The Problem of Diphtheria in the Province of Quebec: 1894–1909

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Diphtheria was the object of one of the more important successes in bacteriological diagnosis and therapy. Quebec medical authorities confronted diphtheria as part of the new public health movement. The authors examine the problems associated with the transfer of laboratory techniques and concepts to the larger social world of medical and public health practice. The years from 1894 to 1909 can be characterized as a period of relative failure with respect to the control of diphtheria, despite the fact that laboratory control of diphtheria and its toxin was more advanced than for any other contagious disease.

La diphtérie a permis de signer l'un des plus grands exploits dans le domaine du diagnostic et de la thérapeutique des affections bactériologiques. Les autorités médicales québécoises combattirent cette maladie dans la foulée du nouveau mouvement de santé publique. Les auteurs étudient les problèmes découlant de la transposition des techniques et des concepts de laboratoire dans le milieu social, plus vaste, de la médecine et de l'hygiène publique. La lutte contre la diphtérie de 1894 à 1909 peut être qualifiée d'échec relatif, même si le combat livré en laboratoire contre cette maladie et sa toxine progressait plus rapidement que pour toute autre maladie contagieuse.

AS SMALLPOX, CHOLERA, and typhus gradually subsided towards the end of the nineteenth century, diphtheria emerged as the most prevalent contagious disease in the province of Quebec.[1] The rise of diphtheria was

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1 For an overview of the evolution of diphtheria in Canada, see Claude E. Dolman, "Landmarks and Pioneers in the Control of Diphtheria", *Journal of the Canadian Public Health Association* (1973), pp. 317–336; Jane Lewis, "The Prevention of Diphtheria in Canada and Britain, 1914–1945", *Journal of Social History*, vol. 20 (1986), pp. 163–176.

more than an epidemiological replacement for smallpox or cholera, however. Unlike its predecessors, diphtheria did not manifest itself in spectacular epidemics leaving thousands dead in a few weeks or months; it was endemic and, despite annual fluctuations, took a steady yearly toll. As such, its control and ultimate eradication required a level of sanitary surveillance, intervention, and expertise that surpassed previous levels of medicalization in the province.

Diphtheria was also the subject of one of the more important successes in bacteriological diagnosis and therapy. The discoverers of diphtheria antitoxin were awarded the first Nobel Prize in medicine, and diphtheria antitoxin became the first biological substance to be subjected to international standardization.[2] Moreover, as Joseph MacFarland pointed out many years ago, the bacteriological diagnosis of diphtheria and the discovery of diphtheria antitoxin forced public health authorities to acquire a renewed interest in bacteriology.[3]

Indeed, as one of the focal points of the "new public health" as opposed to the sanitationist movement of the nineteenth century, diphtheria provides historians with a useful entry to the study of the bacteriological revolution, of which the causes and consequences have been variously described as the "pasteurization" of society and the extension of the clinical "gaze" from the individual to the social body as a whole.[4] In less metaphorical terms, two historically significant and socially interesting processes were at work: the transfer of laboratory techniques and concepts to the larger social world of medical and public health practice and the constitution of a network of institutions and practices populated, in part, by what Erwin H. Ackerknecht has referred to as "nontreating doctors".[5] From a wider historical point of view, the shift of emphasis in medical practice from the individual practi-

2 See Peter Stechl, "Biological Standardization of Drugs Before 1928" (Ph.D. dissertation, University of Wisconsin, 1969). On the scientific controversy surrounding the standardization of diphtheria antitoxin, see Peter Keating, Alberto Cambrosio, and Michael Mackenzie, "The Tools of the Discipline. Standards, Models and Measures in the Affinity/Avidity Controversy in Immunology" in Adele A. Clarke and Joan H. Fujimura, eds., *The Right Tools for the Job: At Work in 20th Century Life Sciences* (Princeton: Princeton University Press, 1992), pp. 312–354.

3 Joseph MacFarland, "The Beginning of Bacteriology in Philadelphia", *Bulletin of the Institute of the History of Medicine*, vol. 5 (1937), pp. 149–195. As Liebenau has more recently argued, antitoxin also gave "city and state health departments an active purpose which they were beginning to lack with the decline of environmentalism". Jonathan Liebenau, *Medical Science and Medical Industry* (Baltimore: Johns Hopkins University Press, 1987), p. 51.

4 On the concurrent transformation of perceptions of disease and society in France during the bacteriological revolution, see Bruno Latour, *Les microbes, guerre et paix* (Paris: A. M. Métailié, 1984) and Claire Salomon-Bayet, ed., *La pasteurisation de la société française* (Paris: Payot, 1986). On the extension of Foucault's concept of the clinical "gaze" to post-bacteriological medicine, see David Armstrong, *Political Anatomy of the Body* (Cambridge: Cambridge University Press, 1983).

5 Erwin H. Ackerknecht, *A Short History of Medicine*, revised ed. (Baltimore: Johns Hopkins University Press, 1982), p. 215.

tioner to the collective observer, as was the case in hospital clinics and dispensaries, and the emergence of a new form of localization of disease in populations rather than persons date from the eighteenth century.[6] However, bacteriology and the new public health movement ushered in the widespread use of two new forms of calibration in the continuing attempt to describe the pathological as a quantitative extension of the normal.[7] Laboratory manipulation of pathogenic organisms and the bacteriological techniques of diagnosis, screening, and therapy opened up the possibility of reducing clinical pictures of disease to degrees of expression of laboratory models of pathogenic processes and measures of distance from statistical norms of health and, in the case of infectious diseases, norms of prevalence.[8]

Given the recent work by Denis Goulet,[9] Georges Desrosiers, Benoît Gaumer, and Othmar Keel,[10] and François Guérard,[11] we are reasonably well informed about the introduction of bacteriology into Quebec medicine and the emergence of a public health system based on bacteriology. As an important subject of a new science, diphtheria put novel demands on Quebec medical practitioners and the public health system.[12] We examine how Quebec medical authorities confronted this disease from the introduction of antitoxin and bacteriological diagnosis into the province to the eve of a major reform in Quebec's public health legislation in 1909.[13] Although this 15-year period may be characterized as one of relative failure with respect

6 For an excellent overview of the rise of clinical medicine as a collective undertaking, see Othmar Keel, "The Politics of Health and the Institutionalisation of Clinical Practices in the Second Half of the Eighteenth Century" in William F. Bynum and Roy Porter, eds., *William Hunter and the Eighteenth Century Medical World* (Cambridge: Cambridge University Press, 1985) pp. 208–256.

7 See Georges Canguilhem, *Le normal et le pathologique*, 2nd ed. (Paris: Presses Universitaires de France, 1972).

8 Almroth Wright's opsonic doctrine and vaccine therapy programme is a paradigmatic example of the laboratory description of disease. See W. Chen, "The Laboratory as Business: Sir Almroth Wright's Vaccine Programme and the Construction of Penicillin" in Andrew Cunningham and P. Williams, eds., *The Laboratory Revolution in Medicine* (Cambridge: Cambridge University Press, 1992), pp. 245–292. For an example of the interplay of statistics and disease definition, see G. M. Oppenheimer, "Causes, Cases and Cohorts: The Role of Epidemiology in the Historical Construction of AIDS" in Elizabeth Fee and Daniel M. Fox, eds., *AIDS: The Making of a Chronic Disease* (Berkeley: University of California Press, 1992), pp. 49–83.

9 Denis Goulet, "Des miasmes aux germes. L'impact de la bactériologie sur la pratique médicale au Québec (1870–1930)" (Ph.D. dissertation, Université de Montréal, Département d'histoire, 1992).

10 Georges Desrosiers, Benoît Gaumer, and Othmar Keel, *Vers un système de santé publique au Québec. Histoire des unités sanitaires de comtés : 1926–1975* (Montréal: Université de Montréal, Département de médecine sociale et préventive, Département d'histoire, 1991).

11 François Guérard, "La santé publique dans deux villes du Québec de 1887 à 1939, Trois-Rivières et Shawinigan" (Ph.D. dissertation, Université du Québec à Montréal, Département d'histoire, 1993).

12 For a review of the literature on the history of public health in Quebec, see Othmar Keel and Peter Keating, eds., *Santé et société au Québec* (Montréal: Boréal, 1995).

13 For a critical chronology of public health legislation in this period, see Denis Goulet and André Paradis, *Trois siècles d'histoire médicale au Québec : chronologie des institutions et des pratiques (1639–1939)* (Montréal: VLB Éditeur, 1992).

to the control of diphtheria, despite the advanced state of laboratory control and manipulation of diphtheria and its toxin compared to other contagious diseases of the time, it represents the beginning of a new era in public health.

The Problem Prior to Bacteriological Diagnosis and Diphtheria Antitoxin

The causal agent of diphtheria, the *Corynebacterium diphtheriae*, was isolated in 1884 by Friedrich Loeffler in Robert Koch's laboratory in Berlin. The toxin produced by the bacteria was harvested shortly afterwards in 1888 by Emile Roux and Alexandre Yersin at the Institut Pasteur in Paris. Two years later, once again at Koch's laboratory, Emile Behring and Shibasaburo Kitasato announced the production of a serum with antitoxic properties that successfully defended mice against the bacterial toxin. Following large-scale clinical trials in 1894, a mere ten years after the isolation of the bacillus, diphtheria antitoxin for human therapeutic use became available in France and Germany. Later that year it entered North America.[14]

To medical practitioners in Quebec, as elsewhere at the end of the nineteenth century, the diagnosis of diphtheria presented two main problems that were only partly resolved by the discovery of the bacterial agent of infection. The first was that of early diagnosis. The initial symptoms of scarlatina — sore throat and membrane formation — were considered quite similar to those of diphtheria.[15] In fact, George Ross's *Practice of Medicine*, used at McGill until his death in 1893, began the section on diphtheria by noting that "it seems to be allied to scarlatina" although the conditions of the alliance were not made explicit.[16]

Once the disease had advanced to the point at which the characteristic diphtheritic membrane had been fully formed, differential diagnosis was relatively straightforward. According to William Osler, pathological studies

14 Comprehensive reviews of the scientific literature on diphtheria and diphtheria antitoxin may be found in G. H. F. Nuttall and G. S. Graham-Smith, eds., *The Bacteriology of Diphtheria* (Cambridge: Cambridge University Press, 1908); F. A. Andrewes *et al.*, *Diphtheria: Its Bacteriology, Pathology and Immunology* (London: His Majesty's Stationery Office, 1923); and J. Graham Forbes, *Diphtheria Past and Present: Its Aetiology, Distribution, Transmission and Prevention* (London: John Bale, Sons and Danielsson, 1932). See also H. J. Parish, *A History of Immunization* (London: E. & S. Livingstone, 1965), pp. 118–163.

15 Today, it is maintained that the diphtheritic membrane is easily distinguishable from the membrane formed in the course of scarlatina on the basis of adhesiveness, the scarlatina membrane being easily removable. See, for example, Stanley Davidson, *The Principles and Practice of Medicine* (Edinburgh: E. & S. Livingstone, 1964), p. 40. For a complete list of articles on diphtheria in Quebec medical literature, see A. Paradis and H. Naubert (in collaboration with D. Goulet), *Recension bibliographique : les maladies infectieuses dans les périodiques médicaux québécois du XIX^e siècle*, Collection "Matériaux pour l'histoire de la médecine québécoise" (Trois Rivières: Centre de recherche en études québécoises, 1988), pp. 49–67.

16 George Ross, *Notes on the Practice of Medicine* (Montreal: McGill University, 1891), p. 193.

of membrane formation in diphtheria had been decisive insofar as they had given rise to the clinical distinction between the firmly adherent diphtheritic membrane and other sorts of "pseudo membranes".[17] Nonetheless, diagnosis of "mild" cases or in the absence of membrane formation remained problematic.

The second problem was croup. The term had entered the clinical vocabulary in the middle of the eighteenth century[18] and has since been referred to as the old name for diphtheria.[19] This is only partly true. Although diphtheria eventually came to occupy croup's place in clinical nosography, it was not a simple process of substitution. While the classic clinical description of *diphtérie* had been given by Pierre Bretonneau in 1826, croup persisted as a diagnostic category; by the last quarter of the nineteenth century, it had evolved into a relatively autonomous clinical entity.[20] It was not until the end of the century — by which time the distinction between croup and diphtheria had been enshrined in official mortality statistics — and the consistent demonstration of the presence of the diphtheria bacterium in "croupous membranes" that majority opinion held that croup was just another name for diphtheria.[21]

There was a non-clinical reason for the persistence of the croup diagnosis: it was often not a notifiable disease. In Montreal, for example, at the beginning of the 1890s, the Municipal Health Bureau had invented the category of "simple croup". Reporting of this disease for purposes of quarantine was permissible but not obligatory as in the case of diphtheria. By opening this borderline or "difficult" category, the Bureau hoped to attract cases for quarantine that would not normally have been reported. In other words, in practice, croup was generally considered by public health authorities to consist mainly of cases of unnotified diphtheria. In 1895, for example, 83 cases of "simple croup" were reported in Montreal even though, according to mortality statistics, over 100 individuals had actually died from the

17 William Osler, *The Principles and Practice of Medicine*, 1st ed. (New York: D. Appleton, 1892), p. 108. It should be noted that this distinction had been made earlier by Loeffler.

18 The term was popularized by Francis Home in his *An Inquiry into the Nature, Cause and Cure of Croup* (Edinburgh, 1765). The word referred to the noise made by a person speaking with a larynx attacked by diphtheria.

19 See, for example, Gaston Ramon, "Un siècle et demi de lutte contre la diphtérie", *Biologie médicale*, vol. 49 (1960), p. 4.

20 For Bretonneau's work, see Zelma L. Dunn, "Pierre Bretonneau and the History of Diphtheria in France in the Nineteenth Century" (Ph.D. dissertation, University of California, San Francisco, 1973).

21 Nonetheless, some writers such as Osler still maintained that "it is more rational to believe there is a non-specific pseudo-membranous laryngitis [i.e. croup]." Osler, *The Principles and Practice of Medicine*, p. 108. It was also possible to distinguish between diphtheria and croup within an enlarged category of diphtheria. Ross, for example, held that the false membranes of diphtheria were either "croupous" (pale yellow) or "diphtheritic" (grey). The croupus membrane was not attributed to the diphtheria "germ" and, as it did not completely destroy the epithelium of the mucous membrane, it was a sort of "false" false membrane. Ross, *Notes on the Practice of Medicine*, p. 197.

disease. It was estimated that at least three-quarters of all cases of "simple croup" were in fact diphtheria that had either been difficult to diagnose or been reported as croup to avoid quarantine.[22] Well aware of this use of the category, in 1896 the Quebec Provincial Board of Health published an official "definition" of croup that was simply an open attack on municipal reporting practices. According to the Board: "Croup is nothing other than diphtheria which attacks the respiratory tract (larynx)."[23]

Although the etiological role of the *Corynebacterium* in the production of diphtheria was well understood by the end of the 1880s, the sources and modes of infection were not entirely clear. Again, according to Ross's *Practice of Medicine*, despite wide acceptance that diphtheria was contagious, there was still some doubt as to whether it was the false membrane or the excretions of the membrane that were infectious.[24] Moreover, although Ross's lectures referred to the diphtheria "poison" or "virus", the origin of the disease often remained environmental: "Diphtheria originates in developing filth, especially fecal matter, sewage, hence hygienic necessities. Diphtheria is one of the oldest epidemic diseases, germs are universal and under favorable conditions readily develop."[25]

In other words, diphtheria could be both infectious and contagious.[26] Similar views about the ubiquity of diphtheria were aired at a meeting of the Montreal Medico-Chirurgical Society held in 1892 where the sewer system was isolated as the source of diphtheria. Dr. F. W. Campbell, professor at Bishop's College Medical School and editor of the *Canada Medical Record*, reported a case in which three members of a family were attacked simultaneously by diphtheria: "the evidence pointed out conclusively that the infection arose from the sewers. He agreed that once the poison got into the sewers it would be impossible to get it out, and he thought that it could be conveyed through the air."[27]

Faulty plumbing was also considered a major source of infection by authorities such as Osler, as it seemed to explain how diphtheria cut across class distinctions. According to Osler: "it is by no means confined to the poorer districts, but occurs in the houses of the better classes, particularly

22 Sessional Papers, vol. 30, 1896, *Second Annual Report of the Board of Health of the Province of Quebec*, "Report of the Bacteriologist", p. 52.

23 Archives nationales du Québec (hereafter ANQ), série E0007, *Délibérations du Conseil d'hygiène*, vol. 1, 1896, p. 147.

24 Ross, *Notes on the Practice of Medicine*, p. 196.

25 *Ibid.*, p. 197.

26 For an analysis of these terms in the case of cholera prior to Koch's work, see François Delaporte, *Le savoir de la maladie : essai sur le choléra de 1832 à Paris* (Paris: Presses universitaires de France, 1990).

27 "Medico-Chirurgical Society of Montreal, Stated Meeting, March 4, 1892", *Montreal Medical Journal*, vol. 20 (1892), p. 783. Oddly enough, it was well known at the time that diphtheria's most prevalent season was winter when the sewers were clearly not as hospitable a site for bacterial production as in summer.

when the plumbing is defective." However, he also admitted that: "The relation between imperfect drainage and diphtheria has not yet been satisfactorily determined."[28] By 1895 Osler had modified this latter statement to read: "A close relation between imperfect drainage or a polluted water supply has not yet been determined."[29] Still, the belief in the relationship persisted and it was not until 1909 that Osler dropped the question from his celebrated textbook.[30] Thus, the discovery of the diphtheria bacillus was intially clear evidence for contagionists and reinforcement for sanitationist views as to the "cause" of the disease.[31]

The sanitationist belief in environmental sources of infection was reflected in municipal health practices. Houses where diphtheria had been reported were disinfected and subsequently inspected for sources of contagion. In Montreal, of the 706 houses inspected following diphtheria notification in 1895, 60 per cent had significant "defects", the most common being plumbing problems such as leaking drains.[32] In the country, where death rates were invariably higher despite prevalent ideas about the virtues of rural living, stagnant pools of water replaced plumbing as the environmental source of infection.[33] As in the city, however, the reluctance of physicians to notify public health authorities combined with the latter's indifference to provincial health regulations usually meant that diphtheria went unchecked whenever it appeared.

Local resistance to the rules and regulations of the Quebec Provincial Board of Health had been a constant problem since the establishment of the Board at the end of the 1880s.[34] Inspectors were constantly sent out to

28 Osler, *The Principles and Practice of Medicine*, p. 99.

29 *Ibid.*

30 William Osler, *The Principles and Practice of Medicine*, 7th ed. (New York: D. Appleton, 1909). It was also widely believed at the end of the century that animals were a source of infection. This no doubt went some way towards explaining why districts lacking entirely in plumbing should be as subject to diphtheria as the poorly drained cities.

31 Although it is recognized today that the most common source of contagion is direct — droplets containing the bacteria from the mouths of infected persons being the vector of transmission — fomites and infected milk have also been implicated. See, for example, Ann G. Carmichael, "Diphtheria" in Kenneth F. Kiple, ed., *The Cambridge World History of Human Disease* (Cambridge: Cambridge University Press, 1993), pp. 680–683.

32 Montreal Municipal Archives (hereafter MMA), *Rapport sur l'état sanitaire de la cité de Montréal, 1895*, p. 67.

33 This was in addition to the rarer case of the local milk producer suspected of delivering diphtheria along with the milk. See ANQ, *Rapports d'inspection*, vol. 1, 1889, J. A.Beaudry, "Inspection Relating to Diphtheria, June 27th 1889", pp. 80–85.

34 The Quebec Provincial Board of Health was formed in 1887 following the smallpox epidemic of 1885. Composed of seven members, four of whom were, by statute, physicians, the Board acquired the authority in 1888 to compel municipalities to form local boards of health. By 1891 fewer than half the municipalities in the province had done so. A second outbreak of smallpox in 1891 gave the Board the will and perhaps the clout to compel the remaining municipalities to comply, so that by 1895 839 of a total of 876 municipalities were endowed with local boards of health. See Sessional Papers, vol. 29, 1895, *Report of the Provincial Board of Health*.

investigate reports of diphtheria epidemics and, more often than not, returned with genealogies of contagion that led nowhere. In 1892, for example, Dr. Laurent Catellier was dispatched to the parish of St. Pierre by Elzéar Pelletier, Secretary of the Provincial Health Board, following newspaper reports that the local Roberge family was harbouring four cases of diphtheria.[35] This, it turned out, was false. However, after going over the curé's sepulture list and consulting with the local physician, Catellier concluded that the community had recently had at least seven undeclared cases of diphtheria. Although the school had been closed following the first four deaths, the attending physician had apparently decided that the cases were not diphtheria even though the characteristic membrane had been present. Lacking in these cases was a peculiar odour which had attained the community status of determining symptom during a previous epidemic. The school had been subsequently reopened and the rumours had begun to circulate.

An inspector sent to Kennebec county in 1894 encountered similar circumstances. There had been at least 60 cases of something, but the trail was cold; it was not clear whether the county had been visited by diphtheria or pneumonia or whether the entire epidemic had been overlain with scarlet fever. The local physician suspected that at least some of the cases had been diphtheria, but was not sure how many. The local health board had done nothing throughout the epidemic; no houses had been placarded, nobody had been quarantined, and school had continued as usual. Disinfection had been done the "old" way: a bit of burning sulphur on a shovel carried from room to room. However, local inhabitants had visited each other less, and it had on occasion been impossible to find volunteers to help a "contagious" family in need. For the local health board, there had been, in principle, nothing to do as no head of household or physician had declared the existence of the disease.[36]

As the provincial inspectors found, declaration of the disease was merely the beginning of a slow social process of containment. Even when a case of diphtheria was notified, it did not necessarily lead to action. Investigating reports of diphtheria in Iberville in 1892, Inspector Beaudry discovered that, although the mayor of the community had been informed, he had simply let the matter drop. Beaudry commented: "It is most often public rumour which declares the existence of cases of diphtheria, either at the death or burial of the victim at which point it was already too late."[37]

In the same case, the local health board had shown little concern over the presence of diphtheria within its jurisdiction and was deeply disinterested

35 ANQ, *Rapports d'inspection*, vol. 2, 1892, L. Catellier, "Inspection relative à la diphtérie", pp. 10–13.

36 ANQ, *Rapports d'inspection*, vol. 3, 1894, J. A. Beaudry, "Inspection relativement à la diphtérie", pp. 217–229.

37 ANQ, *Rapports d'inspection*, vol. 2, 1892, J. A. Beaudry, "Inspection sanitaire re : diphtérie", p. 58 (authors' translation).

when Beaudry pointed out its obligations under the law. Similarly, even when local health boards did placard an infected house, isolation was not always the result. Family, friends, and clients continued to drop around, and those who were supposed to be contained were especially faithful about church attendance. Illness clearly counted as an hour of need.

The local boards were not completely passive and were often quite willing to complain about other municipalities held to be prime sources of contagion.[38] They were sometimes even more interventionist than provincial authorities. In 1887, for example, the Provincial Board refused to endorse a suggestion from the Montreal Health Officer that would have enjoined local clergy to warn the citizens of Montreal about getting together over Christmas and the New Year because of the threat of diphtheria.[39] Similarly, in 1890 the secretary of the local board of St-Henri-de-Lévis wrote to the provincial Health Secretary asking the Board to intervene to prevent church burials of individuals who had died from diphtheria. The Secretary replied that this particular item had been left to the discretion of religious authorities.[40]

It was therefore not much of a surprise to the Provincial Board of Health that in 1894 diphtheria was the most prevalent of the infectious diseases in the province of Quebec. Moreover, partly because of the uneven nature of reporting practices and partly because the concept of the carrier[41] had yet to enter medical knowledge, the Board also found the disease to be most paradoxical in expression:

> In one place it is of so mild a form that it almost passes unnoticed, in another it assumes so serious a form as to make many victims in a very short time; sometimes it hangs about for a long time in a locality, passing successively from one family to another and propagating itself with extreme slowness; at other times it bursts out suddenly with a violence in a great number of families at the same time.[42]

Nonetheless, progress appeared to have been made. At the provincial level, diphtheria mortality had been cut in half in recent years. In Montreal, according to the figures available to local authorities, deaths from diphtheria

38 See, for example, ANQ, *Correspondances envoyées*, vol. 5, "Elzéar Pelletier aux Membres du Bureau d'hygiène de la ville de Hull", August 2, 1892, and "Elzéar Pelletier à le Maire et MM les Conseillers de St. Roch de Québec Nord", August 24, 1892, p. 26.

39 ANQ, Conseil d'hygiène de la Province de Québec, *Délibérations*, vol. 1, December 16, 1887, p. 22.

40 ANQ, *Correspondances envoyées*, vol. 2, Elzéar Pelletier to the Secretary of the Board of Health of St. Henri de Lévis, April 30, 1890, p. 85.

41 See C.-E. A. Winslow, "The Concept of the Carrier" in his *The Conquest of Epidemic Disease* (Princeton: Princeton University Press, 1944), pp. 337–347.

42 Sessional Papers, vol. 29, 1985, *Report of the Board of Health for the Province of Quebec for the Year 1895*, p. 29.

(including croup) had fallen from 170 in 1890, a ten-year low, to just under 100 in 1894.[43] Similarly, in Quebec City the number of deaths had fallen from 215 in 1891 to 34 in 1894.[44] The Provincial Board of Health attributed the decline to "hygiene" — a mix of sterilization, fumigation, and quarantine — and projected the ultimate disappearance of diphtheria to the day regulations concerning contagious diseases were observed. For the Provincial Board of Health, the problem of diphtheria was a lack of discipline.[45]

The Introduction of Antitoxin into Quebec and Ontario: A Comparison

The Board also realized that a new and powerful treatment known as "serotherapy" had emerged on the continent. Produced by injecting horses with diphtheria toxin and harvesting the resulting antibodies from the serum, Berhrings's discovery was now available in glass vials of a variety of sizes.

43 Figures for the period 1876–1907 may be found in MMA, *Rapport sur l'état sanitaire de la ville de Montréal*, 1907, pp. 89–90. Given what we have said about reporting practices and the croup diagnosis, we shall not offer any attempt at a "realistic" assessment of these figures. For more diphtheria statistics, see also Martin Tétrault, "L'état de santé des montréalais de 1880–1914" (Master's thesis, Université de Montréal, 1979), pp. 84–86.

44 Following are the diphtheria statistics for Quebec City for the period 1891–1909. They were compiled from the annual *Rapport des opérations du Bureau d'hygiène de la cité de Québec*, Archives municipales de la ville de Québec (hereafter AVQ).

Year	Cases declared	Dead	% mortality
1891	858	215	25
1892	447	150	34
1893	156	43	28
1894	135	34	25
1895	158	48	30
1896	311	96	31
1897	419	76	18
1898	234	45	19
1899	151	33	22
1900	76	14	18
1901	73	18	25
1902	49	13	27
1903	65	13	20
1904	45	10	22
1905	121	30	25
1906	206	34	17
1907	94	19	20
1908	49	15	31
1909	53	19	36

45 Sessional Papers, vol. 29, 1895, *Report of the Provincial Bureau of Health*, p. 29. In 1896, with diphtheria once again on the rise, the Provincial Board of Health decided to take matters into its own hands and name provincial health officers in municipalities that refused to conform to Board of Health regulations concerning contagious diseases. ANQ, Conseil d'hygiène de la province du Québec, *Délibérations*, vol. 1, 1896, pp. 176–177.

While apparently certain that the treatment had merit, if only because "in the Province of Quebec, as elsewhere, the medical profession urged by public opinion, asked for the serum",[46] the Board was not prepared to institute provincial use of a serum that it considered to be "experimental". On the other hand, the "experimental" status of the therapy did not prevent the Board from encouraging its use. In 1894 the Board had contacted the Institut Pasteur in New York, which had sent a supply of antitoxin. The Board had then sold the product to physicians and pharmacists who requested it. Since the Board had no control over the use of the antiserum, it was unable to say whether or not it "worked". So, while waiting until "science and experience shall have the last word", the Board contented itself with the observation that "it is happy to see that the new treatment of diphtheria by serum is becoming more and more in favour in the Province and that the most satisfactory results are obtained from it."[47]

For the general practitioner, three kinds of serum were readily available in Montreal pharmacies by 1895: Roux's serum (at Arthur Décary), Gibier's serum from the Institut Pasteur in New York (at Lyman and Sons), and Schering's serum (at Henry J. Dart). According to an inquiry carried out by the *Union médicale du Canada*, in 1895 approximately 1,500 vials of serum were sold in Montreal.[48]

In the first years of the use of antitoxin, the assessment of the treatment in Quebec medical journals was generally positive. The *Montreal Medical Journal* published clinical statistics from the Children's Hospital in Paris commenting that reports from all sides were "favorable".[49] However, the results in Montreal were initially "disappointing", and it was not clear whether the poor results were to be blamed on faulty dosage, bad serum, or false expectations.[50] The *Union médicale du Canada*[51] also found merit in the treatment but warned readers about American vaccines, citing a report of the New York City Health Department that had found a number of them to be worthless. The journal was also convinced that the vaccines maintained their curative properties for only several weeks, after which they became dangerous. In view of this, they counselled physicians to import only

46 Indeed, the first subject of experimentation was a Dr. Charles Verges of Laval who had contracted diphtheria from one of his patients in November of 1894. He subsequently contacted the director of the Provincial Health Board, Dr. E. Pelletier, who ordered some serum from New York. The treatment was successful. See Charles Verge, "À propos d'antitoxine", *Union médicale du Canada*, vol. 25 (1895), pp. 16–17.

47 Sessional Papers, vol. 29, 1895, *Report of the Provincial Bureau of Health*, pp. 30–31.

48 "La sérothérapie de la diphtérie", *Union médicale du Canada*, vol. 25 (1896), p. 118.

49 Editorial, "The Diphtheria Antitoxin", *Montreal Medical Journal*, vol. 23 (1895), pp. 557–558.

50 A. D. Blackader, "Diphtheria Antitoxin" *Montreal Medical Journal*, vol. 24 (1895), p. 42. Professor at McGill, Blackader was one of the founding members of the American Pediatric Association in 1889. See "Alexander Dougall Blackader", *Canadian Medical Association Journal*, vol. 26 (1932), pp. 519–524.

51 "Antitoxine diphtérique", *Union médicale du Canada*, vol. 24 (1895), p. 27.

the strict amounts necessary from the Institut Pasteur in New York and to avoid antitoxin that might have lain on pharmacy shelves for too long.

The *Canada Lancet* was at first sceptical and recalled the failure of Koch's tuberculin.[52] Claiming that decreased mortality rates were not proof enough of the safety of the treatment, the editorialist wondered about its effect on the "vital organs" and called for "carefully recorded autopsies" of all victims who died under treatment, in case the antitoxin itself might be the cause. Even though confronted with a large number of favourable reports, the *Lancet* editorial suggested that "in a year or two it [serum therapy] will be among the things that are not." The *Lancet*'s position changed shortly thereafter, however, when it admitted that the treatment was useful only in conjunction with the older, successful treatments (hydrogen peroxide and calomel, for example). Indeed, the editors were quite unwilling to abandon the older methods: "many of our most truthful and reliable members of the profession are willing to testify that they rarely lose a case under their favorite plan of treatment provided they are called in its incipiency."[53]

The Montreal Civic Hospital was the first public medical institution in Quebec to use the antitoxin.[54] Systematic serum therapy began in June 1895, shortly after the opening of the hospital in 1894. Six months later, 170 cases had been treated with remarkable success with Roux's serum from Paris. Mortality was initially reduced to 5 per cent in the English section and 8 per cent in the French section. Cure was generally obtained with a single injection of 10 to 20 cc.[55] However, by 1899 the dose had been doubled to two injections of 20 cc and mortality had risen to 11 per cent.[56] By 1906 mortality had again fallen to 8 per cent.[57]

In Ontario, the first antitoxin trials were also somewhat disappointing. In contrast with Quebec, the Ontario Provincial Board of Health was the sole source of serum. Beginning in 1894, following the advice of the "Committee

52 Editorial, "Antitoxin Treatment of Diphtheria", *Canada Lancet*, vol. 27 (1895), p. 95. The editorialist also believed that serum therapy secured immunity in a manner similar to smallpox vaccination, but was unsure as to the length of the period of immunity. He suspected that it might only be several months.

53 Editorial, "Treatment of Diphtheria with Anti-Toxine" *Canada Lancet*, vol. 27 (1895), p. 189.

54 See editorial, "La sérothérapie de la diphtérie", *Union médicale du Canada*, vol. 25 (1896), p. 115.

55 The head of the French section, Dr. Laberge, explained that the higher mortality rate in the French section was the result of an initial use of lower doses. See Alfred T. Bazin, "Diphtheria: Notes on Treatment by Antitoxin", *Montreal Medical Journal*, vol. 24 (1896), pp. 741–750. It is surprising anybody survived. The building was so badly built that none of the doors or windows shut properly. Indoor temperatures were known to fall to 35°F in the winter; the building was condemned by the province in 1899. MMA, *Report of the Sanitary State of the City of Montreal for the Year 1899*, p. 11.

56 MMA, *Report on the Sanitary State of the City of Montreal for the Year 1899*, p. 20.

57 MMA, *Report of the Sanitary State of the City of Montreal for the Year 1906*, p. 36. By way of comparison, for the period 1896–1909, the mortality rate for diphtheria at the Civic Hospital in Quebec City was 9% whereas the mortality rate for the city as a whole for the same period was 21%. Figures compiled from AVQ, *Rapport des opérations du Bureau d'hygiène*.

on Epidemics", the Ontario Board procured antitoxin from the Biological and Vaccinal Institute in New York. The serum was supplied to hospitals at no charge and distributed to private practitioners at cost.[58] In the first year of antitoxin use, Ontario physicians bought 300 1,000-unit bottles (roughly equivalent to 20 cc of Roux's serum) from the Provincial Board of Health. Although this number fell to 125 the following year,[59] in 1897 the Board distributed over 3,000 bottles.[60] It is difficult to say how widely or evenly the serum was used, as practices varied considerably between municipalities. The Hamilton Medical Officer, for example, was unconvinced of the antitoxin's efficacy[61] whereas the Brantford Medical Health Officer enthusiastically decided, without the Board's approval, to distribute free syringes and free antitoxin for indigent cases.[62]

General practitioners were somewhat more cautious. One Toronto physician writing in the *Canadian Practitioner* warned against placing too much faith in the antitoxin for, even if, as he mistakenly believed, the antitoxin killed the Klebs-Loeffler bacillus, there were "other pathogenic germs in the throat ... which will continue to call forth our best remedial efforts".[63] These remedial efforts were the usual panoply of antiseptics and sublimates intended to kill the bacteria and wear down and remove the false mebrane. Such remedies continued to attract attention in medical journals well after the introduction of antitoxin.[64]

When physicians did try the antitoxin, they were not always successful. Two years after antitoxin became available in the Toronto area, the editorialist for the *Canadian Practitioner* reported that not only were results mixed, but a number of practitioners considered the antitoxin "worse than useless".[65] However, as individual physicians were loath to advertise their "failures", the only available published figures from general practice were furnished by two professors at the Ontario Medical College for Women, who reported 40 successful cases of antitoxin treatment. Somewhat surprisingly, all cases recovered after a single injection of between 500 and 1,000

58 See Andrew Gryfe, "The Taming of Diphtheria: Ontario's Role", *Annals of the Royal College of Physicians and Surgeons of Canada*, vol. 20 (1987), p. 117.

59 Ontario Sessional Papers, vol. 28, 1896, *Annual Report of the Provincial Board of Health: Quarterly Report of the Committee on Epidemics*, p. 41.

60 Ontario Sessional Papers, vol. 30, 1897–1898, *Annual Report of the Provincial Board of Health: Fourth Quarterly Report of the Committee on Epidemics*, p. 76.

61 Ontario Sessional Papers, vol. 30, 1897–1898, *Annual report of the Provincial Board of Health: Report of the Medical Health Officer for Hamilton*, p. 121.

62 Ontario Sessional Papers, vol. 30, 1897–1898, *Annual Report of the Provincial Board of Health: Report of the Medical Health Officer for Brantford*, p. 115.

63 W. J. Wilson, "Diphtheria", *Canada Lancet*, vol. 28 (1895), pp. 111–115.

64 For an example of post-antitoxin therapeutic innovations, see R. J. Wilson, "Laryngeal Diphtheria Treated by Calomel Sublimation: Report of Two Cases", *The Canadian Practitioner*, vol. 21 (1896), pp. 198–200.

65 Editorial, "Antitoxin in Laryngeal Diphtheria", *The Canadian Practitioner*, vol. 21 (1896), p. 775.

units within the first 24 hours of onset. Following announcement of this perfect success rate, the two professors then turned on their medical colleagues and casually reported that: "We find upon enquiry that a very large number of the physicians of this province, and indeed of this city, do not use the serum."[66]

Institutional use of the antitoxin produced mixed results that, when compared to those of municipal institutions in Quebec, may only be described as poor. At the Toronto Isolation Hospital, antitoxin was first tried as a "supplement", not as a "substitute", for regular treatment beginning in November 1894. Use was prudent, if not wary: less than 5 per cent of patients were treated. The statistics were presented by E. B. Shuttleworth, bacteriologist at the Toronto Board of Health, who reported that in the two years since the introduction of antitoxin 1,191 cases of diphtheria had been treated at the Isolation Hospital, 48 with antitoxin. Mortality for untreated cases ran to 17 per cent whereas that for treated cases had risen to 29 per cent.[67]

Despite these unfavourable figures, Shuttleworth continued the experiment and in 1897 treated more than a third (113) of the Isolation Hospital's 292 diphtheria patients with antitoxin. This time the patients were selected to constitute a "fair sample" of the overall diphtheria population. Using serum supplied by Parke Davis & Company, the hospital administered antitoxin dosages ranging from 500 to 5,000 units.[68] Once again, the numbers were disappointing: untreated patients had a mortality rate of 14 per cent while treated patients had a mortality rate of 19 per cent.[69] Antitoxin treatment at the Isolation Hospital was thus abandoned the following year, during which mortality declined considerably, casting further doubt on the value of antitoxin treatment.[70] Shuttleworth persisted, however, and reintroduced antitoxin at the Isolation Hospital in 1899. Fifty per cent of all patients under 10 years of age were treated with antitoxin and mortality rose once again. Shuttleworth refused to attribute this latter increase to the antitoxin, arguing that, since the large decrease in diphtheria mortality during the years 1892 to 1895 had taken place prior to its introduction, the present increase could also be ascribed to the same unknown "natural" factors.[71]

66 A. B. Eadie and T. F. McMahon, "A Report of Forty Cases Treated with Antitoxin", *The Canadian Practitioner*, vol. 21 (1896), p. 796.

67 University of Toronto Archives (henceforth UTA), Box 167, *Annual Report of the Local Board of Health: Report of E. B. Shuttleworth, Isolation Hospital, Nov. 23, 1897*, p. 23.

68 It should be noted that early and much more sporadic use of the Parke Davis (also known as Mulford) serum was not as successful as the Roux serum. Laberge reported that, when the supply of Roux serum ran out at the Montreal Civic Hospital in the fall of 1898, he was forced to rely on the Parke Davis serum for 17 cases, five of whom died. Mortality for the period from June to December 1898 had been 14% of 571 cases treated at the hospital. See "Le sérum Mulford dans la diphtérie", *Union médicale du Canada*, vol. 28 (1899), pp. 26–27.

69 UTA, RG Reports, Box 164, *Annual Report of the Local Board of Health*, 1899, p. 53.

70 *Ibid.*

71 *Ibid.*

Nonetheless, when antitoxin therapy was reintroduced after another year's interruption, again only half the admissions were treated. Mortality declined slightly to 21 per cent, although it remained well above that year's average hospital mortality of 15 per cent and considerably above the rate for non-treated cases. The trend continued until 1904. Diphtheria mortality declined, but mortality among antitoxin-treated cases remained significantly higher than among cases treated with pre-antitoxin methods. Ten years after the introduction of antitoxin into the Toronto Isolation Hospital, Shuttleworth published the following figures:

	Cases	Deaths	Per Cent.
Anti-toxin treatment	1,132	181	16.0
Ordinary treatment	3,968	486	12.2

He then commmented: "In a report of this kind any speculations as to the cause of the pronounced failure of a remedy from which so much was expected would probably be out of place. A bare statement of fact is therefore presented."[72]

It was often argued in the medical literature of the time that hospitals tended to fare rather poorly when it came to antitoxin statistics as cases generally arrived at the hospital as a last resort. Consequently, it was often too late for an effective use of antitoxin. Aware of this objection raised by those in favour of the new therapy, Shuttleworth examined the Riverside statistics, dividing them into two groups: city cases, or those who had begun antitoxin treatment under the care of a private physician before being transferred to the hospital; and hospital cases, who had not been put under antitoxin treatment until their admission. Comparing the two groups, Shuttleworth found no difference.[73]

Shuttleworth also examined a second objection raised against the use of hospital statistics in the evaluation of antitoxin therapy. It had been claimed that a preselection among hospital patients to treat only the most severe cases with antitoxin explained the poor performance of antitoxin in the hospital milieu. However, the Riverside patients had been randomly chosen; every second diphtheria admission had received antitoxin. Once again, Shuttleworth's comparison showed no difference.[74]

Results were much better at the Victoria Hospital for Sick Children. Beginning in 1901, all diphtheria cases were treated with what were considered large doses — 3,000 units[75] — repeated as often as needed. The

72 E. B. Shuttleworth, "Report on Work in Connection with Diphtheria at the Isolation Hospital", *Annual Report of the Local Board of Health*, 1904, p. 41.

73 *Ibid.*

74 *Ibid.*

75 This was the same dosage used at the Isolation Hospital. At the time, standard British dosage was double this amount and rose sometimes to 20,000 units.

results were exceedingly good. In the first hundred cases, mortality was 3 per cent; the following year, it fell to 2 per cent.[76]

Bacteriological Diagnosis and Antitoxin

When antitoxin first appeared on the market, it was widely believed that bacteriological diagnosis was "indispensable" for antitoxin treatment.[77] However, neither the expertise nor the facilities for such an undertaking were available. Neither of Quebec's two main cities had municipal laboratories. The capital city did not open its laboratory until 1907,[78] while Laval University had only that year (1894) opened a bacteriological laboratory, following an important reform of the medical curriculum initiated by the Provincial Medical Board that had, among other things, made the teaching of bacteriology manadatory.[79]

At the Université de Montréal (then known as the École de médecine de Montréal), bacteriological teaching did not begin until 1894 when, as at Laval, courses were offered in conformity with the 1894 medical legislation.[80] Although the teaching of bacteriology had begun in 1886 at McGill, the professor, Wyatt Johnston, had only taught it as a summer course. Johnston had graduated from McGill in 1884 and had spent the summer of 1885 in Germany studying under Virchow. Bacteriology did not become a year-round, obligatory course at McGill until 1896 when it became a core course in the newly opened department of Public Health and Preventive Medicine.[81]

The opening of the Provincial Health Laboratory in 1894 thus put the province in competition with the universities in terms of diagnostic capabilities. Given the lack of local expertise, the province was forced to turn to Wyatt Johnston at McGill to head the new facility located in Montreal. As far as diphtheria was concerned, Johnston was able to announce that the Provincial Health Board was henceforth offering free bacteriological exami-

76 R. D. Rudolf, "The Use of Antitoxin in the Treatment and Prevention of Diphtheria", *The Canadian Practitioner and Review*, vol. 28 (1903), pp. 303–307.

77 "Le diagnostique bactériologique de la diphtérie", *Union médicale du Canada*, vol. 25 (1896), p. 299.

78 AVQ, *Rapport des opérations du Bureau d'hygiène, 1907*, p. 2. By this time bacteriological examinations for diphtheria were somewhat out of vogue. In its first five years of operation, the Municipal laboratory averaged only about 10 diphtheria examinations per year.

79 Laboratory teaching of bacteriology was made mandatory in 1896. See Denis Goulet and Othmar Keel, "Les hommes-relais de la bactériologie en territoire québécois et l'introduction de nouvelles pratiques diagnostiques et thérapeutiques (1890–1920)", *Revue d'histoire de l'Amérique française*, vol. 46 (1993), pp. 426–428.

80 See Denis Goulet, *Histoire de la Faculté de médecine de l'Université de Montréal : 1843–1893* (Montréal: VLB Éditeur, 1993), pp. 108–109. See also Denis Goulet and Othmar Keel, "L'introduction de la médecine pasteurienne au Québec", *Actes du XXXI^e congrès international de médecine* (Bologne: Monduzzi, 1988).

81 *McGill Faculty of Medicine Calendar*, 64th Session (1896–1897), p. 56. We assume that in both cases some sort of makeshift laboratory was available as both universities offered "practical" parts of the course.

nations to all medical practitioners in the province. Small boxes containing a swab and a test tube for the samples to be taken from patients' throats had been deposited in a number of pharmacies in Montreal and at similar depots in municipalities that requested them.[82]

In the first four months, 103 samples were tested. Montreal was the only municipality to partake of the programme, however, for the outlying areas were troubled with transport problems. The post office refused to allow samples to be sent through the mail unless they were marked express, a practice that Johnston claimed was not only expensive but in many cases impossible:[83] only half of the municipalities in Quebec had express mail service.[84] Only after the Provincial Health Bureau enlisted the support of the American Public Health Association and conducted a lengthy battle with the Canadian Postmaster General did federal authorities finally relent and, in 1896, allow specimens to be sent fifth-class mail.[85] Even with such a provision, the diagnostic service was not a very attractive offer. In keeping with municipal/provincial rivalry, it was decided that the provincial Board of Health should not do more or even as much as the municipalities. Therefore, as the province refused to provide daily collection from depots outside Montreal, "as should certainly be done in the case of a [then non-existent] municipal diphtheria service",[86] the service was far too slow to be of more than academic interest.

The results of the first full year of testing[87] showed that only 56 per cent of the samples submitted were positive, and results were not always clear-cut. To begin with, samples taken four days or more after the onset of diphtheria often gave falsely negative results. Secondly, even when a rapid growth of bacteria presented itself, there remained the problem of type. One

82 The laboratory had opened in 1894. Installation had cost $1,000 and, in addition to the part-time services of the bacteriologist (Johnston) and a chemist ($600), expenses had run just over $100 for the first year. The Board claimed to have had the idea of opening a laboratory since 1892 when members had visited similar installations in New Orleans and Mexico City. During the year 1894–1895, the laboratory had concentrated mainly on investigations of the Montreal water supply.

83 Sessional Papers, vol. 29, 1894–1895, *Report of the Board of Health for the Province of Quebec, 1895*, "Report of the Director of the Laboratory", p. 90.

84 Sessional Papers, vol. 30, 1896, *Report of the Board of Health for the Province of Quebec*, p. 53. Most European countries as well as the United States allowed diphtheria culture samples to be sent through the mail.

85 ANQ, *Correspondances envoyées*, vol. 16, 1896, pp. 300–315, and vol. 20, 1898, p. 487.

86 Sessional Papers, vol. 30, 1896, *Report of the Board of Health for the Province of Quebec*, p. 48.

87 For the year ending April 1, 1896, the Provincial Laboratory reported the results of 572 throat swab samples that had been submitted for bacteriological examination. All were from Montreal. This represented 67% of all cases of diphtheria and diphtheritic croup reported to the City Health Office. One hundred and twenty-five of these cases, or approximately 20%, came from private practice while the remainder were provided by the Civic Hospital where all cases admitted were examined. Cases from the Catholic section of the Civic Hospital were analyzed at the Provincial Laboratory while samples from the Protestant section were examined at the General Hospital Pathological Laboratory. Sessional Papers, vol. 30, 1896, *Report of the Board of Health for the Province of Quebec*, p. 58.

culture, for example, taken from a patient without the characteristic diphtheritic membrane, had revealed an organism twice as long and twice as thick as the Klebs-Loeffler bacilli. Subsequent cultures of the sample, however, reverted to the morphological form of the diphtheria bacillus.

In the absence of standard morphological criteria, recourse was often made to functional tests. However, for the purposes of quarantine, these tests took too long; the inoculated guinea pigs took from two to three days to die and different colonies from the same culture varied sufficiently in virulence to require follow-up tests in the event of a negative result. The surprising variability and the clinical unknowns surrounding the samples became the foundation for the following "rule of thumb":

> When there is definite growth of bacilli from the throat, the case should be provisionally regarded as one of diphtheria until shown otherwise, whether the clinic symptoms and the morphological characters are typical or not, as the tendency to variability is far more distinctive of the diphtheria bacillus than any one of the forms in which it occurs.[88]

The major source of clinical confusion was tonsillitis. Almost half of the cases termed "follicular tonsillitis" revealed themselves, on functional analysis, to be diphtheria. Conversely, as only slightly more than half of the cases termed diphtheria found bacteriological confirmation, it was supposed that a great many of these cases were indeed tonsillitis.

While samples from the Civic Hospital showed a greater percentage of positive results, there was nonetheless considerable difference between the Protestant and Catholic sections. In the Protestant section 87 per cent of samples labelled as diphtheria gave positive results, whereas in the Catholic section only 66 per cent did so. This was attributed to the fact that many patients admitted to the Protestant section had undergone preliminary bacteriological examination at the Montreal General Hospital before being transferred to infectious diseases.[89]

As a whole, including samples from both institutions and private practitioners, the results were somewhat disappointing. In theory and in Johnston's own personal experience, the bacteriological diagnosis of diphtheria was supposed to be 90 per cent accurate.[90] Several reasons for the unexpected results were advanced. First, Johnston speculated, it was likely that physicians had sent puzzling or obscure cases more often than not. Such preselection would have differentiated these results considerably from those obtained by random sampling. Secondly, a uniform procedure had not

88 *Ibid.*, p. 51.

89 *Ibid.*, p. 51.

90 Positive rates varied enormously at the time. In Breslau, bacteriological examination confirmed clinical diagnosis in 90% of cases. In Boston, the rate was 62%. See W. C. Park and C. Bolduan, "Mortality" in Nuttall and Graham-Smith, eds., *Bacteriology of Diphtheria*, note 1, p. 579.

always been followed in the cultivation of the samples. As Johnston pointed out: "I found a greater uniformity of the results in the Provincial Laboratory where all the tubes are inoculated by one attendant who strictly followed my instructions, than in the hospital laboratory where they were made by various physicians."[91]

Over the years, the number of samples submitted to the laboratory declined, in part because the Provincial Board of Health resented the fact that the Provincial Laboratory was doing the work of a Municipal Laboratory. Montreal was the only city on the continent with a population greater than 100,000 not to have facilities for the bacteriological diagnosis of infectious diseases. It did have a bacteriologist but had been unable to find the $300 to $500 in the $105,000 annual budget that would have equipped a laboratory for bacteriological work. Moreover, once the province had established that an individual was harbouring an infectious disease, it did not have the power to quarantine nor the right to inform the city of a positive test. Only the physician could be informed, and he might not report the results to the city. Thus, in terms of public health, most of the tests the province had performed were of only statistical interest.[92] Consequently in 1896 the Board of Health suspended diphtheria diagnoses for the city, thereby forcing Montreal to open its own laboratory.[93]

The decline in the number of tests was also partly due to the problem of waiting. Diphtheria antitoxin was considered most potent when administered within the first few days of illness. From a therapeutic point of view, bacteriological diagnosis was not very helpful as it was simply too slow. In practice: "It has quite properly become the rule to give antitoxin and isolate the patient in all cases where clinical grounds exist for doing so, without waiting for the bacteriological report."[94]

Emphasis was henceforth laid upon the importance of bacteriological testing for the purpose of quarantine. Analyses had shown that from eight to ten days after the disappearance of the membrane only two-thirds of individuals tested were free of the bacillus. In the remainder, the bacillus persisted for up to six weeks and in some cases up to a year and a half.[95] This in itself raised a number of problems. Standard practice dictated that quarantine be raised two weeks after the disappearance of the false membrane. If a bacteriological follow-up was necessary for quarantine to be raised, it had to be decided how often and according to what standard the tests should be made. In outlying municipalities, the problem was even more

91 Sessional Papers, vol. 30, 1896, *Report of the Board of Health for the Province of Quebec*, p. 51.
92 *Ibid.*, p. 54.
93 ANQ, *Correspondances envoyées*, vol. 16, Elzéar Pelletier to The Mayor of the City of Montreal, November 6, 1896.
94 Sessional Papers, vol. 35, 1902, *Report of the Board of Health for the Province of Quebec*, p. 48.
95 *Ibid.*, p. 48.

acute: as municipalities outside Montreal did not have the habit of submitting samples to confirm the original diagnosis, it seemed even less likely that they might be induced to substantiate cure through laboratory tests. Furthermore, the discovery of apparently healthy "carriers" called the very sense and purpose of quarantine into question.[96]

By 1904 even quarantine was dropped as a reason for resorting to bacteriological diagnosis. Bacteriological diagnosis, it seemed, was suited only for "doubtful" cases.[97] In 1907 only 18 analyses for diphtheria were done by the province.[98] The same year, the Montreal Municipal Laboratory conducted approximately 100 analyses[99] whereas, of the 191 bacteriological examinations carried out by the Quebec Municipal Laboratory, only six were for diphtheria.[100] Together, the three laboratories had confirmed or disproved a mere 10 per cent of the notified cases of diphtheria in the province that year.[101]

Assessing the Impact of Anti-Diphtheria Measures

It has been argued that the introduction of diphtheria antitoxin led to an immediate decline in the mortality rate from that disease.[102] According to the statistics compiled by the Provincial Health Bureau, diphtheria mortality in the province of Quebec began to drop in the second half of 1898. From just over 2,000 deaths a year, it sank to around 1,000 where it remained for a decade. Given the steady growth in population this meant a further 50 per cent decline from approximately 60 per 100,000 to 30 per 100,000. What part of this decline was due to the antitoxin itself, to the standard quarantine measures, or to a simple decrease in the prevalence of the disease was difficult to assess.

From the clinician's point of view, diphtheria antitoxin was clearly a useful specific. However, in an age before standard clinical testing, it was difficult to ascertain the degree to which this was true. Clinical statistics concerning antitoxin therapy were subject to a number of criticisms. To begin with, assessment was often based on general hospital statistics, which were subject to internal evolution.[103] For example, the most widely circu-

96 Sessional Papers, vol. 36, 1903, *Report of the Board of Health for the Province of Quebec*, p. 65.

97 Sessional Papers, vol. 38, 1905, *Report of the Board of Health for the Province of Quebec*, p. 34.

98 Sessional Papers, vol. 4, 1908, *Report of the Board of Health for the Province of Quebec*, p. 97.

99 MMA, *Rapport sur l'état sanitaire de la cité de Montréal, 1907*, p. 36.

100 AVQ, *Rapport sur les opérations du Bureau d'hygiène*, 1907, p. 2.

101 Sessional Papers, vol. 54, 1921, *Report of the Board of Health for the Province of Quebec for 1919*, p. 37.

102 For example, with regard to Montreal, Tétrault has claimed that: "Il faut certainement attribuer à l'utilisation du sérum anti-diphtérique à partir de 1892, la chute remarquable du taux de décès par diphtérie." Tétrault, "L'état de santé des montréalais de 1880 à 1914", p. 84. This, as we have seen, is erroneous on several counts.

103 As far as hospital statistics were concerned, 30 years after the introduction of diphtheria antitoxin, Andrewes, who obviously ignored the figures from Toronto, maintained that the only good figures available were still those provided by Fibiger in 1898, in which diphtheria patients admitted to a

lated statistic at the beginning of serotherapy was the comparative mortality before and after serum therapy. Even though most hospitals showed a significant drop in case mortality — usually 20 to 25 per cent — it was easy to object that, prior to antitoxin, only the most severe cases had been sent to the hospital and that the sharp drop was merely a reflection of the increase in the number of cases hospitalized.[104]

This particular argument could hardly be raised with regard to the Montreal Civic Hospital as it had not been open long enough prior to antitoxin therapy to generate any meaningful statistics. For the Quebec Municipal Hospital, which opened in 1891, the objection seemed equally without point. The average mortality rate for the five years preceding the use of antitoxin was clearly higher than that for the five years following — 19 versus 7 per cent — and this could not be attributed to an increase in the number of cases treated as this number actually decreased (42 patients per year as opposed to 30 patients per year).[105]

Outside the hospital milieu, within which very few cases of diphtheria were treated,[106] there were a number of other problems attendant upon assessment of the role of antitoxin treatment in the decline of diphtheria. Johnston, for example, believed that the introduction of antitoxin may have had the perverse effect of making diphtheria more prevalent. If the use of antitoxin transformed severe cases into mild cases and the patients were subsequently left to move about, then the "natural quarantine" of prostration and death would most certainly have been disrupted.[107]

Despite the decline in diphtheria mortality, Quebec compared quite unfavourably with neighbouring provinces and states. In a report to the Board of Health presented in June 1898, the Secretary pointed out that, while diphtheria accounted for less than 2 per cent of deaths in Maine and 4 per

Danish hospital were treated with antitoxin only on alternate days. The experiment lasted for a year resulting in 3% mortality for patients treated with antitoxin and 12% for untreated patients. Andrewes, *Diphtheria*, p. 262.

104 Andrewes, *Diphtheria*, p. 593. One way of avoiding this problem was to calculate case mortality based on the day of commencement of treatment. The reduced mortality of cases treated early were taken as proof of the antitoxin's effectiveness and the numbers obtained were considered relatively immune to the larger movements in hospital statistics. Nonetheless, in a critical review of this line of inquiry in 1923, Andrewes pointed out: "Statistics of this type have, indeed, been characterized as worthless, on the ground that since milder cases usually get well at home, and consequently those admitted to hospital five to six days after the onset are of a more severe type, no true comparison can be made with the early-treated cases" (p. 260). There were two further objections raised, namely that the disease had become milder — which of course was impossible to disprove — or that it had entered a low point of one of its five- or ten-year cycles. On the notion that diphtheria was cyclic in its expression, see Andrewes, *Diphtheria*, p. 591.

105 These figures have been compiled from AVQ, *Rapport sur les opérations du Bureau d'hygiène*, 1891–1909.

106 In Quebec City, for example, cases treated in the Municipal Hospital in the period 1896–1909 accounted for 11% of notified cases.

107 Sessional Papers, vol. 30, 1896, *Report of the Board of Health for the Province of Quebec*, p. 52.

cent of deaths in Ontario, it was responsible for approximately 6 per cent of deaths in Quebec.[108] The Secretary at first attempted to deny the validity of these figures, claiming that, since death certificates in the province were generally filled out by parish priests, the statistics for Quebec were medically unsound. To this unconvincing explanation the Secretary added an easier answer as to why the figures for Quebec might be so high: there were simply more children in Quebec than in the other provinces and states. Since diphtheria generally attacked the young, it was inevitable that Quebec would have a higher rate of mortality due to diphtheria.

This latter fact was more a condition of possibility than a cause, however. As the Secretary admitted, given the advent of antitoxin therapy, there was no inevitability in the large number of deaths from diphtheria. The "real" problems entailed in the control of diphtheria were, according to the Secretary, lax and insufficiently equipped municipalities, a poorly trained medical profession that was often more a hindrance than a help to public health authorities, and finally indifferent mothers who were willing to see at least one or two of their offspring disappear without making too much fuss.[109]

In preparation for a counter-offensive, the Secretary surveyed the options. It was becoming increasingly difficult to bully the municipalities: "they have become accustomed to our threats."[110] However, raising the ante and taking public health violators to court would not be an easy solution. While it might be possible with the smaller municipalities, the larger ones were capable of resistance. A previous attempt to pursue the city of Montreal had ended in failure when the mayor had applied pressure on the provincial government and forced the Board to drop its case. Even with a number of well-publicized court cases, it would ultimately be necessary to establish a means of keeping the municipalities under constant surveillance either by increasing inspections or by establishing sub-inspectors in each municipality.

As for the medical profession, it was too late to train the opponents of the ideas of germs and contagion. The only option was to drag some of those physicians who refused to recognize the contagiousness of diphtheria before the Disciplinary Council of the College of Physicians in the hope that others would learn by dire example.

The only way to change indifferent mothers, it seemed, was to make the antitoxin free. Again, there were problems. As there was no question of making the substance universally free, there had to be a means test, which could only be carried out by the municipalities. If municipalities were to conduct the means test, they would have to pay for the antitoxin to prevent the inevitable abuses. However, it was already difficult enough to get muni-

108 ANQ, *Correspondances envoyées*, vol. 20, 1898, "Mémoire sur les ravages de la diphtérie présenté à l'assemblée du 17 juin 1898", pp. 423–426.

109 *Ibid.*, p. 425.

110 *Ibid.*, p. 426.

cipalities to pay for the simple necessities of hygiene. That they would pay for a therapeutic substance seemed unlikely.[111]

The Secretary's report provoked the formation of a committee to study the question further and to make recommendations. Reporting back to the Board of Health several months later,[112] the committee decided that the time had indeed come to move to the offensive and proposed three lines of attack. The first was to be a campaign of shame and denunciation euphemistically termed "public education". The comparative mortality figures that had at first sight seemed dubious were now to be diffused to religious, educational, and municipal authorities who in turn were to blame "families" for the province's backwardness. All those who resisted or criticized quarantine and disinfection procedures were henceforth to be branded "ignorant" and "behind the times".

The second route was to be judicial. The committee felt that the Board had been too soft on municipalities and that it was time to teach them a lesson. It was believed that ten suits, evenly distributed across the province, should suffice. The committee also proposed that a certain number of physicians be pursued in the courts. What charlatans were to the College of Physicians, it argued, medical practitioners who opposed provincial health regulations were to the Provincial Health Board.

The third target was the school system, which was to be put under the American system of surveillance. Public health officers would make daily visits to the schools to pick up the lists of absent students. The students' homes would then be inspected by a public health officer. If an absent student was ill and there was no attending physician, the municipality would be forced to send a doctor. In larger urban centres the surveillance was to be constant, whereas in smaller centres it would be restricted to periods of epidemics.

That, at least, was the theory. In fact, few of the reforms projected by the Secretary or the committee were put into practice. The propaganda campaign was restricted to publication of the presumably embarrassing statistics in the Board's annual report. Although the Board did announce that recalcitrant municipalities and individuals would be taken to court, there is no trace of any municipality or individual appearing before the bench as a result of Board action.[113] As far as errant physicians were concerned, the Board did not even publicly propose court action. Instead it retreated, stating that only

111 *Ibid.*, p. 4.

112 ANQ, *Correspondances envoyées*, vol. 21, 1898, "Rapport du comité préposé à l'étude des moyens propres à limiter les ravages de la diphtérie", pp. 199–210.

113 Sessional Papers, vol. 34, 1899–1900, *Sixth Annual Report of the Board of Health of the Province of Quebec*, p. 34. There is no mention of any suits in the Board's outgoing correspondence and it is clear that such an undertaking would have generated a great deal of paper. Moreover, a review of *La revue de jurisprudence*, vols. 4–12, 1898–1906, shows no civil suit implicating either the Board or the municipalities with regard to quarantine or notification.

the Council of Discipline established by the province's medical profession had the competence to deal with practitioners who flouted the laws of "sanitary science".[114] The Board soon found that its competence in the schools' domain was also exceedingly limited.[115]

While the Board did recommend that municipalities should provide the antitoxin to poor families free of charge, Quebec City and Sherbrooke were the only ones to do so.[116] The results of providing free antitoxin in Quebec City, for example, were equivocal. While morbidity fell 37 per cent, mortality fell a slight 6 per cent from 27 to 21 per cent, still higher than the Quebec Municipal Hospital mortality rate prior to the introduction of antitoxin.[117]

Finally, there was no increase in the number of inspections for diphtheria. In fact, inspections decreased. From a high of 12, the year the Secretary proposed the increase, inspections for diphtheria dropped to an average of two per year for the next 10 years.[118] This was not because notification procedures had improved. By 1903, for example, municipalities were reporting fewer cases of diphtheria than were reported in cemetery returns — mortality appeared to have outdistanced morbidity.[119] There was, in other words, no way to determine the actual incidence of diphtheria except to multiply mortality by 10 on the assumption that antitoxin treatment was indeed widespread. How widespread the treatment was could not be ascertained without knowledge of the incidence of the disease. Thus, by the standards of the time as well as present standards, it was impossible to prove that diphtheria antitoxin worked.

Conclusion

In 1894 diphtheria was the only contagious disease to have both a well-described etiology and a therapy: two conditions which might have led to its eradication. Yet by 1909 diphtheria was still the most prevalent contagious disease in the province of Quebec. Was antitoxin therapy therefore a failure? While it may be true that antitoxin worked, we have no way of knowing how well, because we now have penicillin. We also know that antitoxin was not the cause of diphtheria's disappearance; immunization with anatoxin was ultimately the key.[120] As a disease for which there was

114 Sessional Papers, vol. 32, 1898–1899, *Fifth Annual Report of the Board of Health of the Province of Quebec*, p. 53.

115 *Ibid.*, p. 23.

116 Sessional Papers, vol. 31, 1897, *Report of the Board of Health for the Province of Quebec*, p. 28.

117 These figures have been compiled from AVQ, *Rapport sur les opérations du Bureau d'hygiène*, 1891–1909.

118 Sessional Papers, vol. 32, 1898–1899, *Report of the Board of Health for the Province of Quebec*.

119 Sessional Papers, vol. 37, 1902–1903, *Report of the Board of Health of the Province of Quebec*, p. 23.

120 See, for example, Lewis, "The Prevention of Diphtheria"; Bastien Sasseville, "Immunisation antidiphtérique en Ontario et au Québec, 1926–1940" (Master's thesis, Université du Québec à Montréal, Département d'histoire, 1994).

a specific cure, diphtheria initially offered the newly formed Quebec Provincial Board of Health hope of success that was not to be had over other infectious diseases. In its effort to eradicate diphtheria through the application of new bacteriological knowledge, the Board encountered a series of obstacles that pointed to its own weakness as an organization, to persistent problems in the Quebec public health care system, and to the difficulty of transferring knowledge from the laboratory to the clinic. These problems, unlike diphtheria, have not gone away.