

THE RELATION OF BOVINE TUBERCULOSIS TO EARLY TUBERCULOSIS IN CHILDREN *

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It is now generally conceded that infection with the tubercle bacillus is, in the majority of cases, an incident of early life, and that, regardless of the time of development of clinical symptoms, tuberculosis is, in its origin at least, essentially a disease of childhood. Unfortunately, however, the recognition of this fact has failed to effect, as yet, any wide-spread movement directed toward the prevention of this early infection, which is the fundamental problem of the antituberculosis campaign. This is not to say that there are not numerous agencies dealing with many different elements of the problem, but the sum total of their work is pitifully small when compared with the tremendous amount of effort and money expended in combating the disease in adults, much of which expenditure is, and will continue to be, wasted until it is diverted to basic preventive work among children.

It is the purpose of this paper to attempt to emphasize one very much-neglected phase of this subject. While all recognize that infection with tuberculosis in a very great proportion of cases results from exposure to other human cases, it is now also well established that, in a certain smaller proportion of cases, the disease is derived from tuberculous cattle; but strange to say, this knowledge not only makes but little impression on the laity, but also, so far as practical activity is concerned, is regarded with indifference by the greater portion of the medical profession. Indeed, I have even heard clinicians especially interested in tuberculosis deprecate any agitation of this subject on the ground that it tended to divert popular attention from the larger subject of human infection, apparently ignorant of the importance of this factor in the causation of the disease, or failing to appreciate how easily it should be controlled if only sufficient interest in it be aroused.

Formerly, tubercle bacilli from whatever source were considered as identical except for minor differing characteristics regarded as due to changes in environment. Klein very early pointed out certain differences between bacilli derived from bovine and from human sources, but it was not until 1896 that Theobald Smith clearly differen-

* Read before the Section on Diseases of Children at the Sixty-Fifth Annual Session of the American Medical Association, Atlantic City, N. J., June, 1914.

tiated the two types. Briefly, the bovine bacillus is usually shorter and thicker than the human, stains more uniformly and grows more slowly and sparsely on artificial culture mediums, with less acid production; but it is chiefly distinguished by its very much greater pathogenicity for animals, especially cattle and rabbits, which are with difficulty infected with human bacilli. The most reliable laboratory method, therefore, for determining the type of bacillus from any given source is by rabbit inoculation. If the rabbit develops a rapid generalized tuberculosis, the infecting organism is to be regarded as of the bovine type.

The recognition of the differences in the characteristics of the two varieties of bacilli naturally led to doubt as to the identity of the pathologic conditions produced by each, culminating in Koch's famous dictum, in 1901, that human infection with the bovine bacillus was so rare that tuberculosis in cattle was negligible in respect to the etiology of tuberculosis in man.

This view was revolutionary, but, being supported by so great authority, it was at once evident that the importance of the question demanded an accurate determination, and as a result of the immense amount of investigative study which has since been devoted to the problem, we are now in possession of data which enables us to speak with considerable certainty regarding many of the points involved.

These data have been derived from the work of the British Royal Commission on Tuberculosis, of the German Tuberculosis Commission and of numerous individual investigators. Without going too much into detail, their results may be summarized as showing conclusively, in so far, at least, as character of bacillus is concerned, that pulmonary tuberculosis is practically always human in type, although two lung cases yielding the bovine type of bacillus were found by the British commission. On the other hand, in children a considerable percentage of the abdominal, meningeal and bone and joint tuberculosis and tuberculosis of the lymph-glands has been shown to be of bovine origin.

The British commission investigated 108 cases and found 19 of bovine infection, as follows: 2 cases of pulmonary tuberculosis; 14 cases of abdominal tuberculosis and 3 cases of cervical lymphadenitis. The German Tuberculosis Commission examined 56 cases and in 6 found bacilli of bovine type.

Park and Krumweide, of the New York Research Laboratory, have themselves studied 478 cases (1912), and adding these to the reports of others, have tabulated some 1,511 cases. These give results as follows (quoting their tables):

TABLE 1.—HUMAN AND BOVINE TYPE OF BACILLUS IN 1,511 REPORTED CASES (PARK AND KRUMWEIDE)*

Diagnosis	16 Years and Over		5 to 16 Years		Under 5 Years	
	H	B	H	B	H	B
Pulmonary tuberculosis ...	778	3	14	..	35	1
Tuberculous adenitis, axillary or inguinal.....	3	..	4	..	2	
Tuberculous adenitis, cervical	36	1	36	22	15	24
Abdominal tuberculosis....	16	4	8	9	10	14
Generalized tuberculosis, all forms, including meninges	40	1	19	5	172	33
Tuberculous meningitis....	1	..	3	..	28	4
Tuberculosis of bones and joints	32	1	41	3	27	
Genito-urinary tuberculosis	22	1	2	..		
Tuberculosis of skin.....	10	3	4	6	2	
Miscellaneous cases	2	1	..	1	1	
Totals	940	15	131	46	292	76

Mixed or double infections, eleven cases.

* H means human; B, bovine.

TABLE 2.—PERCENTAGE INCIDENCE OF BOVINE INFECTION

Diagnosis	Adults 16 Years and Over Per Cent.	Children 5 to 16 Years Per Cent.	Children Under 5 Years Per Cent.
Pulmonary tuberculosis...	0.4	0.0	2.8
Tuberculous adenitis, cervical	2.7	38.0	61.0
Abdominal tuberculosis ...	20.0	53.0	58.0
Generalized tuberculosis (alimentary)	14.0	57	47.0
Generalized tuberculosis... including meninges (alimentary)	0.0	16	8.6
Tuberculous meningitis (other than above)....	0.0	0.0	66.0
Tuberculosis of bones and joints	0.0	0.0	4.6
Tuberculosis of skin.....	3.3	6.8	0.0
	23.0	60.0	0.0

In their own series, of the fatal cases in children under 5 years, 12.5 per cent. were bovine infections; while in the total series, 26 per cent. of all cases in children under 5 years were of bovine origin; 35 per cent. in children 5 to 16 years of age, and only 1.5 per cent. in individuals above 16 years of age. The tables also show the rarity of fatal tuberculosis due to bovine infection in those over 5 years old, but a very high percentage of abdominal tuberculosis and cervical lymphadenitis due to bovine bacilli.

Practically all authorities concur in the interpretation of these findings, though differing in their estimates of the relative importance of the two types of infection.

Dr. S. A. Knopf, in a recent personal communication, says: "I believe strongly in the transmission of tuberculosis from cattle. Laboratory, as well as clinical experiments, and the experiences of the past few years of American and European investigators, show conclusively that about 10 per cent. of tuberculosis in children is due to the bovine type of bacillus."

M. J. Rosenau, in a similar communication, states that "up to one-fifth or one-fourth of all cases of tuberculosis in infants and children are associated with the bovine bacillus."

In England, Delépine, from a very careful study of the question, concludes that "it is possible to say without fear of exaggeration that not less than 25 per cent. of the tuberculous children under 5 years of age suffer from infection of bovine origin."

A. P. Mitchell, in a study of 72 cases of cervical adenitis in children, occurring in Edinburgh and its immediate vicinity, found sixty-five cases yielding bovine bacilli and only 7 cases yielding human bacilli. Thirty-five of the bovine cases were in children under 5 years old, and the remaining thirty in children under 12 years old. Of the children 2 years old or under, 84 per cent. had been fed on raw cow's milk.

J. Frazer of Edinburgh, in 100 cases of bone tuberculosis in children, found bovine bacilli in 62 per cent., and human bacilli in 35 per cent. of the cases, while 3 per cent. yielded both types. As indicative of the probable source of infection in the bovine cases, 73 per cent. of these children were under 3 years of age and had been fed unboiled cow's milk. Conversely, of the cases showing a human type infection, 71 per cent. gave a history of exposure to other cases in their families.

Sims-Woodhead and other English investigators report similar findings, although percentages vary in different localities. Edinburgh shows a particularly high percentage of bovine infections. Similarly, in Germany, wherever the subject has been studied by the bacteriologic

method, the percentage of bovine cases has been found to be from 19 to 26.

Orth, to cite but one eminent German authority, believes that at least 10 per cent. of all tuberculosis in children is due to bovine infection, and estimates that there are 200,000 persons in Germany with bovine bacillus infections.

It is clear, then, if we accept the type of bacillus as the criterion of the source of infection, that bovine tuberculosis plays a highly important part in the production of human tuberculosis, particularly those forms of the disease which occur most commonly during childhood, and is by no means a negligible factor as claimed by Koch.

Not all investigators are agreed, however, that the type of bacillus, as so far determined, is a valid criterion of the total amount of bovine infection in man. Von Behring and his followers claim that the bovine bacillus is a very common cause of even pulmonary tuberculosis, maintaining that the infection occurs in very early life from the ingestion of bovine bacilli, which, it has been shown, may pass through the uninjured intestinal mucosa and reach the lungs by way of the mesenteric lymphatics and blood-stream, often leaving no abdominal lesions by which to trace their course. Bacilli so introduced into the body are believed to be capable of prolonged latent existence in the tissues, becoming active under favorable conditions even after many years, and in the meantime changing in type from bovine to human. This view has been strongly supported by Vallée, Calmette and many others, Calmette asserting, in 1905, that a majority of cases of pulmonary infection originated in this way.

In this country, Ravenel has been one of the warmest advocates of the theory of the possibility of this method of infection. He has shown experimentally that infection of the lungs may be so produced, and has, in at least one instance, succeeded in changing a typically human type of culture, by passage through calves, into one showing typical bovine characteristics. He believes that the dearth of direct experimental evidence of such change is due to technical difficulties in the way of inducing artificially and over a sufficient period of time, conditions analogous to those under which the transmutation of type is supposed to occur in the human body, and pertinently points out the fact that if the tubercle bacillus is unable to change its characteristics under variable environments, it therein radically differs from bacteria in general.

Von Eber, also, believes in transmutability of type, and claims to have been able, by passage through cattle, to produce from human cases a virulent type of bovine bacillus (from adults 36 per cent. and from children, 53 per cent.).

Another important question bearing on the problem of change of type arises from the apparently almost exclusive incidence of fatal tuberculosis of bovine origin in children below 5 years of age, and the rapid decline of all forms of bovine tuberculosis infection during the period of late childhood. It seems competent to inquire, since bovine infections constitute, as we have seen, so large a proportion of the tuberculosis of early life, what becomes of the bovine bacilli in those subjects who do not die, many of whom must surely later exhibit other forms of the disease. If bovine bacilli do not change their characteristics with the advance in age of their hosts, it would appear that they ought to be abundant in adults.

Though there exists some actual and much presumptive evidence to warrant a belief in variability of type, however, it must for the present be said that the weight of opinion is to the contrary; but it must also be conceded that, regardless of the ultimate solution of this problem, we have in the already proved statistics of demonstrable bovine infection in children, ample occasion to regard tuberculosis in dairy cattle as a very serious menace.

It is true that this statement is still controverted by some, but it can be shown that their adverse reasoning is, for the most part, based on clinical and not bacteriologic evidence. Thus, Medin, in a report on the autopsy findings in 7,630 children who died at the Stockholm Hospital from 1842 to 1911, during the first year of life, considered that in only 2 per cent of the cases was there evidence of primary intestinal infection, and that in the remaining 98 per cent. the infection was primarily in the lungs. He says in thirty years' experience he has never seen a case of tuberculosis which he could ascribe to the use of milk. Such evidence is fallacious, as no one is at the present time able to differentiate the types of infection clinically.

As bovine bacilli practically always gain access to the human body through the ingestion of contaminated milk or milk products, methods of prophylaxis must be directed toward the eradication of the disease from dairy herds (an economic and biologic problem too vast for more than mention here), but more especially must depend for success largely on measures designed to render milk from even tuberculous animals suitable for dietetic use.

The United States Bureau of Animal Industry estimates that at least from 20 to 30 per cent. of the dairy cows in the United States are tuberculous, and, while in certain areas the percentage is very much higher; these figures are probably fairly indicative of the prevalence of the disease in cattle throughout the civilized world.

Many tuberculous cows expel bacilli with their milk, and in a very much greater proportion, virulent bacilli are found more or less con-

stantly in the intestinal discharges; so manure, as the most common and practically a universal contaminant of milk, is perhaps the chief vehicle for the transmission of tubercle bacilli from cow to baby.

Certified milk, or what may be had in a few cities, an almost equivalent grade of milk, which is produced from efficiently tuberculin-tested cattle, under such rigid conditions of cleanliness as to almost altogether preclude manure contamination, is the only commercial milk which affords reasonable assurances of safety, and it should be obtained for little children whenever possible. Its cost of production is such, however, that it must remain a high-priced milk, beyond the reach of the great bulk of the population, and it cannot, therefore, of itself, have any very appreciable direct influence in the control of the spread of bovine infection to man. Recourse must then be had to methods which will render safe the ordinary grades of market milk. Dairy hygiene, unfortunately, in spite of high development in certain limited districts, is practically everywhere still extremely primitive, and so far as we can now see, ordinary milk, in a fresh state, will indefinitely remain a most dangerous food, the disadvantages of which, in respect to the general supply, can only be obviated by the proper application of pasteurization. This process is now obligatory in some of our large cities for all grades of milk except certified and inspected, and is also quite widely used in the milk trade even where not compulsory, but commercial pasteurization should be considered adequate only when carried out under conditions which assure a fresh and not excessively contaminated supply, heated to the requisite temperature of 60 C. for a period of twenty minutes, quickly cooled and kept iced, delivered early and consumed without delay, for such milk is prone to rapid fermentative changes. It is clear that these conditions can be enforced only by a system of strict and energetic official control, which is as yet impossible of realization in most communities. As at present carried on, pasteurization of market supplies is often worse than useless, because of the inadequacy of the methods used, and the insufficiency of the system of supervision by proper authority; and I am therefore very strongly of the opinion that while we should be unremitting in our advocacy of all possible improvements in dairy hygiene, including compulsory efficient pasteurization, we should, however, for the present teach that the only absolutely safe milk is that which is heated within the home of the consumer. Milk which is brought to just below the boiling-point in the family kitchen will never transmit bovine tuberculosis to the babies of the household; and since we are no longer afraid of the bogey of destroyed "vital principles" or what not in heated milk, knowing that the only "vital principles" in milk when it reaches the consumer are such as are contained in the bodies

of the living and oft-times pathogenic bacteria with which it is contaminated, I am coming more and more to believe that, for infant-feeding, at least, all grades of milk should be so treated. It is, at any rate, imperative that young children should be given raw milk only when known to have been derived from cattle free from tuberculosis.

It is unquestionably our duty as physicians to instruct our patients and the public that bovine tuberculosis is, without giving it undue weight and always keeping it in proper subordination to the larger problem of infection from human sources, a grave menace to human health, but that it is, by the simple expedient of home pasteurization, a disease most easily prevented in man; and as typhoid fever is now coming to be regarded as a reproach to the community in which it occurs, so must this disease become.

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