



*This pamphlet is issued by the Provincial Board of Health,  
Ontario*

# An Analysis of Diphtheria Deaths in Ontario

BY

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UNIVERSITY OF TORONTO PRESS



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A STATISTICAL study of deaths due to diphtheria made by Carey for the Massachusetts State Department of Health, led to an inquiry being instituted by the writer into the same subject in Ontario. As a matter of interest, it may be noted that diphtheria deaths were registered for the first time in England in 1859, and in the Province of Ontario in 1870. Between the years 1870 and 1880 death registrations were incomplete, and for some unknown reason, no deaths from this disease were registered during the year 1875, or, if they were, no record of them is obtainable. This analysis, therefore, is concerned with diphtheria death registrations between the years 1880 and 1918.

These registrations have been analyzed and tabulated to illustrate the total deaths each year due to diphtheria, the percentage of diphtheria deaths of the total deaths from all causes and the ratio of diphtheria deaths per 100,000 of population (Figures 1, 2, 3). Each tabulation includes all years between 1880 and 1918.

There is a striking similarity in the form of the curves plotted to illustrate these points. In all of them the fall in the death rate between 1906 and 1918 is manifest. In each the fact that in 1918 there was recorded the lowest diphtheria mortality yet observed in the Province of Ontario, is clearly brought out. Despite a steady increase in the population from 1,884,000 in 1880, to 2,800,000 in 1918 the total number of diphtheria deaths fell from 1,251 in the former year (1880) to 335 in the latter year (1918).

In order that there may be no misconception in regard to the possible significance of diminished case incidence, a graph has been prepared showing the number of reported cases of diphtheria for the years 1901 and 1919 inclusive (Figure 4.) From this it will be seen that there is a steadily increasing case-incidence even though the case fatality rate has been diminishing. This is in harmony with the facts observed in many other parts of the world. The death rates in pre-antitoxin and antitoxin periods in various countries in the world is well illustrated by the chart prepared by the Statistician's Department of the Prudential Insurance Company of America (Figure 5). Similarly the contrast between results obtained in pre-antitoxin and antitoxin periods may be observed by reference to charts illustrating the Philadelphia and Newark, N.J., experiences (Figures 6-7).

Another interesting observation relates to the difference in the death rate amongst cases treated in hospital and those who were not hospitalized. In Toronto, for example, the difference in death rate has been as follows:

Year.	Percentage of Deaths of Hospital Cases.	Death of Patients not in Hospital (Percent- age of cases reported.)
1912	8.0	12.63
1913	6.15	10.10
1914	7.82	10.29
1915	6.51	12.91
1916	7.00	13.14
1917	4.18	10.90
1918	6.40	19.62

It will thus be seen that the death-rate amongst cases of diphtheria treated in hospital in Toronto is very much lower, as a rule, than amongst those not admitted to hospital. Amongst these latter, however, some of the fatal cases may have received no medical or nursing care. To offset this it must be noted, that a considerable number of hospital cases were admitted in a moribund condition and died within twenty-four hours after admission. This point, as well as the others, are brought out in the following table:

DEATHS FROM DIPHTHERIA, CITY OF TORONTO, 1912-1919.

Year.	Cases Reported.	Treated		Not admitted	
		Hospital.	in Hospital.	Hospital.	Deaths.
1912	1,383	663	720	53	91
1913	895	569	326	35	33
				* (18)	
1914	873	601	272	47	28
				* (11)	
1915	746	537	209	35	27
				* (14)	
1916	1,249	884	365	62	48
				* (30)	
1917	1,445	1,124	321	47	35
				* (30)	
1918	1,163	1,015	158	65	31
				* (25)	
1919	2,132	1,327	805	96	72
				* (24)	

\*Indicates number of hospital cases dying within twenty-four hours after admission; having been admitted, very often, in a moribund condition.

A similar observation has been made by Kolmer (3) in a study of diphtheria deaths in Philadelphia. (Figure 8.)

It has long been recognized that delay in the administration of antitoxin is one of the most important reasons why we continue to have deaths due to diphtheria; which deaths it may be remarked are really preventable. The difference in case fatality according to the day of the disease on which antitoxin is given is well shown in the following tables prepared by Kolmer (4), (Figure 9). Further reference will be made to this point in a consideration of our own investigations.

To ascertain what were the essential factors in the Ontario experience a circular letter was prepared and sent to physicians who had been in attendance on patients who died of diphtheria. With this letter was sent a questionnaire; which the physicians were requested to fill in and return. The letter and questionnaire were as follows:

"An endeavour is being made to ascertain why the death rate of diphtheria remains at its present high level in spite of adequate laboratory facilities and most generous provision for free distribution of diphtheria antitoxin.

"To understand why this situation exists, it will be necessary to obtain the cordial support and co-operation of the medical practitioners in Ontario, in the statistical study which is being undertaken.

"Will you, therefore, supply, as completely as possible the information which is requested on the enclosed sheet, regarding this fatal case of diphtheria recently reported by you.

"Your assistance in this will be greatly appreciated and the results of an analysis of the return may be very valuable in devising some plan whereby diphtheria deaths which are preventable may really be prevented."

#### DIPHTHERIA.

January, 1920.

Name of deceased .....	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Date of death .....	4	5	6	7	8	9	10
What was the date of the onset?.....	11	12	13	14	15	16	17
.....	18	19	20	21	22	23	24
.....	25	26	27	28	29	30	31

February, 1920.

(Accurate information is particularly requested).	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
When was the patient first seen by you? .....	1	2	3	4	5	6	7
.....	8	9	10	11	12	13	14
.....	15	16	17	18	19	20	21
.....	22	23	24	25	26	27	28
.....	29						

NOTE.—If hospital case see "E" below.

March, 1920.

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	2	3	4	5	6
	7	8	9	10	11	12
	14	15	16	17	18	19
	21	22	23	24	25	26
	28	29	30	31		

#### ANTITOXIN.

- (a) When was it first given? .....
- (b) Quantity given, 1st dose.....units on.....day case was seen  
 2nd dose.....units  
 3rd dose.....units  
 or total amount .....
- (c) Was there any delay in obtaining serum? .....
- (d) In your opinion was delay in calling in a physician a factor in the fatal result in this case? .....
- (e) Was this case treated in a hospital? If so, please state date of admission .....

## REMARKS:.....

In all just over 100 replies were received before the preparation of this article was undertaken. Four representative replies are given herewith:

## DIPHTHERIA.

Dr. O'C.	July, 1920.						
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
Name of deceased, A. P.	4	5	6	7	8	9	10
Date of death, July 14th, 1920.	11	12	13	14	15	16	17
What was the date of onset?.....	18	19	20	21	22	23	24
	25	26	27	28	29	30	31

(Accurate information particularly requested.)	August, 1920.						
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
When was patient first seen by you?	1	2	3	4	5	6	7
July 14th, 1920.	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				

NOTE.—If hospital case see "E" be low.

	September, 1920.						
	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30		

## ANTITOXIN.

- (a) When was it first given? .....
- (b) Quantity given, 1st dose.....units on.....day case was seen  
2nd dose.....units on  
2nd dose.....units on  
or total amount .....
- (c) Was there any delay in obtaining serum? .....
- Was diagnosis confirmed by a swab? .....
- (d) In your opinion was delay in calling in a physician a factor in the fatal result in the case? .....
- (e) Was this case treated in a hospital? If so, please state date of admission .....

REMARKS.—"I did not attend this case during recent sickness with diphtheria—never saw the case until about one hour before death. He had had the disease a month before, with post diphtheritic paralysis, and when I saw him he was dying and I simply told his people so and left. They mentioned a couple of doctors who had seen him, but I do not know who attended him during the attack."

DIPHtheria.

Dr. C.

Name of deceased, G. V.

Date of death, June 26th, 1920.

June, 1920.

What was the date of the onset?	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
About June 1st.			1	2	3	4	5
(Accurate information is particularly requested.)	6	7	8	9	10	11	12
When was the patient first seen by you? June 24.	20	21	22	23	24	25	26
	27	28	29	30			

NOTE.—If hospital case see "E" below.

ANTITOXIN.

- (a) When was it first given? Not given.
- (b) Quantity given, 1st dose.....units on.....day case was seen  
 2nd dose.....units on  
 3rd dose.....units on  
 or total amount .....
- (c) Was there any delay in obtaining serum? No.  
 Was diagnosis confirmed by a swab?? No. Swab negative.
- (d) In your opinion was delay in calling in a physician a factor in the fatal result in this case? Yes.
- (e) Was this case treated in a hospital? If so state date of admission. No.

REMARKS.—*"The patient had an attack of sore throat with white patches, foul breath, about June 1. No doctor called. I saw her June 24th, when she was moribund with diphtheric paralysis and myocarditis, vomited continually, palate paralyzed and unable to move her legs; pulse 150. I was afraid to give antitoxin with her condition so critical. Swabs were negative."*

DIPHtheria.

July, 1920.

Dr. L. McL.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
					1	2	3
Name of deceased. H.	4	5	6	7	8	9	10
Date of death, August 1st, 1920.	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
	25	26	27	28	29	30	31

What was the date of the onset?.....

August, 1920.

.....	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
(Accurate information is particularly requested).	15	16	17	18	19	20	21
	22	23	24	25	26	27	28
	29	30	31				



September, 1920.

When was patient first seen by you?	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
			1	2	3	4	5
	6	7	8	9	10	11	12
	13	14	15	16	17	18	19
NOTE.—If hospital case see "E" below.	20	21	22	23	24	25	26
	27	28	29	30			

ANTITOXIN.

- (a) When was it first given? .....
- (b) Quantity given, 1st dose.....units on.....day case was seen.  
 2nd dose.....units  
 3rd dose.....units  
 or total amount .....
- (c) Was there any delay in obtaining serum? No.  
 Was diagnosis confirmed by a swab? .....
- (d) In your opinion was delay in calling in a physician a factor in the fatal result in this case? Yes.
- (e) Was this case treated in a hospital? If so, please state date of admission. No.

REMARKS.—*"I saw this case half an hour before death. The child had been sick all week without medical attendance, the parents thinking it a case of tonsillitis. The patient was comatose when I saw him first."*

DIPHtheria.

July, 1920.

Dr.: G. W. W.

Name of deceased, T. E. B.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
					1	2	3
	4	5	6	7	8	9	10
Date of death, August 12th, 1920.	11	12	13	14	15	16	17
	18	19	20	21	22	23	24
What was the date of the onset? .....	25	26	27	28	29	30	31

August, 1920.

(Accurate information is particularly requested).	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	2	3	4	5	6	7
	8	9	10	11	12	13	14
	15	16	17	18	19	20	21
When was the patient first seen by you? .....	22	23	24	25	26	27	28
	29	30	31				

September, 1920.

NOTE.—If hospital case see "E" below.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
				1	2	3	4
	5	6	7	8	9	10	11
	12	13	14	15	16	17	18
	19	20	21	22	23	24	25
	26	27	28	29	30		



TABLE III.—COMPLICATIONS.

AND OTHER FACTORS.

Sudden Deaths.	Lack of Nursing Care.	Myocardial Failure.	Paralysis Noted.
12	8	26	5

TABLE IV.

DELAY IN CALLING PHYSICIAN.

No. of days ill before Dr. called.								Unrecognized Cases.	Moribund when Called.
1	2	3	4	5	6	over 6			
2	13	14	17	18	8	12	13	6	
No. ill two days or under—15.								No. ill over two days—85.	

TABLE V.

ANTITOXIN DOSAGE

1M	3M	5M	5M to 10M	10M to 15M	15M to 20M	20 to 25	over 25M	Intra-venous	Intra-muscul	Not stated	Given in Divided Doses	No. of Doses given				
1	2	6	16	10	22	6	9	7	1	87	63	1	2	3	4	ove
Average Dose			-				26M units									
Smallest			,,				- 1M		,,							
Largest			,,				- 15M		,,							

TABLE VI.

NEG. SWABS—CLINICALLY POSITIVE CASES.

*Lab: Diagnosis Neg. in Clinically Positive Cases.*

6

In some instances incomplete information was received so that the total number of cases is not the same in each table.

A summary of the analysis of the age, of the cases shows that approximately 63% were children of pre-school age. This emphasizes the fact that diphtheria mortality will not necessarily be favourably influenced by the extension of medical and nursing service in schools. Table IV. serves again to refer to a point already raised, the importance of early treatment. In 85% of these fatal cases, the physician was not called until the patient had been ill for more than two days: and in over one-half of the cases more than four days elapsed before treatment was begun.

In Table VI. another very important point is established. In six cases, which at first were considered clinically doubtful, a negative laboratory report on the throat swab was received, but the case ended fatally, and diphtheria was given as the cause of death. The desirability of administering antitoxin, at once, in clinically doubtful cases of diphtheria where only one throat swab is taken, is clearly evident.

In this connection it should be remembered that the reason why all of these throat swabs from clinically positive cases were negative may be due to the fact that such swabs are frequently received from distant points, and 48 hours may elapse between the time when the swab is taken and the time when it reaches the laboratory. A physician who cannot have throat swabs cultured within a few hours after they are taken should, in all doubtful cases, administer antitoxin at once, and not await the result of the laboratory examination.

The average dose of antitoxin administered in these cases was 26,000 units. This is quite adequate if administered early; but if the patient is seen late in the disease, and the case is clinically severe more antitoxin may be necessary. In more than 60% of these cases 20,000 units or less was administered, altogether. Furthermore, in 63 cases, the antitoxin was given in divided doses instead of in one adequate single dose, when the patient was first seen. It is highly desirable to inject the entire amount of antitoxin which is to be given in one dose, and this should be administered at once and not in divided doses, twenty-four, thirty-six, or forty-eight hours after the patient is first seen—then, again, antitoxin should very often be given intravenously, if treatment has been delayed. In this series it was given intravenously in only seven cases apparently in a total of thirty-nine.

Certain very definite indications emerge from a consideration of the facts elicited by this investigation.

## SUMMARY.

(1) Early Treatment.—The most important single factor responsible for the continuance of diphtheria deaths is the neglect of early treatment. Failure in this respect is usually due to delay in calling a physician in cases of sore throat in little children. Every sore throat is potentially dangerous. Only the physician can decide which cases are serious and which unimportant... Education of the public in this matter is a matter of vital moment.

(2) Physicians will be well advised, in the opinion of the writer, in administering antitoxin in single rather than in divided doses. Attention is also directed to the desirability of administering at least 5,000 units of antitoxin intravenously in late and severely toxic cases, as soon as they are seen by the physician. In such cases the remainder of the dose which the physician has decided to give, may be injected subcutaneously or intramuscularly. Absorption is ten times as rapid after intravenous, and four times as rapid after intramuscular as after subcutaneous injection.

(3) In regard to the dosage, opinions differ. There are those who hold that a dosage of from 10,000 to 50,000 units is adequate in all cases. Whyte of Toronto, Place of Boston, and Woody of Philadelphia, believe in larger doses, even up to 150,000 units. In this connection the statement of Park (4) that "the greater the quantity of antitoxin in the blood the more rapid will an appreciable amount pass to the tissues," should be had in mind. This may decide the issue of life or death in cases of diphtheria where treatment has not been undertaken early.

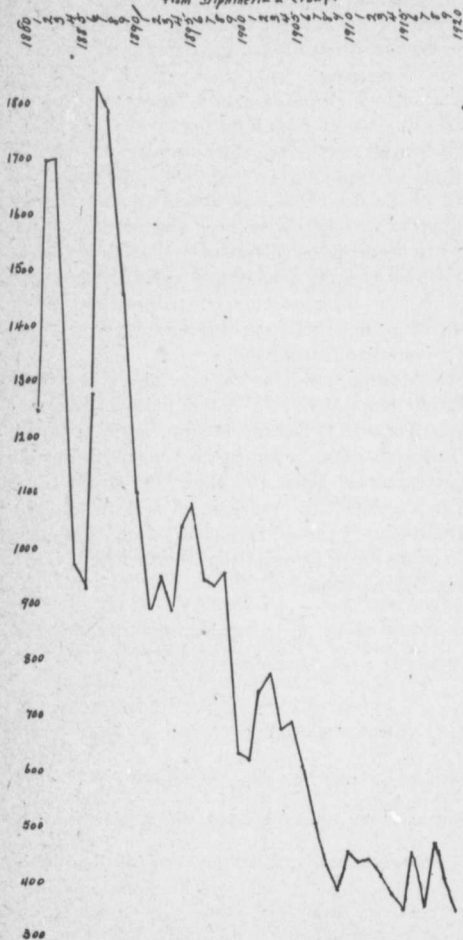
The writer is greatly indebted to Mr. S. J. Manchester, of the Registrar-General's Branch of the Department of the Provincial Secretary of Ontario, who prepared the charts illustrating the Ontario experiences.

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- (1) Carey —Boston Medical and Surgical Journal, Vol. CLXXX, No. 3, January 16th, 1919, p. 67.
- (2) Kolmer—Infection, Immunity and Specific Therapy. W. B. Saunders & Co.
- (3) Kolmer—Ibid.
- (4) Park —Pathogenic Micro-organisms. 7th Edition, Lea & Febiger, 1920.

# Deaths from Diphtheria & Croup-Ontario

Total Deaths in each year  
from Diphtheria & Croup.



<u>Year.</u>	<u>Total Diphtheria Deaths.</u>
1880	1,251.
1881	1,704
1882	1,708
1883	976
1884	929
1885	1,282
1886	1,833
1887	1,786
1888	1,459
1889	1,101
1890	893
1891	952
1892	890
1893	1,044
1894	1,075
1895	942
1896	925
1897	976
1898	634
1899	599
1900	738
1901	772
1902	676
1903	687
1904	608
1905	503
1906	423
1907	380
1908	450
1909	430
1910	435
1911	423
1912	371
1913	339
1914	443
1915	341
1916	461
1917	396
1918	335
1919	

Fig. 1

# Deaths from Diphtheria & Croup- Ontario

Percent of total deaths.  
(all causes)

1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919 1920



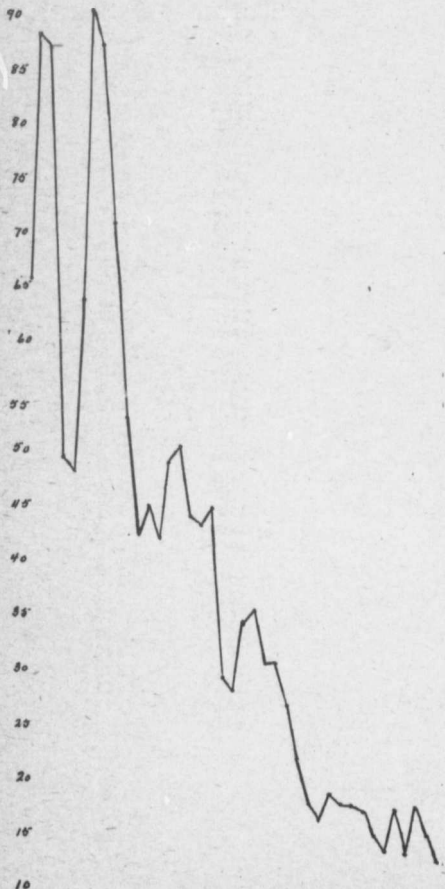
<u>Year</u>	<u>Percentage of total deaths (all causes.)</u>
1880	6.3
1881	7.4
1882	8.2
1883	4.7
1884	4.3
1885	5.9
1886	8.0
1887	7.6
1888	6.1
1889	4.7
1890	3.7
1891	4.4
1892	3.8
1893	4.5
1894	4.7
1895	4.2
1896	3.7
1897	3.6
1898	2.4
1899	2.1
1900	2.5
1901	2.7
1902	2.5
1903	2.4
1904	2.0
1905	1.7
1906	1.3
1907	1.1
1908	1.1
1909	1.3
1910	1.3
1911	1.3
1912	1.1
1913	.98
1914	1.3
1915	1.0
1916	1.2
1917	1.1
1918	.77
1919	.79

Fig. 2

# Deaths from Diphtheria & Croup - Ontario

Ratio per 100,000 of population

1880 1881 1882 1883 1884 1885 1886 1887 1888 1889 1890 1891 1892 1893 1894 1895 1896 1897 1898 1899 1900 1901 1902 1903 1904 1905 1906 1907 1908 1909 1910 1911 1912 1913 1914 1915 1916 1917 1918 1919

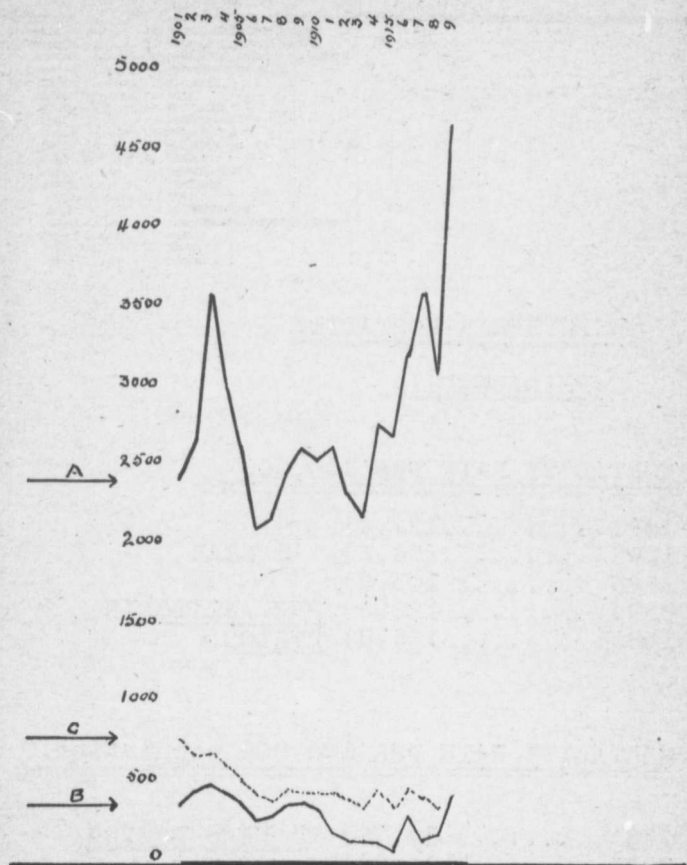


<u>Year.</u>	<u>Ratio per 100,000</u>
1880	66.0
1881	88.6
1882	87.4
1883	49.7
1884	46.3
1885	64.1
1886	90.8
1887	87.6
1888	71.0
1889	53.0
1890	42.6
1891	45.0
1892	41.9
1893	49.0
1894	50.3
1895	43.9
1896	43.1
1897	44.8
1898	29.3
1899	29.0
1900	33.9
1901	35.3
1902	30.5
1903	30.5
1904	26.6
1905	21.6
1906	17.5
1907	15.9
1908	18.5
1909	17.5
1910	17.4
1911	16.7
1912	14.5
1913	13.0
1914	16.8
1915	12.8
1916	17.1
1917	14.5
1918	12.0
1919	12.0

Fig. 3



# Cases of Diphtheria - Ontario



- A Cases of Diphtheria reported to Provincial Board of Health.
- B Deaths reported to P.B.H.
- C Deaths registered by Registrar-General.

Fig. 4

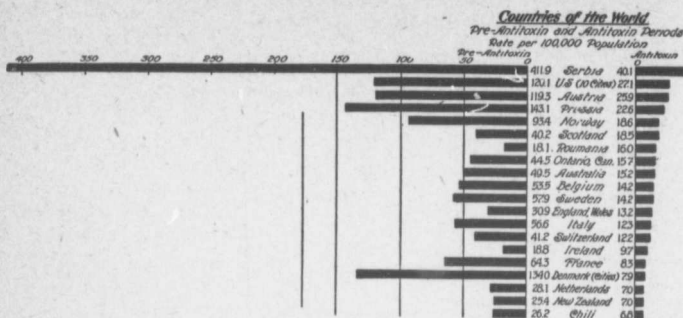


Fig. 5

DIPHTHERIA MORTALITY

PHILADELPHIA.

MORTALITY RATE PER 100,000

1891.....	127.4)	
1892.....	156.3)	5 YEAR
1893.....	103.9)	
1894.....	122.5)	<u>PRE-ANTITOXIN</u>
1895.....	115.9)	<u>PERIOD.</u>

MORTALITY RATE PER 100,000 population.

1906.....	37.78)	<u>5 YEAR PERIOD</u>
1907.....	34.60)	
1908.....	33.35)	<u>ANTITOXIN IN</u>
1909.....	33.6 )	
1910.....	31.7 )	<u>GENERAL USE</u>

(Kolmer)

Fig. 6

RESULTS OF ANTITOXIN TREATMENT:

NEWARK, N. J., 1895-1915:

Deaths per 100 cases.

	<u>Antitoxin Used</u>	<u>Not Used.</u>
<u>1895 - 1899</u> .....	10.8	21.6
<u>1900 - 1904</u> .....	7.3	19.9
<u>1905 - 1909</u> .....	6.2	23.2
<u>1910 - 1914</u> .....	5.9	17.6
<u>1915</u> .....	4.4	18.1

Fig. 7

DIPHTHERIA MORTALITY.

PHILADELPHIA.

AVERAGE MORTALITY FROM DIPHTHERIA.

1909-1910-1911.

Patients treated

in Hospital..... 9.9%

Patients treated

in Private Practice..... 13.07%

(Kolmer)

Fig. 8

CASE FATALITY:

ACCORDING TO DURATION OF DISEASE WHEN  
ANTITOXIN WAS GIVEN.

PHILADELPHIA, PA. 1910-1914.

Deaths per 100 cases.

First Day.....	1.1
Second Day.....	5.6
Third Day.....	6.8
Fourth Day.....	7.7
Fifth Day.....	9.2
Sixth Day.....	9.3
Seventh & later....	11.4

Fig. 9