CLEAN MILK.

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It may seem to some that an explanation should be made in bringing this subject of Clean Milk before the members of this Society. It is, however, in my opinion, a subject well worthy of discussion, for surely the health of the people is a matter for social inquiry, and I hope to show that the provision of clean milk is of the highest importance from the standpoint of health. While milk is a useful but not indispensable article of diet with adults, it is an absolute necessity to infants and young children. Since the cow is, in Ireland, the chief source of our milk, it is with the dangers and difficulties of the use of cow’s milk that I am chiefly concerned.

The milk of the cow differs somewhat in chemical composition from that of the human mother, but it may be so modified as to make it an easily digestible substitute on which a normal infant will grow and thrive. The chief danger involved in using cow’s milk as a food for infants and children and even adults is not in its chemical composition but in the presence in it of bacteria which may cause disease. It is with these bacteria, their source, and the methods used to prevent their presence in milk that my paper to-day deals.

First, perhaps, I should say a few words on bacteria in general. Bacteria or microbes or germs are exceedingly minute vegetable organisms of very simple type. They are present almost everywhere—in the air we breathe and in the water we drink, on the surface and in the interior of our bodies. Since the great pioneer work of Pasteur we know that there are enormous numbers of different types of bacteria. Some of these are harmful, and may cause such diseases as typhoid fever, diphtheria and tuberculosis; some are actually beneficial, as those which enable certain plants to utilise the atmospheric nitrogen for their growth. To one organism we may be indebted for a dangerous attack of pneumonia and to another for the pleasant flavour of the favourite cheese we enjoy at lunch.

The bacteria found in milk may be definitely harmful and disease producing, or harmless, or those which are relatively harmless to the adult but dangerous for young children.
These microbes may gain access to the milk in various ways. It is necessary to point out that milk is a very suitable culture medium for many types, and that the methods of its production makes it very liable to contamination with dirt containing bacteria from human and animal sources. Further, its initial high temperature favours the growth and multiplication of any germs which may be present in it. It is difficult to realise the rate of increase of bacteria, but it has been shown that, under suitable conditions of food and temperature, some bacteria may double in number every half hour, or, in other words, one microbe might in twenty hours have a progeny of one million million.

The three chief sources of dangerous bacteria in milk are:

1. Diseases of the cow.
2. Diseases of the milker or others handling the milk.
3. The addition of dirt, chiefly excreta of the cow, either directly or indirectly to the milk.

The number of diseases which affect both the cow and man is not large. Diphtheria, scarlet fever, and foot and mouth disease may be conveyed to man from cows by milk, but only rarely. By far the most important disease common to both is tuberculosis. There are two chief types of tubercle bacilli—the human and the bovine. The former is alone responsible for tuberculosis of the lungs or consumption, but both may affect other parts of the body and a considerable amount of tuberculosis of the abdomen, the lymphatic glands and bones is due to the bovine type of bacillus. It is probable that an adult consuming milk from a tubercular cow will rarely acquire tuberculosis from this cause, but the child has much less resistance against the bovine type of the disease. A great mass of figures, all proving how widespread are the effects of the bovine type of tubercle bacillus might be given, but this is unnecessary. It is enough to say that about 6 per cent. of all deaths from tuberculosis are due to drinking tubercular milk, and that very many children who escape death are rendered ill and weakened or life-long cripples as a result of consuming such infected milk. It has been estimated that about 25 per cent. of milking cows are suffering from tuberculosis of some part of the body, and that 2 per cent. have tubercular disease of the udder. The former may produce milk containing tubercle bacilli, the latter almost certainly do. The former class, however, often excrete from the intestine large numbers of bacilli, and, unless precautions are taken to secure clean milking, these may get into the milk from the cow's faeces.
I examined a series of Dublin milks, and found out of fifty that four contained living and virulent tubercle bacilli—that is, 8 per cent.

Almost any infectious disease which affects the milkers may be conveyed to the consumers by way of the milk. The chief of these are the enteric or typhoid group of fevers, diphtheria and scarlet fever. A person who has recovered from typhoid fever may become what is called a "typhoid carrier." Such a person, although himself well, is constantly excreting in the urine or faeces virulent typhoid bacilli, which may reach the milk from his hands or clothing. A number of cases of such people who were engaged in the milk trade have been recorded.

While the diseases dealt with up to the present are serious enough they are not, with the exception of tuberculosis, difficult to control. Public health authorities by periodic medical inspection of the workers can usually exclude those suffering from any infectious disease, or, if an epidemic should arise, can trace it to its source, where it can be dealt with. Similarly veterinary inspection of the cows should be able to exclude those whose health renders their milk unsafe for human use.

As regards tuberculosis, all cows with tubercular disease of the udder should be slaughtered, and the milk of no cow with tuberculosis in any part of the body should be used as food for man. Tuberculosis can be diagnosed by tuberculin tests, which should be periodically done in all dairy herds. It is possible by its use to build up and maintain a tubercle-free herd, as Buckley, a practical farmer, has proved in his herd of 100 milk cows. Every cow is tested with tuberculin on its arrival, and only those which do not react are retained. They are again tested at the end of three months, and subsequently every year. From 1907 to 1917 688 tests were made. Only two cows reacted at the second test and none subsequently. The direct examination of milk for tubercle bacilli is also useful, but unfortunately a result cannot be given for about a month.

The chief disease to be put in the third group—that is, due simply to dirt of a non-specific character—is gastritis and enteritis of infants and young children, usually termed, from its most marked symptom, infantile diarrhoea. This is a disease of the summer and autumn months, affecting almost exclusively infants who are not breast fed. While I have to confess that the precise cause is not known, there is no doubt that it is a dirt disease, and it is almost certain that its most common ultimate source is cow's excreta. My own opinion, it is
only an opinion, is that the disease is due to massive doses of bacteria or their toxins, which, taken in small amounts, are relatively harmless. Park and Williams have observed the effects on infants of various types of milk, and have come to the following conclusion: "Over 1,000,000 bacteria per cubic centimetre are certainly deleterious to the average infant. No harm from the bacteria previously existing in recently heated milk was noticed in these observations unless they had amounted to many millions, but in such numbers they are decidedly deleterious." It may therefore be concluded that a milk is likely to produce infantile diarrhoea in proportion to the number of bacteria which it contains. It was starting from this point that I undertook a bacteriological investigation of milks sold in Dublin during a year. In all 100 samples were examined, all of which had been purchased either from shops or carts in the city. The samples were taken in the morning and examined in the laboratory within at most two hours of their collection. The tests made were total number of bacteria, number of lactose fermenting bacilli and number of streptococci per cubic centimetre. The lactose fermenting bacilli and the streptococci are two types of bacteria which, in milk, are derived almost entirely from faecal matter, and are therefore indicators of the amount of manure introduced into the milk. I should say that a cubic centimetre represents about twenty drops.

It was found that the results showed very great variations in the number of bacteria present even in milks examined on the same day. Behind these variations, however, it was obvious that in the warm weather the numbers were much greater than in the cold. In fact, the numbers of bacteria followed closely the temperature of the milk. Without giving too many figures it may be stated that while the average number of bacteria in winter was 600,000 per cubic centimetre, in summer 4,000,000 were present. Lactose fermenting bacilli averaged in winter 700 and in summer 13,000 per cubic centimetre. On many occasions over one million streptococci were found in each cubic centimetre. The most grossly contaminated milk contained over 73 million bacteria in a cubic centimetre. During August, September and October several milks were found to contain a quarter of a million lactose fermenting bacilli in each cubic centimetre. The presence of even one of these in a cubic centimetre is usually sufficient to condemn a water as unfit for human use.

It will scarcely be necessary to give more figures to show how grossly contaminated the milk supply of Dublin is. It should be stated, however, that in other cities where no regula-
tions as to the cleanliness of milk exist the conditions are very similar, little better and little worse. Whence come these enormous numbers of bacteria? Either directly or indirectly the source of the greater number is cow dung. It should be the great aim of the milker to keep the faeces of the cow apart from milk, but usually no effort is made to do so. The cow is ungroomed and unwashed, and dried faeces which adhere to her hair in large masses are loosened during the milking operation and drop into the pail. The milker's hands may or may not be washed before milking, but even if washed are freely used to place the cow in a suitable position and hold the milking stool, which is usually filthy. Wet milking is almost universally practised—that is, the hands are moistened either with saliva or with milk before and during the milking, so that dirt on the milker's hands is washed into the milk. In addition to the filth from the cow, dust and dirt from the milker's clothes and from the air of the shed find an entry into the milk.

I examined various samples of cow's faeces and found in one gramme of old dried manure from the leg of a cow 426 million bacteria. This amount, which would fit on the surface of a sixpenny piece, if added to the milk of one cow would introduce 47 thousand bacteria per cubic centimetre. I fear that this amount is usually exceeded.

Another factor of considerable importance is the cleanliness of the milking pail and other vessels used. Traces of old dried milk may contain very large numbers of bacteria which contaminate the fresh milk.

At every step from cow to user milk is liable, unless carefully guarded, to become still further contaminated either from dust and dirt if left uncovered or from dirty vessels.

Further, it must be stated that the initial bacterial content by no means represented the picture found when the milk has finally reached the baby's bottle, for milk is a good culture medium, and is, at first, at a suitable temperature for growth. The two factors of time and temperature are of the highest importance in determining the final bacterial content of milk. A milk of fairly good quality, containing 6,500 bacteria per cubic centimetre, was divided into three parts, one of which was kept at 46 deg. F., another at 57 deg. F., and the third at 70 deg. F. At the end of 25 hours that kept at 46 deg. contained 29,000 bacteria, that at 57 deg. 124,000, and that at 70 deg. 146 million per cubic centimetre. It is therefore evident that even the purest milk kept at too high a temperature for too long a time will exceed in bacterial content a fresh milk obtained under the most filthy conditions.
The important factors in causing large numbers of bacteria in milk are therefore—

1. The cleanliness of the milking conditions.
2. The cleanliness of the vessels used.
3. The time elapsing between milking and delivery.
4. The temperature of the milk between milking and delivery.

If the milk is to be pure all of these must receive the most careful attention.

No one could realise more thoroughly than I the difficulties the farmer has to contend with in his efforts to produce clean milk. On every side he is faced with myriads of bacteria ready to get into the milk and to multiply in it. But his difficulties should not make him give up the struggle but rather urge him to further efforts to defeat the microscopic enemies of the babies who drink his milk.

Recently I was asked to investigate the conditions under which the milk supply of two Dublin hospitals was produced, and a brief account of these investigations may help to make clear the difficulties in producing pure milk.

In one dairy the cows were housed in a good clean byre, and considerable precautions were taken to secure clean milking. The cows were groomed, the udders and milkers’ hands were washed, and the milkers wore clean white coats. But the cleaning of the pails and churns was badly done, and traces of old dry milk were visible on the interiors. The water which was used to rinse out the vessels was taken from a trough which was used by horses as a drinking trough and also to wash out the dirty buckets from which the cows were washed. A milk churn was rinsed out with sterile water, and this was subsequently found to contain in all 293,000,000 bacteria. This number is probably only part of the bacteria present in this churn, but the effect of these would be to introduce 4,300 bacteria into each cubic centimetre of 15 gallons of milk put in the churn.

Samples of milk were taken at different periods. The first from a milking pail immediately after the milking of one cow contained 6,500 bacteria per cubic centimetre, and may be regarded as fairly satisfactory. The second was the mixed milk taken from a large churn. It contained 21,800 bacteria in each cubic centimetre. The third was the milk as it was delivered to the hospital five and a half hours later. It contained 75,000 bacteria per cubic centimetre. The first sample remained sweet for 76 hours, the second for 54 hours and the third for 40
hours after milking when kept at a constant temperature of 62 degrees F.

In the case of the second farm the cows were milked in a field, and their udders were not washed or cleaned in any way, but the milkers washed their hands. The vessels appeared clean, but a churn which was examined was found to contain 133,500,000 bacteria at least. The milk was poured into the churns, which were exposed to the full heat of the sun on a hot day. The milk was not cooled and remained in the field until it was taken into a dairy in the city, where it was cooled to some extent. Milking lasted from 10.30 to 12.30, and the milk reached the town dairy at 2.30, when its temperature was found to be 88 deg. F. After the slight cooling it received its temperature was only reduced to 80 deg. F., a quite insufficient amount. A number of samples were taken and examined. Two from the milking pails of two milkers were found to show considerable differences—one containing 7,400 and the other 20,800 bacteria per cubic centimetre. Cleanliness of the cows would have eliminated this irregularity and improved the results. Mixed milk from a churn contained in one cubic centimetre 29,000 bacteria. When the mixed milk arrived at the city dairy three and a half hours later it contained 220,000 bacteria, and when it was delivered to the hospital after another delay of two hours the number had reached 398,000 per cubic centimetre. The first milk from the milking pail remained sweet for 72 hours, while that delivered to the hospital soured in 36 hours.

The hide-bound conservative, the class to which many farmers belong; will say that all these things may be true—it would be too much to expect an unqualified assent—but that the milk produced in the usual way was good enough for his father and is good enough for him. It is for his customers to say that it is not good enough for them. He may say further that it is impossible to improve milking conditions and to secure a cleaner milk, and will probably conclude his remarks with an attack on new-fangled nonsense and dark threats of giving up farming. In order to find out how much could be done to get clean milk without elaborate apparatus a thorough bacteriological investigation at a farm was undertaken. The degree of cleanliness here was perhaps a little above the average, but the cows were ungroomed and unwashed. The milker's hand-washing was not at all thorough and was done before the tying up of the cow. At first samples of the milk obtained in the usual way at nine milkings were examined. The average number of bacteria per cubic centimetre in these milks was 79,000. The average number of lactose fermenting bacilli was 102, and the milk became sour to the taste in about 60 hours. Then
certain changes were introduced. The pails were thoroughly cleaned, scalded, and covered with muslin covers until required for use. The long hairs about the udder were clipped. The teats were washed with soap and warm water and dried with a clean cloth. The belly and the insides of the legs were rubbed over with a damp cloth. The milker put on a clean apron, and scrubbed his arms and hands with a brush, soap and warm water, and dried them on a clean cloth. The cover was removed from the pail and the cow milked, the first couple of jets from each teat being rejected. Under these conditions in nine milkings the average number of bacteria per cubic centimetre was 2,570, about one-thirtieth of that in the first series. Lactose fermenting bacilli were found in one cubic centimetre on only two occasions. The milk remained sweet for 185 hours, between seven and eight days—about three times as long as in the first series.

These results show that it is quite possible to instruct the farm labourer in how to produce clean milk. In this experiment the milker had only instruction for a few minutes at a time for four days, and yet the milk which was obtained on the last occasion when he was alone and unaided was almost identical with those obtained when I was present to instruct and direct. The total amount spent on special apparatus did not exceed a few shillings for soap, cloths, brush, and muslin covers.

This experiment, together with many others of various investigators, prove that it is quite possible to produce milk of very good quality if sufficient attention is given to details of cleanliness, without any great expenditure on apparatus.

The next question to be considered is how the public is to obtain a safe food for babies. There appear to be two alternatives. The first is to be content with the milk as it is supplied at present. Since in its raw state it may contain tubercle bacilli and the specific cause of the other diseases together with the unknown cause of infantile diarrhoea, it must be heated sufficiently to kill the majority of the disease-producing organisms. There are several objections to this, the chief of which is that milk so treated is deprived of much of its important food value owing to the destruction of the vitamins, and also that, as shown by the conclusion of Park and Williams, it is not altogether free from danger to infants. It is best to use raw milk, but to do so we must have a pure milk supply.

For some years there has been a scheme in England for the production of pure milk, known as Grade A (certified) milk. This milk is supplied by certain farms, and the necessary regulations are as follows:—The herd must be free from
tuberculosis, as judged by periodic tuberculin tests. The equipment and methods of the farm must be satisfactory. The milk must be cooled and bottled immediately after milking and sold within two days. At no period must it contain more than 30,000 bacteria per cubic centimetre, and no lactose fermenter must be present in one-tenth of a cubic centimetre. Only six of the Dublin milks which I examined contained less than the specified number of bacteria.

The use of certified milk is widespread in the United States, the standards of some cities being very strict—10,000 in Philadelphia for example. In addition to this certification many cities have a minimum standard number of bacteria, no exceeding of which is permitted. In Boston the standard is 500,000, in Milwaukee 250,000, and in Rochester 100,000. In Ireland we have no scheme for the supply of certified milk and no maximum standards, and both are very badly wanted. If Dublin milks were on sale in Boston 48 per cent. of them would have been condemned and their suppliers prosecuted. With us so long as fat is not abstracted and water is not added no offence is committed, although, in my opinion, it is a far more criminal act to sell a solution of manure in milk than a mixture of milk and water. Milk is to-day sold merely as milk, and we know nothing of its cleanliness or whether it is safe to drink. Dirty milk fetches the same price as clean, so why should the farmer bother to produce it clean? Yet if we buy a dozen oranges we require sound fruit and not rotten, and if our breakfast eggs resemble those of Punch's curate we make a fuss about it. In the case of milk, however, what we do not see we do not bother about. If in the morning we find last night's milk sour we blame the heat of the night or thunder, but never the milk supplier.

I would suggest the following requirements for a supply of certified milk for Ireland. They are more lenient than those of England or the United States, but at least they are a beginning. All cows the milk of which is to be certified should be examined periodically by a veterinary surgeon and be negative to the tuberculin test and be otherwise healthy. All workers should be examined at intervals and pronounced free from transmissible disease. The dairy should be suitable for the purpose and be kept clean. The equipment should be of approved design, and facilities for proper cleaning be available. The milk should be cooled immediately after milking, and be sold within 24 hours. No certified milk should contain more than 100,000 bacteria per cubic centimetre, and lactose fermenting bacilli should not be present in 1-25th of a cubic centimetre.
The fulfilment of these requirements would guarantee that certified milk was a safe food for infants and young children.

In addition to this scheme of certification I would suggest the establishment of standards of purity, as judged bacteriologically, just as there are at present standards for fat and solids. I would prohibit the sale of any milk containing more than 2,500,000 bacteria and 5,000 lactose fermenting bacilli per cubic centimetre, and would fine or, better still, imprison the suppliers of such milk. These standards are exceedingly lenient, probably too lenient, and if they are exceeded those responsible have shown a carelessness which is criminal and are not fit to be engaged in the milk trade.

And now I come to the most important part of my paper, and the reason for bringing the subject before the Statistical and Social Inquiry Society. Last year in the City of Dublin 382 babies died from enteritis, and dirty milk was the cause of death in the majority of these. This bare figure gives little idea of the illness of those others who have escaped death. Apart from all feelings of humanity, mere financial expediency would urge that the loss occasioned by this amount of illness should cease.

I have endeavoured and I hope I have succeeded in explaining the dangers of dirty milk and the possibility and practicability of bacteriologically clean milk. You may be tempted to answer me by saying that the remedy for the present unsatisfactory state of affairs rests with the medical profession and the public health authorities. "Am I my brother’s keeper?" It rests, however, with the public, of whom you are a chosen few with a better developed public spirit than the majority. The profession and the authorities are prepared to act if the public is behind them, but without this support they are powerless. If there is a demand for pure milk that demand will be met as all commercial demands are met, and there will be a pure milk supply. What is necessary is a waking from the present apathy on the subject. Therefore I appeal to you on the subject of pure milk in order that the existing dangers to health and life itself, particularly the health and lives of young children, may be averted.