1970s when it was combined with vaccinations for tetanus and pertussis to create a single inoculation, DPT (also known as DTP and DTwP, Chapter 6). In 1974, this vaccination became part of the WHO's newest initiative, the Expanded Programme on Immunization (EPI). The tactic focused on providing global immunization for children from diseases that included whooping cough, tetanus, measles, poliomyelitis, tuberculosis, and of course, diphtheria. The EPI strategy was (and continues to be) extremely successful and reduced cases of diphtheria by greater than 90% (World Health Organization 2006:25).

With immunization campaigns conducted on international and national scales, we would expect that there would be no cases of diphtheria in Canada. Unfortunately, *C. diphtheriae* infections persisted when ten-year booster shots were forgotten and when skepticism of modern medicine was abundant. I now turn to take a closer look at the internal and external circumstances said to continue to threaten the health of Canadians.

The Internal Threat

The internal risk of contracting diphtheria within Canada varies by province. Vaccination programs in Ontario keep the risk of contracting the disease low. The provincial government actively campaigned to inform the public about the threat of anti-vaccination through outreach programs and pamphlets. Since 1982, legislation insists on the mandatory vaccination of school-aged children

(Canadian Medical Association 2011:183) to prevent childhood mortality. The effectiveness of the legal strategy was praised; however, only the provinces of Ontario and New Brunswick, and partially in Manitoba, have adopted such measures. The vaccination laws contain an exemption clause for those who cannot be vaccinated due to medical and religious reasons. As with much government legislation, the public reaction to mandatory vaccination ranged from gratitude to outrage.

The strongest public pushback took the form of anti-vaccination protests. Anti-vaccination movements have existed for many years, in and outside of Canada, out of disbelief in biomedical remedies, as well as because of religious proscriptions. While historically there have been many protests against mandatory vaccination in Canada, the uprisings over diphtheria in the 1970s were provoked by the DPT immunization. Anti-vaccination protests against the DPT legislation were widespread, fueled in part by complicated medical jargon and concerns about possible side effects from immunization. Some vaccination resisters linked vaccination to other health problems and autism (which has never been proven by testing or scientific study) (Baker 2003:4003). The Ontario government did little to address these protests, and stuck firmly to the decision to implement vaccination programs into the school system (with religious exemptions).

Members of the anti-vaccination movement seemed to be oblivious to the horrors of childhood disease in Canadian history. While it is important to live holistically, or in any manner of one's choosing, it is also important to be fully aware of why vaccination programs exist. Canadians had suffered through a long time within which childhood death was a common occurrence. The longevity Canadians enjoy today is due, in part, to the protection provided by vaccinations. Some childhood diseases, like diphtheria, are so far from our experience and distant from our realm of perception that some Canadians have not even heard of them, including diphtheria. Before choosing to avoid vaccinations, it is important to understand *why* they exist, and what the *real* risk of the disease entails.

The Foreign Threat

The second risk to Canadian health comes from the state of global health. The twentieth century saw the intermingling of countries into a vast globalized world, where all cultures are able to interact freely. While diphtheria is endemic across

the globe, the threat of diphtheria in developing countries has been consistently higher due to the inaccessibility of toxoid vaccinations (Pan American Health Organization 2005:3-4). Rates reaching over 1,000 cases per year throughout the 1980s were found in some parts of the world, including Brazil, Bangladesh, China, India, Nigeria, and the Philippines (World Health Organization 2015). Thankfully, the WHO has forecasted a budget of nearly $380 million in US dollars for immunization programs, becoming a huge provider of vaccinations to those who may not have been previously able to receive them (World Health Organization 2012:1).

Figure 19.2: Diphtheria immunization in Moscow (Bourke-White 1933).
Image courtesy of Marxists Internet Archive.

Developed nations are not to be forgotten, however. The two World Wars, for example, created many challenges to sanitation and prompted the implementation of health initiatives. More recently, an outbreak of diphtheria occurred in 1974 in the Soviet Union, and peaked in 1983 and 1985 (Figure 19.2), due to a low immunization rate that compromised the health of the nation. After the break-up of the Soviet Union, the Newly Independent States (NIS) had over 125,000 cases of diphtheria between 1990 and 1995. The large jump in cases was due to the lack of healthcare and sanitation while the NIS worked to gain control of their countries (Health Canada 1998:4). The Canadian government saw this outbreak as a potential threat, as globalization meant more people were immigrating and traveling across the globe, making it possible for unimmunized foreigners to bring new, possibly mutated strains of diphtheria to Canada (Health Canada 1998:4).

While there are threats from inside the nation, the international threat seemed to be the main concern in 1997. It is interesting to examine the concept of the "other" in this context. Hall (1996) discusses a concept called 'orientalism'

which describes the view that people from foreign countries are 'exotic' or 'other'. It is a way of distinguishing two categories of *familiar*, and *different*.

This theme ties well into the discussion of why foreign cases of diphtheria are painted in words of fear, even though it is the same endemic disease Canada experienced in the past. The 'othering' of a disease from a foreign country may be used in the Canadian context as a reminder that childhood disease still exists, and that the Canadian government wants its citizens to take advantage of the health systems provided in order to avoid outbreaks. Rather than painting a story of stigma or exotic disease, Canadian government pamphlets use words that promote thinking about disease as a constant and volatile threat to health. This Canadian diphtheria story, that is, the history of the disease in Canada, is also included in brochures. The brochures use vocabulary which instills emotions of fear while speaking about the internal struggle against disease. The need for vaccination in Canada is described as demanding haste, rather than as a suggestion. The government tends to use the narratives of children losing their lives to instill this type of fear. It is meant to frighten Canadians as a reminder of the dangers experienced in the past, and to convey the need to take precautions for the future (Health Canada 1998:1-5).

Mary Douglas also addresses the idea of disease threats from outside in her publications on cultural theories and risk (Douglas 1992:1). Douglas explains how blame is often used in politics to describe situations which are claimed to put global safety or health at risk. Blame is used to dispel and explain misfortune and to displace aggression from other the state. While Douglas uses pollution to characterize the effects of blame, the same can be used to describe disease (Douglas 1992:5). Public Health efforts in Canada use blame to advantage by explaining the safety measures that have been taken, and by frowning upon those who do not take advantage of the precautions provided. In this way, blame can be placed on foreign nations, and onto Canadians who may oppose vaccination. By blaming specific groups, hostility is directed toward individuals and communities, not toward the state. This is a useful tactic for the government to employ, as it urges citizens into taking precautions for the greater good of the community.

The Future of Diphtheria

Thanks to immunization, the chances of getting diphtheria in Canada within the twenty-first century are extremely low. The programs for immunization run by the Government of Canada have given families security in knowing their children can live without the threat of unforgiving infectious disease. While our troubles with the diphtheria may seem solved, we must always remember the loss of life that diphtheria caused in our country, and continues to cause in many places around the world. In 2014, there were 7,431 reported cases of Diphtheria worldwide (World Health Organization 2015). Let us hope this number can be decreased even further with the help of the WHO.

While the future is unknown, it is important that aid continue to be provided to countries that need it most. The strides made by medical research can only leave us hopeful that one day the 'strangling angel,' and other childhood diseases will only exist in history books, silenced by time and medicine.

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