

THE RELATIVE IMPORTANCE OF THE BOVINE AND HUMAN
TYPES OF TUBERCLE BACILLI IN THE DIFFERENT
FORMS OF HUMAN TUBERCULOSIS.*

WM. H. PARK AND CHARLES KRUMWIEDE, JR.

Assisted by

BERTHA VANH. ANTHONY, MARIE GRUND, AND LOUISA P. BLACKBURN.

(From the Research Laboratory of Department of Health, New York, N. Y.)

The results of the examination of various cases as published in the *Journal of Medical Research* (Volume XXIII., page 205), showed conclusively that infection with bovine tubercle bacilli in New York City and its vicinity is essentially a disease of children, and a serious menace to life in infants. Because of this, it was decided to examine additional material, especially from fatal cases of tuberculosis in children. These additional cases have given results closely approximating those already published and, therefore, serve to verify the reliability of these figures.

No further details are given of technical procedures or methods of differentiation. These have been fully discussed and there is nothing to add. The only point that needs mention and cannot be too often reiterated is, that correct cultural differentiation depends largely on suitable culture media. Even with long experience one finds irregularities creeping in, viz., minimum growth of human viruses on some batches of media, or irregularities in individual tubes planted from the same material. We have prepared egg media in numerous ways and with widely varying reactions and have been unable to find anything that accounts for these variations. In the routine examination of a series of cases these irregularities are quickly noted and controlled. They would be especially dangerous in the cultural differentiation of isolated cases if rabbits were not used to control the results.

The above remarks must not be interpreted as a criticism of the egg medium, for there is no doubt that it is very

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nearly perfect for isolation and cultural differentiation and shows a minimum of variability.

The study of the Smith Reaction has been continued and the complete results are given separately (see page 335 of this number).

Differentiation in the following additional cases has, in some instances, been on cultural characteristics alone. The bovine viruses have, however, been fully tested in rabbits.

TABULATION* OF ADDITIONAL CASES EXAMINED.

Diagnosis of Cases Examined.	Adults 16 Years and Over.		Children 5 to 15 Years.		Children Under 5 Years.		Notes.
	H.	B.	H.	B.	H.	B.	
Pulmonary tuberculosis	3	—	—	—	2	—	Case from Babies' Hospital.
Tuberculous adenitis, cervical	—	—	—	—	—	1	
Abdominal tuberculosis	—	—	—	—	1	—	
Generalized tuberculosis, alimentary origin	—	—	—	—	—	1	
Generalized tuberculosis	—	—	—	—	6	—	
Generalized tuberculosis, including meninges	1	—	—	—	7	—	
Tubercular meningitis	1	—	1	—	12	1	
Tuberculosis of bones and joints	—	—	—	—	1	—	
Genito-urinary tuberculosis	3	—	—	—	—	—	
Tuberculosis of skin.	1	—	—	—	—	—	
Totals	9	—	1	—	29	3	Total cases, 42.

* For method of tabulation, see previous article, Vol. XXIII., page 338.

Including these cases in the tabulations already published gives the following tabulation of cases examined:

FINAL TABULATION OF CASES EXAMINED.

Diagnosis of Cases Examined.	Adults 16 Years and Over.		Children 5 to 16 Years.		Children Under 5 Years.		Notes.
	H.	B.	H.	B.	H.	B.	
	Pulmonary tuberculosis.	281	—	8	—	7	
Tuberculous adenitis, inguinal and axillary.	1	—	4	—	—	—	
Tuberculous adenitis, cervical.	9	—	19	8	6	13	
Abdominal tuberculosis.	1	—	1	1	1	3	Only three cases given under this heading. Many of the cases in the following subdivisions showed marked intestinal lesions and possibly some were of alimentary origin. One bovine case had tuberculous osteomyelitis of the metatarsal bone.
Generalized tuberculosis, alimentary origin.	—	—	—	—	1	2	
Generalized tuberculosis.	2	—	1	—	18	4	
Generalized tuberculosis including meninges.	1	—	—	—	25	1	

FINAL TABULATION OF CASES EXAMINED. — *Continued.*

Diagnosis of Cases Examined.	Adults 16 Years and Over.		Children 5 to 16 Years.		Children Under 5 Years.		Notes.
	H.	B.	H.	B.	H.	B.	
Tubercular meningitis.	1	—	2	—	26	2	No autopsy. Extent of lesions elsewhere unknown.
Tuberculosis of bones and joints.	1	—	10	—	7	—	
Genito-urinary tuberculosis.	6	1	1	—	—	—	The adult bovine case was tuberculosis of kidney. Removal of kidney. Complete recovery.
Tuberculosis of skin.	1	—	—	—	—	—	Possibly primary in bone.
Tuberculous abscess.	1	—	—	—	—	—	
Totals.....	305	1	46	9	91	25	

Double infection, one case. Both types isolated. Generalized tuberculosis including meninges, thirteen months. Mesenteric nodes gave human type. Meningeal fluid gave bovine type.

TOTAL CASES—478.

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The additional cases necessitate some change in the mortality tabulations given in Volume XXIII., page 361. As it is noted, there is a slight lowering of the percentages in the Babies' Hospital series and also in the cases considered as a whole.

TOTAL FATAL CASES IN CHILDREN.

Diagnosis.	Children 5 to 16 Years of Age.		Children under 5 Years.		Notes.
	H.	B.	H.	B.	
Pulmonary tuberculosis.	—	—	7	—	One case included, probably fatal, data incomplete.
Tuberculous adenitis.	1	—	—	—	Other cases recovered as far as is known.
Abdominal tuberculosis.	—	—	—	3	Three other cases, one bovine and two human, were operative cases with recovery as far as known.
Generalized tuberculosis.	1	—	19	4	Two other bovine cases died directly of exanthemata with complications.
Generalized tuberculosis including meninges.	—	—	25	2	One case gave both type of bacilli, included under bovine, as this type caused the meningitis.
Tubercular meningitis.	2	—	26	2	
Totals . . .	4	—	77	11	or 12½% due to bovine type under 5 years.

FATAL CASES. BABIES' HOSPITAL.

Diagnosis.	Children 5 to 16 Years.		Children Under 5 Years.		Notes.
	H.	B.	H.	B.	
Pulmonary tuberculosis.	—	—	6	—	One case included, probably fatal, data incomplete.
Generalized tuberculosis.	1	—	14	2	
Generalized tuberculosis including meninges.	—	—	21	1	One case gave both types of bacilli, included under bovine, as this type caused the meningitis.
Tubercular meningitis.	—	—	18	1	
Totals . . .	1	—	59	4	or 6½% due to bovine type under 5 years.

No additional cases from the Foundling Hospital have been examined, but the table is repeated here for completeness. As has been noted this is really a special series of children, fed exclusively cow's milk, giving an excessively high incidence of bovine infection. They should be so considered and general deductions cannot be drawn from them and applied to infant mortality at large.

CASES. FOUNDLING HOSPITAL.

Diagnosis.	Children Under 6 Years.		Notes.
	H.	B.	
Abdominal tuberculosis.	—	1	Two of the bovine cases died directly of exanthemata; the tuberculosis was not altogether negligible. These two cases not included in the total fatal cases.
Generalized tuberculosis.	3	3	
Generalized tuberculosis including the meninges.	1	1	
Totals	4	5	Total cases, 9.

If we consider the Babies' Hospital cases alone the mortality due to bovine infection is six and one-third per cent. The total mortality cannot be considered normal while the Foundling Hospital cases are included. Exclusive of these the general mortality would be a small fraction under ten per cent. These percentages are believed to give a truthful picture of the percentage limits of mortality and are applicable to the general population of New York City and on the whole to most American cities. The children received at the Babies' Hospital represent the average New York City child, while those at the Foundling Hospital represent the portion fed on cow's milk.

AGE INCIDENCE OF TOTAL FATAL CASES UNDER FIVE YEARS.

Diagnosis.	Between 4 and 5 Years.		Between 3 and 4 Years.		Between 2 and 3 Years.		Between 1 and 2 Years.		Under 1 Year.	
	H.	B.	H.	B.	H.	B.	H.	B.	H.	B.
	Pulmonary tuberculosis.....	—	—	1	—	—	—	2	—	4
Abdominal tuberculosis.....	—	—	—	—	—	—	—	2*	—	—
Generalized tuberculosis.....	1	—	—	1	3	—	5	2	10	1
Generalized tuberculosis including meningis.....	—	—	1	—	2	—	8	2†	14	—
Tubercular meningitis.....	—	—	2	—	5	1	10	1	9	—
Totals.....	1	—	4	1	10	1	25	7	37	1

* One case, bovine type, definite age not given, infant. Not included.
 † Case of double infection included here.

If we further correct the application of the percentages deduced, it is evident from the above table that we should apply them mainly to the first three years of life. The cases examined between three and five years are few in number. Further, the pulmonary type of disease becomes more evident at this age and if more of this type of disease had happened to fall in this age period the percentage would have been reduced. The source of our material did not include many cases about this age and only four cases came to us between five and sixteen years, not including the pulmonary cases, the outcome of which we could not determine. We are inclined to believe that around the ages of four to five years the incidence of fatal bovine infection rapidly falls and that one factor in this fall is the increase in the pulmonary types of infection.

Since the completion of the article in Volume XXIII, a complete report has been published by Burckhardt of his investigation of surgical tuberculosis. The following tabulation gives the results of this important work. As will be noted the percentage of bovine infection is higher than one would expect.

Diagnosis of Cases Examined.	Adults 16 Years and Over.		Children 5 to 16 Years.		Children Under 5 Years.		Notes.
	H.	B.	H.	B.	H.	B.	
Tuberculous adenitis, cervical.	5	—	3	1	—	—	
Abdominal tuberculosis.	3	—	1	—	—	1	One case originally classified here, changed to next heading.
Generalized tuberculosis.	1	—	—	—	—	—	Clinically the abdominal symptoms only were marked.
Tuberculosis of bones and joints.	9	1	12	2	4	—	One case (child) age not stated, therefore not tabulated, gave human type.
Genito-urinary tuberculosis.	3	—	1	—	—	—	
Tuberculosis of skin.	1	—	—	—	—	—	
Totals	22	1	17	3	4	1	(1) Total cases, 49.

The observations of Burckhardt on the comparison of the pathological and clinical details in his bovine and human infections in joints is interesting. Of twelve cases of tuberculosis of the knee, two were noteworthy by the absence of marked bone lesions. One of them had lasted one year, this was of the human type. The other, which showed a very small bone focus in the tibia only after careful search, had lasted for thirteen years. This case was of bovine origin. The age of the patient was nineteen years. Recovery in both instances was complete.*

Of the three cases of tuberculosis of the hip there was one bovine infection. Here again the history was of long duration, viz., eight years. This case (eleven years old) also showed only superficial granulations. The two other cases, which were human infections, showed deep bone involvement. The operative results in the bovine case were very good. Another bovine infection of the elbow joint showed only granulations on the capsule. This case, however, had lasted only one year.

Because of these peculiarities in the bovine cases Burckhardt thinks it would be well to investigate those joint cases showing practically no bone involvement and especially those cases giving a long history of infection. From the cases already cited one might expect many if not the majority of such cases to be bovine infections. This is only a suggestion, and only further cases could give the necessary evidence to prove this possibility.

It is of interest to note that the only distinct bone infection without joint complication due to the bovine bacillus is one reported by Oehleker. This case gave a long history of six and three-quarter years. The disease was limited to one metacarpal bone.

Another report is that of Rothe, who publishes a continuation and amplification of Gaffky's work. The bronchial and

* On the appearance of the preliminary report we had written to Dr. Burckhardt, who kindly sent us details of his cases prior to his final publication which would have given us the opportunity of including them in our preceding report had the letter reached us. Due to some clerical error the letter was filed away and not brought to our notice till too late.

mesenteric nodes of one hundred children up to five years of age were examined. The material was from successive autopsies on children dying from any cause. Guinea-pigs were inoculated and if the inoculations were positive, cultures were isolated and tested. The results of his work and Gaffky's are given in the following table copied with slight change from Rothe's article:

Author.	Number of Cases and Age.	Number Positive.	Both Nodes.	Tuberculosis Present in Mesenteric Nodes Only.	Tuberculosis Present in Bronchial Nodes Only.	Human Infections.	Bovine Infections.
Gaffky	300; under 14 years.	57 = 19%	29	11	17	55	(2?) See next paragraph.
Rothe	100; under 6 years.	21 = 21%	13	3	5	20	1
Totals	400.	78 = 19.5%	42	14	22	75	3 (?)

In the two cases in which Gaffky failed to isolate cultures, the great difficulty encountered is good presumptive evidence of their being bovine. They cannot be excluded and if the figures are used at all they should be considered as bovine, failing proof to the contrary. If these cases are not included Gaffky's figure should be completely excluded from any consideration of the incidence of bovine infections. Rothe says: "Lässt man die beiden Fälle der 1. Untersuchungsreihe, in denen die Gewinnung einer Reinkultur nicht gelungen war, als unentschieden ausser Rechnung, so verbleiben 76 tuberkulöse Fälle, darunter. 75—98.68 per cent mit humaner und 1:1.32 per cent mit bovine infection." What he should have said was, excluding Gaffky's cases altogether because they are incomplete and inclusive, there are left twenty-one cases of tuberculosis, of which twenty or 95.24 per cent are human and one or 4.76 per cent are bovine. If Gaffky's cases are considered and the two doubtful cases are classed as bovine the percentage is very much the same. The following tabulation gives the results of Rothe's work. It is

difficult to tabulate his cases, as the details of the post-mortem examinations are not given.

Diagnosis of Cases.	Children Under 5 Years.		Notes.
	Human.	Bovine.	
Pulmonary tuberculosis.	5 3	1	The bovine case had swollen mesenteric nodes which were considered non-tuberculous on macroscopic examination. One of four inoculated guinea-pigs became tuberculous.
Abdominal tuberculosis.	— 2	—	Slight latent tuberculosis of mesenteric nodes.
Generalized tuberculosis.	6 3	—	Three cases were latent or slight tuberculosis of lymph nodes.
Tubercular meningitis.	1 —	—	
Totals	20	1	

The above table brings out very strongly the difficulty encountered in tabulating cases of different authors who have had different aims in view. Thus in one instance slight tuberculosis of the lymph nodes in the thoracic and abdominal cavities is placed under generalized tuberculosis to bring out the fact that the bacilli have disseminated. On the other hand, a more marked tuberculosis involving the lungs with what has theoretically been assumed to be secondary involvement of the intestines and possibly the mesenteric nodes, is classified under pulmonary tuberculosis. Although this seems contradictory we have attempted to keep certain distinct types of disease separate, but where such types do not exist to classify on the basis of the amount of dissemination. In this case, as in our previous report, the degree of involvement is noted by placing the slight infections to the right of a vertical line subdividing the space for these cases.

One fact in Rothe's article is very valuable for comparison of the value of different media. Gaffky failed to isolate two viruses as has been noted. Rothe states that isolation was

successful from the first guinea-pig passage seventeen times, from the second guinea-pig passage ten times, from the third, four times and in one case each, only after the fifth, eighth, and ninth passage. The last two were the bovine strains from the case of pulmonary tuberculosis. He used two per cent glycerine beef serum for isolation. This compares very badly with results obtained with egg media. Except for unavoidable variations in media and in individual technic, the positive results from the first pig, if the pigs are sufficiently tuberculous to give the necessary material, should be ninety-five per cent at the very lowest. This includes human and bovine viruses. As a matter of fact we have found it to be very exceptional to fail to isolate from the first pig, even with bovine viruses.

Finally, the results of Möllers are to be added. He reports the study of cultures isolated from the sputa of fifty-one cases of pulmonary tuberculosis. In ten, three isolations were made at different times, in nine, cultures were isolated twice, in the remaining thirty-two one culture only was isolated. Fifty of these cases were adults, one was an infant (the age groups were kindly sent us by Dr. Möllers).

Bullock also reports twenty-three cases of pulmonary tuberculosis yielding cultures of the human type. Adding the preceding reported cases and those of Fabyan (see foot note at end of previous report) gives the following tabulation:

TOTAL SUMMARY OF CASES REPORTED.

Diagnosis of Cases Examined.	Adults 16 Years and Over.		Children 5 Years to 16 Years.		Children Under 5 Years.	
	Human.	Bovine.	Human.	Bovine.	Human.	Bovine.
Pulmonary tuberculosis . .	363	(1?)*	3	—	13 3	1 —
Tuberculous adenitis, axillary	1	—	—	—	2	—
Tuberculous adenitis, cervical	18	1	17	13	9	8
Abdominal tuberculosis . .	13	4	1 6	3 3	3 5	6 4
Generalized tuberculosis, alimentary origin	6	1	2 —	3 —	12 —	10 —
Generalized tuberculosis .	27	—	3 —	1 —	20 5	1 —
Generalized tuberculosis including meninges, alimentary origin	—	—	1	—	3	8
Generalized tuberculosis including meninges . .	4	—	7	—	27	—
Tubercular meningitis . .	—	—	1	—	1	2
Tuberculosis of bones and joints	26	1	28	3	19	—
Genito-urinary tuberculosis	11	—	1	—	—	—
Tuberculosis of skin . . .	2	—	1	—	1	—
Miscellaneous cases:						
Tuberculosis of tonsils .	—	—	—	1	—	—
Tuberculosis of mouth and cervical nodes . .	—	1	—	—	—	—
Tuberculous sinus or abscess	1	—	—	—	—	—
Sepsis, latent bacilli . . .	—	—	—	—	1	—
Totals	472	9	71	27	124	40

Mixed or double infections: — 3 cases:

Generalized tuberculosis. Alimentary origin. 30 years. Human and bovine type in mesenteric nodes. Human type in bronchial node.

Generalized tuberculosis. Alimentary origin. 5½ years. Human type in spleen. Bovine type in mesenteric node.

Generalized tuberculosis including meninges. Alimentary origin. 4 years. Human type in meninges and bronchial nodes. Bovine type in mesenteric nodes.

TOTAL CASES — 746.

* See Addenda for additional cases of Royal Commission not included here, due to lack of complete details.

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COMBINED TABULATION CASES REPORTED AND OWN SERIES OF CASES.

Diagnosis.	Adults 16 Years and Over.		Children 5 to 16 Years.		Children Under 5 Years.	
	H.	B.	H.	B.	H.	B.
Pulmonary tuberculosis . .	644	(1?)	11	—	23	1
Tuberculous adenitis, axillary or inguinal	2	—	4	—	2	—
Tuberculous adenitis, cervical	27	1	36	21	15	21
Abdominal tuberculosis . .	14	4	8	7	9	13
Generalized tuberculosis, alimentary origin	6	1	2	3	13	12
Generalized tuberculosis .	29	—	4	1	43	5
Generalized tuberculosis including meningitis, alimentary origin	—	—	1	—	3	8
Generalized tuberculosis including meninges . . .	5	—	7	—	52	1
Tubercular meningitis . .	1	—	3	—	27	4
Tuberculosis of bones and joints	27	1	38	3	26	—
Genito-urinary tuberculosis	17	1	2	—	—	—
Tuberculosis of skin . . .	3	—	1	—	1	—
Miscellaneous cases :						
Tuberculosis of tonsils .	—	—	—	1	—	—
Tuberculosis of mouth and cervical nodes . .	—	1	—	—	—	—
Tuberculous sinus or abscess	2	—	—	—	—	—
Sepsis, latent bacilli . .	—	—	—	—	1	—
Totals	777	10	117	36	215	65

Mixed or double infections, 4 cases.

TOTAL CASES—1,224.

Taking the cases given in the total tabulation and combining the important diagnoses under one heading gives us the following table, which shows clearly the percentage incidence of bovine infection. Caution is necessary in applying these figures, they tell nothing but the incidence; the seriousness of the infection is indicated in the preceding tables.

PERCENTAGE INCIDENCE OF BOVINE INFECTION.*

Diagnosis.	Adults 16 Years and Over.	Children 5: to 16 Years.	Children Under 5 Years.
Pulmonary tuberculosis	0% (?)†	0%	4.1%
Tuberculous adenitis, cervical.....	3.6%	36%	58%
Abdominal tuberculosis	22%	46%	59%
Generalized tuberculosis.....	2.7%	40%	23%
Tubercular meningitis (with or with- out generalized lesions).....	0%	0%	13.6%
Tuberculosis of bones and joints....	3.5%	7.3%	0%

* Exclusive of cases of double infections. In considering pulmonary cases it must, however, be remembered that bovine tubercle bacilli have been isolated from the lung in cases of generalized tuberculosis in children.

The number of cases under some of the headings is too small to deduce percentages. Reference to the preceding table makes this evident.

† If the two bovine cases of the Royal Commission (see Addenda) were included, the percentage would be 0.3%. We have not included these two cases as the additional human cases could not be included. If we combine the pulmonary cases regardless of age we can then add these cases, giving us a total of 710, exclusive of the one doubtful case. Of these, 3 or 0.42% were bovine infections.

This table gives only the incidence of infection and nothing as to the severity of the disease. This is seen by referring to the main tables in which we divide the cases according to severity. Under certain diagnoses a great many latent or slight infections are included, which may never have had any effect on the health of the child had not some intercurrent infection lead to death. Furthermore, due to selection of material, the number of cases of generalized tuberculosis of alimentary origin is markedly out of proportion and bears no relation to the incidence of these cases in proportion to other types of disease. If we rearrange the figures under these headings leaving out all but severe types of disease and consider the selected cases of alimentary tuberculosis separately, the following table gives the results. Only cases under sixteen years are considered, as we have only noted the severity of disease in these cases in the tables. The percentage of our cases are given for comparison.

PERCENTAGE OF BOVINE INFECTION. (*Revised.*)

Diagnosis.	Children 5 to 16 Years.		Children Under 5 Years.	
	Combined Figures.	Own Figures.	Combined Figures.	Own Figures.
Abdominal tuberculosis.....	66%	50%	69%	75%
Generalized tuberculosis, alimentary origin.....	60%	—	48%	66%
Generalized tuberculosis.....	20%	—	11%	18%
Tubercular meningitis, secondary to tuberculosis of alimentary type.....	—	—	72%	—
Tubercular meningitis (other than preceding).....	—	—	6%	5½%

Revising the percentages in this way gives close agreement. The percentages are highest in the relatively less common types of tuberculosis. In the two types of tuberculosis, which mainly constitute the fatalities in young children, the percentages range from five and one-half per cent to eighteen per cent. All things considered, we feel safe in saying that the percentage of deaths from bovine tuberculosis in young children, viz., six and one-third per cent to ten per cent as deduced from our unselected cases in New York City, are applicable to most cities throughout the world whose milk supply is similar to ours.

Addenda. — Since the completion of this final summary of our work the “Final Report of the Royal Commission appointed to inquire into the relations of Human and Animal Tuberculosis” has appeared. Only Part I., viz., the Report, has reached us. The Appendices which will contain the experimental data and details of the cases examined are not available. Failing these details it is impossible for us to include their added cases in our tabulations, nor is it possible to discuss their final conclusions. For this reason we add simply a short summary of the conclusions given in the report.

Concerning the existence of different types of tubercle bacilli they say: "For purposes of description it is advantageous to distinguish three types of tubercle bacilli, recognizable by their individual characters. These are the human, bovine and avian types. The human type, although so named, is not the only one found in cases of tuberculosis in man. It is the organism present in the majority of such cases, but in some cases of human disease the bacilli present are of the bovine type, and in others the bacilli have special characters distinguishing them from each of the three principal types. In natural cases of tuberculosis in cattle the only type of bacillus present is the bovine type." The conclusions on the differential characters of the human and bovine type are practically identical with our own. All their viruses from man are tabulated as bovine or human in all their characteristics with the exception of the viruses from cases of lupus. The following gives a short summary of their final results as they tabulate them:

CASES OF HUMAN TUBERCULOSIS OTHER THAN LUPUS (108 CASES).

Nature of Case.	Bovine.	Human.	Mixed Viruses, Human and Bovine.
Primary pulmonary tuberculosis,	0	14	0
Sputum from individual cases of pulmonary tuberculosis	2	26	0
General tuberculosis	0	3	0
Tuberculous meningitis	0	3	0
Bronchial gland tuberculosis.	0	3	2 (H. 13 A.D.; H. 60 W.B).
Cervical gland tuberculosis	3	6	0
Primary abdominal tuberculosis,	14	13	2 (H. 49 T.C.; H. 90 I. P.
Joint and bone tuberculosis.	0	13	1 (H. 16 J. H.).
Tuberculosis of testicle, kidney, or suprarenal. One each	0	3	0

The most astonishing thing is the presence of bovine tubercle bacilli in the sputum of two cases. One case was twenty-one years, the other was thirty-one years of age. In one case the examination was repeated after seventy-six, one hundred and seventeen, and one hundred and eighteen days with the same results. In the other case, a second specimen collected after one hundred and eighteen days gave the same results. Both cases subsequently died. The cause of death in one was given as phthisis, the other apparently had general tuberculosis with intestinal ulceration. At the time of collection of the specimens they were clinically cases of primary pulmonary tuberculosis. No autopsy could be obtained.

The other noteworthy point is the number of mixed viruses. In the preceding report the Commission gave the results on certain passage experiments without drawing any final conclusions. The changes found, they now conclude, were due to the presence of a mixture of human and bovine viruses in the original viruses. In the case of some of the viruses, for instance, H. 13 A.D., such a conclusion is justified. The extraordinary fluctuations in Virus H. 49 could also be accounted for in this manner. That it is justified in all cases, however, seems almost beyond the possibility of experimental proof. As soon as material has passed through calves a possible experimental error, viz., "spontaneous" tuberculosis of the calf, is encountered. That this error can be surely avoided in each case seems to us almost impossible. Critical judgment, however, must be withheld till every detail of the experiments is published.

The cultures from cases of lupus form a group by themselves. Twenty cases were examined. Culturally the viruses fell into either the human or bovine type. In virulence, however, only one was typically of the bovine type and two of the human type. The cultures were tested by inoculation into calves, rabbits, monkeys, and guinea-pigs. In some or all of these animals the virulence, with the exception of the above three cultures, was less than one would expect with one or the other type as determined culturally. The decrease of virulence from the type with some of the viruses was very

marked. In a few of these viruses it was possible to raise the virulence to that of the type. It is of interest to note that the only other aberrant cultures isolated were from two horses and these like some of the lupus cultures were culturally of the bovine type, but of degraded virulence. Passage experiments resulted in an increase of virulence to that of the bovine type.

The aberrant cultures were restricted to those isolated from the cases of lupus and equine tuberculosis already described. From the description they are neither typically bovine nor human in all their characters. The most striking thing is that they should have mostly come from one type of disease in man.

As to passage experiments and other means to cause modification of type they report complete inability to cause any change; the only exceptions being the lupus and equine cultures, where it was possible to enhance the virulence of some cultures by passage experiments.

They concluded: "Thus we are inclined to regard transmutation of the bacillary type as exceedingly difficult if not impracticable of accomplishment by laboratory procedure, though in view of certain instances in which we obtained from one and the same human body both types of bacillus, we are not prepared to deny that the transmutation of one type into another may occur in nature." The lupus cultures and the cultures from the horse they believe must be considered to be naturally modified human or bovine tubercle bacilli, as the only other alternative is to consider them added fixed types.

For the preceding reason virulence cannot be considered a fixed characteristic, which makes it impossible to regard difference of virulence for the calf and rabbit as sufficient to establish the non-identity of the human and bovine types.

"There would therefore remain only slight cultural differences on which to found the conclusion that the human and bovine types represent two distinct organisms. We prefer to regard these two types as varieties of the same bacillus. . . ."

CONCLUSIONS.

Bovine tuberculosis is practically a negligible factor in adults. It very rarely causes pulmonary tuberculosis or phthisis, which causes the vast majority of deaths from tuberculosis in man and is the type of disease responsible for the spread of the virus from man to man.

In children, however, the bovine type of tubercle bacillus causes a marked percentage of the cases of cervical adenitis leading to operation, temporary disablement, discomfort, and disfigurement. It causes a large percentage of the rarer types of alimentary tuberculosis requiring operative interference or causing the death of the child directly or as a contributing cause in other diseases.

In young children it becomes a menace to life and causes from six and one-third to ten per cent of the total fatalities from this disease.

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