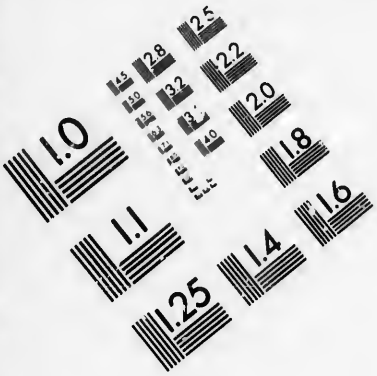

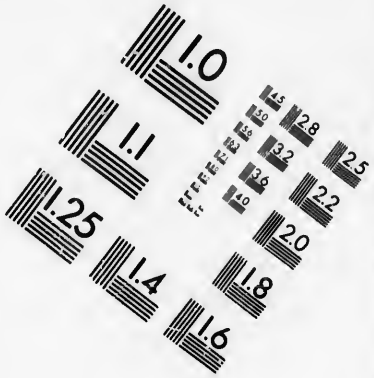

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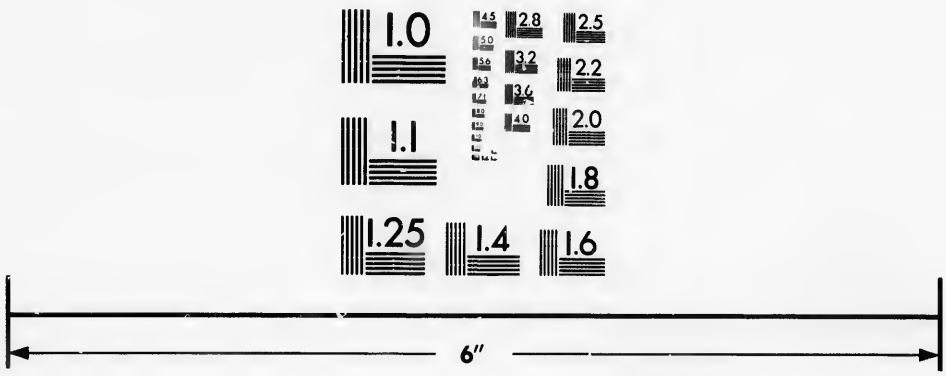

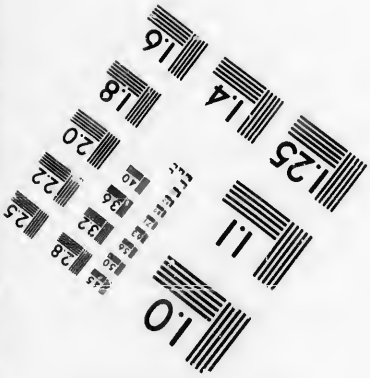

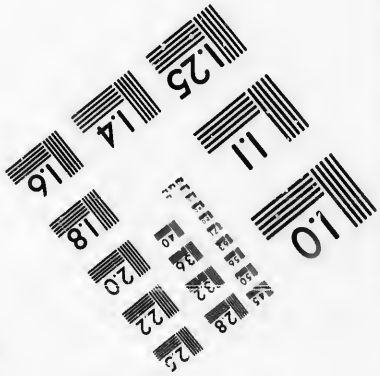

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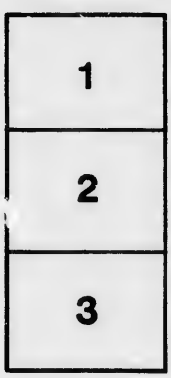

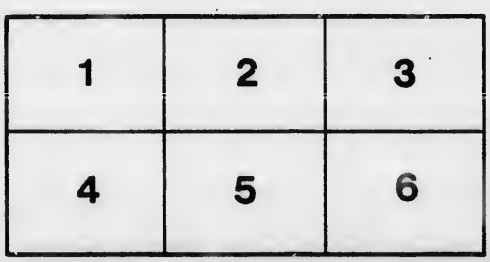

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REPORT

ON

TUBERCULOSIS IN ONTARIO

PRESENTED TO

THE PROVINCIAL BOARD OF HEALTH

AND

ADOPTED WITH RECOMMENDATIONS THEREIN CONTAINED

BY

P. H. BRYCE, M.A., M.D.,

SECRETARY.

TORONTO:

WARWICK BROS & RUTTER, PRINTERS; 68 AND 70 FRONT STREET W.

1894.

REPORT ON TUBERCULOSIS IN ONTARIO.

By P. H. BRYCE, M.A., M.D.,

Secretary Provincial Board of Health, Toronto.

Presented to the Provincial Board of Health, February 15th, 1894, and adopted with recommendations therein contained.

It may be stated that since the publication in the autumn of 1892 of the Bulletin on the "The Milk Supply Problem" and on "Diagnosis of Tuberculosis in Cattle,"* the importance of this subject has been making itself increasingly felt, not only amongst sanitarians and the medical profession, but amongst the public at large who are milk and meat consumers, and perhaps still more amongst the farming and live stock community who are producers of the materials for consumption.

It has fortunately, happened, however, that as the medical profession have begun to realize the actual character of tuberculosis as a contagious disease and are uttering warning words to the public of the dangers of infection by way of the respiratory and alimentary tracts, that some light has come which has served in some slight degree to make the cloud hanging over this all-important subject less dark, and to cause, perhaps, even some rifts in it to appear. This progress in the solution of the problem has been due to Prof. R. Koch, who discovering in 1881 the cause of the disease to be a microbe, did ten years afterward in tuberculin discover a means for proving its presence, so delicate, and yet so accurate that the most unbelieving amongst veterinarians are to-day confessing to its marvellous diagnostic value and significance.

The presence of tuberculosis in man at the present day is almost coincident with the extent of the area occupied by him; but this prevalence is specially marked in the civilized nations of temperate climates. Here and there are communities notably free from its ravages; but even on the *mesas* of Central Mexico at 7,000 feet above the sea its prevalence in some

* "The Milk Supply Problem," by P. H. Bryce, M.A., M.D., "Diagnosis of Tuberculosis in Cattle," by J. J. Mackenzie, B.A.

cities seems to indicate that once introduced into a community there it will spread by infection as well as in the damper sea-side cities of temperate climates.

Various localities, as the Tennessee Mountains and the slopes of the Rockies, famed in the early days of settlement as being free from consumption, have had only to become known as health resorts and to have towns and cities grow in order to exhibit in their death-rates the presence of tuberculosis to much the same extent as less favored localities, even in its existence in the native inhabitants.

The invigorating climate of Canada is in many ways favorable to the rearing of a sturdy population; but in urban communities, notably on the sea-coast and the shores of the Great Lakes, tuberculosis shows a death-rate as great proportionately to the total death-rate as those of many much older settled communities.

Remembering that emigration has been from European countries where tuberculosis has prevailed for centuries, and recognizing the contagious character of the disease, its transmission to Canada has been as natural as were cholera and typhus in the emigrant ships of 1832 and 1847.

According to Ontario Statistics its prevalence was for the whole Province:—

Year.	Whole Province.	Per 1,000 pop.	Cities.	Per 1,000.
In 1882.....	2,464	1.3	804	2.2
In 1892.....	2,592	1 2	841	2.2

Until the discovery of the microbe of the disease by Koch in 1881, scrofula, tabes, hydrocephalus, etc., had not been proved absolutely identical with pulmonary tuberculosis; but now that all these are known to be due to a common cause, it becomes necessary to add to the statistics of consumption or phthisis a very large number of deaths from tuberculosis classed under these several headings.

What these relative proportions are has not been settled; but in the following tables the results of much close study and observation are set forth.

Lehmann, of Copenhagen, gives the results of the total deaths in tha city from tuberculosis for twenty years, from revised death certificates, as follows :—

LEHMANN'S TABLE OF DEATHS FROM TUBERCULOSIS, ETC., GIVING SEX DURING 20 YEARS IN COPENHAGEN.

Age periods.	1 to 5 years.		5—10		10—15		15—20	
	M.	F.	M.	F.	M.	F.	M.	F.
Average deaths in 20 years.....	105 58	92.3	73.3	71.9	28.0	28.2	36.9	41.7
Percentage of tuberculosis	1.83	1.97	10.36	11.88	15 53	32.03	37.4	42.68

(*Continued.*)

Age periods.	20 to 25 years		25—35		35—45		45—55	
	M.	F.	M.	F.	M.	F.	M.	F.
Average deaths in 20 years.....	81.05	66 35	148.8	158.8	194.4	158.7	232.1	157.9
Percentage of tuberculosis	35.5	33.1	41 5	33.6	31.7	29.9	29.9	23.8

Owing, however, to the fact of tuberculosis in children being, as in the adult, especially an atrophic or wasting disease, but differing in being especially characterized by diarrhœa, a very large proportion of death returns, for diarrhœa, cholera infantum, and atrophy, have been found by *post mortem* examination to have been due to tuberculosis.

The following tables collated by Gaertner give some of the most recent and extended data upon this subject.

DEATHS from Tuberculosis for different age-periods—Based on autopsies and death certificates—Collated by Gaertner.

For every 10,000 population living at different age periods.	Years. 0-1.	1-2.	2-3.	3-5.	5-10.	10-15.	15-20.	20-25.	25-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Over 80.	Total.
Prussia (1875-1879, Wartzburg)	23.45	20.41	12.51	6.83	4.66	5.86	18.37	30.24	36.73	41.12	48.42	67.94	93.18	61.72	25.80	31.37
United States of America	18.5	10.5	5.9	2.9	2.0	3.3	12.8	23.7	27.9	27.2	26.4	29.6	44.5	68.5	96.8	18.1
Heller (of Kiel) from autopsies	245	114	76	34	14	16	22	35	39	39	38	37	50	85		

For every 10,000 of population living at different age-periods.	Years. 0-5.	5-10.	10-15.	15-20.	20-25.	25-35.	35-45.	45-55.	55-65.	65-75.	75-85.	Over 85	Total.
Copenhagen (1861-79)	16.70	9.56	8.0	20.10	24.12	31.21	40.43	54.71	60.73	74.59	52.36	.....	30 75
Cities of Sweden (1861-70)	33.95	10.55	7.0	14.65	23.65	29.35	39.40	45.70	55.80	56 20	.....	.....	29.56
England (1851-60)	13.0	5.6	10.2	29.0	41.6	43.0	40.8	34.7	28.5	26.0	8.6	5.0	26.7
England (1860-1870)	9.7	4.5	8.3	26.5	39.3	42.4	40.3	33.6	26.8	16.3	5.9	3.6	24.8

For every 10,000 of population living at different age-periods.	Years. 0-0.5.		0.5-1.		1-5.		5-15.		15-20.		20-30.		30-40.		40-50.		50-60.		60-70.		70-80.		Above	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Brussels (1885-6-7)	87	108	168	86	80	85	12	15	22	19	61	41	89	42	87	43	73	18	49	17	6	5	3	0

For every 10,000 of population living at different age-periods.		Years. 0-1.	1-2.	2-5.	5-10.	10-15.	15-20.	20-30.	30-40.	40-50.	50-60.	60-70.	70-80.	Above 80.
Bavaria (1888-1889)	M	50.4	49.2	17.8	7.0	5 9	17.9	41.6	49.3	52.9	63 7	69.2	44.0	14.90
	F	45.9	50.6	17.8	9.6	11.3	24.8	37.7	42.9	35.0	38.7	45.7	26.6	

The melancholy record set forth in these tables is accentuated by the remark of Lehmann, based upon his tables, that in the female sex from fifteen to fifty-five years of age every third person died of tuberculosis. This does not, however, accurately present the picture of the mortality from tuberculosis, since the mortality varies somewhat for different age-periods.

The following table, prepared by Wahl. of Essen, shews the death-rate for each 10,000 living in the five different age periods:

DEATHS FROM TUBERCULOSIS—COLLECTED BY WAHL, OF ESSEN.

Mortality for Essen.	0-5.	6-20.	21-40.	40-60.	Over 60.	Total.
Number of inhabitants in the years 1864, 1871, 1875, 1879, 1881	44,353	79,772	94,178	35,710	7,531	261,544
Died altogether	4,595	734	1,372	906	608	8,126
Died from tuberculosis	173	170	482	315	78	1,238
For 10,000 living there died altogether	1,036	92	145	252	807	310.5
For 10,000 living there died from tuberculosis	39	21	51	88	103	47.00
For 100 deaths there were tuberculous	3.7	23.1	35.1	34.7	12.8	15.00

With such tables as a basis of study we may now examine the death-returns for Ontario. Taking the year 1892, we obtain the following:

DEATHS IN ONTARIO IN 1892.

COUNTIES.

——	Under 1 year.	One to 5 years.	Over 5 years.
Cholera Infantum	304	32	5
Cholera Morbus	6	4	24
Diarrhœa	75	42	59
Dysentery	7	7	28
Hydrocephalus	45	20	7
Tabes	1		5
Phthisis	107	47	1,597
Other tubercular diseases			10

CITIES.

Cholera Infantum	296	30	3
Cholera Morbus	4	2	13
Diarrhœa	57	17	13
Dysentery	4	4	7
Hydrocephalus	17	6	2
Tabes	4		5
Phthisis	176	31	2
Other tubercular diseases	1		6

GRAND TOTAL.

Cholera Infantum Cholera Morbus Diarrhœa Dysentery Tabes	758	138	160
Phthisis	283	78	2,231
Hydrocephalus	62	26	9
Other tubercular diseases	1		16
	1,104	242	2,416

From this table a result comparable to that in England and some States of the Union is obtainable.

DEATHS PER 1,000 FROM TUBERCULOSIS IN DIFFERENT COUNTRIES.

Country.	Phthisis.				Other Tubercular Diseases.			
England	1885	1.75	1886	1.71	1885	0.65	1886	0.72
United States (census)	1880	1.8	1890	1.6	1890	.....	.....	..
Ontario (returns)	1881	1.2	1891	1.17	1881	0.11	1891	0.17

But if we apply the results of the accurate *post mortem* studies, whether in Germany, Holland or England, we find that the percentage of persons affected with tuberculosis must be greatly increased.

Correcting the Ontario tables so as to make them comparable with others, we obtain the following results :

According to English tables 12½ per cent. of the total population is of 0 to 5 years, or, with an estimated population in Ontario of 2,146,020 in 1892, this equals 268,250, of which 1.5 per cent., or 32,190, are under one year of age. The population then of 5 years and over remaining is 1,877,750.

Adopting Heller's statistics from *post mortem* studies as being probably most nearly accurate, we obtain the following comparative results :

	Age periods.		
	0 to 5.	1 to 5.	5 and over.
Deaths in Ontario in 1892 according to returns, from—			
Tabes Mesenterica	5	2	10
Hydrocephalus	62	26	9
Phthisis	283	78	2231
Other Tubercular diseases	2	....	16
Total	352	106	2266
Heller's ratio of 2.5 per cent. under 1 year ; 0.75 per cent. from 1 to 5 years ; 0.0497 per cent. 5 years and over—			
Die annually affected with tuberculosis	805	1770	8332
Difference showing number returned as dying from some other cause	446	1664	6066
Theoretical number of deaths from Phthisis in Ontario based on Brussels' tables of revised death certificates	362	472	8584

Without assuming more than relative correctness for even the most accurate of these foreign figures, and without asserting their complete applicability to Ontario returns, yet when the total deaths at any period in Ontario per 1,000 is compared with that in other countries, and when the percentage relation of tuberculosis in Ontario to the total deaths is observed, as in the following tables, it is plain that analogies sufficiently close may be drawn which indicate only too clearly the prevalence of the disease in this Province :

Rate per 1,000 Population.	In Ontario in 1892.	England 1890.	United States in 1890.
Death-rate from all causes	10.7	19.5	18.0
Death-rate per 1,000 from tuberculosis	1.2	1.7	1.6

It is further illustrative to notice that of 11,008 cases admitted in 1892 into Ontario hospitals—many of which were surgical—6 per cent.

suffered from some form of tuberculosis; while of the inmates of Ontario asylums for the insane during the same year 23.4 per cent. of all who died, died from this cause.

Having thus illustrated the actual, and from analogy the theoretical prevalence of tuberculosis in man in Ontario, we have to examine into the question of the prevalence of the disease in cattle.

According to the returns of the Department of Agriculture for 1892 the total number of horned cattle in Ontario was as follows:

Milch cows	787,836
Store or beefing cattle	366,705
Young and other cattle	868,755
Total	2,029,140

Unfortunately no statistics are available as to the prevalence of diseases in Ontario cattle, and, indeed, few anywhere.* We may, however, from analogy arrive at certain conclusions with regard to the prevalence of tuberculosis based upon certain statistics elsewhere which are of value in this enquiry. Just as it is found that amongst men engaged in different occupations tuberculosis prevails in varying degrees, so we have reason to believe that different classes of cows are affected in different degrees. Milch cows, owing to their being generally housed, especially in dairies supplying public milk, and owing to the draft made upon their physical powers by the prolonged lactation, are both more exposed to the disease through contaminated air and less liable to resist the disease when so exposed. For similar reasons the many valuable herds of imported cattle, housed carefully, would be more exposed to any infection present in the stables; while, perhaps, it may further be fairly concluded that in some of the finer herds, in-breeding, where present, will have tended to transmit any family predisposition to disease in a manner similar to that seen in certain families of the human species.* On the other hand, young cattle born largely in the spring-time spend their lives till autumn in the fields, and, in probably the proportion of instances, around the straw-stack in winter, leading a largely open-air life. Indeed, until the young heifers become milkers, and until the young steers become store cattle, they are relatively but slightly exposed to the contagion of disease, through ex-

*To illustrate this fact it is of interest to observe the immunity of cattle in the Virginia Experimental Station herd. There 54 cattle were tested with tuberculin, and 1 gave the reaction. In that climate cattle live largely an out-door life.

Another herd in same State, of 35 head, when tested gave the reaction in one case. Reaction was proved by *post mortem*.

posure to the close atmospheres of stables, too often contaminated with germs of tuberculosis, except so far as the calf may have inherited the disease at birth or subsequently contracted it from the tuberculous mother during the suckling period, either through the milk or by means of the discharges from the mouth or nose. What these relative dangers are will be later referred to.

To illustrate, however, the relative prevalence of tuberculosis in cattle, the following figures from various sources may be given.

Tuberculous cattle in different countries.

Country.	Number slaughtered.	Affected.
		per cent.
Berlin (Germany)	Slaughtered	4.5
Upper Silesia (Germany).....	Slaughtered in one abattoir ..	9.5
New York State.	Slaughtered in abattoirs	2 to 3

In England, with the Pleuro-pneumonia Act of 1890, under which, within sixteen months, to end of 1891, some 12,000 cattle were destroyed, either as being infected or as having been exposed to the disease, the Department of Agriculture took advantage of the slaughtering to determine the prevalence of tuberculosis by examination of every carcase by skilled veterinarians. The results were as follows:—

All cattle examined, 12,000.	Tuberculous 12.22 per cent.
	16.09
Cows	1.53
Bulls	2.77
Other cattle over 1 year	1.2
Under 1 year	

The relative prevalence of tuberculosis in different parts of England varied. Thus, of all cattle slaughtered in Midlothian District, 22.5 per cent. were tuberculous; and of all cattle in the London District, 15.5 per cent. were tuberculous. In both cases the cattle were kept under very similar conditions.

In some herds slaughtered the percentage of tuberculized was as high as 75 per cent., "and only a few herds were without tuberculized animals." Earl Spencer's herd of Jerseys, containing over a score of animals was tested by Prof. McFadyean and found by test to all have tuberculosis. The whole herd was slaughtered and results of *post mortem* confirmed the diagnosis.

It will be of interest to give at this point a condensed history of the presence of tuberculosis in Ontario, in the several instances where the facts, as at the Ontario Agricultural College, are obtainable, these having been published in the Annual Reports of the Department of Agriculture since 1885. Referring then to the herd of the Ontario Agricultural College the reports of the veterinarian in different years state the following facts:

In 1885 one (Guernsey) cow, never in good condition since importation, died of tuberculosis.

In 1886 no case was reported.

In 1887 there were two cases. One, a polled Angus bull, had been ailing for several months, seen by veterinarian a few weeks before dying. One, a polled Angus cow, had been barren, was sick for several months and then died. Lungs were slightly, while pleura, mesentery, liver and ovary were all infected.

In 1888 no case was reported.

In 1889 no case was reported, herd sold, barns having been burnt.

In 1890 an Ayrshire cow (7 years old), milking, began to fail rapidly. An experiment on a calf was made by suckling a grade Durham calf for a month. It was then separately housed for 7 months; throve well and was killed. Miliary tubercles were found in calf, in pleura, liver and mesentery.

The summary of cases given by Professor Grenside to date, 1890, included 3 Durhams or Durham Grades; 1 Devon; 1 Ayrshire; 1 Hereford.

In 1891 one Galloway cow (9 years) was isolated for observation and study by students. Was slaughtered and *post mortem* held. She proved tuberculous.

In 1892 the veterinarian reports that in no one of his eleven years' connection with the College, had he been called upon for so little veterinary attendance, and commends most highly the intelligence, vigilance and close observation of the stock foreman. The veterinarian further states "we have encountered no trouble from tuberculosis amongst the College herd.' Referring, thereafter, to the fact of the disease being liable to appear at any time in the herd owing to its insidious character and the difficulty of diagnosis in the early stage he points out the use to which tuberculin had been recently put and gave practical directions as quoted from German publications for its use.

In 1893, owing to the results which had been obtained with tuberculin by various experimenters in Germany, France, England, etc., the extreme

advisability of extending the work of investigating the progress of the disease in this Province became evident; and after the discussion of the paper on tuberculin, by J. J. Mackenzie, B.A., at the Niagara Falls meeting of the Health Officers' Association, and after the following resolution based thereupon was read and carried unanimously—

"In view of the strong scientific evidence, as presented in the paper by Mr. J. J. Mackenzie, with regard to the possibility of diagnosing tuberculosis at an early stage, and regarding the widespread prevalence of the disease in milch cattle, as shown by European and American health reports, this Association would most strongly urge upon the Provincial Minister of Agriculture, the Dominion Minister of Agriculture, the Provincial Board of Health and all local boards of health, to enter upon the systematic examination of all milch cows, but especially those utilised in public dairies."

—advantage was taken of the first opportunity which presented itself of having Mr. Mackenzie assisted by Mr. Cooper, V.S., of Toronto, make the first series of experiments with tuberculin made in Ontario on several suspected animals and a herd near Toronto.

Experiments were followed up by publishing in a Bulletin on Public Milk Supplies, Mr. Mackenzie's paper with results of experiments. These were so conclusive that on the first report to the Minister of Agriculture of a suspected case in the College herd at Guelph, he requested the Board to co-operate with the veterinarian, J. H. Reid of the College. The experiments dated April, 1893, were made and subsequent *post mortems* held, Mr. Mackenzie at the time addressing the students on the theory of the action and practical uses of tuberculin. The tests were extended to other suspected cattle in October and December, and the results tabulated.* In these tables are likewise given the *post mortem* results in the experiments with tuberculin at the Experimental Farm, Ottawa, supplied through the kindness of W. Saunders, Esq., Director, with whom co-operation in this work has been continuous.

Experimental Studies on Milk and Meat of Tuberculous Cattle.

In various reports the question of the presence of the bacilli of tuberculosis in the milk and meat of diseased cattle has been discussed. The following table of results from various sources is given. Dr. Ernst, Mass., who carried on an extended series of experiments in 1890 on the milk

*See table appended to Report.

of tuberculous cows, whose udders were healthy, so far as could be determined, obtained the following results. McFadyean's and Mackenzie's results are also given.

Microscopic examinations.	N	Bacilli present.
Samples of milk from cows showing clinically no udder infection	114	31 5 per cent., tuberculous.
Guinea pigs inoculated with one to three drops of same milk	74	13 per cent. on post mortem.
Feeding pigs with same	12	50 per cent.
Feeding calves "	23	23 per cent.
Paris Congress Rep. *re* Tuberculosis, 1888, Prof. Bang (Copenhag'n) where udder was diseas'd	27	100 per cent. in centrifugalized milk.
Prof. McFadyean and Woodhead, particulars how taken not given	600 cows.	1 per cent.
Mackenzie (no udder diseased, either clinically or post-mortem) centrifugalized milk	5	40 per cent.

Mr. J. J. Mackenzie, B. A., analyst of the Provincial Board, who had charge of all the experimental work carried on in connection with the tuberculin tests, and the microscopic investigation of milk, feeding experiments etc., obtained in the two Guernseys, Joan and Sarah, the two Holsteins No. 1, Artis Kassie Queen and the grade cow Old Racket, of the Ontario Agricultural College herd, where the milk was examined for bacillus tuberculosis, the following results: On two different occasions the bacillus was found in Joan's milk and also on two occasions in Sarah's. In the other animals careful examination failed to show its presence. The method used in examining the milk was as stated by Mr. Mackenzie as follows:

"Instead of using a given sample of milk and allowing it to sediment, the whole milking from each cow, or sometimes two milkings, was put through the separator at the dairy building. In the separator the milk is placed in a hollow steel sphere which is spun at the rate of about 6,000 revolutions per minute, the consequence being that all the heavier particles fly to the wall of the sphere. The specific gravity of the bacilli of tuberculosis being greater than that of the milk, they fly to the outside, and may be scraped off the wall with the slime which collects there during the process of separation. This slime was examined microscopically, and only in the cases of Joan and Sarah was it found to contain the bacillus of tuberculosis, although large quantities of other bacilli were present, as well as immense numbers of leucocytes. A comparative test was made in the case

of Joan and Sarah in the following manner. In one case the cows were milked at the ordinary periods and the milk passed through the separator, in the other they were milked every hour for two days and the milk handled in a similar way. It was thought possible that by so handling the milking the chances would be increased of blood elements appearing, and perhaps also bacilli. The results however showed no difference either in the number of leucocytes or in the number of bacilli. It is interesting to note, however, that the slime from each cow's milk differed in the number of leucocytes present, Joan's milk having many more present than Sarah's."

The injection experiments on these several cows are found tabulated in the Tables appended.

In 1890 the Local Government Board of Great Britain published results of feeding experiments in guinea pigs and rabbits with muscle from tuberculous cows, and gave details. The first cases by Cruikshank resulted in a high percentage of infection ; but a third series carried out by Prof. McFadyean of Edinburgh, with muscle from tuberculous cattle was negative in results, and in keeping with similar experiments by Nocard and Bollinger. In the report of that Board for 1891, Prof. Brown refers to the matter and says, " there is to be noticed an important difference in the methods adopted in the two series. The first cases were fed with muscle trimmed roughly as by the butcher; while in McFadyean's series the meat was obtained from the parts most distant from the tuberculous parts, and antiseptic precau tions with knives used."

"In 1891 experiments with cooked meat were made. On May 21st, 1891, 21 healthy guinea pigs were divided into four lots and fed with meat from diaphragm, spleen and lungs. It was minced, made into sausages and submitted to different degrees of cooking, boiling and frying. In pen A meat was thoroughly cooked, in B underdone, in C well boiled, in D lightly boiled, in E fed raw. Feeding was repeated for three days. First experiments begun May 21st had failed on July 10th, second experiments begun July 17th were repeated for three days.

"The arrangement and feeding of animals is as follows :

" A, four guinea pigs fed (17th and 18th July) on raw tuberculous meat as above.

The tuberculin is manufactured by cultivating the bacillus tuberculosis for about six weeks in glycerine veal broth and then extracting this thoroughly with glycerine. The extract is freed from bacilli by filtration through porous porcelain and afterwards evaporated down to a syrupy consistency by heat thus, at the same time, destroying any bacilli which may have passed through the filter.

This concentrated extract is used in a 10 per cent. solution for injection.

"B, four guinea pigs fed (18th July) upon meat as fed to A, but boiled for a quarter of an hour.

"C, four guinea pigs fed upon meat as above, but boiled for forty minutes.

"D. Three guinea-pigs, originally fed on partially boiled meat, on the 21st April. These three were inoculated on 18th July with pieces of the tuberculous material from a tuberculous cow. Two died from blood poisoning within fifty-six hours. The third one remained apparently healthy up to 18th September, when it was killed and examined. *Post mortem* examination showed well-nourished body, but extensive local tubercles at seat of inoculation (inner thigh). Lungs, spleen and kidney were also implicated.

"1st August, 1891.—The one remaining guinea-pig in D was transferred to X (square box), and in D were placed four healthy young guinea-pigs from stock. These four were fed on ordinary food with milk from the tuberculous udder. This feeding was continued for several days.

"1st August, 1891.—Animals in A, B and C were fed again as on 18th July, amely:

"A. Raw meat. B. Boiled 20 minutes. C. Boiled 40 minutes.

"1st August, 1891.—In E on this date are three guinea-pigs as originally fed on raw tuberculous meat on 21st April and ordinary food ever since.

"All the animals were then put on ordinary food (hay, oats and plenty of green meat) until the 19th September, when they were all sent to the Royal Veterinary College for examination.

The *post mortem* results were as seen in following table:

	Lungs.	Bronchial glands.	Liver.	Spleen.	Kidneys.	Mesenteric glands.	Intestines.
A 1	T	T	T	T	T	T	.....
2	.....	.....	.....	.....	.....	T	.....
3	T	.....	T	T	.....	T	.....
4	.....	.....	T	.....	.....	T	T
B 5	.....	.....	.....	.....	.....	.....	.....
6	.....	.....	.....	.....	.....	.....	.....
7	.....	.....	T	.....	.....	.....	.....
8	T	.....	T	.....	T	T	T
C 9	.....	.....	.....	.....	.....	.....	.....
10	.....	.....	T	.....	.....	.....	.....
11	.....	.....	T	T	.....	.....	.....
12	.....	.....	T	.....	.....	.....	.....
E 13	T	T	T	T	.....	.....	.....
14	.....	.....	T	T	.....	T	.....
15	T	.....	.....	.....	.....	.....	.....
	5	2	10	5	2	6	3

"The letter T means that the organs referred to were found to be tuberculous; it is, however, to be noticed that these animals were fed with two different lots of tuberculous meat, and it is impossible to decide which lot was most infective. But there is no doubt of the fact that cooking the meat in the manner described failed to destroy its infectivity."

"In another series of experiments, four lots of guinea-pigs, four in each lot, were fed on tuberculous material which had been cooked by being placed in cold water, the meat having been cut into slices half an inch thick and two inches square. The vessel containing the meat was put over a small furnace, and the water was gradually brought to the boiling point. The meat was kept boiling for fifteen minutes in one case, and thirty minutes in the next instance. Two lots of guinea-pigs were fed several times on the meat which had been kept boiling for fifteen minutes, and the other two lots with the meat which had been cooked thirty minutes. All of them were killed after several weeks and found to be free from all traces of tubercle. It appears therefore that thorough cooking is effectual in destroying the activity of tubercle virus. But it is also evident that such thorough cooking as was effected in this case could not be applied to large joints, nor to any kind of meat without entirely destroying its flavor."

How the Bacilli obtain Entrance to the System.

Where the bacilli of tuberculosis as of any other disease obtain entrance to the system, they do it by one of two ways. Arrived on the mucous membrane of either the respiratory or intestinal tracts, they find temporary lodgment, and escaping, we must assume, the agencies hostile to their entrance, pass in through the delicate limiting membranes of the epithelial cells in the walls of the bronchi and the alveoli of the lungs, and of the absorptive villi of the intestines. Within this limiting membrane is the innumerable mesh-work of minutest blood capillaries and lymph vessels. As the blood in the lung capillaries is in the most intimate contact with the air beyond the limiting membrane, and as apparently there is no selective influence present, the bacilli pass indifferently into the venous or lymphatic current of these minute vessels.

Where entrance is by the villi of the intestines, the bacilli previously taken in with the food, will have remained in and passed on with the chyle into the circulatory system by the chyliferous lymphatic vessels, and probably to some extent by the venous capillaries of the villi.

The subsequent fate of the bacilli is, however, of extreme interest. When tuberculosis has been produced by injecting a solution of broth containing bacilli into the vein of some animal, as the rabbit, it is found that the blood has passed, bearing with it bacilli, to the lungs, spleen and other large glands. Everywhere, however, intimately interlaced with the blood capillaries are the minute lymph channels which are abundant in the lungs, spleen, liver, etc., and hence at whatever points there is a stasis of blood in the minute capillaries, the active blood elements, the leucocytes, endeavor to free it from any foreign hurtful influences which may be present by seizing the bacilli, and finally, to some extent, carrying them as foreign materials into the lymphatics in which the circulation of lymph moves from the periphery at all points towards the great veins of the heart.

From the arrangement of the lymphatic vessels in their groups or plexuses in different parts of the body, it will hence be apparent that bacilli, entering the system by one of the two ordinary ways, *i.e.*, by the respiratory or by the digestive tract, are (in case they are not destroyed by the phagocytes, *i.e.*, the protecting white blood corpuscles) likely to become localized in the formation of tubercles in various organs. The importance of the distribution of the lymphatics of the intestinal tract in the one case and of the lungs in the other is so great in connection with the question of the way of entrance of bacilli into the system, that a brief *resumé* at this point may be in order.

Regarding the lymphatic vessels of the thoracic region, we find that those on the right side of the body (coming from head, arm, neck, chest, heart, right lung and part of the liver) empty by a common duct into the main venous channel of the same side (*vena subclavia*), whence the lymph goes to the heart. All the remaining lymphatics of this region (*i e.*, the left side) empty into the thoracic duct (the great lymph carrier of the body), which empties into the main vein of the left side (*vena subclavia*) which sends the lymph along with that of the right side, to the right side of the heart.

Amongst the groups of lymphatics, those of the lungs are superficial and deep. Those of the surface form a rich net-work quite close underneath the pleural covering of the lungs (*pleura pulmonalis*), while the deep ones following the ramifications of the blood vessels pass towards the root of the lungs, where, after having passed through a few pulmonary glands, they unite with the branches of superficial lymphatics. Both then pass through the

bronchial glands, which are situated between the roots of the lungs and the bifurcation of the bronchi, and form several larger stems, which follow the course of the bronchi and trachea to the lower part of the neck, where they empty into the main lymphatic trunk on the right side (*truncus lymphaticus dexter*), while those on the left pass up and empty into the thoracic duct (*ductus thoracicus*).

The lymphatics of the chest wall and mediastinum form a distinct system from those of the lungs proper. They are divided into the anterior mediastinal lymphatics, which begin in the abdominal cavity on the anterior abdominal muscles, pass between the fibres of the diaphragm at the sternum, and run along beneath the sternum, being united, in the neighborhood of the *vasa mammaria interna* with the anterior mediastinal glands, finally emptying on the left into the ductus thoracicus, and on the right into the right lymph duct.

The intercostal-lymphatics which run backwards in the intercostal spaces take up the dorsal lymph vessels in the neighborhood of the vertebral column, and pass, in the posterior part of the intercostal spaces through the intercostal glands. They finally form at the most posterior part a plexus, by means of which they are united with one another, and the vessels which issue from this plexus pass through the posterior mediastinal glands, emptying finally from both sides into the ductus thoracicus.

In the abdominal cavity the system of lymphatics which are connected with the course of the alimentary canal are as follows : (*a*) Those which form plexuses underneath the mucosa, and which are specially denominated lacteals ; (*b*) The subperitoneal system, which runs between the peritoneum and the muscular wall of the intestines. The former set (the true chyle vessels) run around the wall. The latter set (the true lymphatics) run lengthwise. They are believed to be connected by numerous large vessels. As soon as both sets reach the point of attachment of the mesentery, they pass between the two layers of it and run tolerably direct towards its root.

In the mesentery the lymph vessels meet with a large number of glands, the mesenteric glands, being about 150 to 180 in number. The lymph and chyle vessels all pass through several of these glands, and gradually unite into larger and larger vessels, till they reach the root of the mesentery, where they pass into the cœliac plexus.

This is situated in the neighborhood of the cœliac artery, and is made up of the lymph vessels from the intestines, stomach, spleen, pancreas, and a part of the liver, and its branches are united with 10 to 15 cœliac glands. From this plexus arises a short branch (or in many cases several) which ascends alongside the cœliac artery, and takes part as the middle root in the formation of the receptaculum chyli.

Course of Bacilli in Inoculation Experiments.

The subject of the formation of tubercles as a result of inoculation with cultures of bacilli is one which has given rise to considerable discussion, and one in which there exist at present two distinct views. These two views differ as to the part played by the various tissue elements in the genesis of tubercle. The one view, maintained by Baumgarten and his followers, is that the tubercle arises from the multiplication of fixed tissue elements; whilst another upheld by Metchnikoff and the French school is that to the free cells (white blood corpuscles or leucocytes, lymphocytes) is entirely or mainly due the formation of tubercles. The latter idea is the one which seems to be most justified by the results of experiments and is the one which explains most clearly the phenomena seen.

Borrel has shown by intravenous injections of cultures of the bacilli into the ear vein of rabbits that immediately after the injection the bacilli are englobed by polynuclear leucocytes and that they become collected in the capillaries of the lungs, producing there minute thrombi or plugs where shortly the leucocytes are disintegrated, setting the bacilli free. These, with the debris from the disintegrating leucocytes, are taken up by larger mononuclear leucocytes, to which he traces the formation of the giant cells and epithelioid cells of the tubercles. Thus are formed intravascular tubercles. At the time of the disintegration of the polynuclear leucocytes bacilli pass in them out into the alveoli (*i. e* air cells of lungs) where they are taken up by the so-called dust cells which he considers as coming from the vessels, whether of the lymph or of the blood, and not formed from the alveolar epithelium. There is thus started an intra-alveolar tubercle. The development of these initial tubercles goes on until caseation takes place; at which time the distinctly local character of the disease gives place to a more generalized condition in which the lymphatics are involved as shown by a hyperplasia of the neighboring lymph glands, and a filling of the lymphatic lacunae

and capillaries with migratory cells filled with bacilli so that they appear as if injected. This is followed by the production of tubercles in the lymphatics; at the same time an invasion of other organs takes place and a pneumonic condition of the lungs may arise.

These researches depend upon inoculation of the ear vein of the rabbit, which vein carries the blood by the right heart direct to the lungs. When Borrel injected the mesenteric vein the same process occurred in the liver, the thrombi forming in the capillaries of the portal circulation. When we consider the subject of tubercular infection through the intestinal tract we have several different possibilities offered to us as to its future course. Tchistowitch has seen leucocytes between the epithelial cells of the mucosa of the intestine with several bacilli in their midst, and he considers them as passing in loaded with these bacilli, which they have picked up on the free surface of the intestine. Should they enter in this manner then we may have formed in the submucous adenoid (lymphoid) tissue a primary tubercle which would lead finally to an intestinal ulceration. But they may possibly pass into the lacteals and give rise there to infection of the lymphatics and tuberculosis of the mesentery and of the mesenteric glands. A third possible and extremely probable course would be into the venous capillaries and thence into the portal circulation; where we may conclude they would, as Borrel has shown, give rise to tubercles in the substance of the liver. If then these possibilities all occur in one or other instance, then we must look upon primary tuberculosis of the intestine, (secondary infection of these organs arising from primary tuberculosis of lungs, being naturally a comparatively common event) of the mesentery or the liver as evidences of intestinal infection.

Degrees of Infection and their Bearing on the Individual.

While the statistics already quoted sufficiently illustrate the high degree to which the infection of tuberculosis has extended both in men and animals, the problem of "To what extent the presence of the disease in the individual has affected its general health at any time, from that of the initial infection to that when death has ended the struggle?" is one which must depend, (*a*) upon the individual constitution; (*b*) the virulence and extent of the infecting agency; (*c*) upon the seat of infection in the system, and (*d*) upon the environment of the individual,

including such elements as climate and housing, age, nature of employment, amount and quality of food, etc. With so many determining factors in the problem it is plain that no general rule can be laid down, which can closely guide us in precisely prognosing the ultimate results in any given cases; but it is of the utmost importance that we determine as far as possible the broad conclusions to which our studies along several lines would seem to point. How great is the influence of climate on tuberculosis, is well illustrated by the accompanying foot-note.* . All observers seem agreed that there is transmitted both in men and animals a hereditary tendency to scrofulous or tubercular inflammations in the offspring of tuberculous parents; and in Medicine much has been learned of the methods by which such tendencies may be counteracted. In both men and cattle, however, it is the unfortunate fact that this hereditary weakness occurs especially in those persons and cattle who are exposed through environment, as amongst the poor of cities, amongst dairies in the suburbs of cities, etc., to the quantitative virulence of the infecting agency. Hence it will be at once apparent that the sanitary question of how to lessen the existence of tubercular bacilli exter-

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*GUELPH, December 29th, 1893.

To DR. P. H. BRYCE,
Parliament Buildings, Toronto.

SIR,—Enclosed please find statement as to the condition of two pure bred Hereford cows slaughtered November and December, 1893.

The animals in question were shipped out to Southern Alberta, October, 1889. Wintered in a good pasture with open shedding (sheltered) and hay in abundance when needed. Turned loose all summer on the prairie.

Elevation about sea level, 3,000 feet.

Believe me, yours faithfully,
(Sgd.) EDMUND A. ELTON.

Lilly Grove pure bred Hereford cow, seven years old (barren). The above-mentioned cow was apparently a splendid specimen of her breed, always in good condition. Calved at three years, and has not calved again. Butchered December 6th, 1893. Lungs—The lower portion of the right lung entirely gone for about four inches, otherwise the lungs seemed quite sound. On the diaphragm was a tubercle about 2 inches long 1½ inches wide one-half an inch thick, containing hard, cheesy matter. Intestines—rolling in fat which was dotted all over with small pea-like tubercles containing hard, cheesy matter. On the right flank close to the hip bone was a mass of tubercles resembling a heaped up mass of peas, all containing a hard, cheesy matter. Small pea-like tubercles adhered to the main carcass along the full length of the animal from neck to tail. Ovaries—Enlarged and contained hard, cheesy matter. Liver, etc, appeared healthy.

Midnight (Lord Wilton), pure bred Hereford cow, six years old. Prolific breeder. Spayed spring of 1898; showed no ill effects from the operation. Fattened rapidly on the prairie. Slaughtered November, 1893. Symptoms a long drawn cough. Occasional at first, but more frequent after winter of 1892-1893 when she strayed away during a storm. Slunk her calf and did not return until spring, as thin as a rail. Large glandular swelling under jaw. Lungs—both badly diseased. One more than half gone with creamery pus exuding from it. Intestines, covered with fat but healthy. Liver, ovaries, etc, healthy.

nal to the body (as in the air of rooms, stables, etc.,) holds a most intimate relation to the lessening of the virulence of the infection within the body. This is apparent, for when it is remembered how general the disease is it is hardly supposable that most persons have not some time or other inhaled the germs of the disease, and that, natural resistance being present, it must be that every exposure increases the likelihood that this resistance may be overcome under some circumstances which make the infection greater or increase its temporary virulence. These circumstances may be those peculiar to daily employment, the presence of dampness and impure air, to another case in the same house, or the special occasion when exposure has produced a localized congestion or chilling of the respiratory air passages or when the protecting influence of a healthy mucous membrane in the bowels has disappeared owing to ulceration due to some disease as in typhoid fever. There would seem little doubt but that it is similarly when unsuitable food has produced an irritation and congestion o the stomach and bowels in children that bacilli introduced in milk are likely to find their way into the system. Remembering these various influences for or against the introduction and progress of infection, there would seem to be other circumstances incidental to the mode and point at which the bacillus is introduced into the organism which determine the future course of the infection.

We have already followed the course of the lympathic circulation, as well as the results where bacilli in quantity are introduced by intravenous injection, or into the walls of the abdomen. We have seen that the bacilli are carried along in the blood-stream to points in different organs, and that, while local tubercular centres are established as in lung and spleen, the leucocytes to some extent transport the infective bacilli from these foci in the blood-vessels into those of the lymphatic system. From the many *post mortems* in both man and animals which show very frequent presence of tubercular deposits in the lymphatic glands of different parts of the body there would seem to be no doubt but that the glands in tubercular as in other microbic infections act directly as receptacles for the nocuous materials which are removed from the blood by the depurating influence of the lymphatics.

In order to illustrate the distribution of tubercles produced by the localization of bacilli in the body, the following tables, showing so far as possible the distribution of tubercles in different organs, as observed in *post mortem* examinations are given:

Class of *post mortem*.	By whom.	Number in each.	Lungs.	Bronchial and Mediastinal glands.	Pleura.	Mesentery and Intestines.		Liver and Uterus.		Spleen and Udder.	
						Mesentery.	Intestines.	Liver.	Uterus.	Spleen.	Udder.
			per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent	per cent
Ontario Agricultural College herd	Mackenzie	28	64	85	....	7	7	42	....	....	7
Ottawa Experimental Farm herd	Robertson	30	83	73	26	13	4	43	6	....	....
New Jersey (cattle)	Conrow	48	70	56	..	....	....	....	....	2	25
Germany (cattle)	Roeckl	7329	75.3	29.4	51.5	13	....	....	....	....	....
In children	Steiner and Neuretter	302	....	90	..	11.9	....	....	....	....	....
"	Woodhead	127	....	....	....	62	33	....	....	....	....
" meningitis	Bertalot	24	....	83	....	4	....	....	..	....	....
Persons	Queyrat	11	90	36	....	36	63	....	....	....	....
"	Biedert	1069	79	58	....	29	31	....	....	....	....
"	Leroux	214	99	....	....	...	33	38	....	47	....
"	Muller	....	92	B 81 M11	..	57	....	....	..	....	....
Children in hospital in Berne (organs first attacked)	Demme	1933	10	35*	....	3.5	....	....	....	....	....
Persons	Reimer	42	....	85	....	2	....	....	....	...	....
"	Henoch	18	....	94	....	17	....	....	....	....	....

*Peripheral glands.

Amongst other statistics not readily comparable are the following:

Biedert found in 1,069 tubercular persons autopsies of his own and others:

Lymph glands affected in	88 per cent.	Lungs affected in	79 per cent.
Mesenteric " "	58 "	Intestines "	31 "

In 7,329 cases of more exact returns of *post mortems* in cattle, the results as given are as follows :

—	—	Per cent.
General tuberculosis	459	6.26
Lungs	5,178	75.37
Pleura pulmonalis	3,812	55.49
Peritoneum and mesentery	3,316	48.27
Pleura of chest-wall	3,209	46.71
Bronchial glands and mediastinal glands	2,022	29.43
Liver	1,940	28 24
Spleen	1,273	18.53
Uterus	699	10.17
Inguinal glands	364	5.30
Pharyngeal glands	299	4.35
Trachea	233	3.39
Udder	111	1.62
Intestinal	89	1.30
Ovary	86	1.25
Lymph glands of liver	80	1.16
Lymph glands of thorax and abdomen	66	0.96
Heart and pericardium	62	0.90
Kidney and renal peritoneum	48	0.70
Bones	27	0.39
Intestines generally	22	0.32
All organs in thorax and abdomen	16	0.23
Lymph glands of trachea	13	0.19
Diaphragm	13	0.19
Stomach	11	0.16
Larynx	9	0.13
Muscle	6	0.09
Glands of knee joint	4	0.06
Brain	3	0.04
Spinal cord	2	0.03
Tongue	1	0.01
Thymus	1	0.01
Vagina	1	0.01
Testicle	1	0.01

Charrin found in a seven and a half months' fœtus dying on the third day, tubercles of abdominal organs and only scattered tubercles in the lungs. Merkel found in a fœtus, lungs intact, easeation of hard gum, bones infiltrated, caseation of neck-glands and caseation of back of left ankle joint.

Wiegert is confirmed by Carl Sprengler, who states that tuberculosis in children primarily establishes itself in the bronchial glands.

Neumann states that in many instances it is probable that tubercle bacilli are taken up by the bronchial mucous membrane and are probably carried to the nearest lymph glands, where they are deposited.

Babes found during eight years experience at the children's hospital, Buda Pesth, that no matter of what disease a child may have died from, 50 per cent. of *post mortems* showed tubercles of the cervical, bronchial and mediastinal glands.

Fleisch says the bronchial glands are by far the most frequently attacked first and most seriously.

Bollinger, of Munich, a most careful observer, states that without regard to age, organs are affected in the following order: 1, lungs; 2, lymph glands; 3, intestinal mucosa; 4, serous membranes; 5, larynx; 6, spleen; 7, joints, etc..

Pizzini found tubercular infection of the cervical and mesenteric glands in many persons who had died from suicide, drowning, etc, etc., not known to be tubercular. He further found, in inoculation experiments on 40 animals with tubercular material from tubercles in such, that 42 per cent. of bronchial glands and 5 per cent of cervical glands proved capable of producing infection; but none of the mesenteric glands were infectious.

Loomis, with tuberculous material from bronchial glands, produced, by inoculation, infection in animals in 6 out of 15 cases.

According to Roeckl, of 51,427 cattle slaughtered in 1888-1889 in abattoirs and butcher shops in Germany, the percentage of infection, according to age, was as follows:

Age.	Tubercular.	Age.	Tubercular.
Up to 6 weeks.....	0.6 %	From 3 to 6 years....	33.1 %
From 6 weeks to 1 year	0.6 %	Over 6 years.....	43.4 %
From 1 year to 3 years	11.4 %	Account not given....	11.2 %

The first most noticeable fact which these statistics illustrate is the large percentage of instances in which tubercles are found in the lungs and bronchi, when compared with the total number of *post mortems* or with their presence in other organs. The second prominent fact, as seen in the German and other tables, is the large percentage of cases of tuberculosis in cows or cattle of several years of age as compared with the cases in younger cows or heifers. In the New Jersey tables, in first class of 62 cows, 77 per cent. of all tested with tuberculin produced the characteristic reaction, and were found on slaughtering to be infected, while in the second class of 49 heifers only 26 per cent. were condemned by the test—only 3, however, out of the 13 being slaughtered and the proof of the disease demonstrated by *post mortem*. The third important

feature is that the intestines and abdominal lymphatics are relatively much less frequently infected than the respiratory organs and glands of the thoracic cavity. For instance, in the cases from the Ontario Agricultural College herd, out of one set of 14 *post mortems* there was not a single instance of tubercle of the intestine and only 1 in which small tubercles in the mesentery were present. In one instance, however, the disease was entirely abdominal, being located in the liver and adjoining glands.

With these facts before us, the pressing question is by what means does the bacillus in the majority of instances get into the system. If through the intestines, by way of the lymphatic capillaries in the villi, it would seem almost a necessity, judging from the distribution of these lymphatics in the walls of the intestines and subsequently in the larger plexuses, that intestinal and mesenteric tubercles in almost every case be a necessary consequence. The fact, however, that it has been proved by Mac-Callum and others that absorption of iron compounds from the intestines is preferably by the blood capillaries in the villi would seem to indicate the possibility of bacilli from the intestine entering the blood current directly, being thence rapidly carried away into the portal circulation to form in the liver primary tubercle, and thence, by secondary infection, passing to the lungs. The intra-venous experiments on rabbits would further indicate that the localization of bacilli in lung capillaries is the natural result of infection being primarily hæmatogenic, *i.e.*, by the blood-vessels where the blood current passes directly to the lungs. After, however, a careful balancing of probabilities, remembering the extreme minuteness of tubercle bacilli and their necessary presence in the food, where infection *per intestinam* takes place, it would seem probable that their ordinary entrance is by the chyle; and if so that then the infection of abdominal lymphatics would be an almost necessary consequence.

Turning to the question of infection by the respiratory tract, the fact, already mentioned that congestions of the mucous tract of the larynx, trachea, bronchi, and lungs and the laceration of these parts by mineral dust, and especially by angular particles as in stone-cutter's phthisis, are apparently the favoring and most frequent conditions under which the bacilli find entrance to the system, points very decidedly to very frequent hæmatogenic infection, i. e. by the blood capillaries. If this be true then there can be no difficulty in the explanation of the relatively high percentage of cases of lung tuberculosis, or of the equally high prevalence of caseous bronchial glands, when the distribution of the lymphatics

of the bronchi and of the interior of the lungs is remembered. The relatively high percentage of tubercles in the lungs may be further explained by the fact that bacilli passing into the intestine are rapidly carried through and from the body, while when they lodge in the bronchi or lungs they must necessarily be dislodged or be carried into the system.

If then the preponderance of aerial infection both in man and in animals be considered as both theoretically assumed and proven by both physiological and pathological data, not only are we informed as to the direction in which our efforts for preventing the dissemination of the disease by the air must be exerted but we must further realize that the very presence of tuberculized tissue in the lungs, bronchi, larynx, etc., even at an early stage of the disease, presents most positive dangers of infection to others from the excretions from the lungs. This danger in man is frequently illustrated, where in the clinical diagnosis of tuberculosis dependence must be placed upon perhaps nothing more than an abnormally rapid pulse, an afternoon slight rise, and a morning subnormal temperature until, in the expectorations not yet purulent and accompanying a slight cough, bacilli are found under the microscope abundantly present. All our knowledge regarding such as this and even more advanced cases seems to point to the fact that if by climate and medication the congestion of the mucous membrane of the respiratory tract can be lessened, and the nutrition of the blood by food, etc., be maintained and increased, the individual may have life indefinitely prolonged, apparently by the phagocytes of the blood either destroying bacilli in the blood current, by building up around them areas of cicatricial tissue at their localization in capillaries and surrounding tissues, or perhaps still oftener by carrying them into the lymphatic channels whence they are transported and locked up in caseous and calcified glands. Experience, however, shows that the breaking down of cicatricial and caseous tissues, whether in lung tissue or in gland, is, owing to congestions, anæmia, etc., always an imminent danger, whether in man or in animals; and hence that the re-introduction of bacilli into the blood-current with a renewal of the general infection, must never be lost sight of.

DEDUCTIONS BASED ON STATISTICS, POST-MORTEMS AND EXPERIMENTS.

From the statistical evidence set forth at some length, derived from mortality returns and from *post-mortem* examinations; from the physiological and clinical studies already presented; and from the biological experiments on animals and microscopic investigations on the milk and flesh of animals briefly detailed it seems possible for us to make some deductions,

which will enable us later on to formulate some practical conclusions for dealing with the problem of lessening the prevalence of tuberculosis. The principal deductions are :—

1. That tubercular infection has existed in greater or less degree in man, according to *post-mortem* evidence in a percentage, in some groups of cases, to the extent of from 25 to 50 per cent.

2. That it produces fatal results at different life-periods after the first year to an almost equal degree.

3. That the tubercular process, fatal in so large a degree, may nevertheless exist in man and in animals, according to the localization, condition and extent of the tubercle, the constitution of the individual, the environment, as of climate, etc., for an indefinite length of time, the individual finally dying from other disease.

4. That the infection may, however, be present in such instances to an extent sufficient to transmit the disease through the air passages, and possibly in cattle through the medium of the milk.

5. That in many cases the disease may remain in an inactive condition, the man continuing in a fair condition of health, and able to pursue his ordinary avocation, and the cow appearing well-nourished and giving milk in apparently normal quantities ; but that in all such cases there is an ever present danger of cold, or other occasion of inflammation setting up general infection of the system with fatal results.

6. That the seat of the disease will largely determine the degree of danger of infection and the direction of its transmission.

7. That in cattle, while the bacilli are probably always present in the milk when the udder is tubercular, yet the bacilli may be present in the milk in a considerable percentage of cases where even *post mortem* examination reveals no tubercles of the udder.

8. That in woman tuberculosis of the mamma is but seldom found.

9. That in cases where tubercle is present in lymphatic glands, in lungs, liver and other organs, the juice of the muscles has been found in some instances to produce infection, even where no tubercle of muscular tissue could be discovered.

9a. That the inoculation of either men or cattle, when not experimental, takes place in practice always by way either of the respiratory or of the alimentary tract.

10. That such inoculation is dependent upon the extent and frequency of the passage of infective materials into either tract, and largely upon the receptive condition of the mucous membrane in both cases. A healthy mucous membrane offers much resistance to the passage of bacilli.

11. That the infection may begin in the epithelial surface of the air cells of the respiratory tract, and probably, in some instances, also in that of the mucous membrane of the intestinal tract.

12. That when bacilli pass into the system they do so either by way either of the blood capillaries or of the lymphatic vessels in the walls of the air passages and the villi of the intestines.

13. That when they have passed into the blood capillaries they may produce localized tubercles at the point of inoculation, or may, by passing into the blood current, produce infection at points and in organs distant from the same.

14. That inoculation into the lymphatics, while capable of producing localized infection, tends to transmission of the bacilli to the neighboring lymphatic glands and to the prevention of the progress of tubercular infection of the system.

15. That while inoculation by means of the blood vessels of the intestines may result in tubercles in the liver, spleen, etc., yet inoculation by the chyliferous lymphatics is likely to result in tubercles localized in the lymphatic glands, especially of the intestines and mesentery.

16. That both in man and cattle by far the most common seat of tubercles is in the lungs and adjacent lymphatic glands; and that this fact, along with the statistical evidence of the frequently repeated cases of pulmonary tuberculosis in persons exposed to the infected air of sick rooms and in cows to that of infected stables, points to the inference that the great proportion of cases of tuberculosis are the results of aerial infection by way of the respiratory tract.

17. That while the great number of deaths from tuberculosis in children, as from *tabes mesenterica* or consumption of the bowels, points to the probability of frequent cases of infection through milk and other food by way of the alimentary tract; yet the still larger number of cases of lung tuberculosis in children, the relatively small number of calves and young cattle infected with tuberculosis and the comparatively few instances of tuberculous cattle in which the intestines, mesentery or other abdominal organs are found on examination to be exclusively tubercular, point very strongly to the conclusion that infection by way of the intestines is relatively seldom in cattle, and that where it does take place in children it most probably is dependent on the previously unhealthy and congested state of the mucous membrane of the walls of the stomach and of the intestines.

PRACTICAL ASPECTS OF THE QUESTION IN ITS RELATION TO THE VITAL AND COMMERCIAL INTERESTS OF THE PROVINCE.

We have already in the first paragraph endeavored by Ontario and foreign statistics to indicate the probable extent of the existence of tuberculosis; and in order to see the practical bearing of this prevalence we may apply these statistics to the question of determining the probable number of persons in any community suffering from the disease.

If thus applied we would see that for everyone who dies in any year there are two or more who are tubercular, and who from conclusions arrived at from our studies are likely to be infectious for a considerable portion of their illness to those around them. The statistics showing the average length of time during which a cow is sick of tuberculosis before death are not very definite; but if we accept the same length of time as in man, say for two years, according to Dr. Billings, we see that their power for disseminating the disease is very extended indeed. Assuming, what is probably roughly correct, the general dissemination of the disease in cattle in different parts of the Province in any township where the number of cattle is known, and distributed over the farms in such townships, we would have of cattle suffering from the disease in each, the following: *

Illustrative table showing number of cattle in 15 counties, 7 west and 8 east.	Total milch cows.	Total cattle.
In 7 south-western counties—		
Average per county	21,718	61,254
Average per township	2,400	6,500
Average per township tuberculous at 2 per cent. of whole	48	Av. at 1 per cent., 65
In 8 eastern counties—		
Average per county	27,306	52,750
Average per township	2,190	6,000
Average per township tuberculous at 2 per cent	42	Av. at 1 per cent., 60

What such infection localized in any premises means may further, in some degree, be understood from the statistics of the deaths from consumption during 11 years in two Ontario counties, where, taking the same family names it is found that of all names 43 per cent. are found repeated

* Prof. Wright, of Glasgow, illustrates the loss in Scotland by the number of deaths from tuberculosis in cattle at £440,000, on 450,000, cows in calf, a loss in value of 7½ per cent. owing to sickness and death. Prof. McCall reports a case, where, of a herd of Ayrshires, 50 per cent. died of tuberculosis in 8 months. In a herd of 90 dairy cattle, 15 per cent. died of tuberculosis in one year.

more than once, and that of these latter the average number of deaths for each name is 2.6 persons, while in some instances the number reaches four for persons of the same name. Apart from the loss of life, the loss of time through sickness and the expenses of the sickness, nursing, etc., is enough to indicate an economic loss to the state, simply incalculable. This may be further illustrated. In the case of cattle the economic loss to the agriculturist is at once apparent. Assuming for purposes of calculation a percentage for milch cows as tubercular of 6 per cent., a figure notably lower than any foreign statistics, where as in London the number has been found to reach 15 per cent., and assuming the length of sickness before a fatal termination as being two years, we would have annually dying 3 per cent., of 787,836 ; that is 23,635 cows or over 500 in every county in Ontario. (From 2 to 3 per cent., according to Cooper Curtis, V.S., of the New York State Commission on tuberculosis is the amount of tuberculosis in public abattoirs in that State). This at a valuation of $30.00 per head would mean $15,000.00 of an annual loss to the stock interests of the farmers of each county. Make the loss 1 per cent. of the total milch cows, and still we would have an annual loss per county of $5,000.00. We must add to this a proportion of nearly half as many store cattle, and in a minor degree a loss amongst 868,755 young cattle. Prof. Wright estimates the loss in Ayrshire alone at £49,000 annually.

That the annual loss, however minimized, is enormous must be admitted by the most sceptical and hence we are compelled to ask ourselves what measures if any are practicable for lessening it.

INSPECTION OF CATTLE.

Dealing first with the question of cattle, it is at once apparent that a preliminary requisite to comprehensive or effective action is a knowledge of the extent to which tuberculosis exists in Ontario cattle. The relatively high character of Canadian cattle, as regards freedom from the so called acute contagious diseases whether compared with those of the United States or of Europe, has long been recognized ; and it is perhaps only fair to believe that relatively as regards tuberculosis, no cattle will be found more free from reproach. But, while it may be that the climate is favorable to vigor, and while the intelligent care of stockmen in Ontario is such as to cause them to at once take active measures for stamping out pleuro-pneumonia or anthrax, which would shortly decimate our herds, the condition is different with a disease insidious in its attack, and rela-

tively slow in its progress. Moreover, the long winters, causing the housing of many cattle, present positive dangers of the dissemination of the disease, which dangers have been unfortunately only too fully illustrated in herds, whose history we are in part acquainted with.

(*a*) *Abattoirs.*—Viewing the matter, therefore, from the standpoint of prevention, it is apparent that amongst the first practical measures legislation may very properly be passed, similar to that existing in Germany, etc., whereby every urban municipality of over say 3,000 population shall be required to cause the construction of a public abattoir, in which every animal intended for human food within the municipality must be slaughtered and sold only after inspection of meat has taken place. The protection to the public health in this way is so apparent as not to require discussion; while the inspection of the carcase by a competent medical health officer or a veterinarian would enable us within a single year to accurately guage the prevalence of the disease. The cost to the municipality would be merely nominal, as the license for slaughtering would be gladly paid by every butcher anxious to take advantages of the many facilities such buildings would have as compared with the crude structures and appliances in slaughter-houses, now everywhere the cause of nuisance and local complaint.

(*b*) *Cow Byres.*—The provisions for the inspection of cow byres and milch cows already exists in the Public Health Act, and some of our urban municipalities have taken fair advantages of such powers. The work done has, however, at the best, been but nominal. Attention of the local health authorities has been given almost wholly to the work of preventing milk deficient in butter-fat from being sold. Undoubtedly, the quality of milk as regards the addition of water has in many towns been notably improved; but further than a periodic inspection of the cleanliness of the byres and the general condition of the cattle, almost nothing has been done. The difficulties in doing positive work in this field, beyond such general inspection, are now becoming evident. In the various herds of cattle tested by the tuberculin test, whether in Ontario or elsewhere, it has been so common a remark that only a small percentage of such have shown, even to skilled veterinarians, notable clinical evidences of disease, where subsequently the test and *post mortem* examination have shown disease to be present, that the ordinary town sanitary inspector or policeman in his general rounds of visitation may be forgiven for reporting in the usual phrase, "cattle found in fairly good condition." That clinical examination is, at

the most, very imperfect, is amply illustrated in the Report of the Tuberculosis Committee of the United States Veterinary Medical Society, extracts from which are given below.

Dr. Austin Peters, M.R.C.V.S., Chief Inspector of Cattle for the New York State Board of Health, therein says:

First. "That in a typical dairy farming community, like Orange County, bovine tuberculosis is not as prevalent as many veterinarians believe, there having been only 35 cows killed out of about 10,000 examined; that is, .035 per cent. were found to be diseased under ordinary means of inspection."

Second. "In Westchester County, out of about 10,000 examined, in the neighborhood of 85 head were slaughtered, but there were more errors in diagnosis made here than in Orange County; a number of mistakes, six or eight perhaps, having been made. In Orange County, out of the 35 cows killed, only one was not tuberculous, and the diagnosis in her case was not positive, as before she was killed it was suspected that she might be suffering from pneumonia, which proved to be the case."

"The value of dairy inspection was better demonstrated in Westchester County, as here several herds were found badly infected with tuberculosis. In one instance it was found necessary to destroy an entire herd, not counting a few that died before final arrangements were made for killing the remainder (eleven head having been killed in December); 52 animals all told were slaughtered on two different occasions, one bull, tuberculous, 39 cows, all more or less tuberculous except one, four two-year-olds and eight yearling heifers, 50 per cent. of them being tuberculous."

From what has been already remarked regarding the existence of bacilli in the mucous secretions of the respiratory tract it is apparent that most important results follow the passing of such infectious secretions from the body, whether as expectorations in man, the saliva and nasal discharges from cattle or the constantly drying particles from lips and nostrils. The first infect the floors and, when dried, the atmosphere of dwelling apartments, work rooms, etc., and the latter the mangers, food, drinking water and the air of stables; to which must be added the actual transmission by contact, where cows lick one another and their calves.

While it is apparent that the degrees of danger to others in any particular instance will depend upon the seat of the tubercular process, as the lungs bronchi, larynx or in other instances the liver, mesentery intestines, etc., yet the relatively high prevalence of affected lungs and bronchi, both in man and animals makes it apparent that no precision of clinical diagnosis is likely to be enough to enable us to say that any man or animal may not from the first become the transmitter of infection. Perhaps even the repeated absence of bacilli in the sputum of man might be in practice a sufficient evidence of the absence of danger of infection; but the important fact is to be remembered that bacilli are often relatively more abundant in the expectorations before the ulcerative process in the lungs has noticeably advanced.

To further indicate the need for precise investigation in order to properly estimate the prevalence of the disease the following paragraph from the New York report is given *re* tuberculin.

Chief Inspector Peters says in report already quoted :

Tuberculin as a diagnostic agent was not extensively used, two herds only having been tested with it, one in Westchester County in March, on the herd when all the animals were killed ; the other near Poughkeepsie, Duchess County, in May, the animals being killed early in June. In both herds the results were quite satisfactory, but the latter one was much the better to use for the experiment, as it contained a few healthy creatures, and their general condition was better than in the first instance when it was tried. The Poughkeepsie herd consisted of two bulls and thirty-one cows and heifers, which were tested with tuberculin, besides which were three yearling heifers, which were not inoculated, and two young calves. Of the thirty-three animals all but four cows reacted to the tuberculin and one was unsatisfactory, as she was not well and had a temperature of 106 degrees at the time of the inoculation. Hence twenty-eight animals out of thirty-three may be looked upon as tuberculous according to tuberculin.

" Although I have always been a skeptic regarding the utility of tuberculin, the experience I have recently had with it has changed my views a great deal, and I now believe that it may be a very valuable agent if properly used.

" In suspicious cases, where doubt is felt as to whether an animal is tuberculous or not, it is well worthy of a trial ; and in herds where a number of cases of tuberculosis are found, I believe it to be advisable to test the entire herd with it."

Similar conclusions are arrived at by all experimenters, whether in Europe, the United States or in Ontario, and hence we are forced to believe that the work of determining the existence of tuberculosis in the Province is a matter demanding the most thoughtful consideration.

Regarding the problem in New York State, Cooper Curtis, V.S., remarks, " With tuberculin and plenty of inspectors it is going to be a serious task to eradicate the 2 per cent. of tuberculous cattle from the herds of New York ; but it is feasible and promises the best results and certainty of fulfilment. Without tuberculin scarcely the badly diseased, or those selected for death in the near future, can be chosen."

There remains therefore in Ontario in addition to abattoir and cow byre inspection the general inspection such as indicated by Mr. Curtis. It would mean for the 8,000 cattle of any township two inspectors testing 20 per day in order to perform the work in 400 days.

As to what is done elsewhere the account by Dr. Woodhead, of Edinburgh, as to the methods of inspection carried out in Denmark as witnessed by himself are of interest.

METHODS OF CATTLE INSPECTION IN DENMARK.

(*a*) First of all the sub-maxillary glands are examined ; these are easily felt, and any change is readily made out.

(*b*) The glands at the root of the neck and those in front of the haunch bones are always carefully examined. The glands in the flank

should be equal in size, about the size of the middle finger, and not hard. Mere enlargement, even when considerable, is however, not looked upon as of great importance if it is perfectly equal on the two sides.

(*c*) The animal is made to cough by means of pressure on the trachea, and the lungs are carefully examined during and after the coughing.

The conditions of the skin over the flanks is carefully observed; it should, in a healthy animal, be "loose," like that of a dog, soft and pliable; any adhesion, hardness, or harshness, should be carefully noted.

(*d*) The udder is carefully examined for inequality of size and for any induration. It is a somewhat curious fact that tuberculous disease usually affects the hind quarters of the udder, which becomes hard and knotty, but not painful; whilst in acute inflammation of the udder, the anterior quarters are quite as much affected as the posterior; the pain is usually very acute, and the process is accompanied by much more marked febrile symptoms.

(*e*) Then the glands above the udder, high up between the quarters, are most carefully examined. In cases of tubercular disease of the udder these glands are invariably affected, are unequal in size, and the larger one, corresponding to the affected quarter, is usually considerably indurated

(*f*) Careful auscultation is carried out at least once a month; the fore-foot of the side that is being examined being always well advanced. The normal expiration sound lasts half as long as the normal inspiration and if this rhythm is deviated from in any way, a further and thorough examination of the lungs should always be made.

(*g*) The examination is continued still further if the slightest suspicion of tubercular disease is aroused by the above investigation, and an examination per rectum is made, with the object of determining whether there is any tubercle of the peritoneum or not. As the onset of the disease in the udder is so rapid, and as yet it is held by most observers that the bacilli may make their appearance in the milk, even where the udder is not directly affected, it follows that if there is the slightest suspicion of the existence of tubercular disease in a cow, the milk from that animal should not be put into the milk supply, and as a matter of fact, on the Danish farms above referred to, it is not sent to town but it is either thrown out, or after being most thoroughly disinfected by prolonged boiling, is given to the pigs.

(*h*) The farmer keeps a record of the quantity of milk given by each cow, and a note of what is done with it; and any milk that is put out of the supply by the veterinary surgeon or by the farmer himself, on account of suspected disease, is paid for by the company, or the difference between the full value and the value as pig food.

Any other inflammatory condition of the udder is carefully noted, and even then the milk is withdrawn from the regular regular supply.

(*i*) A small quantity of milk is always drawn off by the veterinary surgeon, who carefully notes its color. If it is too thin and watery looking he immediately condemns it; whilst if it loses the peculiar blue tinge that freshly-drawn milk from a healthy cow almost invariably has, and takes on even a slight yellow tinge instead, the milk from the infected quarter is not used for any purposes, although the milk from other quarters may be used, after being thoroughly boiled, for the feeding of pigs.

The authorities of the Association insist rigidly on the fortnightly inspection, because it has been observed that very great swelling may appear as a sign of udder tuberculosis in from ten to fourteen days, as in this position the onset of the tuberculous disease is usually much more rapid than in the lungs, in which the process in a very large majority of cases appears to be far more chronic in character. In all cases, the condition of the glands must be systematically and carefully observed.

PREVENTION OF DANGER FROM THE INFECTED.

However greatly the statistics already quoted show the demand for immediate action being taken in the work of inspection both for determining the prevalence of tuberculosis in the Province, and for preventing the danger from the use of tuberculous meat and milk, it is apparent that the stockman and general public should be at once placed in a position to take every possible precaution for preventing the dissemination of the disease in herds or in individual cattle.

(*a*) *Isolation.*—Whenever a case of acute contagious disease in man or in child exists, the first act on the part of the medical practitioner, or medical health officer, is to demand the isolation or separation of the sick from other susceptible persons. This is the first measure we would look for in dealing with any animal regarding the health of which there could be any doubt. But the illustrations already given as to how seldom the early stages of disease in the tuberculous cow can be detected by even experienced veterinarians, point out the need for recognizing the absolute necessity for every stable where cattle are kept being so constructed, as that its cleansing can be readily carried out, and that its ventilation be made of the most perfect character.

(*b*) *Ventilation.*—The details of the construction of stables for cattle cannot be discussed at length in this report; but what should be aimed at can be illustrated from the following considerations: In man, the lungs

weigh about two and one-half pounds; respirations occur 17 times per minute, and the cubic inches of air expired with each respiration is about 27. With these facts as a basis the best practice in public hospitals in Great Britain and elsewhere is to allow from 1,500 to 2,000 cubic feet of air space for each patient, and the change of the air by ventilation, at least three times per hour, in order that the carbonic acid and the result of respiration may not be increased from the normal of three parts per 1,000 to beyond six parts.

Assuming that the weight of a cow is five times that of a man, and that the lungs maintain the same proportion it is evident that the cubic air space required for the health of a cow in a stable should be five times as great as for a man. We omit the fact that a cow makes four or five respirations more in a minute than a man; but it is apparent that if we are to expect cow-byres to be other than simple breeding-places for tuberculosis and for its dissemination, most radical changes must be made in the great majority of stables where cows are now housed. Ordinarily the cows stand almost as close as enables them to lie down, the ceilings are low the space behind them small, and the presence of artificial ventilation is the exception rather than the rule. While it is quite true that crowding means warmth, yet it is equally true that it means that where in a stable few or many cows are housed together all breathe a common air, and all are exposed to the same common danger of infection. That theory is in this matter close in keeping with fact, is seen from the multiplied statistics showing the increased percentage of tuberculosis, with age, in cows, the very high percentage in the milch cows of city dairies where they are constantly housed, the unusually high percentage of the thorough-bred herds most carefully housed and cared for, and the relative freedom of young cattle running in the fields and under sheds in winter, and the few calves found to be affected with tuberculosis. This latter fact is of extreme importance in this connection, since it seems the most convincing proof that aerial infection by way of the lungs, rather than infection from the milk of the mother, is the common method by which tuberculosis in cattle is spread.

The importance of this latter fact cannot be sufficiently dwelt upon; for in it lies an amount of hope for the future, which encourages us to put forth every energy for taking advantage of what it teaches.

(*c*) *Food and Water for Cattle.*—In the ordinary cases where proper feeding is resorted to there can be little or no danger of infection by

food; but the dissemination of influenza and glanders in horses from drinking water illustrates the danger of infection where cows drink from the same trough, especially where, as in many good stables, a common stream of water flows in front of the stalls. The mucous discharges from the mouth and nostrils of a diseased cow, will be taken up with the water by others, and so infection will be spread. The remedy for this can, by a simple structural convenience, be applied. With regard to the feeding of calves, the facts already given distinctly indicate the direction preventive measures should take. While readily admitting the advantages for rapid growth by suckling in the early life of a calf, yet the ease with which hand-fed calves are reared, obviates any practical difficulty in at once removing the calf at birth from the mother to some warm stable, free from every possible danger of contaminated air. Remembering the presence in the milk of the bacilli of tuberculosis, in cases where the cows may appear in good health, and the possibility of infection by the stomach, prudence points to the advisability of raising the milk to a temperature of 175 degrees F. for 10 minutes before feeding in order to destroy the germs of the disease. With the general adoption of these methods, and remembering the rarity of pre-natal infection, it will be seen that in a very short period every farmer may have a herd free from tuberculosis, if stable infection is wholly removed, and no new cattle introduced to the farm, until by the tuberculin test, they have been proved free from the infection.

(*d*) *Treatment of Infected Animals.*—It is hardly necessary to say that in dealing with this matter whether in man or cattle, we find ourselves face to face with the greatest practical difficulties. The broad fact exists of $50,000,000 of capital invested in cattle in Ontario; and how to conserve this enormous capital, and at the same time protect the lives of the people, as well as the future health of Canadian stock demands the most serious consideration of everyone interested directly or required officially to deal with the question. It is manifest that while no half measures will be of any serious value in limiting the disease, yet no recommendation for the wholesale destruction of diseased animals will meet with that popular approval necessary to the hearty co-operation of those having the largest interests at stake.

Manifestly, however, the prompt inspection of cattle along the lines indicated, the better construction and ventilation of stables, and the isolation of animals as already suggested is wholly practicable; while the

selection of animals whose removal from the duty of milk-producing is demanded, may steadily be carried on. What then must be done with these? It has again and again been noted that many of these are still apparently in good condition. It is our view that these should on the one hand be treated with successive injections of tuberculin, with a view to possible cure, while at the same time they are being fed with a view to their future slaughter as beef, under inspection at death.

(*e*) *Quarantine.*—The term is used in its application to the defensive measures carried out by the Federal Government with a view to preventing the introduction of diseased cattle into Canada. This quarantine is both maritime and inland. The former, long established, has been directed chiefly against pleuro-pneumonia and rinderpest, and in recent years incidentally perhaps against tuberculosis, while the latter operates against cattle from the United States, and is especially directed against pleuro-pneumonia and Texas cattle plague.

Remembering how crude up to most recent years have been the measures taken for preventing the spread of infectious diseases amongst emigrants on ship-board, and how imperfect even yet, excepting the St. Lawrence Quarantine, is the means available for disinfecting passenger ships, we cannot be surprised if we find that in the matter of ship-room for cattle, especially to Europe, and, for that matter from Europe, little or no attention has been paid to cubic air space, when, as has recently frequently been pointed out, the cubic air space per emigrant to American ports has in some instances not been more than 150 cubic feet. Remembering that it is the older steamers that are almost wholly engaged in cattle carrying; that they are slow, taking 12 and 14 days in an ordinary passage, and that sanitation as provided in modern steamships is almost unknown in them, it is not then difficult to understand how such vessels must have been in their badly-lighted, damp, lower decks plague spots abounding with the germs of infectious disease from diseased cattle amongst the thousands which have been carried from year to year since the business of importing and exporting cattle began, and of how cattle exposed for several weeks in the damp and confined air of these holds can hardly have failed to become inoculated with the germs of tuberculosis. In the Report of the Department of Agriculture of the Local Government Board of Great Britain for 1892 an illustration is given of what it is believed proves conclusively the existence of infection in one

of these ships: and which if properly viewed affords a true explanation of the dispute which has for months gone on relative to the existence or non-existence of pleuro-pneumonia in Canadian cattle.

"On October 11th a telegram was received at the Board of Agriculture from a well known and experienced veterinary inspector in the County of Fife reporting what he suspected to be a case of pleuro-pneumonia in his district. Instructions were given to him to slaughter the animals and forward the lungs to London. On examination it was observed that about one-third of the posterior part of both of the large lobes was swollen and solid to the touch, and that there was extensive pleuritic exudation over the diseased part, and on cutting into the substance of the lungs the marked interlobular exudation, which is the most prominent lesion observed in contagious pleuro-pneumonia, was revealed, the case was therefore treated in the ordinary way—a travelling inspector was despatched to the farm to carry out the slaughter of all the cattle that had been in contact, and to make the usual inquiries on the origin of the diseased animal.

"In the course of his enquiries the travelling inspector ascertained that the animal which had been slaughtered was one of a cargo of Canadian cattle which had been landed at Dundee on the 29th of September, where it was sold by auction and subsequently removed on October 6th to the farm in Fifeshire. On arrival it was placed along with the home stock, but finding it unwell it was removed on the following day to another farm for isolation.

"The owner gave notice to the Veterinary Inspector of the district, who after keeping the animal under observation for two days decided in his own mind that it was a case of pleuro-pneumonia.

"On the 22nd and 23rd of October further cases of pleuro-pneumonia were reported on two other farms in the County of Fife; the cattle were accordingly slaughtered, and found to present all the appearances which are observed in pleuro-pneumonia. Both these animals were of Canadian origin, and were also purchased at Dundee on the 6th of October and brought direct to these farms.

"From the extent of the lung involved and the alteration which had taken place in the structure, it was evident that the disease had not been contracted since landing in this country. Under these circumstances the Board decided to trace and slaughter all the animals which were sold on the 6th of October in the Mart at Dundee. This was carried out by the travelling inspector, and when slaughtering out the herds where the first case was detected in Fifeshire district, evidence of the disease in the early stage was detected in a small portion in the centre of one of the lungs of a home-bred beast 17 days after it had been in association with the diseased Canadian."

Dealing further with quarantine, another practical question arises as to the probable danger of inoculation of cattle with tuberculosis while detained in quarantine during three months, as provided under the Regulations. It is manifest that if infection in past years has been introduced to the quarantine grounds, the conditions of infection will there be the same as in other stables or yards. What prevention in the matter of the importation of cattle means is from these statements at once apparent. Every Canadian ship engaged in the cattle trade should at once be dealt with at the St. Lawrence quarantine station in a manner

as thorough as where smallpox or cholera has existed on shipboard. Such a disinfection as a routine measure, should be instituted, at any rate until some method of artificial ventilation is introduced, before any imported cattle are carried in the same ship that cattle are exported in. With regard to inland quarantine, the frequent changing of the quarantine grounds, easily carried out, should be enforced as a necessary routine precaution. With the facts with regard to the diagnostic value of tuberculin, as already set forth, it is hardly necessary to remark that no animal to be imported should be purchased for breeding purposes unless by the test it has been shown to be free from any trace of the disease.

PREVENTIVE MEASURES IN MAN.

Where so much has been written on the subject, it is hardly necessary to do more than point out what has already been from time to time referred to in various reports already adopted by this Board. We therefore summarize the conclusions which deal with the practical aspects of the question.

Inspection.

What this means is indicated by the laws relating to other infectious diseases.

(*a*) *Notification.* Before practical measures dealing with any particular case can be applied, it is necessary from the public standpoint that the existence of cases of the disease be known. This means that the law shall provide that physicians and householders be required to notify municipal health departments or local boards of health of any cases which may exist in their practice or houses. When this has been done printed instructions can be left for the guidance of householders and a record kept of the progress of such cases.

(*b*) *Inspection proper.* This must naturally follow notification, but its operations must be much more extended. There exist, for instances, according to Dominion census returns in Toronto, assuming its population to be one-tenth of that of the whole province, 3,200 industrial establishments, employing 16,000 persons, with an average of 5 emyloyees in each. The industries carried on are of the most varied character and under the most varied conditions (viewed from the health standpoint). Some, owing to the dust caused by the operations carried on are in themselves most

irritating to the mucous membrane of the respiratory tract, and create conditions most favorable for inoculation with the germs of tuberculosis, if present.

Others are carried on in rooms, over-crowded and ill-ventilated. In these, especially, does the danger become great, when consumptives are found amongst the operatives.

In addition to these places there are, especially in cities, public institutions, as hospitals, asylums, etc., in which cases of tuberculosis in large numbers are constantly present.

Schools and colleges ought, similarly with places of public resort, as hotels, court-rooms, railway stations, lecture-rooms, lodge-rooms, railway and street cars, etc., be subject to inspection, with a view to maintaining their cleanliness and freedom from infection.

(*c*) *Isolation.*—The use of the term here indicates what is meant as being necessary, with a view to preventing the dissemination of the microbes of the disease. The preceding paragraphs, relating both to statistical prevalence of the disease and to the infectious character of the sputum and other emanations from the persons of those affected, explain what prevention must mean. As matters stand at present it must mean that, in houses and places where consumptives live, the individual sick must be encouraged, and in such cases as in factories, workshops, etc., be required to adopt special precautions with regard to the disinfection of sputum, clothing, etc., and that special disinfectant precautions by employers with regard to the work-rooms so occupied be enforced.

(*d*) *Homes.*—This idea of inspection of work-rooms at once brings into prominence the other side of the question—one much larger and more difficult perhaps of solution—that of municipal provision in the shape of "Homes for Consumptives." The counties have *Homes* in many instances for the poor and aged; how much more necessary, both from the standpoint of protecting the public health and of prolonging the lives of the sick, to have homes, as farms situated on protected sites, where those who are forced to earn a living might support themselves in part by occupations of various kinds, and where the invalided poor might, while prolonging their lives, and in some cases recovering, be less of a burden to their families, while removed from the danger, by intimate contact, of spreading the disease in their own too crowded homes!

Bearing upon the recommendations made in this report, there is herewith submitted a summary of methods and laws which elsewhere have been proposed for dealing with this disease in man and cattle. In the meantime, and until such time as special homes and hospitals for the treatment of consumptives be constructed, it is urgently demanded that the tuberculized in general hospitals, asylums, etc., be segregated in wards specially set apart for them.

The information has been supplied by the principal neighboring States through a circular letter issued. Following is a summary of answers.

Rhode Island.—No particulars available.

Illinois.—No decided action taken beyond United States Live Stock Commission.

Tennessee.—No official investigation. State Veterinarian appointed. No funds.

Wisconsin.—Have State Vecerinarian. No reply from him.

Indianapolis.—Live Stock Sanitary Commission. No reply from him.

Texas.—No Commission.

Iowa.—Has a State Veterinarian. He states he has destroyed, almost uniformly, any cases of tuberculosis reported.

Indiana.—Farmers have become acquainted with disease. State Live Stock Commission exists.

Indiana.—Vetenarian says there are no cases in the state. Ten were killed in four years. No examination of the cattle made. Every case reported as suspected is examined.

Michigan.—State Live Stock Commission exists. Laws were received. State Board of Health has made notification of consumption compulsory by physicians and householders.

Ohio.—Live Stock Commission exists. No herds have been examined for tuberculosis. Laws received.

Missouri.—State Veterinarian says, "No steps taken to determine extent of disease. No special provision therefore. Enough of latitude under the law to carry out such investigations and very necessary."

Washington.—Bureau of Agriculture. No action for quarantine or slaughter has been taken, because of the general prevalence of the disease. Bureau supplies tuberculin. Washington Territory State Board by resolution empowers its members to employ a veterinary surgeon for inspect-

ing any suspected cases of tuberculosis. If the Board's views are disregarded, the Board considers it advisable that members publish the existence of the case.

New York State has a special Commission appointed to deal with tuberculosis and to make special examination of cattle. Where tuberculosis is found to be present it is empowered to have apprisers fix the value of the cattle and give compensation where such are slaughtered. Extracts from the report of this Commission refer especially to the value of tuberculin as a diagnostic agent for detecting its presence in early cases of the disease. California has notification of the disease in men partially enforced. The laws of different German States require the inspection of all slaughtered animals at municipal abattors where inspection is very complete. The carcases are destroyed or dealt with in such a manner as to prevent infected meat from being dangerous if consumed.

With the many phases in which this question of tuberculosis is seen to present itself, it is evident that no labor, however great, which may have been taken to illustrate the scientific and sanitary bearings of the subject can adequately convey the full significance of the problem for solution, or of the enormous difficulties in the way of at once suggesting and still more carrying out practical measures for the same. Whatever practical measures are demanded by the situation must be such as will meet with the approval of the stockman, of the legislator and of the general citizen. No person is free from the dangers attaching to the disease and none can devolve on others his personal interest and responsibility. It would appear that by a *Commission* composed of several individuals, representative of the scientific, sanitary, agricultural and commercial interests, conclusions based upon an appreciation of the broader facts, might be arrived at, which would, if acted upon, be productive of benefits in a few years, which at present it is impossible to realize.

TABLE—Giving result of post mortems on 28 cattle slaughtered at Tuberculin Reaction being given.

—	Date of Injection.	Amount injected c.c.—Centimetre	Temperature before injection.	Highest temperature reached.	Hours after injection.	Bronchial Glands.
			°	°		
1. Imported Guernsey Bull.	July, 1893....	4 c.c.	100⅖	106½	11-15	Badly diseased
	Oct. 10, 1893	6½ c.c.	101⅖	105⅘	10-30	
	Dec. 19, 1893	4 c.c.	100	104⅕	13-55	
2. Grade (Lassie) cow	July, 1893.....	4 c.c.	100⅖	105⅖	13-35	Only one or two glands.
3. Ayrshire Cow (Cherry of Netherland).	July, 1893.....	4 c.c.	100⅕	106	11-10	Autopsy results not given in detail, simply tuberculosis well marked and extensive.
4. Guernsey Bull-Calf (6-7 mths. old)	July, 1893.....	2 c.c.	101⅖	107	11-15	Autopsy results not given in detail, simply tuberculosis well marked and extensive.
5. Holstein Cow (Artis Kassie).	October 10. 1893	6½ c.c.	100⅘	106½	10-25	Healthy.....
	December 19, 1893..	4 c.c.	101⅖	106	13-45	
6. Holstein cow (Alvo).	October 10, 1893....	6½ c.c.	101⅘	107⅖	8-55	Badly diseased caseating and suppurating.
	December 19, 1893..	4 c.c.	100⅕	103⅖	15-15	
7. Holstein cow (Artis Kassie Queen).	October 10, 1893....	6½ c.c.	101⅖	107	8-50	....
	December 19, 1893..	4 c.c.	100⅖	101⅘	10 25	
8. Guernsey cow (Joan).	October 10, 1893....	6½c.c.	100⅖	105⅖	13-55	.....
	December 19, 1893.	4 c.c.	100⅖	101⅖	16-50 Next m'rn'g at 9.30	
					102⅘	
9. Guernsey cow (Sarah).	October 10, 1893....	6½ c.c.	100⅖	106⅖	13-10	Very largely diseased.
	December 19, 1893..	3 c.c.	99⅘	104⅘	14-55	
10. Devon Grade Heifer (Cherry II.) 1 year 8 mths. old.	October 10, 1893. ..	4.4 c.c.	100⅖	106⅕	7-25	Very large and generally involved
	December 19, 1893..	3 c.c.	100⅕	106⅗	9-25	
11. Red Poll cow ...	October 10, 1893....	6½ c.c.	100⅕	106⅖	10 30	.....

Ontario Agricultural College for suspected Tuberculosis, owing to
Hour of injection 6 a.m.

Lungs.	Liver.	Intestines and other abdominal organs.	Udder.	Remarks.
Extensive and diffused tubercular deposits in both.	Healthy.....	Healthy....		Testicles healthy.
Healthy.....	Healthy.....	Healthy....		Disease well marked but not extensive.
Numerous nodules, softening of left lung.	Healthy.....	Healthy....	Disseminate tubercles.	
Caseating nodules in apex of left lung.	Healthy.....	Healthy....	Healthy....	
.....	.....	.....	.....	Practically no reaction at second test. *Milk examined and no bacilli found.*
....	.....	....	.....	Practically no reaction at second test. *Bacilli in milk twice.*
Right several large softening nodules. Left active inflammation.	Enlarged caseating gland pressing on ductus choledochus	Healthy....	Whole tissues suspicious.	Flesh very yellow, *Bacilli in milk twice.*
Tubercular nodules in both lungs.	Healthy....	Mesenteric glands enlarged.	Healthy....	This heifer presented at each test a second maximum, viz.: 106° 15.10 min. 106° 11.30 min. Returns of P. M. not yet in.

TABLE—Giving result of post mortems of 28 cattle slaughtered at Tuberculin Reaction

—	Date.	Amount injected	Temperature before injection.	Highest temperature reached.	Hours after injection.	Bronchial Glands.
			°	°		
12. Red Poll cow (Anna).	October 12, 1893....	4.4 c.c.	100⅘	104⅖	15-5	
	December 19, 1893..	3 c.c.	100⅘	102⅕	15-20	
13. Ayrshire heifer (Patience II).	October 10, 1893 ...	4.4 c.c.	102	105⅘	14-15	
	December 19, 1893..	3 c.c.	100⅕	102⅖	14-00	
14. Holstein heifer..	October 10, 1893....	4.4 c.c.	100⅘	103	13-20	Suppurating
	December 19, 1893..	3 c.c.	100⅗	106	13-40	numerous deposits.
16. Grade cow	October 10, 1893....	6½ c.c.	100⅕	105⅘	11-40	
17. Grade cow (Old Racket).	October 10, 1893....	4.4 c.c.	100⅖	105	14-50	One small
	December 19, 1893..	4 c.c.	101	104⅗	13-50	gland diseased.
18. Ayrshire cow (Nellie).	October 10, 1893....	4.4 c.c.	100⅖	101⅖	14-45	Healthy.....
	December 19, 1893..	3 c.c.	100⅖	101⅖	10-20	
19. Red Polled calf (Anna II).	December 19, 1893..	1 c.c.	101	105⅘	11-30	
20. Ayrshire calf (Nellie II).	December 19, 1893..	1 c.c.	100⅕	104⅜	13-55	
21. Jersey heifer (Canada Rose)	December 19, 1893..	2 c.c.	101⅕	105⅖	10-25	Extensively diseased.
22. Ayrshire heifer (Duchess V.).	December 19, 1893..	1½ c.c.	100⅘	106⅕	14-00	
23. Jersey Grade calf (Spot II.).	December 19, 1893..	1½ c.c.	101	105⅖	11-30	
25. Holstein heifer (Conelia Cassie)	December 19, 1893..	3 c.c.	101⅖	106⅕	10-30	A few small tubercles.
26. Holstein bull-calf (Kassie's Queen's Mink Mercedes).	December 19, 1893..	2 c.c.	100⅕	105⅗	14-5	Badly involved.
27. Grade cow (Dairy Queen).	December 19, 1893..	4 c.c.	100⅕	105⅘	14-0	Few glands diseased.
28. Grade cow (Blue Bell).	December 19, 1893..	4 c.c.	100⅘	104⅗	14-0	One small gland suspicious.

Ontario Agricultural College for suspected tuberculosis, owing to being given.—*Concluded.*

Lungs.	Liver.	Intestines and other abdominal organs.	Udder.	Remarks.
Right extensively diseased. Left with numerous caseating nodules.	Small, rather cirrhotic, otherwise healthy.	Healthy....	Healthy.	
Adherent to diaphragm.	Adherent extensively diseased, several abcesses, one large suppurating cyst.	One small tuberculous gland.		P. M. returns not yet in. *No bacilli in milk.*
Right apex infiltrated, also caseating nodules. Left several small nodules necrotic, and well marked.	Several nodules with enveloping fibroid areas.	Healthy....	Healthy.	Evidences of caseating action.
				P. M. returns not yet in.
Diffused tubercles in both lungs, left extensively hepatized.	Healthy.....	Healthy....		P. M. returns not yet in.
				P. M. returns not yet in.
Several small tubercles in left lung.	Two or three tubercles.	Healthy....		P. M. returns not yet in.
Healthy	Extensively involved also scattered tubercles in lymph glands.	Healthy....		
Healthy..... ..	Healthy	Udder suspicious, remaining organs healthy.		
Healthy.....	One small caseating nodule.	Healthy....		

Results of Tests on cattle at Experimental Farm, Ottawa.
Tuberculin Reaction confirmed by *post mortem*.

Animal.	Date.	Bronchial Glands.	Lungs.	Liver.	Other organs.
1. Jersey cow.	1892 and 1893.	Diseased ...	Both lungs very badly also pleura		
2. Calf of same, premature birth, 1 mth. 11 days old.		Healthy....	Healthy....	Small tubercular deposits	Small deposits on abdominal wall of diaphragm.
3. Short horn bull.		Diseased ...	Both lungs, especially the left diseased.		
4. Devon cow..		.....	One lung diseased.	.....	Inflammation of abdominal organs.
5. Polled Angus		.....	Lungs bad.		
6. Jersey		.....	Both lungs bad.		
7. Durham ...		....	Both lungs..	....	
8. Durham ...		.. ..	....	.....	No post mortem clinically diagnosed as tuberculosis.
9. Durham ...		... .	Both lungs.		
10. Short horn grade.		Healthy....	Both lungs, and grapey deposit on trachea and pleura costalis.	Tubercles in liver capsule.	Healthy
11. Ayrshire cow		Badly diseased.	Right lung almost solid, pleura costalis diseased.	Healthy....	Tubercles in abdominal cavity, bunch attached to uterus.
12. Grade cow..		Badly diseased.	Lungs bad, grapey deposit on pleura costalis.	Healthy....	Grapey deposit in abdominal walls and attached to uterus.
13. Jersey cow..		Healthy....	Healthy....	Liver badly diseased.	
14. Short horn grade.		Diseascd ...	Healthy....	Tubercles in liver capsule and in substance of liver.	
15. Durham cow		Diseased ...	One small area at tip diseased.	Healthy....	Small mass on diaphragm.
16. Short horn cow.		Diseased ...	Diseased, pleura costalis also.	Diseased.	

Results of Tests on cattle at Experimental Farm, Ottawa.—*Concluded.*

Animal.	Date.	Bronchial Glands.	Lungs.	Liver.	Other organs.
17. Short horn cow.	1892 and 1893.	Diseased ...	Both lungs.	Diseased.	
18. Devon bull.		Healthy....	Both lungs, grapey deposit on pleura costalis.	Diseased.	
19. Holstein cow		Healthy....	One lung diseased.	Diseased ...	Healthy.....
20. Holstein bull calf.		Healthy....	Small pimply growth on pleura pulmonalis, lungs healthy.	Healthy....	Healthy.
21. Ayrshire cow.		Diseased ...	Diseased ...	Healthy....	Healthy.
22. Durham grade.		Diseased ...	Healthy.	Diseased ...	Mass of tubercles on peritoneal lining of diaphragm.
23 French cow.		Healthy....	Both lungs..	Diseased ...	Healthy.
24. Devon cow..		Diseased ...	One lung sound, one slightly diseased, grapey deposit on pleura costalis.	Diseased ...	Healthy.
25. Devon cow..		Diseased ...	One lung diseased.	Healthy....	Healthy.
26. Durham grade.		Slightly diseased.	Healthy....	Healthy....	Healthy.
27. Holstein....		Diseased ...	Healthy....	Healthy....	Healthy.
28. Holstein....		Diseased ...	One lung diseased.	Healthy....	Healthy.
29. Durham bull		Healthy....	One lung badly.	Diseased ...	Healthy.
30. Holstein (?).		Healthy....	One lung diseased, tubercle attached to trachea.	Diseased ...	Healthy.