

**Report on an investigation as to the conditions of the cowsheds, dairies
and milk supply : 1909 / A. G. Anderson.**

Contributors

Anderson, A. G.
London School of Hygiene and Tropical Medicine

Publication/Creation

Rochdale : J. & P. Macdonald, 1909.

Persistent URL

<https://wellcomecollection.org/works/r4c4weyy>

Provider

London School of Hygiene and Tropical Medicine

License and attribution

This material has been provided by This material has been provided by
London School of Hygiene & Tropical Medicine Library & Archives Service.
The original may be consulted at London School of Hygiene & Tropical
Medicine Library & Archives Service. where the originals may be consulted.
Conditions of use: it is possible this item is protected by copyright and/or
related rights. You are free to use this item in any way that is permitted by
the copyright and related rights legislation that applies to your use. For other
uses you need to obtain permission from the rights-holder(s).



Wellcome Collection
183 Euston Road
London NW1 2BE UK
T +44 (0)20 7611 8722
E library@wellcomecollection.org
<https://wellcomecollection.org>



Digitized by the Internet Archive
in 2015

<https://archive.org/details/b21355319>

SFG

(p)
SFG.4486
1909

P7402



County Borough of Rochdale.

REPORT

ON AN

Investigation as to the Conditions

OF THE

COWSHEDS, DAIRIES,

AND

MILK SUPPLY.

1909.



A. G. ANDERSON, M.D., D.Sc., M.A., D.P.H.,
Medical Officer of Health.

Rochdale:
J. & P. MACDONALD, 48, YORKSHIRE STREET,
PRINTERS.

Pamphlet Collection



LSHTM Library.

Due date stamped below.

Recallable after One Week
If required by others.

--	--



SFG.4486

(p.)

1909

Preface.

To the Chairman and Members of the Health Committee of the County Borough of Rochdale.

GENTLEMEN,

In accordance with your instructions, I have now the honour to present to you a Report on an investigation as to the conditions of the milk supply of the County Borough of Rochdale. This Report is divided into five sections with four appendices.

In Section I, the cowsheds are divided into three classes, Good, Fair, Bad; and the essential features which form the basis of this classification are fully described.

This is followed by a description and discussion of the general conditions prevailing in and around these cowsheds and dairies; and of the appliances and methods in operation in this district for carrying on the trade of dairy-men and milk vendor; while at the same time these have been fully considered in so far as they are, on the one hand, in conformity with modern requirements for the production of a reasonably pure milk; or on the other hand, militate or even prevent the attainment of this object.

A very full and tabulated description of every cowshed within this Borough will be found in App. A, which forms the ground-work of this Report.

As supplementary and illustrating this Section, App. B contains several sketches representing some of the different types of cowshed in this district; and for the purposes of comparison, App. C shows the plan and cross section of a model cowshed and dairy premises.

Section II introduces the question of milk in relation to health and disease—especially milk-borne diseases.

The first and minor portion discusses the important bearing of a good or bad milk supply on the general health and physique of any community; and especially on that important section—the infantile population.

The bearing of the milk supply on the work of lady health visitors, and the expediency of the expenditure on municipal milk depôts for the pasteurisation and sterilisation of milk, while at the same time not checking the source of pollution at the fountain head—the cowshed—are all briefly considered.

The subject of "summer diarrhoea" in children, and its association with impure food and milk, and filth conditions, falls well within the scope of this Report; and an epitomé of some of the recent bacteriological work has been included.

Then, in a brief historical sketch, the establishment of scarlet fever, diphtheria, and typhoid fever as milk-borne diseases are passed under review; while at the same time bringing into prominence some aetiological factors, and some recent bacteriological work of interest and practical importance, especially regarding "typhoid carriers."

The major part of this section deals with tuberculosis in relation to milk; and in this respect, of first importance are the conclusions issued in 1907, by the last appointed Royal Commission, regarding the identity of human and bovine tuberculosis, and the transmission of the latter to the human subject, especially children, through the medium of tuberculous milk.

These conclusions, and the valuable experimental work by which they have been extended and confirmed by many eminent Continental and British bacteriologists, have been discussed at considerable length. For, it is from the accumulation of such scientific evidence, we now believe that the usually accepted, but not proved, inhalation theory of tuberculosis is no longer tenable, and must be modified; and that tubercular infection through the ingestion of tubercular milk must receive more serious and practical consideration than heretofore.

Much of the experimental work I have divested of its scientific nomenclature, and stated in the language of ordinary every-day life, with the hope that this subject may not only arrest attention, but sustain the interest which the importance of the subject demands.

For, although it is nearly thirty years since the causal bacillus of tuberculosis was discovered, and although year by year our knowledge of the aetiology of this disease has gone on accumulating; this, combined with experience, has taught us that, for the cure of tuberculosis, therapeutics and sanatoria have had as yet only a limited value, that prevention is better than cure, and that this disease is eminently within the domain of preventive medicine: yet, it is a notorious fact that so little has yet been done—so little yet achieved in this very field where preventive medicine is yet destined to achieve one of its greatest triumphs; and the day may come, when cases of tuberculosis will be as rare in England as cases of smallpox are to-day.

Section III deals with filth or dirt in milk; its sources and significance; and the unavoidable and permissible standard in a reasonably pure milk.

Section IV deals with some aspects of the bacteriology of milk; the nature, sources, and significance of the bacteria found in view of the establishment of a bacterial standard for impurities in milk.

Section V contains a short résumé of the chief legislative measures with some suggestions for the control of the milk supply; while App. D, contains the chief provisions of the Milk and Dairies Bill as set forth in its memorandum; and an epitomé of the more important Sections of the Tuberculosis Order, 1909.

In preparing this report it has been my constant aim, while treating of conditions as they actually exist, and as set forth in App. A, not to pursue a destructive policy, but, rather, on the other hand, by appealing to commonsense and reason, to suggest a constructive policy; and if possible to stimulate that spirit of scientific enquiry, which is so essential for the progress of any trade or industry. For I fear the agriculture industry, like many others, has too frequently been false to its own best interests by failing to take advantage of available science.

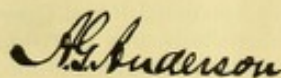
In conclusion, I avail myself of this opportunity to express my appreciation of the uniform kindness and support which I have received from the Chairman and Members of the Health Committee, since taking up my duties here as Medical Officer.

I also desire to acknowledge the work done by Mr. Whiteley and the assistant inspectors in carrying out the work of inspection. The sketches and plan of model dairy are from the pen of Mr. Duncan, assistant inspector, who also gave me considerable assistance in preparing this work for the press; while my colleague, Dr. McMaster, has frequently assisted me with many useful suggestions.

I have the honour to be

Mr. Chairman and Gentlemen,

Your obedient Servant,



Town Hall, September, 1909.

Medical Officer of Health.

Contents.

SECTION I.	Pages.
No. of Dairymen inside the Borough; No of Dairymen outside the Borough; Method of Inspecting and Reporting	3
COWSHEDS.	
Average Occupation, etc.; Division into Groups; External Conditions: Yard Paving; Dung Pits. Cubic Space and Overcrowding; Ventilation and Lighting; Use made of Ventilators; Cleansing of Cowsheds; Bedding; Feeding Tubs.....	3—7
CLEANLINESS OF COWS AND MILKING.	
Cleanliness of Cows; Cleansing of Udder before Milking; the Milker and Cleansing of the Hands; Wet Milking; Milking Machines.....	8—9
WATER SUPPLIES AND DRAINAGE	9—10
DAIRIES AND MILK STORES; CHILLING AND STRAINING OF THE MILK; AND CLEANSING OF VESSELS.	
Construction and Suitability of Dairies and Milk Stores; Milk Storage; Vessel Washing Accommodation, and Appliances; Hot Water Supply; Construction of Vessels; Chilling of Milk; Straining or Filtering the Milk; Notes on Appendix C (Model conditions)	10—13
SECTION II. MILK IN RELATION TO HEALTH AND DISEASES—ESPECIALLY MILK-BORNE DISEASES.	
DISCUSSION ON THE IMPORTANCE OF A PURE MILK SUPPLY: Infant Feeding with Impure Milk; Bottle Feeding and Breast Feeding; Conditions which tend to Contaminate Milk; Health Visitors in Relation to Infant Feeding and Impure Milk; Municipal Milk Depôts: MILK-BORNE DISEASES— Zymotic Enteritis or Summer Diarrhoea, and Infantile Mortality; Summer Diarrhoea and Water Carriage System; Scarlet Fever, Typhoid Fever, and Diphtheria—Historical, Zymotic Epidemics, Typhoid Carriers: TUBERCULOSIS IN RELATION TO MILK— Scientific and Experimental Evidence; Post-mortem Evidence in Relation to Tuberculosis in Children; Prevalence of Tuberculosis in English Milking Herds; Evidence from Statistics of Registrar General; Discussion and Conclusions; Environment in Relation to Health and Disease.....	13—27
SECTION III. DIRT OR FILTH IN MILK.	
SOURCES OF POLLUTION.— Human Sources; Dirty Milk Utensils; Air and Dust; Artificial Pollution; Flies; From the Cow. Significance of Filthy Milk; The Permissible and Unavoidable Sediment Content; Correlation of Filth and Microbes in Milk; Manchester Investigations; The Law and Local Authorities in Relation to the Elimination of Tubercular Cows	27—30

Contents—continued.

SECTION IV. BACTERIAL STANDARD FOR IMPURITIES		
IN MILK.		Pages.
The Bacteria on which the Standard is based; The Permissible and Unavoidable Bacterial Content; Chilling the Milk; Chief Sources of Bacteria in Milk; Yorkshire Investigations, Tables, and Conclusions...		30—34
SECTION V. THE CONTROL OF THE MILK SUPPLY WITH SOME SUGGESTIONS.		
Previous Legislation; Private Enterprise; Education; Prospective Legislation		34—38
INDEX TO APPENDIX A.		39
APPENDIX A.—Tabulated description of Cowsheds		40—56
„	B.—Sketch of Types of Cowsheds in the Borough.....	57
„	C.—Sketch of Model Cowshed and Dairy Premises	58
„	D.—Summary of Milk and Dairies Bill, and Tuberculosis Order, 1909	59—60

Section I.

No. of Farms,
Cowsheds, and
Cows.

This report deals exclusively with the production of milk at farms situated actually within the Borough. The total number of such farms is 75; the total number of cowsheds 141; and the total number of milch cows contained in these at the time of inspection was 1,207.

Dairies outside
the Borough.

There are at present 129 dairy farmers on the Register whose farms are situated outside the Borough, but who bring their milk into the town for sale; and we have reason to believe that there are at least 50 other dairy farmers, outside the Borough, who bring their milk into the town for sale, but who have not registered with the Local Authority of Rochdale in whose district they carry on the trade of milk purveyors.

Method of
Inspecting and
Reporting.

Two Sanitary Inspectors visited each farm and a thorough inspection was made. Their report took the form of detailed answers to a series of questions set out on sheets with which they were supplied; and measurements were made in each case regarding cubic space, lighting, and ventilating areas. These answers have been condensed, summarised and transferred under appropriate headings to form App. A of this report. In doing so great care has been taken to ensure that all the salient features of each cowshed, dairy, and milk store have been fully and accurately represented.

COWSHEDS.

Average
Occupation, etc.

Of the 141 cowsheds mentioned, 4 are either unoccupied or occupied by young stock, leaving a total of 137 cowsheds at present occupied by milch cows. This is equal to an average of 8.81 cows to each cowshed; 16.09 cows to each farm; and 1.8 cowsheds to each farm.

Division into
Groups.

As regards structural conditions and arrangements, it has been found possible to divide the 137 occupied cowsheds into three fairly distinct groups, namely: I, good; II, fair; III, bad. The following short table gives the respective number, the number of cows affected, and the average occupation, in each group:—

OCCUPIED COWSHEDS.			
	No. of Cowsheds.	No. of Cows Affected.	Average No. of Cows to each Cowshed.
Group I—Good	30	400	13.33
„ II—Fair	39	419	10.74
„ III—Bad	68	388	5.70
TOTALS... ..	137	1207	8.81

From this table it will be seen that though one half the total number of cowsheds are classified as "bad," yet the number of cows housed under the worst conditions is less than one-third of the total number.

GROUP I.

The 30 cowsheds of this group are of various types, many of them being of modern construction; some of them being old buildings reconstructed, or renovated, or altered to comply in some degree with modern requirements; and nearly all of them being sufficiently spacious to allow of from 700 to 800 cubic feet of air space for each stall.

Division A.

In the best of them the lighting area equals or exceeds an average of 3 square feet per stall or cow; the windows are so well arranged and distributed that every part and corner of the cowshed is clearly visible; the ventilation is carried out by proper tube inlets and openable windows, and by extraction shafts carried to the ridges of pitched and sloping roofs; the ceilings are formed of well-wrought boards; the floors are of good flags, concrete or blocks, so laid that the cows seldom lie in their excreta, and are well sloped and channelled to properly trapped drain inlets situated outside the cowsheds; the stalls are so arranged that the cows breathe into ventilated passages, and not directly on to the walls; the space at the rear of the stalls is sufficiently wide to prevent any splashing of the walls with cow dung, and where there are two rows of stalls the space between the rear of the animals forms a wide raised gangway along which air may easily circulate; the finished surface of the walls is fairly smooth; there is a good and sufficient water supply in the cowshed itself; and the dung pit is sufficiently removed to prevent entrance of effluvia from it to the cowshed, at any time. See App. B., Sketch I. This cowshed, however, is adjoining the barn.

Division B.

In others of this group some of the best features are absent. Some of the cowsheds, though otherwise well constructed and arranged, have roofs which form the continuation of the sloping roofs of barns, and the outlet ventilating shafts are not carried up to or on a level with the ridge of the higher roofs, as in App. B., Sketch I., but cut short at 2 or 3 feet above the slope of the cowshed roofs; thus rendering the outlet ventilators only operative at certain intervals. In one new and otherwise very good cowshed the top of a wall left open to the rafters of a barn is the only means of outlet ventilation.

Division C.

The worst type in this group are those cowsheds in which the ceilings are rather low, flat, and form the floors of hay lofts above. In one instance at least where other conditions and arrangements are satisfactory, no arrangement had been made for the escape of warm impure air at the ceiling, and the atmosphere was found to be offensive. Many of the ceilings of this type, however, have been cut away immediately over the heads of the cattle for the whole length of the cowsheds and for a width of from 4 to 6 feet; and the hay lofts above have been boarded off with tongued and grooved boards, thus forming chambers into which the respired air from the cows might rise and escape through extraction shafts carried to the ridges of the hay loft roofs, and at the same time protecting the hay from pollution.. See App. B., Sketch 5.

Many of the cowsheds in the last two divisions of Group I have the lighting badly arranged, and whilst one portion is sufficiently lighted, another portion may be in comparative darkness.

GROUP II.

In this group have been placed such cowsheds as do not comply with modern requirements, but which are capable of being improved, without great difficulty, to such an extent as to render them at least equally as good as the worst type in Group I.

Division A.

Most of them are constructed with hay lofts above, and have openings of some kind or other as ventilators into the hay loft itself. Many of them are arranged with the stalls in two rows, the cows facing each other across gangways varying in width from 6 to 11 feet. This arrangement is a bad one, the cows breathe into one another's faces, and should it happen that there is one

tubercular cow it provides a ready means for the dissemination of this disease through the whole herd by means of discharges from the nose and mouth and on coughing. These gangways in some cases are open for their full height up into the hay lofts; and in others are covered at the level of the cowshed ceiling with open-jointed loose boards bearing the hay above. See App. B., Sketch 4. In both cases considerable pollution of the hay takes place as the result of the upward movement of the respired and vitiated air from the cows, and by the settlement of dust from the bedding and cowshed.

Division B.

Others in this group are separate buildings not in very good structural condition as regards walls, floors, ceilings, and drainage; not sufficiently lighted and ventilated; but where the hay is not stored above the cows, as in App. B., Sketch No. 3. An instance of this kind is a cowshed with pitched roof, not underdrawn, and with no means of outlet ventilation except through the joints of the slates; with feeding passage of good width at front of cows, but insufficient space at rear of cows; with good flag floor properly sloped and channelled, but with the windows badly arranged and the light badly distributed.

GROUP III.

This group embraces all those 68 cowsheds which are badly constructed, badly arranged and badly drained; many of which are in their present condition unfit for housing cows and incapable of improvement, unless at great expense and with difficulty.

In most of this class the lighting is very bad, and in many cases there is really no light at all except when the cowshed door stands open. The ventilating arrangements are often very primitive and insufficient, and in more than one case there are no arrangements whatever either for the outlet of foul air or the inlet of fresh air. The floors are badly constructed, the walls are of rough material, the ceilings formed of open jointed boards in a dilapidated condition and forming the floor of the hay loft above. In the most common type the front of the stalls is open to a large barn containing a large volume of cold air which so far from assisting in the proper ventilation of the cowsheds, has a tendency to cool the smaller volume of warm impure air in the cowshed and to cause a back-draught on to the heads of the cattle. See App. B., Sketches 2, 3, 6, and 7.

A brief description of three distinct types in this group of "bad" cowsheds will give a good idea of the conditions as a whole.

No. I Type.—Cows facing wall having openings to barn; openings above heads of cows made up with boards and rough sacking. No means of ventilation except small hit and miss ventilator in door. No light except that borrowed from barn door which is fitted with small sealed window. Space at rear of cows 3ft. 6in. wide. Walls of rough stone on which dust from bedding has lodged. Lower parts of walls along rear and sides caked with dung which has splashed on to them and dried. Floor constructed of flags which are broken and uneven and into the large open joints of which the liquid excrement has percolated. The channel badly laid and badly sloped; no drain whatever; the absorbent nature of the shoddy relied on for the removal of liquid. The floor of the stalls not paved, but covered with a layer of clay into which some of the shoddy has been pressed. No water supply within a reasonable distance of cowshed. Dung pit within 3 yards of cowshed door and not drained. Cowshed much overcrowded. Ceiling dilapidated and very low.

No. II Type.—Cows facing wall without any openings. No means of ventilation; all crevices stuffed up with hay or straw; opening under door blocked outside with cow dung. No light except small pane of obscured glass fixed in door. Walls of rough stone and in a dilapidated condition, holding dust and splashings of cow dung. Space at rear of cows about 4 feet. Floor constructed of soft absorbent bricks; part

of floor formed as channel to an untrapped drain inlet inside cowshed. Ceiling dilapidated and very low. Cowshed much overcrowded. Bed of stalls formed of boards laid on clay. No water supply within reasonable distance. Dung pit adjoining and communicating with cowshed.

No. III Type.—Constructed entirely of wood not wrought or smoothed. Cows facing and breathing directly on to the rough wood walls. No means of ventilation. Lighted by one small window. Floor of soft bricks; no proper channel; drains out on to field. Surface of walls and roof very dusty. Overcrowded. No water supply near. Dung pit almost adjoining.

External
Conditions.

The external conditions and arrangements are generally unsatisfactory. Particulars of construction of yard surfaces and of the drainage and its outlets, also the situation and construction of the dung pits, will be found in the detailed summary:

Yard Paving.

Many of the yards are unpaved and undrained; and many are paved with defective and unevenly laid cobble stones. Such conditions as these render thorough cleansing and freeing from refuse almost an impossibility. In a few cases, however, the yard surfaces are paved with grit setts, well laid and sloped to sufficient and suitable drain inlets, and are kept clean.

Dung Pits.

With very few exceptions no proper arrangements have been made at the farms within this Borough for the reception of the dung and sweepings from the cowsheds. In only some of the most recently constructed are the floors and walls constructed of impervious material. Every dung pit should be entirely disconnected and at a suitable distance from the cowshed and milk store. It should have the floor and walls of impervious material, and it should be connected to a drain or cesspool by gully trap placed outside the pit, and towards which the floor should slope. (See App. C). One generally finds that the dung is thrown out into a corner of the yard or curtilage without much regard to the distance from the cowshed or living premises; and the liquid manure instead of being properly drained away, lodges on the uneven surface of the yard, or percolates into the soil or open joints of the pavement.

Cubic Space and
Overcrowding.

Of the 137 occupied cowsheds, 72 were found to be overcrowded. In adjudging whether a cowshed is overcrowded or not, the cubic space available for each cow has not been the only consideration. The minimum cubic space considered to be allowable, varies with different authorities from 600 to 800 feet per cow, and during this inspection all cowsheds having less than 600 cubic feet of air space per cow have been classed as overcrowded, while at the same time those cowsheds having more than 600 and less than 800 cubic feet per cow, but not having sufficient means of ventilation, have also been classed as overcrowded. Where, however, the means of ventilation have been good, and in reasonable use, a minimum of 600 cubic feet has been considered satisfactory. Cubic space, however, is not the only and probably not the most important consideration; without an efficient system of ventilation and good lighting, and plenty of floor space to secure cleanliness, cubic space has a limited value. Speaking generally, the means provided for the ventilation and lighting of the cowsheds is neither good nor sufficient, except in the more recently constructed or reconstructed premises; and, the peculiar construction of a large number of the premises renders their improvement in this respect a matter of difficulty and expense. In some cowsheds no recognised means of ventilation whatever have been provided; and in others such means have been provided, but without any regard to suitability of position, or to any consideration of the relative capacities of inlet and outlet areas. A hole in the wall, or an unglazed window pane, has been pointed out to the inspectors as "the ventilator." Casual openings let into the wall are not satisfactory on account of their irregularity of size and action, and the ease with which they can be plugged up. It is very disappointing when even the means which have been provided for ventilation in the cowsheds in

Ventilation and
Lighting.

Use made of
Ventilators.

this Borough, are not reasonably used; in fact it was the rule to find all the available means, and every opening or crevice likely to assist to any extent in the renewal of the air, absolutely blocked up; windows made to open were swollen fast in their frames, wall inlets were stuffed with hay, straw or sacking, and even the openings in badly fitting doors were stuffed up. The traditional conservatism of farmers as regards ventilation and lighting is very interesting. Many farmers still believe in the virtue of darkness, in which condition the cows are supposed to feed better and produce more milk. Such fallacious notions can only be dispelled by wider study, and by contrast with the experimental results obtained from cows kept in well ventilated and well-lighted cowsheds. A cowshed cannot be considered efficiently lighted, unless the light can penetrate to every part, and this can only be attained by the proper disposition of windows in the side walls or roofs or both, and each cow should be allowed 3 square feet of window space. The farmer has yet to learn that light is one of our best disinfectants and a preventive of many diseases, especially Tuberculosis, and further, that darkness, dirt, and disease invariably lurk together. To secure efficient ventilation, where a sufficient supply of fresh air is constantly supplied without causing a draught, many devices in recent years have been suggested, and are too numerous to discuss in this Report. But it may be safely said that the simplest methods are invariably the best, and further that no system, however simple or elaborate, can be of any good unless used. The side and end windows should open inwards at the top on bottom hinges, so as to be utilised for inlet ventilators, and in this way to disperse the air entering as much as possible. The extraction of the impure air is usually best obtained by the proper arrangement of shafts and extracting cowl, fixed in the centre of the roof when the walls are unobstructed, but when one wall is obstructed, as near this wall as possible.

Cleansing of
Cowsheds.

Great improvement is necessary before anything like a reasonable standard of cleanliness in the cowsheds can be assured. With the exception of the removal of the dung from the channels, twice each day, and the bi-annual lime-washing of the walls, and in some instances the ceilings also, no proper regard is paid, in the majority of cases, to the efficient cleansing of the cowshed itself. The consequence is that many of the walls, partitions, and fittings bear accumulations of filth, principally dung splashings and dust, which proves more and more difficult to remove the longer it is allowed to remain. The floors, too, particularly the portions used as gangways at the rear of the channels, are not kept sufficiently clean; in many cases they exhibit no signs of having been thoroughly cleansed or swilled with water for a considerable period.

Bedding.

Various materials are used for bedding the cows, among them being straw, moss litter, saw-dust, refuse from the hay chopping machine, and straw previously used in the stable (a very objectionable and dangerous material). But by far the larger number of the cows are bedded on shoddy—a kind of waste material obtained from the cotton-waste manufactories in this town. Whilst recognising the cheapness of shoddy, the convenience of obtaining it, and its usefulness in the absorption of liquid manure in the cowsheds, it is at the same time a very light and fluffy material; and when spread beneath the cow in a thin layer as is usually done, it is very readily displaced by the cow and by every movement in the cowshed, and is thus liable to cause a considerable amount of dust, which is very undesirable in a cowshed. To obviate this there are many devices which could readily be adopted; such as mixing it with sawdust or moss litter; or damping it slightly with a watering can; or a thick layer of shoddy might be put down and a layer of sawdust or moss litter or straw, etc., on the top of it. This would require more shoddy, but at the same time it would provide a better bed for the cows.

Feeding Tubs.

In only one cowshed within the Borough were trough mangers fixed in the stalls themselves, and these were not in use. The custom is to feed the animals from loose tubs, sometimes of oak, sometimes of galvanized iron, and

in a few instances of soft wood, such as is used in the making of margarine tubs. Provided a loose feeding tub is constructed of impervious, smooth material, and so as to be easily cleansed, and providing great care is exercised in its cleansing and storing, little objection can be made; but when no systematic cleansing of the wood tubs is carried out as is the case in some of our cowsheds, the danger of spreading infection from a diseased cow owing to interchange of the tubs cannot be anything but great. In this way one Tubercular cow in a cowshed may infect the whole herd by the interchange of feeding tubs.

CLEANLINESS OF COWS; AND MILKING.

Cleanliness of Cows.

In some cases the cows were found to be clean both as regards the hides, the udders, and the teats, and it is desired to give all due credit to those farmers who have adopted a daily grooming of the cows, and a systematic cleansing of the udders and teats, with clean cloths before each milking. It is, however, regrettable that in the great majority of instances, the cows were only fairly clean, and showed no signs of such careful and systematic attention. In the worst cases found, a reprehensible neglect in this respect was apparent—the hides were covered with dust, the udders were dirty, and the hind quarters often caked with dung only removable by tearing off the hair of the hide itself.

Cleansing of Udder before Milking.

On enquiry during inspection the following replies were elicited—see App. A:—

I—Rubbing the udder with hands of milker	30
II—Rubbing the udder with a dry cloth	25
III—Brushing the udder	11
IV—Washing with warm water	1
No attempt at cleansing stated	8

All these alleged methods of cleansing the udder, unless carried out intelligently, with a clear understanding and earnest desire to attain the end in view, may be, and often are, an additional source of milk pollution. During the inspection, and at other visits, when one of those who adopt Method I. was asked to show how he carried out his method, the milker sat down and usually placed the pail beneath the udder, which he rubbed with both hands and then proceeded to milk. It never seemed to occur to him that in this way the milk pail had received a considerable amount of dust and detachable manure, which it might have escaped if there had been no rubbing. Further, by such procedure it is of little importance whether the hands are previously washed or not. Likewise, the wiping of several udders with the same cloth—Method II—and the cloth itself unless frequently and thoroughly cleaned, both present many risks. Method III has much to recommend it, when the cows are groomed and the udders cleaned and brushed regularly and at the proper time. The washing of the udder—Method IV—is not practised in this district. The farmers think that it would cause Mastitis and decrease the milk secretion. In this there is some truth when cows are kept under abnormal conditions and the process not properly carried out. But that it neither causes the one nor the other is proved by the experimental evidence of many dairy companies and dairymen. Any method may be considered so far satisfactory just in proportion as it is intelligently carried out to attain the end in view; but when one finds that both the method and the practice combine to defeat the object in view, we must conclude that this very important matter does not receive any very serious nor intelligent consideration.

The Milker and Cleansing of Hands.

It is very difficult to estimate to what extent the thorough washing of the hands before milking is observed; but it is to be hoped that the great majority carry it out more or less, however imperfectly. Although the answer given to this question is always in the affirmative, the Dairies' Inspector informs me that occasionally he meets with cases, when the hands of the milkers are so filthy, that he stops the milking until the hands have been thoroughly

scrubbed and washed. Hence, one must be to a certain extent guided by some circumstantial evidence and by the observations made by the inspectors at times of milking; and, it is very significant and disappointing to find, that no appliances for washing and cleansing the hands are actually within, or sufficiently near, any of the cowsheds.* It is thus at least evident that the practice of washing the hands after milking each cow, as carried out by the cleanest of milkers in many districts, is not attempted here. One regrets to still find that not infrequently the milker comes from the field or farm yard and sits down to milk with hands soiled and unwashed; or, if washed, done imperfectly. In no case is an over-all or white clean blouse used, although these would prevent a great deal of contamination of the milk from often dust-laden and infectious garments. Gross cases are still reported, where the milker is seen to blow his nose with his fingers and wipe them on his dirty sleeve or trousers, or spit on his hands and rub them before going on milking. But it is to be hoped such instances are becoming rare. In this respect one regrets the passing of the milk-maid. Her tidy clean appearance with sleeves folded up and hands and arms clean were always at least some guarantee of cleanliness.

Wet Milking.

Wet milking is a very reprehensible and filthy process and should never be allowed. No dirt is so difficult to remove from milk as that which enters in a liquid or semi-liquid form. It is often disgusting to look at, when teats are covered with excreta and the hands not too clean; they often look as if dipped in treacle. Further, this process is liable to be a fertile source of contamination of the milk by the transference of any infectious matter, not only from the teats, but especially from the hands of the milker. Each time a film of milk is left on the teats in which germs thrive and multiply, and at next milking these are removed and washed into the milk. During the winter months this process is often detected by the ulcerated and excoriated condition of the teats.

Milking Machines.

In recent years these have been introduced. But, while they save labour and do the milking more completely, and in theory should attain that desirable ideal of clean milking, as yet they possess several drawbacks and are not in general use. The apparatus is complicated, difficult to clean, and expensive.

WATER SUPPLIES AND DRAINAGE.

Water Supplies.

Of the 75 farms reported on, 38, or about one half the number, are provided with Town's water, supplied from the mains either of the Rochdale Corporation or of the Heywood and Middleton Water Board. The supplies to the remaining farms consist chiefly of spring water collected in wells, and either laid on in pipes to various parts of the premises and gravitating thereto, or pumped into some receptacle from which it is drawn when required. Some of the supplies are from surface or shallow wells, and some others are simply from running streams liable to pollution at any time. In the majority of cases the supply is abundant, though very seldom laid on so as to be as convenient as it ought to be. The experience of the past has frequently demonstrated the dangers of disease and epidemics from a water supply which is not above suspicion of contamination. When any other than Town's water is used it ought to be examined before use. The water supply should be abundant and laid on under pressure to the different buildings—to the boiler house, milk vessel scalding house, feeding house, cowshed, etc. In the cowshed the water should be carried from the main or from a cistern in front of the stalls, with branch pipes passing off to each cow's trough, so that a continuous supply is maintained and the cow does not depend on fortuitous circumstances for a drink of water. A hose attachment is also necessary within the cowshed for flushing purposes. In very few of the cowsheds within the Borough is there a sufficient supply within the cowshed for cleansing purposes, and in the great majority of cases there is no supply within the cowshed at all.

Drainage.

In only 4 or 5 cases are the drainage systems on the farms connected with the public sewers, and these systems properly trapped, ventilated and intercepted. In the majority of cases the farms are not so situated as to render the sewer

available, and consequently other means of disposal have been resorted to. Cesspools and cess-tanks of varying, and often excessive capacity, but in no case with impermeable floor and walls, form the completion of most of the drainage systems. In many instances these tanks are provided with overflow arrangements, which discharge the surplus sewage on to the surface of the land. But as there appears to be no systematic and periodical emptying and cleansing of these receptacles, and the sewage is allowed to overflow for long periods, it is difficult to see any great advantage in this arrangement over the primitive and objectionable method, obtaining at about a dozen of the farms, of turning the sewage directly on to the land or into streams. The disadvantages of, and even danger from, this last-mentioned practice, especially at such places as depend upon shallow wells and surface water for their water supply, is very obvious. The liquid manure, which may be both bovine and human, percolating through the soil, often readily finds access to surface water supplies and wells, and may contaminate the water, which in turn is being used for dairy purposes may readily contaminate the milk. In this way a vicious circle of infection may become established. Many sporadic outbreaks and severe epidemics have now been traced to this cause, and Rochdale provides an example—in September, 1880, Dr. J. Henry, Medical Officer of Health, described an outbreak of Typhoid Fever due to the pollution of the milk by water from a defective well. The excreta from a case of Typhoid in the dairy farm house was thrown into a leaky cesspool and from this cesspool the dip of the soil inclined towards the farm well. An epidemic of Typhoid broke out a fortnight after this Typhoid case, and the incidence of the disease fell on those using the milk from this farm. There were 35 cases, and 26 of these were drinkers of the suspected milk, or 74 per cent. of the total cases, and there were 9 deaths. There was also evidence to show that besides being used for dairy purposes, the water from this well was probably used to adulterate the milk.

Drain inlets were found inside, in at least 25 per cent. of the cowsheds; the majority of these inlets are trapped, but in several instances they form simply an upper portion of an old brick or stone drain, with no means whatever for the prevention of the entrance into the cowshed of effluvia from these drains.

Of the remaining 75 per cent. of the cowsheds, several have no drain inlets at all, the absorbent nature of the shoddy bedding being relied upon for the removal of liquid manure. Most of them, however, are provided with trapped inlets outside the cowshed, and the floors of the cowsheds are sloped to the inlets. In some cases, where alterations have recently been carried out, or the drains have been reconstructed, all the drainage arrangements are on modern and sanitary principles.

DAIRIES AND MILK STORES; THE CHILLING AND STRAINING OF THE MILK; AND THE CLEANSING OF VESSELS.

To fully understand the great lack of suitable accommodation which prevails in respect of dairy houses and milk stores at the farms in this Borough, it must be borne in mind that the farmers here are not to any extent really dairy farmers, but are what are known as "milk-kitters," that is, persons who immediately transfer the milk produced, to the kits or metal vessels from which the milk is supplied to customers in the town. In many cases, indeed, the milk never enters the dairy at all, but is strained or sieved inside or close to the cowshed, from where the cans are loaded into the milk float ready for delivery. In such cases the only milk stored is that which is left over after the round is finished, and which may, or may not, be mixed with the next consignment of milk to the town.

Construction and
suitability of
Dairies and
Milk Stores.

There are no proper and suitably placed dairies or milk stores. Almost without exception the places used as such are part of the dwelling-house and communicate with the living rooms occupied by the farmer and his family.

Milk Storage.

The place used as a milk store is generally a dark and badly ventilated cellar under the kitchen, not often in good repair, and not infrequently containing an inlet (either trapped or untrapped) to a drain. The vessels used for the storing of the milk are generally wide open-topped glazed earthenware mugs, and very little attempt is made to prevent the possible entrance of dust to the milk during storage.

Vessel Washing Accommodation and Appliances.

The rooms in which the vessels are washed and stored until required, are, on the whole, very badly situated, ill-adapted, and not at all commodious. In about 90 per cent. the vessel washing is carried on in rooms attached to the house and used both as sculleries and pantries, and for the washing of the family linen. In a few instances the kitchen or living room itself is the only available room for living, washing, sieving of milk, and cleansing of vessels. Such conditions as here described should not be permitted. They are a direct contravention of all sanitary principles and Bye-Laws which govern such matters. If there is any possibility of contamination or infection of the milk, such conditions provide every facility for such to take place. No dairy farm is now considered properly equipped, nor the business properly conducted, unless the milk store and the house in which the milk vessels are cleansed and scalded or steamed are both entirely disconnected from the cowshed; and have no communication with living rooms by doors, stairs, passages or windows. The privy, midden, drain or water-closet should not ventilate into either milk store or scalding house, and from which they should be sufficiently removed. (See App. C).

Hot Water Supply.

As regards the supply of hot water for purposes of cleansing and sterilising the vessels, it can only be said that it is neither adequate nor convenient; a side boiler of small capacity forming a portion of the kitchen fire-range, or a kettle placed on a kitchen fire, cannot be expected to supply sufficient boiling water to ensure the cleansing of the large number of vessels used on an average farm. The usual procedure is to pour into a large milk kit or can a small quantity of boiling water which is suddenly cooled and which becomes tepid before it reaches the bottom. Consequently, the vessels can never be either scalded efficiently or in such a manner as to destroy Bacteria. Further, such inadequate arrangements and irregular methods nearly always lead to great carelessness, and one has no hesitation in saying that all milk vessels treated in this way are swarming with Bacteria and are a great source of milk pollution. In a recent investigation Dr. Orr took four cans which had been "scalded" as it is carried out by Yorkshire farmers, and were just ready to receive fresh milk. He poured about 6 tablespoonfuls of pure sterile water into each, and after rinsing removed from each can 1 c.c. (= 15 drops), and estimated the number of Bacteria. These numbered 48,000; 2,325,000; 19,960,000; and 605,000 per c.c. (or in each 15 drops). In the first case with a low count, the farmer filled his cans with actually boiling water containing soda, and allowed them to steep for half an hour. Vessel scalding even when done properly is not sufficient, but as ordinarily conducted is useless. Every dairy farm ought to have a high-pressure steam boiler, and all milk vessels sterilised by steam. By this means only can milk vessels be rendered Bacteria-free. All apparatus in the milk vessel cleansing house—boiler, steam chests, sinks, slopstones, etc., should be entirely reserved for this and no other purpose. No family linen, utensils, nor eatables, nor any articles connected with the household should enter this room. (See App. C).

Construction of Vessels.

Many of the large kits are of good construction, being provided with double-lid arrangements—an effectual method of preventing contamination of the milk by dust during transit; and also with grooved concave bottoms allowing of proper draining or dripping. Detachable and accessible taps are used for the drawing off of the milk; the old objectionable method of lading out with a measuring can being done away with. Unfortunately some of these kit cans contain badly fixed brass measuring or gauge strips, behind which grease and sediment lodge and are difficult to remove. When such strips must be fitted inside these vessels, the openings should be carefully soldered. In the

"head-can" used for the collection of milk in the cowshed is a fixed metal sieve which is very objectionable. It cannot be properly cleaned unless the vessel is steamed; and the extent of pollution which it carries is best realised when it is removed for renewal. These sieves should not be fixed to the cans. The milking pails used are of tinned iron, galvanised iron, or enamelled iron, generally specially made for the purpose, but sometimes being ordinary buckets used exclusively for the purpose. The chief aim should be to provide vessels as free as possible from nicks and crevices, and with all parts readily accessible and easily cleansable.

Chilling of Milk.

In only 4 farms were any special means of cooling the milk adopted, and in two of these the apparatus was not in use. In no case, however, was the apparatus fixed in a suitable place; in one instance it was attached to the wall of the cowshed, only a few yards from a cow's tail. Although the cooling of the milk to 40-50°F. immediately after milking to inhibit the growth of Bacteria is of the highest importance; yet, if not properly understood and properly carried out, it may also become a great source of further contamination. During the process a large milk surface is exposed when passing over the cooler, and when the cooler is not in use its surface is also exposed and liable to contamination, which later is washed into the milk when next the milk passes over its surface. The extent of contamination will depend on the Bacterial content of the air which is greatest in the cowshed. Therefore, no cooler should be in a cowshed, but adjacent in a clean room, and when not in use should be carefully covered.

Chilling by placing the cans in running water or even iced water are not satisfactory—on account of the bulk of milk the cooling is not equable and it takes longer time. One of the best forms of cooler on the market is the "Lawrence." It is simple, cheap, and efficient.

Straining or Filtering the Milk.

This process becomes necessary through want of cleanliness. The method of passing the milk through one or more metal gauze sieves is the one most prevalent, though in many cases muslin cloths are used in addition. Many of these metal sieves or strainers are so constructed as to be difficult to get thoroughly clean with ordinary methods of washing, and some of them were even found to be out of repair and altogether useless for straining purposes. There is little excuse for the use of uncleanable strainers. There is now on the market a vessel stamped out of a single sheet of metal and with detachable and easily cleansable sieves, and which is sufficiently cheap to be within the reach of the farmer. One of the best forms of filter, the "Ufax," in which cotton wool is utilised as the chief filtering medium, is not in use in this district; although it has been proved to be at least 6 times more efficient than muslin and wire gauze.

Many dairymen appear to cherish the notion that, no matter what takes place before, after straining we have a pure milk; and fail to appreciate the truth that some part of everything which enters the milk, especially Bacteria, will pass through the strainer—the grosser parts are only kept back. Such convenient and pleasing deception can only be dispelled by education and a deeper sense of responsibility.

Appendix C.

In App. C to this Report is given the plan and cross section of a model cowshed and dairy premises. A detailed description is omitted, as the general plan that should be followed as well as the disposition of all the parts is sufficiently evident. Such an arrangement provides the best conditions:—(1) for the effective lighting, ventilation, cleansing, drainage, and water supplies; (2) for securing the cleanliness of milk vessels and milk stores; (3) for straining and chilling the milk; (4) for preventing infection and any contamination of the milk. Under such a scheme most of the disadvantages and serious defects in dairy-working as it is generally carried on in this district, and which has been so frequently adverted to and described in the preceding pages, would disappear. Not only could the business be carried on

with much less labour, but with greater pleasure and greater profit. We have here such conditions as admit, and are conducive to the production, of a reasonably pure milk, and without which even the efforts of the cleanly disposed will be largely frustrated.

Regarding some of the dimensions given in the cross section there is some slight difference of opinion, especially as regards the manure channel and length of cowstall. The aim is to have the stall of just such length that the cows' hind feet stand on the edge of the channel. The stall is often too long and then the excrement instead of being discharged into the channel, falls on the stall, dirtying the cows' hindquarters and udder when she lies down. The manure channel should be about 2ft 6in. in width and 6in. in depth. It is frequently found of such construction that the liquid manure becomes dammed back by solid excrement. The tail becomes besmeared, and then in turn the cow's body as well as the bodies of her neighbours and those who feed and milk. Experience shows that a good working arrangement in cross section, for feeding passage, feeding trough and stall, channel and gangway, is 4 feet, 1½ feet and 6 feet, 2 feet and 5 feet respectively. There should also be rails in front to prevent the cows reaching over into the feeding passage. With such general arrangements very little is required to keep the cows clean. They always lie well on the bed, and soon begin to appreciate that it is more comfortable to lie clean than in such a way as to have their hindquarters lying in dung. The channel should slope transversely away from the cows as well as in length, and the liquid therein be conveyed through the external wall and discharged over a gully trap, which in turn is connected with a drain or to a tank situated in a field sufficiently far removed from the dairy. The tank should be watertight, provided with a sludge pump and emptied regularly on to the land. The floor should always be formed of cement concrete, smooth but grooved so as to afford a foothold for the animals. Also the walls should be rendered smooth by cement to their full height or at least to a height of 6 feet by cement or glazed bricks. If they are rough then they become splashed and caked with excreta and cannot be kept clean. The stalls in this plan are represented as single. We are now aware that Tuberculosis spreads rapidly among dairy herds by contagion; and therefore in every new cowshed a separate stall and glazed earthenware feeding trough should be provided for each cow, in order to prevent as far as possible the propagation of Tuberculosis. Then in every cowshed there ought to be sufficient and convenient arrangements for the washing of the hands, and an adjacent room for straining and cooling the milk. Some other features which should obtain and which have been adverted to are represented in the model plan.

Section II.

MILK IN RELATION TO HEALTH AND DISEASE — ESPECIALLY MILK-BORNE DISEASES.

Discussion on
the Importance
of a Pure Milk
Supply.

It would be superfluous at this time of day to emphasize the importance to any community of a pure milk supply. So universally is this recognised that no department in public health work, has, in recent years, received more consideration. The medical man, the chemist, and especially the bacteriologist has shown that milk is a foodstuff potential for great good or for great evil.

Infant Feeding
with Impure
Milk.

While milk forms a large part of the diet of every member of the community, and often in the case of infants and invalids the only food, there is no one who does not benefit from a pure milk supply. On the other hand, with an impure milk supply there is no one who does not suffer; and no section of our population is affected more deeply and responds more readily to either the one condition or the other than our infantile population. More than half the infants born in Rochdale at the present time are bottle fed; and our experience here is just as elsewhere, that from various causes the number is yearly increasing. These infants depend entirely on cow's milk from the very first, and during the most active period of growth, to lay the physical foundations on which the superstructures of the future men and women are to be raised. Hence, it may be said, that this important question of the milk

supply combined with infant feeding and nursing, lies at the heart and core of the cause of our so-called physical degeneration and the decadence of the English race, about which there is so much at the present moment written and spoken. For, if the foundation is not well laid in infancy, it can never be in later life; and the finished structure of the man or woman if not stunted and dwarfed for life, never reaches its full development.

Then when we compare the mortality among bottle fed with breast fed infants, we find that on an average for every death amongst the latter there are three to five deaths amongst the former. To explain this difference we have to consider the bacteriology of our milk supplies. The breast fed infant receives its milk, as Nature intended it to be, pure and germ-free. Whereas its less fortunate brother, the bottle fed infant, receives its milk impure, germ-laden and often poisonous. This is a serious reflection, but its truth is only too evident when one contemplates the general conditions under which the milk is produced and manipulated. With the majority of farmers and dairymen cleanliness in the scientific sense, and such as is required to produce reasonably pure milk, is not understood. With many it is not even considered. With some it is ignored. One has only to picture what is happening during the process of milking in a badly arranged, badly constructed, ill-ventilated, ill-lighted, filthy cowshed, with the air foul and oppressive and the dung pit adjacent or a few feet from the door. Where the cows are seldom or never groomed, and their bodies, especially the hind quarters and udders, covered with dust and their own excreta. Where appliances for the washing of hands are not to be seen, and the milkers returning from all kinds of work may, with no over-all or clean blouse, and with hands washed or unwashed, sit down to milk into vessels, which for the want of steaming or adequate scalding, are teeming with bacteria. Everywhere throughout the whole process, from the cowshed, from the cow, from the milker, and from the utensils, the milk receives repeated additions of visible grosser filth and the more dangerous invisible pathogenic microbes, which lurk everywhere where filth abounds. The microbes once in the milk nothing at the farm can separate. The finest filter or strainer only removes the grosser filth, but not the microbes. A regiment of these could pass through the smallest pores of the finest milk strainer. The microbes now thrive and multiply rapidly in the milk, and the products of their activity bring about those changes which are spoken of as "milk going wrong," "becoming sour and curdling," etc., while there are other changes far more delicate and subtle, concerned in the production of colours, flavours and toxins.

Health Visitors
in Relation to
Infant Feeding
and Impure
Milk.

Health authorities in nearly all towns and counties are now appointing lady health visitors, and in many places their work is supplemented by a staff of voluntary lady workers. The duties of these are chiefly to advise mothers regarding the nursing and feeding of their children, but it is very evident that much of their work is frustrated and can never reach its full fruition while the milk about which they advise is not above suspicion. Many health authorities, recognising this anomaly and the difficulty of obtaining a pure milk supply, have established municipal milk depôts for sterilising the milk, and as far as can be learned from available and comparable statistics, the results are very encouraging. Very few infants fed on depôt milk suffer from infantile diarrhoea. But experience has shown that many circumstances militate against the permanent success of such institutions. There is the initial expense and maintenance, and it is difficult in so many cases to get people to attend regularly once or twice a day for the milk. Further, such institutions are a recognition and palliation of culpable filth, and at best they can only be considered as temporary expedients, while the larger and more logical ideal of a pure milk supply is constantly held in view.

The teaching of bacteriology shows clearly that the great source of contamination is the cowshed, the cow, the milker, and the utensils, and the only reasonable and logical solution is to remove the evil at its source by the establishment of a higher standard of cleanliness.

MILK-BORNE DISEASES.

From the point of view of preventive medicine, and as more widely affecting all sections of the community, we have now to consider (1) the chief milk-borne zymotic diseases—zymotic enteritis, scarlet fever, typhoid fever, and diphtheria; (2) tuberculosis in relation to milk.

ZYMOTIC ENTERITIS.

Summer
Diarrhoea and
Infantile
Mortality.

One of the most fatal of infantile diseases is "Summer diarrhoea"—epidemic or zymotic enteritis. It causes a mortality of about 25 per 1,000 births during the first year of life, and is notoriously greatest amongst the urban poor and bottle fed infants.

This is pre-eminently a filth disease associated with overcrowding, want of ventilation and light, want of cleanliness, foul air emanations from any filth, and all such conditions as contribute to the contamination or excremental pollution of food and milk. This may occur readily enough during the process of milking and handling the milk, or it may occur readily enough when the milk is stored in small overcrowded ill-kept houses. It may also occur indirectly by the fouling of food and milk by the feet of flies and various other agencies. The conditions most favourable for this last mode of infection are in and around houses, where the yards and courts are unpaved or badly paved and drained, where the system of removal of sewage allows of the accumulations of filth; and especially if the soil is loose and porous or "made up" and consequently polluted with excrementitious and decaying organic matter. In such soil, sewage and intestinal bacteria abound, and as opportunists they wait until the soil, temperature, moisture, etc., are favourable for their multiplication and dissemination, as occurs during the hot and dry months of summer, when they get abroad, air-borne, and by various means, to poison food, especially milk.

Although in recent years a great deal of valuable work has been done on the bacteriology of epidemic diarrhoea, and although most observers are agreed that the disease is of bacterial origin, and several different micro-organisms have now been isolated from the excreta of patients during several epidemics of summer diarrhoea, it appears that we are not yet in a position to fix on any one of these as the causal micro-organism. Klein has investigated the cause of many such epidemics and describes a bacillus—the bacillus enteritidis sporogenes—which he frequently isolated from the evacuations of patients in cases of infantile and summer diarrhoea; and some of these outbreaks were undoubtedly due to the ingestion of polluted milk, from which also the bacillus was isolated.

More recently during the past four years Morgan and others working in the Lister Institute have made an extended investigation of this disease, and have found in the stools and bowel one bacillus—Morgan's No. 1 Bacillus—to predominate in frequency over all other pathogenic micro-organisms associated with intestinal affections. It is also important to note that batches of house flies obtained from certain London districts were frequently found to contain Morgan's bacillus, and consequently flies at any moment may become active agents in polluting food and milk, and spreading this disease. This bacillus grows well in milk and readily produces diarrhoea and death in young animals; and is probably an important causative agent in the production and dissemination of summer diarrhoea.

There are many other organisms which have been associated with infective or summer diarrhoea and other forms of catarrhal diarrhoea, some of which are the bacillus enteritidis gäertner, the bacillus ærtrycke, the para-typhoid or para-colon group, the bacillus coli-communis, and the bacillus of dysentery; this latter bacillus appears an improbable cause and might be excluded, although in America it is proved beyond doubt that bacilli of the dysentery type are frequently a cause of summer diarrhoea in that country.

It appears that bacteriologically no sharp line of demarcation can as yet be drawn between the different forms of diarrhoea met with in infants and adults. The probability is that the condition may be produced in both by a variety of micro-organisms, and this may be the interpretation of what we find

in practice, that the clinical features vary considerably in different epidemics. Many of these bacteria are readily found in all kinds of decaying and putrefying foodstuffs—meat and milk. Others again of which the bacillus coli-communis may be taken as a type, and some of its near allies, which are now known to be the cause of summer diarrhoea, have become normal inhabitants of the intestinal canal in man and the lower animals, and in a normal healthy bowel they remain quiescent or even assist in the processes of digestion. But in any abnormal or pathological condition of the bowel, as during typhoid fever, gastro-enteritis, and other forms of diarrhoea, these bacteria show great variability in degrees of virulence and pathogenicity. Consequently, when milk becomes infected from such a source there is proportionately greater risk to those who use it than if infection had occurred from normal excreta. One so frequently finds in investigating the cause of obscure and sporadic outbreaks of various forms of gastro-enteritis, that it was just preceded at the farm or milk-shop from which the milk was supplied by some one or more being ill in the same way, and that no precautions had been taken to prevent contamination of the milk. However, from the point of view of preventive medicine all these micro-organisms possess one feature in common—they are associated with filth and sewage, and the excreta of man and animals, and hence diarrhoeal diseases are pre-eminently filth diseases, and the prevalence of these in any community is frequently taken as an index of the hygienic conditions of that community.

Summer
Diarrhoea and
Water Carriage
System.

Newsholme, in a study of epidemic diarrhoea covering a period of 17 years, finds that towns which have adopted the water carriage system of disposal of sewage suffer much less from diarrhoea than those retaining other methods of removal of excrement; and that the average of the total infant deaths due to this disease during the hot months of the third quarter of the year in the largest towns of England was from 75 to 80 per cent.; and this high incidence and mortality falls chiefly on the bottle fed infants among the poorer classes in our towns. Many outbreaks of this disease in cities and hospitals are recorded every year and directly traced to polluted milk. In Brighton in 1901-02 there were 220 infantile deaths, and it was possible to trace 191 of these fatal cases to polluted milk. At the same time we justly recognise that the quality of the milk is not the only contributory factor to our high infantile mortality; often enough children suffer from insufficient quantity of milk; but, even in these cases, the greater is the need for what they do get being reasonably pure. Nevertheless, I believe that it is no exaggeration to state that, if we had a reasonably pure milk supply infantile summer diarrhoea would gradually almost disappear, and a great diminution in our infantile death-rate would ensue.

SCARLET FEVER, TYPHOID FEVER, AND DIPHTHERIA.

Historical.

One of the earliest observers to suspect milk as a medium for the conveyance and spread of zymotic disease was Dr. Michael Taylor, of Penrith, who in 1857, while investigating the cause of an outbreak of typhoid fever was able to establish a chain of evidence which proved conclusively that milk was the medium. To the same observer is also due the credit of investigating the cause of an outbreak of scarlet fever at Penrith in 1870, and first proving beyond doubt that milk was also a medium of transmission and spread of scarlet fever. Hence, was established for the first time the important knowledge that typhoid fever and scarlet fever were both milk-borne diseases.

To Dr. W. H. Power (Local Government Board), however, the credit is due of first showing that diphtheria also may be a milk-borne disease. He investigated an outbreak of this disease in North London in 1878. The investigation was a difficult but highly interesting one; and, reasoning by the process of exclusion, he found that the only possible conclusion was the one above stated—the truth of which since then has only been too clearly established. Since these discoveries were made a vast amount of bacteriological work has been accomplished, and our knowledge of the aetiology of zymotic disease correspondingly extended.

In 1881 the bacillus of typhoid fever was discovered, and three years later the bacillus of diphtheria. Each event which marks the discovery and isolation of the causal microbe of any disease must be considered as one of the highest importance to suffering humanity.

Witness the case-mortality of diphtheria to-day and the diphtheria in pre-antitoxin days. In the latter it frequently averaged 30 to 40 per cent.; now, there would be very few fatal cases from diphtheria alone if anti-diphtheritic serum could always be administered early. Thus through the labours of scientific workers our knowledge and treatment of this and many other diseases has been raised from the level of superstition and ignorance, and placed on a rational and scientific basis.

Zymotic
Epidemics.

In reviewing the epidemiological literature since typhoid fever, scarlet fever, and diphtheria were discovered to be milk-borne diseases in 1857, 1870, and 1878, respectively, there has been in the same order 200, 70, and 30 well-marked epidemics due to infection through milk, and for which England has already paid a heavy death toll.

Many of these earlier epidemics were described with a keenness of observation and accuracy of detail which does credit to their investigators; and, who not infrequently exhibited something of the scientific spirit which seeks for truth and hates obscurities. In the perusal of these reports one thing stands out prominently and impresses one deeply—that infection almost invariably followed the milkman's cart or the line of distribution from the milk shop; and, therefore, that the focus of infection is generally to be found about the dairy farm or milk shop. The harmless necessary cow is not to blame, for she is insusceptible to typhoid fever; and, although from time to time some weighty evidence has been adduced to prove that there are certain diseases of the udder of the cow akin to scarlatina and diphtheria in man, and transmissible through the milk, this matter must be considered sub judice, and bovine scarlatina and diphtheria not yet proved. The source of the infection is human. The milk is infected by infective persons handling the milk. In scarlet fever and diphtheria during the initial, acute, and possibly as yet undiagnosed stage, all discharges from the mouth, nose, and throat are very infectious, and in coughing, sneezing, speaking, and spitting, infective matter is disseminated into the atmosphere as a fine spray and will readily enough infect milk. Convalescents must also be a frequent source of infection; for we now know that the bacillus of diphtheria often remains in the throat 8 to 9 weeks; and that the infection of scarlet fever may remain for a long time about those who suffer from discharges from the nose and ears, and from swollen glands; and about the articles of the home, especially the clothes, unless there has been thorough disinfection. Hence it often occurs that when some infectious disease is or has been in the house of the milker or dairyman, or anyone handling the milk, although they themselves may remain immune, yet at the same time they may act as carriers of the infection to the milk.

As regards typhoid fever, the chief seat of mischief is in the bowel. For about two weeks in the early stage of the disease the bacilli are present in the blood. Later they appear in the stools, and during convalescence they appear in the urine in about 25 per cent. of all cases.

Typhoid
"Carriers."

Regarding the duration of the period of infectivity, recent bacteriological work has revealed some interesting facts. Formerly a patient after five or six weeks quarantine was supposed free of infection, and if sufficiently recovered, discharged as fit to return to work. But at this stage in about one half the cases the bacilli are being still excreted in the stools and urine, and this may continue for weeks or months in some cases; while in other more unfortunate cases it may continue for years, and such are now termed "chronic bacilli carriers." So long as excretion of bacilli continues such persons are potentially infective to others; and when such persons are engaged in dairy work or in the handling of food, there are serious risks of contamination through the hands becoming soiled with excreta in the performance of the ordinary toilet, and through gross and culpable neglect to wash the hands.

To what an extent infection is transmitted and spread in this way may be inferred, when we consider that it is only a few years since "bacilli carriers" were discovered, and since then several outbreaks have been recorded. In 1907 Dr. D. S. Davies, Bristol, describes two institutional outbreaks, where the "bacillus carrier" was acting as cook and dairy maid. In the New York Medical Record, 1907, Soper records that a cook, who in 5 years was engaged with four families, gave rise to 28 cases. In the previous year 31 cases occurring in 14 years in an institution in Scotland were traced to "bacilli carriers," and many similar cases have been reported in Germany.

Then in every infectious disease there are the "ambulant" and "missed" cases. In these cases the symptoms and illness are so slight that the real cause is not suspected and remains undiagnosed, yet these cases are infectious to others.

Lastly, outbreaks of typhoid fever have been clearly traced to dilution of the milk, and to washing of the milk vessels with sewage polluted water—Rochdale epidemic (see page 10).

Regarding the other infectious diseases, it has frequently been stated that smallpox, measles, and whooping cough may be conveyed by milk, but none of these statements are based on scientific evidence, and for the present must be considered not proved.

TUBERCULOSIS IN RELATION TO MILK.

Every year sees the accomplishment of so much valuable work and the production of such a voluminous literature, that it is only here possible to summarise some of the more salient features of this complex problem as it presents itself to-day to health authorities.

Koch in 1882 first announced to the world his discovery of the bacillus tuberculosis. It was an epoch-making discovery and will ever remain as a classical masterpiece of bacteriological research. Tuberculosis is the most widely spread of all diseases affecting humanity and still produces the highest mortality; still claiming its title as the "Captain of men of death" (Bunyan). Out of every 9 deaths in Rochdale one is due to some form of tuberculosis. No disease affects domestic animals more widely, and amongst these none are more susceptible than the bovines, which include the domestic cow.

In his original paper (1882) Koch clearly and definitely stated that he was of opinion that bovine tuberculosis was identical with human tuberculosis and therefore a disease transmissible to man, which should be treated as any other infectious disease. At the British Medical Congress on Tuberculosis, London, 1901, Koch, from certain experiments and observations then submitted, stated that human and bovine tuberculosis are practically distinct, and that if man is susceptible to the latter, infection is rare.

So important was this pronouncement and so far-reaching were the consequences it was destined to exercise on the whole question of preventive medicine, that a Royal Commission was appointed that same year to investigate and report on the whole question.

In January, 1907, they issued a second interim report; and as this is the last and most authoritative scientific tribunal which has sat on this question their conclusions and verdict are given verbatim:—

"There can be no doubt but that in a certain number of cases the tuberculosis occurring in the human subject, especially in children, is the direct result of the introduction into the human body of the bacillus of bovine tuberculosis; and there also can be no doubt that in the majority at least of these cases the bacillus is introduced through cows' milk. Cows' milk containing bovine tubercle bacilli is clearly a cause of tuberculosis and of fatal tuberculosis in man. Of the 60 cases of human tuberculosis investigated by us, fourteen of the viruses belonged to Group I, that is to say, contained the bovine bacillus. If, instead of taking all these sixty cases, we confine ourselves to cases of tuberculosis in which the bacilli were apparently introduced into the body by way of the alimentary canal, the proportion of Group I becomes very much larger. Of

the total sixty cases investigated by us, twenty-eight possessed clinical histories indicating that in them the bacillus was introduced through the alimentary canal. Of these thirteen belong to Group I. Of the nine cases in which cervical glands were studied by us, three, and of the nineteen cases in which the lesions of abdominal tuberculosis were studied by us, ten belong to Group I. These facts indicate that a very large proportion of tuberculosis contracted by ingestion is due to tubercle bacilli of bovine source. A very considerable amount of disease and loss of life, especially among the young, must be attributed to the consumption of cows' milk containing tubercle bacilli. The presence of tubercle bacilli in cows' milk can be detected, though with some difficulty, if the proper means be adopted; and such milk ought never to be used as food. There is far less difficulty in recognising clinically that a cow is distinctly suffering from tuberculosis, in which case she may be yielding tuberculous milk. The milk coming from such a cow ought not to form part of human food, and indeed ought not to be used as food at all. Our results clearly point to the necessity of measures more stringent than those at present enforced, being taken to prevent the sale or the consumption of such milk."

This may be stated more simply as follows:—

The Commission confirmed what had already been pointed out by earlier observers, and regarding which all are now agreed; that there are two chief types of the tubercle bacillus—a human type and a bovine type. In human tuberculosis the former type is present in the great majority of cases, and in a certain proportion of human cases the bovine bacillus is now known to be present, and setting up bovine tuberculosis in the human subject. The bovine bacillus, on the other hand, is always present in bovine tuberculosis and appears to be the organism prevalent in animal tuberculosis.

In their biological, cultural and pathogenic properties there are some slight differences between these two types of bacilli. The bovine bacillus is much more virulent towards the lower animals than the human bacillus; but it does not appear to be equally virulent in the case of the human subject; for in the case of children suffering from primary intestinal and glandular tuberculosis which is usually caused by the bovine bacillus, through the ingestion of tubercular milk, the condition nearly always shows a certain degree of chronicity, which probably indicates a lower degree of virulence towards the human subject. But having regard to these differences the tuberculosis set up by the bacillus of human tuberculosis and bovine tuberculosis is, so far as anatomical and histological and clinical features are concerned, one and the same disease.

Then since man and children are very susceptible to infection by the bovine bacillus through tuberculous milk and otherwise; and since animals can be infected experimentally by the human type; therefore, man and bovine animals are reciprocally infective.

The Commission examined the tubercular material from 60 cases of human tuberculosis and sub-divided their results into three groups—Group I, Group II, and Group III. Groups II and III are not here considered as the bacillus found present in these groups was chiefly of the human type. But into Group I they placed 14 cases, or 23 per cent., of the whole, in which they found the bovine bacillus present. These were all cases of young children, and in 13 of the 14 cases the primary affection appeared in the intestinal tract, and in only one case was the bovine bacillus found in sputum. Altogether in 28 cases out of the 60 the history indicated infection by feeding through the alimentary canal. For in 9 cases of tubercular glands of the neck in children, the bovine bacillus was found present in 3; and, in 10 out of 19 cases—all children—the bovine bacillus was isolated from tubercular intestines, tubercular peritoneum, and abdominal glands. That is out of the 28 cases, 13, or 46 per cent., showed the presence of the bovine bacillus; and, since these were all cases of children, the Commission considered they had the strongest evidence in coming to the above-mentioned conclusion; that these 14 cases in Group I were in reality cases of bovine tuberculosis occurring in man; and consequently, that a very large proportion of tuberculosis, especially amongst children, is contracted

by ingestion of tuberculous milk; and, in urging the necessity for more stringent measures to be adopted by sanitary authorities to prevent the sale and consumption of tuberculous milk.

It may be further noted that in nearly all cases where the bovine bacillus has been isolated from a human subject, they have been cases of children with some evidence of infection through alimentation by ingestion of tubercular food or milk.

A similarly appointed Commission—the German Imperial Commission—have had the same questions under consideration, and their report has recently been issued by Dr. Weber. This report is in substantial agreement with the report of the English Commission. Dr. Weber states that in 84 cases of tuberculosis in children which he exhaustively examined, he found no less than 21 infected with the bovine bacillus. Thirteen occurred in primary abdominal tuberculosis, six in cases of tuberculosis of neck glands, whilst of 18 cases of tubercle of the lung all gave bacilli of the human type.

Two of the earlier observers and ablest exponents of the ingestion theory of tuberculosis were Von Behring and Calmette. The former, four years previous to the issue of the above interim report, at Cassel in 1903, stated that infection in the great majority of cases took place in infancy through tubercular milk by way of the alimentary canal, and that consumption in the adult was frequently due to this primary infection in infancy; that the bacillus tuberculosis can pass through the wall of the intestine and leave no wound nor trace behind to mark its passage; and then appears to take up its abode probably in some abdominal gland structure, where it may remain in the body inactive for years, and at a later period in life become active and virulent at some inopportune moment, when through illness or otherwise the resisting powers of the individual has been temporarily lowered. At first this theory was received with considerable scepticism.

But through the experimental work of Calmette and Guérin and their pupils, which appeared in three memoirs published in the *Annales de l'Institut Pasteur*; the accumulating evidence of many workers and observers in different parts of the world; and the above report of the Royal Commission; we are now convinced that there is in this theory much truth. It is not within the scope of this report to discuss the experimental work on which this theory is based, but one of Calmette's earliest observations is extremely interesting, as it has a counterpart in daily life which is seen by every medical practitioner. The experimental animals used were chiefly goats, kids, and bovines; while human, bovine, and avian tubercular material was introduced into these animals in various ways—by injections, suckling previously infected mothers, feeding, etc. After the death of the animal or if killed after a certain experimental time, a careful examination was made. It was observed that if young animals were fed on tubercular material the form of tuberculosis that generally followed was of the abdominal type. The mesenteric and abdominal glands first became affected, setting up a form of *tabes mesenterica* in the young animal. This was followed in some cases at a later date by infection of the lungs and in some cases, when the animal lived long enough, the deep cervical glands of the neck were frequently found to be tubercular. This last phase was of great interest, because up to this time tubercular glands of the neck were generally supposed to be due to infection through the mucous membrane of the mouth, tonsils, and pharynx; the bacilli, air-borne, entering the mouth in breathing or deposited on the inner surface of the mouth in feeding.

But it was further shown by Calmette and others that if the tubercular material was introduced by a tube into the stomach of a tuberculosis-free animal so as to avoid infection by the mouth, the initiation and progress of the disease was just the same as above stated. On the other hand the same experiments performed on adult animals appeared to produce tuberculosis of the pul-

monary type—a form of pulmonary phthisis. The exact counterpart is seen in human beings. Tuberculosis of the glands, and especially the abdominal glands—*tabes mesenterica* or consumption of the bowel—is one of the common forms of tuberculosis in children; while phthisis pulmonalis, or consumption of the lungs, is the prevalent form of the disease in adults.

To facilitate the understanding of these important experimental results, and the explanation offered, I will venture to put the matter simply and briefly. There are in the human body two great vascular systems—the circulation of the blood and the circulation of the lymph, and both are continuous the one with the other. The former is maintained by the heart and blood vessels. These vessels in their ultimate ramifications amongst the tissues may vary from $\frac{1}{2000}$ to $\frac{1}{3000}$ inch in diameter and there form networks, the interstices of which are often less than the diameter of the vessels. From these microscopic thin walled capillaries or vessels some of the more fluid portion of the blood is continually oozing out and carrying with it food for the tissues. This fluid which is now lying amongst, and bathing the tissues, and from which the tissues are taking up food and returning to it their waste products is called the lymph. This lymph is now collected and returned back to the blood by another set of vessels, which constitute the lymphatic system. But this lymph containing much waste products must be re-organised before being returned to the blood, and this is accomplished by numerous small structures situated along the route of the lymphatic vessels called lymphatic glands, and through which the lymph passes. Now, since the minutest structures—the tissue elements—in the human body are all microscopic and are bathed in lymph, we can readily understand that if tubercle bacilli should enter the mouth and gain an entrance through the mucous membrane or lining membrane of the mouth, then they are within the lymphatic system; and since the direction of the lymph is always first towards the lymphatic glands, the bacilli will probably be carried by the lymph stream to the nearest lymphatic glands of the neck.

On the other hand, if tubercle bacilli by ingestion of food or milk should be carried to the bowel, and gain an entrance through the mucous membrane or inner lining of the wall of the bowel, then they are also within the lymphatic system, and will probably be carried by the lymph stream to the nearest lymphatic glands situated in the membrane which surrounds and supports the bowel, called the mesentery; and hence the origin of the terms, mesenteric glands and *tabes mesenterica*, which means a wasting or consumption of the glands of the mesentery.

Then again, there are considerable differences in structure and arrangement of parts in the lymphatic glands of young and adult animals. In the young animal it is such as to offer considerable obstruction to the passage of the bacilli; whereas in adults it is such as to more readily allow the passage of bacilli through the gland and ultimately into the blood circulation, in which they are carried directly to the lungs.

But another of the duties of these glands is to destroy intruding bacteria; and the gland itself often becomes a battle ground, and as appears in the case of young animals and children, the glands offer a more determined resistance than in adults. If victory is with the gland, then the bacilli are destroyed or rendered innocuous. If the bacilli are victorious, then they may either (1) cause the glands to become swollen and break down as seen in the enlarged glands of the neck, and the mesenteric glands of *tabes mesenterica* (commonest in children); or (2) getting through the glands they may reach the lungs and set up phthisis pulmonalis (commonest in adults).

Such, then, is the explanation offered by Calmette and others for the prevalence of the glandular form of tuberculosis in children and the pulmonary form in adults.

This experimental work of Calmette and his followers has been greatly extended and, on the whole, confirmed by many workers and by a very interesting series of experiments carried out by Sir Wm. Whitla, and Professor Symmers, of Belfast.

More recently some very instructive results have been obtained by inhalation experiments. Rabbits, guinea pigs, and other small animals were placed in an atmosphere laden with fine black particles of carbon or coal dust or Chinese ink. After different periods of time the animals were killed, and the course taken by the carbon particles readily traced. In all cases the upper air passages were found laden with fine carbon particles. But as regards the rabbit, which is a nose breather, the particles did not appear to have got further than the upper parts of the trachea or wind pipe, and in the other animals the particles never reached the lung unless the animal was made to breathe in this atmosphere for a long time.

In consequence of such experimental work, many eminent workers in this field of research are of opinion that, not only is the ingestion theory the most probable, but discuss the improbability of infection of the lungs by inhalation, unless it occur through the upper air passages, where the bacilli may be deposited by inhalation or ingestion of food, and then passing through the mucous membrane find an entrance to the tonsils, to be carried by the lymph stream to the glands of the neck.

They further advert to what is well known to every student of physiology: that the pathway from the nostrils to the lungs is so well guarded by physical barriers in the form of angles, bends, and turns; that bacilli, dust, and foreign matter are obstructed and caught in these parts; while again in a large part of this passage are living structures, so numerous as cannot be numbered, which like serried ranks of men with brooms maintain a constant strong outward sweeping motion. The effect of this is to try and expel all intruding germs and foreign matter, just as is seen and as one experiences when a crumb of bread or a drop of fluid attempts to go down the wrong way.

Although these investigations cannot be further considered here, I have discussed them at some length, as they direct attention to a subject hitherto not sufficiently appreciated, namely—the great risk of tubercular infection through the ingestion of tubercular milk and meat.

Important evidence and statistics bearing on this important question of tubercular infection through milk, are now available from the records of examination of cases postmortem. Such statistics are invaluable when collected with care by pathologists of high reputation, and when due care has been taken to differentiate between whether the intestinal tuberculosis was primary or secondary in origin. In this country Dr. Still, at the Sick Children's Hospital, Great Ormonde Street, London; and Dr. Shennan, Royal Hospital for Sick Children, Edinburgh, have tabulated with great care their examinations of two series numbering 547 children, who died in these institutions from tuberculosis. The former found 29.1 per cent., the latter 28.1 per cent., of the cases examined showed definite evidence of primary intestinal infection.

The number is considerable, and provides the most trustworthy evidence we have of the extent to which children contract primary intestinal tuberculosis.

Further, it has to be kept in view that only a portion of those who become infected in infancy die in infancy, many who become infected may recover, while many may survive with varying health to die in adolescence or at some later period.

Similar pathological records of the prevalence of tuberculosis in children are now available from many hospitals and other institutions in Germany, France, and America; and from the published statistics and views of many pathologists, we learn that, while congenital tuberculosis is just as rare in babies as in calves, and is seldom met with in infants under three months; that

Postmortem
Evidence in
Relation to
Tuberculosis in
Children

after this age it increases progressively through childhood, and the frequency with which intestinal and other forms of tuberculosis is met with in children varies in different places. In Munich it is recorded as occurring in 38 per cent.; in Keil, 40 per cent.; London, 13 per cent.; Edinburgh, 27.8 per cent.; Paris, 38.5 per cent.; Christiania, 42.5 per cent.; Vienna, 40 per cent.; stating the question more broadly, evidences of tubercular infection are met with in about 40 per cent. of all children dying under 15 years of age. In American hospitals the percentage is probably less, as this disease is not so prevalent in that country.

Sims Woodhead also found that out of 127 cases of tuberculosis in children the mesenteric glands showed tubercular infection in 100, and in 43 there was present ulceration of the intestine.

Prevalence of
Tuberculosis in
English
Milking Herds.

Since from the above statistics we can only form an approximate estimate of the extent to which children become infected by tubercular milk, it forms a very interesting source of information to enquire to what extent bovine tuberculosis exists amongst English milking herds, and thereby form some estimate of the existing dangers through drinking tubercular milk.

It is computed that 20—30 per cent. of all the milch cows in England are more or less affected with tuberculosis. But a cow may be more or less affected with tuberculosis and not producing tubercular milk, and on the other hand a cow may show no external signs of tuberculosis and yet be giving tubercular milk.

When the udder is infected, which is invariably secondary to diseases of the internal organs, the milk will always be infected and dangerous; and it is calculated that about 2 per cent. of our milch cows have tuberculous udders. There are over 4,000,000 milch cows in Great Britain, which gives 80,000 with tubercular udders. Putting the annual yield of 500 gallons of milk per cow, there is produced every year 40,000,000 gallons of milk, which if not actually virulent, is not above suspicion.

This infected milk mixes with the pure, and on examination 10—15 per cent. of the mixed milk as supplied in towns show the presence of tubercle bacilli. The mixing of the tubercular milk with the non-tubercular is one safeguard which diminishes the risk of infection. For it has been clearly proved that there is a minimum limit to the number of bacilli required to produce active tuberculosis; and, consequently, the reason why so many escape, is probably, because after dilution the number of bacilli it contains is small and below the minimum. If tubercular milk were consumed by itself, many would become infected. Such milk when injected into small animals such as guinea-pigs, kittens, rabbits, calves, etc., is often capable of setting up acute tuberculosis, and these animals are not any more susceptible to tuberculosis than babies. Even tuberculous milk when diluted proves too frequently infective, but the danger to the consumer is in inverse ratio to the degree of dilution.

Evidence from
Statistics of
Registrar
General.

Again, turning to the reports of the Registrar General, we find that during the past half-century there has been a marked decline in the death-rate from phthisis, which is the form that tuberculosis generally takes in adolescence, and when the bacilli are inhaled as from dried sputum. On the other hand, during the same period, while there has been a slight decline in the death-rate at all ages above 1 year from *tabes mesenterica* or "consumption of the bowel," which is that form of tuberculosis attributable to alimentary infection or infection through ingestion of food or milk; yet among infants under 1 year of age, not only has there been no decline, but an actual increase in the death-rate from this form of tuberculosis.

In some respects, however, these reports, although true in general, are not so trustworthy as the preceding data, because such returns must vary according to variations in diagnosis, etc. The decline in the phthisis death-rate is undoubtedly due to the gradually improving hygienic conditions under which the people live and work, and to a higher standard of living now attainable. During the same period cows' milk has entered more largely into the dietary of young children, and, as regards infants, on account of the great decline in breast feeding, in many towns of England 50—60 per cent. of them have to depend entirely on cow's milk; and while at the same time we find an increasing death-rate from *tabes mesenterica*, there appears a possible relationship of cause and effect; and more so when we consider that the improvement in the hygienic conditions of the people has not yet very appreciably extended to the cowshed and the conditions under which milk is produced, and consequently, that infection through milk has remained unchecked and in infants increases in proportion as bottle feeding on cow's milk increases.

Discussion and
Conclusions.

In reviewing the whole question and weighing the evidence as set forth above, we readily admit that whatever deductions or conclusions are arrived at one must keep in view the following facts.

That the diagnosis of primary intestinal tuberculosis as has been so frequently pointed out by Koch and others is difficult and often uncertain, and in any case it cannot be considered as the only criterion of tubercular infection by means of milk.

Again, children readily swallow their pulmonary expectoration and thus secondary infection of the intestine may rapidly follow primary infection of the lungs. Hence, *tabes mesenterica* or consumption of the glands in the abdomen, although always associated with infection through the bowel, cannot always be taken as evidence of infection by food or milk.

Further, we have to keep in mind that at the present moment a great deal of experimental evidence is being brought forward to prove by which path infection takes place most readily—by inhalation or ingestion. The increasing experimental evidence in support of the ingestion theory and its practical importance in dealing with milk supplies, has been described at some length. On the other hand, the experimental work of many of the German School of Pathologists demands equal consideration. During 1908 a great deal of experimental work was carried on, especially at the Hygienic Institute of the University of Breslau, by Reichenbach, Heymann, and others. The former, in his report states that 40,000 bacilli, introduced in the form of a fine spray, produced infection by inhalation in guinea-pigs; and on the same animals it took a minimum of 140 million bacilli; or 3,500 times as many, to produce infection by feeding or ingestion. Hence, these experimenters conclude that infection by inhalation is quicker and more certain, and takes place with much smaller doses than by ingestion. This result they ascribe to the bacilli that are carried direct into the lung during inhalation. This question, however, must be considered still *sub judice*.

Further, when we find that in some countries, notably China, where cows' milk is seldom or never used; Japan, where the cows are tuberculosis-free; Greenland, where no cattle are to be found; and even in some parts of England, where from various causes little milk is used, tuberculosis is equally prevalent; we have important facts which are difficult to reconcile with present ideas as set forth above, and for which some other explanation has to be found. It appears to me that we have not yet sounded the lowest depth of this difficult problem and that tubercular milk is only one, although a dangerous one, of the many complex factors operating on the health conditions of every community.

In the present state of our knowledge it appears that, while we are not justified in accepting Von Behring's theory in its entirety — especially as regards consumption in the adult being always due to infection from milk in infancy—the older theory that infection always took place by breathing must now be considered no longer tenable and must be greatly modified. The accumulating evidence that the bovine type of bacillus (the bacillus found in tubercular milk) is so often discovered in children suffering from tuberculosis of the bowel and abdominal glands, as well as the large amount of experimental evidence, not only strongly supports the ingestion theory but further clearly points out the direction for administrative measures. For it is probably correct to say that at least 25 per cent. of all forms of tuberculosis in children in this country is caused through drinking tubercular milk. The disease first shows itself as a primary intestinal tuberculosis, and that in 70–80 per cent. of such cases the mesenteric glands become affected, and present the usual clinical appearance as in *tabes mesenterica*.

The above conclusion is in no way invalidated, even if we agree with Reichenbach, Heymann, and others, who maintain that infection takes place more certain, and quicker, and with smaller doses, by inhalation than by ingestion. This evidence is also in agreement with the experimental work of the English Royal Commission, and certainly in accordance with every-day experience. For, while 10–15 per cent. of the raw milk consumed is tubercular, the conditions are amply provided for wide-spread infection taking place in every community; yet, only a comparatively small number of individuals thereby contract tuberculosis.

We have already adverted to one safeguard against infection, provided by the mixing of the tubercular with the non-tubercular milk; and we may now add that in accordance with the above evidence, the rationale of this procedure evidently depends on the fact, that infection through the intestinal tract by ingestion requires larger doses of bacilli to produce the same effect, than what is required by inhalation; and as there is a minimum limit to the number of bacilli required to produce active tuberculosis by either theory, dilution of the tubercular milk tends to prevent the number of bacilli rising above the dangerous or minimum limit.

There is thus so far no essential difference, in principle, between the two schools. The older inhalation school now readily admit that infection takes place by ingestion, but not to the same extent as is proved by the experimental evidence of the ingestion school; but this is only a difference in degree, which time, with accumulating evidence from careful observation and experiment, will remove, either in favour of the one school or the other. Wherein they do differ is, that the inhalation school maintain that the bacilli are carried direct to the lungs in breathing, and hence the certainty and rapidity of infection by inhalation; whereas the ingestion school bring forward evidence to show, that it is difficult for bacilli to reach the lungs by this method, although they admit that infection may take place through the upper respiratory passages. From the point of view, however, of public health administration, this part of the discussion is more academic than practical. To health authorities the broad and incontrovertible facts are as above stated, and as guardians of the public health, England will expect every health authority to avail themselves of the additional powers contained in the Tuberculosis Order, 1909; and make one combined effort to extirpate bovine tuberculosis, which we now know is transmissible to human beings by tuberculous milk, and is the cause of at least 25 per cent. of all forms of tuberculosis in children, and of an amount of loss, suffering, and race deterioration, of which statistics make no record.

Having regard to the above conclusions, it may be here noted that Dr. Nathan Raw has recently put forward an ingenious theory, which is based on clinical and pathological observations, which may be briefly summarised as follows:—

Pulmonary tuberculosis, on the one hand, is a disease nearly always strictly limited to the lungs and is essentially a disease of young adult life between 30—40 years of age; on the other hand abdominal tuberculosis with *tabes mesenterica*, tubercular joints, spinal disease, enlarged glands, and strumous conditions are all essentially diseases of infancy and childhood, and very rarely seen in adult life. Further, it is very seldom that a patient suffering from any of the latter forms of tuberculosis develops the pulmonary form of phthisis pulmonalis. Clinically, they appear to be antagonistic to one another, attacking the body at different periods of life and exhibiting generally opposite symptoms. To explain these observations, Nathan Raw advances the theory that, while the human body is susceptible of attack by both the human and the bovine type of bacillus; yet these bacilli are antagonistic to one another, and do not attack the body simultaneously; that the human type of bacillus is conveyed chiefly by infective matter, such as dried sputum; and that its chief path of entry is, during the later periods of life, by the respiratory passages to the lungs where it sets up phthisis pulmonalis. On the other hand, during the early years of life, the bovine bacillus gains an entrance to the human body by the ingestion of tubercular milk, and is the causal micro-organisms of all the diseases of infancy and childhood enumerated above.

Although space will not allow of a discussion of this theory, yet I have included it here, because in reviewing the experimental work and arguments given in the preceding pages one must admit that the theory is not without considerable support. Further, the antagonism between the two types of bacilli appears to be corroborated by Von Behring and Römer, in some of their recent experiments on the immunisation of bovines by human bacilli against bovine tuberculosis. Hence, if human bacilli protect bovines against bovine tuberculosis, is the converse true, *i.e.*, does bovine tuberculosis in children protect them against human tuberculosis or phthisis pulmonalis? The affirmative is the natural deduction. But, although the theory is ingenious, and attempts to explain away many of the difficulties which at present beset the problem of tuberculosis, we must await the final verdict of scientific evidence.

Environment.

While discussing tuberculosis and its different modes of infection—by inhalation and by ingestion—and their relative frequency and dangers, it appears opportune to note that this question has an obverse side, which although not so frequently commented on, is equally important, and that is the environment. In tuberculous and dirty milk there is the attacking party—the bacillus of tuberculosis and probably other pathogenic micro-organisms. But there is the defending party—the individual attacked, and with every individual must be associated the environment (housing, feeding, social, and economic habits).

For, as a general truth, it may be said, that in proportion as the environment is good or bad, so will be the defensive powers of the individual attacked.

We all live and breathe in an atmosphere more or less in different places laden with tubercle bacilli; and there must be few who have escaped at some time or other drinking tubercular milk. Yet we do not all suffer from tuberculosis. Recently, it has been clearly demonstrated that the tubercle bacillus just like the bacillus of diphtheria, pneumonia, and others, may be found in the throats and nasal cavities of persons in perfect health, and appear to do no harm so long as health remains good and the defensive powers of the blood and tissues active and vigorous.

Either the bacilli are prevented from gaining an entrance into the tissues and blood, or if they do gain a foothold at some wound or weak part, there is immediately thrown round them a cordon or surrounding wall of defence, and by this and many other modes of warfare the bacilli and their toxins are either annihilated, rendered harmless, or converted into innocuous products.

The truth of this is borne out when we consider the large number of cases which reach the postmortem room, in which we find, especially in the lungs and glandular structures, traces of healed scars and small areas which at one time in the life history of the individual was the scene of a battlefield between the intruding bacilli and the defending powers. In recent years many British pathologists have given this subject considerable attention, but as yet the views and statistics given by different observers regarding the probable percentage of such cases varies within wide limits. From some other countries, especially Germany, statistics on this point are more readily available. From statistics collected by Professor M. Hay, Aberdeen, I learn that Burkhardt, in between one and two thousand autopsies at the Dresden hospitals, found tubercle in 91 per cent. of all persons dying above 18 years of age, and 38 per cent. among persons under 18 years. Naegeli, in Zurich, made also an extensive number of autopsies, and found that as he became more familiar with the search for tubercle, 97—98 per cent. of all the bodies of persons dying in hospital above 18 years of age showed traces of tubercle. In persons under 18 years of age the proportion was 18 per cent. These figures include all bodies of persons dying ostensibly of tubercular disease, as well as the bodies of persons dying from all other causes.

Harbitz, of Christiania, who has given considerable attention to the study of the pathology of tuberculosis in children, and after having performed an extensive number of autopsies, comes to the conclusion that 50—60 per cent. of all cases dying under 15 years of age show traces of obsolete or latent tuberculosis, occurring principally in the glandular structures.

That the defending powers were victorious in so many cases is commemorated by the slight destruction of tissue and the healed scar, but had the former—the bacilli—been victorious, then was established in that individual, phthisis pulmonalis.

These facts sufficiently demonstrate how important a factor, in the life history of every individual in the struggle against the microbes of disease, is the power of resistance, which again greatly depends on one's health, strength, and vigour, and these again in their last analysis are dependent on one's breeding and environment.

In recent years there has been possibly too great a tendency to attack the bacillus, while forgetting that to increase the powers of resistance of the people is equally important; and this can only be done by improving the conditions under which people live, more especially in the slums and poorer districts of every town where consumption in all its forms is most prevalent. For I am convinced that, with the environment favourable as regards sanitary housing and airspaces, a plentiful water supply, and the clean water-carriage system for the removal of sewage; such conditions would not only stimulate the greater number, but might even persuade the most careless to attempt to live cleanly, healthy, and vigorous lives: this combined with the proper cooking of plain nutritious food, and a reasonably pure milk; then, the bacillus tuberculosis will remain comparatively innocuous.

Section III.

DIRT OR FILTH IN MILK.

It will facilitate our appreciation of the due significance of this condition if we summarise what has been stated in the preceding pages. Therein, I have attempted to state briefly the evidence on which we consider that scarlet fever, diphtheria, sore throats, diarrhoea, typhoid fever, and tuberculosis are milk-borne diseases; and in doing so, I have pointed out that milk as it comes from a healthy cow is a pure sterile fluid; and, that man himself is chiefly responsible for the filth, dirt, and microbes in milk.

SOURCES OF POLLUTION.

Human Sources. Matter from the mouth, nose, and throat in coughing, sneezing, and spitting. Pollution from excrementitious matter; and from whatever the hands and clothes may happen to be soiled with at the time of milking and handling the milk.

Dirty Milk Utensils. This is one of the most prolific sources of pollution of milk. Many of these utensils are simply swarming with bacteria; and to every fresh quantity of milk that enters, they contribute a countless number of microbes. The danger from this source is further increased, when we know that these utensils are often rinsed with water from a water supply that is not above suspicion.

Air and Dust. Air and dust are correlated sources of the pollution of milk, and the impurities may be either of human, bovine, or other animal origin. One has only to enter a dirty cowshed, or one where the ordinary duties are ill-timed and ill-regulated, and observe the particles from the bacterial and dust-laden atmosphere being wafted into the milk, or settling down by the ordinary laws of gravity. Again, dust accumulates in the vessels set aside for the reception of milk, if not properly stored.

Artificial Pollution. Milk is sometimes "watered," and we can understand that those guilty of this practice will not be too particular about the quality of the diluting agent.

Flies. Flies are also, undoubtedly, carriers of filth and germs of disease into milk.

From the Cow. The milk from cows with tubercular udders nearly always contains tubercle bacilli in great numbers; and sometimes also the milk of cows that are tubercular but as yet show no external signs of it. The discharges in coughing and sneezing, also faeces and urine, from all such cows contain tubercle bacilli. Pus, blood, and matter from purulent and other inflammatory affections of the udder, and from all forms of wet and dried excremental matter.

The accumulation of filth from these and other sources constitute the gross filth or slime in milk; the grosser filth, such as fragments of dung and debris, are separated in the process of straining, while the finer particles of filth and bacteria pass through and form the deposit at the bottom of a deep cone-shaped glass of milk when allowed to stand for a few hours. The various processes of separating and estimating the amount of filth or slime in milk are here omitted, as also its microscopic appearances. But, it has often occurred to me that, if only those concerned in handling milk could see the often nauseating and heterogeneous collection revealed by the microscope, it would appeal even to the most wantonly careless.

Significance of Filthy Milk. It is admitted at once that there is a certain unavoidable and permissible amount of dirt in milk which for the most part may be quite innocuous in character; but by the popular expression "filthy milk," we mean milk that is unreasonably and grossly filthy. The amount of slime or filth in milk must always be taken as an index of the care and cleanliness exercised in the management of the cowshed, in milking, in handling the milk, and in its distribution. Still, it has to be borne in mind that there is no constant relationship between the amount of slime and the pathogenic properties of the milk. Some samples of milk may contain large quantities of dirt, which, although nauseating, may be found not to be very infectious nor pathogenic. Other samples may contain very little slime and yet be found on examination highly infectious and pathogenic. However, it will generally be found that there is a distinct average correlation between the amount of dirt and the pathogenicity of milk, and that the two generally rise or fall together.

It has further to be kept in view that the total sediment found in a milk does not represent the original total pollution.

From many experiments we know, that if a certain quantity of cows' dung be mixed with milk, only about $\frac{1}{3}$ to $\frac{1}{2}$ is recoverable in the sediment, the remainder being usually present in the form of water, soluble salts, extractives, etc. It may be here added that recently several dairymen have been prosecuted for selling milk which contained sediment and dirt above the admissible standard.

Perhaps in no city of England has more important work been done on the slime and bacteria of our milk supplies than in Manchester by Dr. Niven, Medical Officer of Health, and by Professor Delépine. The latter, during the past 10 years, has made a continuous record of his observations and experiments on the daily milk supply of Manchester, and his results are of the highest value both from the scientific and administrative point of view. Between 1898—1900, the average amount of slime arriving daily in 40,000 gallons of milk = 160lbs. In 1906 the average amount of slime arriving daily in 40,000 gallons of milk. = 79lbs. It is calculated by experiment that 5 to 7 grains per gallon is unavoidable and permissible sediment, and milk not containing more may be considered reasonably clean. Deducting this quantity from 160lbs. leaves 120lbs. of objectionable filth, which was swallowed daily by the people of Manchester. In 1906 the quantity was reduced to 39lbs. daily.

Judging milk by this standard in Manchester, 40 per cent. appeared clean in 1898—1900, and 68 per cent. in 1906, an increase of 28 per cent. in 8 years.

In 1898—1900 the average was 12.5 per cent., in 1906 it was reduced to 5 per cent., while very dirty milks have now disappeared.

With this diminution in filth there is a corresponding diminution in the quantity of tubercular milk. From 1897 to 1906, 3,650 samples of mixed milk were examined for the presence of the bacillus tuberculosis. In 1897, 17.2 per cent. of the samples examined were tuberculous, and it was calculated that about 8,000 gallons of milk actually capable of causing tuberculosis was being distributed daily in Manchester. In 1906, the percentage of tubercular milk had fallen to 6.6 per cent., and the quantity of tubercular milk reduced to about 3,000 gallons per day.

However, it is disappointing to find, in spite of the vigorous crusade now carried on in Manchester for many years to provide a pure milk supply, that in reading Dr. Niven's Report for 1908, it is stated that during the year, 334 samples of milk were taken, and on bacteriological examination it was found that 9.34 per cent. of the farmers were still sending tuberculous milk to the city.

Comparing this statement with the figures given in a recent article by W. G. Barnes, Chief Inspector of Dairies for L.C.C., we find that of 200 samples of milk taken haphazard at different railway stations in London, 37 or 18.5 per cent. of these milks were capable of setting up acute tuberculosis when injected into the bodies of guinea pigs. In the Manchester area, up to the end of 1907, 154 tubercular cows had been slaughtered; whilst in Sheffield at the end of 1908, 122 had been slaughtered. These statements serve to emphasize the magnitude of this question, and show how necessary is combined action by every health authority in England before any real progress can be made.

Still, in spite of the retarding difficulties of isolated action, many health authorities continue to make progress towards the ideal of a reasonably pure milk supply; and this has been attained by carrying out, with zeal and fidelity, the various powers conferred by Act of Parliament for the control of milk supplies. When, in 1899, the Dairies, Cowsheds and Milkshops Order was amended to include that milk from tubercular cows was neither to be mixed with other milk nor to be sold as human food, many Corporations, including Rochdale, readily incorporated in their Local Acts the additional though still inade-

quate powers for dealing with tuberculous milk. But the manner in which these powers have been exercised by different authorities, are as diverse as interesting. Many urban authorities through the well-directed, and well-sustained activity and co-operation of their respective public health and bacteriological departments, have already done a great deal to eliminate tuberculous milk. This has implied the systematic and frequent inspection of all milking herds supplying milk within their respective districts, and the isolation and slaughter, when possible, of all cows discovered to be tubercular by inspection, by means of the tuberculin test, or by bacteriological examination of the milk. But there are some urban, and especially rural authorities, who exercise little or no control over the conditions of milk supply within their respective districts. Hence it is that these conditions in country districts are generally found to be much worse. Consequently, the milk when examined usually contains more filth and bacteria than milk produced in the towns where inspection is more thorough.

The failure of so many authorities to exercise the powers conferred on them, has done a great deal to retard any universal and national progress being made towards the extirpation of bovine tuberculosis; and it has also had some interesting local effects. In virtue of the 1899 Amending Order, a health authority can prohibit any dairyman, either within or without their district, supplying milk within their district from any tubercular cow; but, they cannot compel, they can only persuade, that such animals should be slaughtered. Such cows are then of no further value to the dairyman for milking purposes, in the district of an authority where there is systematic and thorough inspection. Consequently, these cows are often sold or transferred to the milking herds in districts where the health authorities are more quiescent and tolerant of bovine tuberculosis. Hence, it comes to pass that the inhabitants of the latter district may not only suffer through the dissemination of tuberculosis by tubercular milk from cows within their own district, but such a district becomes a sort of dumping ground for tubercular cows, whose number is continually augmented by transference of such cows from their more active and contiguous neighbours.

Section IV.

BACTERIAL STANDARD FOR IMPURITIES IN MILK.

During the past few years much valuable work has been done with the view of being able to establish a reasonable and practical bacteriological standard. The subject is a difficult one, and many workers have tried to solve it in different ways. However, one can now perceive the various results all converging to the establishment, in the very near future, of this most desirable standard.

The bacteria in milk, which appear to serve as the most useful and generally accepted index of pollution, are:—

- (1) *Streptococci*, (2) *bacillus coli communis*, (3) *bacillus enteritidis sporogenes*.

These three types of micro-organisms are present in great abundance in the intestinal excreta of man and animals, and, hence, as they are considered characteristic of intestinal sewage and filth pollution, they are consequently taken as a measure of the degree of its presence. This is done by finding the number of these organisms present in a definite quantity—in this case finding the number of these organisms present in a certain quantity of milk.

There are, however, two factors which profoundly influence the number of bacteria present in milk. These are temperature and time. The higher the temperature and the longer the time since milking, the greater is the multiplication of bacteria and their toxic products. Hence, the difficulty has been to fix the conditions on which the bacteriological standard is to be based, especially as regards the temperature at which the milk is to be kept and examined.

The opinion is now almost unanimous that milk, immediately after milking and straining, should be cooled or chilled to a temperature of 10° C. or 50° F., and, as far as possible, maintained at that temperature. In New York milk above 50° F. is defined as adulterated, and wherever found in the hands of dairymen or retailers is liable to summary destruction.

The reasons for chilling are:—

(1) Milk is unfortunately a medium eminently adapted for the growth of bacteria.

(2) Under ordinary conditions of milking and manipulating the milk, there is no absolutely clean milk. Some sediment and bacteria will always find an entrance.

(3) If the milk is chilled to 50° F., the multiplication of the bacteria that have gained entrance is inhibited. If this is not done, even the few bacteria, which may gain entrance into the milk at a cowshed, where scrupulous cleanliness is observed, will, in a few hours in a warm summer day, multiply to millions; so that this milk when examined a few hours after milking may be no better, or even worse, than a milk examined immediately after milking, where cleanliness is not observed. By chilling the milk we eliminate the factor time if the milk is examined within 24 hours after milking.

With these conditions it now becomes possible to adopt a bacteriological standard, the aim of which is to ascertain the amount of filth and bacteria that entered at the cowshed, which is the chief source of pollution. Then, as a permissible and unavoidable sediment content of 5-7 grains per gallon is allowed; so a provisional permissible bacterial content has to be allowed. This is determined as follows:—Many milking experiments are made with the cowsheds, cows, milkers, utensils, etc., in every possible condition, from the scrupulously clean to the very dirty. The number of bacteria present under these different conditions in a small quantity of milk—one cubic centimetre = 15 drops—is determined, and a reasonable number of bacteria decided on as permissible and unavoidable, when the operation of milking and treating the milk is performed with ordinary cleanliness. From many such experiments when due cleanliness is observed, about 15,000 to 50,000 micro-organisms in 1 c.c. is considered permissible; as the conditions vary from cleanliness to very dirty the number of organisms also increase, and in a dirty milk may amount to millions per c.c. of 15 drops. Milk as sold on the street, or from the retailer's shop, frequently shows an average of about $\frac{1}{4}$ to $\frac{1}{2}$ million micro-organisms per c.c.

It is thus possible to classify milks as good, fair, bad, very bad, according to their bacterial content, which is also an index of the cleanliness obtaining in the different cowsheds at which the respective milk is produced.

This method has been generally adopted in America, and by Dr. Orr in his valuable report (1908) to the joint health councils of the county boroughs of the East and West Ridings of Yorkshire, on an investigation as to the contamination of milk. His work extended over one year, and as he examined a very large number of samples of milk, his results may be considered as fairly representative of the present conditions of the milk supply in Yorkshire. I have summarised some of his results in the following table.

TABLE I.

GROUPS.	No. of samples examined	Average bacterial content per c.c. $\approx$ 15 drops.	PERCENTAGES.					
			Source of supply.		Condition of udder.		Lighting and ventilation of cowshed.	
			Town	Country	Clean	Dirty	Good	Bad
GROUP A. (under 15,000 bact. per c.c.)GOOD	8	8,920	25	4.1	15.2	3.7	16.7	5.4
GROUP B. (under 50,000 bact. per c.c.)FAIR	34	28,530	50	44.9	56.5	29.6	58.3	35.1
GROUP C. (under 100,000 bact. per c.c.)BAD	15	74,480	12.5	24.5	13	33.3	11.1	29.7
GROUP D. (over 100,000 bact. per c.c.) VERY BAD	16	240,450	12.5	26.5	15.2	33.3	13.9	29.7

This table deserves serious consideration. We have here experimental evidence of what is our daily experience—that the conditions under which milk is produced in country dairies are very much worse than in town dairies, where inspection is more efficient. That the cleanliness of the udder on account of its liability to excretal pollution, and consequently to pollute the milk, is of the highest importance. The effect of bad ventilation and lighting will be noted. Cleanliness and a low bacterial content are not impossible even under these conditions. But it is again our experience, and borne out by experiment, that those dairymen who, through ignorance, indifference, or laziness, are content with disorderly cowsheds, are not the most likely to make an extra effort to compensate the condition and obtain a clean milk. Hence, in all ill-ventilated and ill-lighted cowsheds, where darkness prevails and sunlight, the best of all disinfectants, is excluded, dirtiness and bacteria are encouraged and flourish; and, consequently, the milk is usually filthy with a high bacterial content.

It is interesting to know where this vast assemblage of 15,000 to 50,000 bacteria per c.c. come from, which at the present time may be considered a provisionally permissible bacterial content. They come from two sources:—

(1) Milk as it is secreted in the udder of the cow is a pure sterile fluid, but as it passes through the teats it becomes contaminated with bacteria which have gained entrance during the intervals of milking. The number from this source is, however, comparatively small, and will be found chiefly in the fore milk, that is in the first "draw," less in the mid milk, and least in the "strippings." If the fore milk—first "draw"—be rejected, the number of bacteria from this source is reduced to a minimum and the loss of milk is small, as the fore milk is poor in milk fat; while the "strippings" are rich in milk fat and contain fewest bacteria.

(2) The remainder come from extraneous sources in the process of milking and handling the milk, and are a liberal allowance for various contingences even when due care and cleanliness is generally observed. However much the number goes above 50,000 per c.c. must be debited to, and is the measure of, preventable uncleanness and carelessness.

I will here append the conclusions arrived at by Dr. Orr in his report to the joint health councils of the County of Yorkshire. These conclusions are based on experimental evidence and most reliable data, and, consequently, are both instructive and important:—

"The chief conclusion to which we are forced is that the greatest amount of contamination of the milk supply takes place at the farm. This is based on the results of the experiments, which showed that—

(a) Of the total organisms in the milk used by the consumer, the greatest number are contributed by the farmer. During railway transit, at the retailer's premises, and in the consumer's house, smaller amounts are added, the amount in each instance being apparently about the same.

(b) Of the glucose fermenting or intestinal organisms such as the bacilli coli communis type and the streptococci, by far the greatest number are added at the farm. The retailer adds a certain number, the consumer none.

(c) The sediment or "dirt" gains entrance to the milk chiefly at the cowshed. In 86.8 per cent. of the samples examined, there was no increase in the sediment when sold by the retailer, but a decrease in 68.8 per cent.

(d) The farmer was responsible for the bacilli enteritidis sporogenes (Klein) in the milk consumed in 66.6 per cent. of the samples. In 11.1 per cent. of the samples these bacilli were added by the retailer or the consumer, while in 22.2 the source was doubtful.

CHIEF SOURCES OF CONTAMINATION.

A. *At the cowshed.*

Improperly cleaned milk vessels and the dirty udders of the cows are the source of by far the greatest amount of contamination by organisms, and especially by glucose-fermenters and streptococci. The dirty milk vessels contribute much more than the dirty udders in summer, but in winter the opposite is the case.

Milkers with dirty hands and dirty clothes, and especially wet milkers, contribute their share of pollution.

The air and dust in the cowshed add to the contamination; and coolers, as often used, contribute a certain amount.

B. *On the retailer's premises or street.*

Badly cleaned cans are a source of contamination here also, although not so great as at the cowshed, owing to the retailer paying greater attention to the cleaning process.

Pollution will take place in retailers' premises owing to the milk receptacles being uncovered, especially where the keeping-place is dusty, or the clothes of the retailer dirty. Organisms may be added by carelessness in handling, e.g., by the use of a dipper which has been kept on a dusty counter.

C. *At the consumer's house.*

Pollution takes place here as a result of keeping the milk in a dusty place and leaving it uncovered. Only a small amount of contamination occurs from the receptacles of the consumer.

Flies are a source of contamination at all stages of transit, but especially at the consumer's house, where they are usually more abundant."

Although on examining, bacteriologically, any sample of milk, it is usually difficult to say to what extent the bacteria present are derived from human or bovine sources; yet, it may be asserted with some degree of confidence that when type (2)—the bacillus coli communis, and type (3)—the bacillus enteritidis sporogenes, are found in milk, they are in all probability derived from external

sources of pollution, probably human, and are not present in the milk as it leaves the udder. These two bacilli, then, are the two most important indicators of excremental and filth pollution. Type (3)—streptococci, although not habitually present, are often found in the teats and diseased udders of cows. Hence, their presence in milk does not indicate their source—human or bovine, or both. These three types of bacteria are closely associated with, and sometimes the cause of, infantile summer diarrhoea, and other gastro-intestinal disturbances. The following results by Dr. Orr are interesting; they demonstrate that as cleanliness increases even the permissible bacterial content diminishes from thousands to hundreds.

TABLE II.

	Average Bacterial Content of Milk per c.c. (c.c. = 15 drops.)					Dirty Cans and Udders.
	Cans Sterilised by Steam.					
	Udders.					
	Dirty.	Dry brushed.	Washed.	Washed and dried.	Washed and left moist.	
Milk from Single Cows	11,250	11,200	No test.	900	472	No test.
Mixed Milk from whole herd of cows :—						
EXPERIMENT A.	17,600	No test.	4047	No test.	No test.	
EXPERIMENT B.	18,000	"	3460	"	"	106,600

Bacterial contamination by means of excreta—in an average of 4 experiments Orr found 3,478,220 bacteria per gram in fresh cows' manure; whereas, in old manure adhering to the hair of the cow and sticking to the udder, legs, etc., he found 5,487, 717,000 bacteria per gram. The old manure is kept warm, and here the bacteria multiply rapidly; and it is from this old manure that pollution of milk chiefly takes place in milking, while very little can occur from fresh manure.

During the past few years several reports of high merit, and books have been written on the bacteriology of milk, and there can be no hesitation in expressing the opinion that the bacteriologist can always measure, with reasonable accuracy, excremental and other kinds of undesirable pollution in milk.

Therefore, it is to be hoped, and I believe, that health authorities will take advantage of available science; and that by instituting municipal bacteriological laboratories, where milk will be tested by a recognised method and a fixed standard, each dairyman will have to bear a certificate according to the purity of his milk, which certificate shall be given by the health authority.

Section V.

THE CONTROL OF THE MILK SUPPLY, WITH SOME SUGGESTIONS.

Legislation.

The chief legislative measures under which health authorities in England have acted in exercising more or less control over milk supplies are briefly:—

(1) The Contagious Diseases (Animals) Act, 1878, which was the first Act of Parliament through which certain powers were conferred on local authorities for the protection and control of milk supplies; and which has formed the ground work of succeeding Orders.

(2) The Dairies, Cowsheds and Milkshops Order, 1885, with accompanying model bye-laws; and with Amending Orders in 1886 and 1899.

(3) The Infectious Diseases Prevention Act, 1890.

(4) Certain sections of the Public Health Act, 1875, and its Amending Acts.

In addition, many authorities since 1899 have obtained special powers to deal with certain conditions, especially tubercular milk, under their local Acts.

These various measures have from time to time been severely criticised and often found very defective for attaining the end in view—a pure milk supply. Probably one of the greatest defects has been that in towns, health authorities have no direct control over the milk supplies coming from farms outside their respective areas. Many such farms are in rural districts where we know from experience that inspection and control are most required. But at the same time, it has to be admitted that the most important of these measures—the Dairies Order of 1885, with its accompanying regulations or model bye-laws, has been administered in many districts—especially rural districts—with considerable laxity. In many places regulations or bye-laws under the Order, 1885, have not been adopted; or, if adopted, are not enforced.

By the Amending Order of 1899, tuberculosis was included among the diseases of cows from which milk was not to be sold as human food, and certain powers given to local authorities. These, in practice, have been found very unsatisfactory in so far as no provision was made for the disposal of tubercular cows. In order to remove these and other defects, and ensure a more uniform and consistent administration of milk legislation, the President of the Local Government Board introduced to Parliament during the present Session, his too long-delayed Milk and Dairies Bill, which he anticipated would be added to the Statute Book this Session. It is much to be regretted that the exigencies of Parliamentary business demanded that this Bill should be included amongst the "slaughter of the innocents," but it is to be hoped that it will be one of the first Bills considered in the following Session.

The main provisions of this Bill as set forth in the memorandum, and a summary of the provisions of the Tuberculosis Order of 1909, which comes into operation on the 1st January, 1910, are given in App. D.

Private
Enterprise.

While legislation and its interpretation by local authorities has been followed by a measured degree of success, a great deal of good has been achieved in raising the standard of the milk supply by private enterprise; and by such companies as the Copenhagen Dairy Company in Denmark, the Aylesbury Dairy Company in England, and the Philadelphia Milk Commission of America. The aim of these companies has been to provide a naturally pure milk supply—a "model" milk supply—rather than artificially purified milk by pasteurisation or sterilisation, and hence the centre of their work is at the farm—the chief source of pollution.

A description of how business is conducted by these companies cannot be given here. But, briefly, each farmer supplying milk has to agree to certain conditions of contract, for the contravention of which there is a heavy penalty—£100 in some cases. The cows have to be warranted free of disease and examined for tuberculosis by the tuberculin test. Conditions of cowshed, lighting, ventilation, cleansing, drainage, water supplies, cleanliness of milkers, cooling and straining milk, chemical and bacteriological tests, protection of milk from infection, and other standards are distinctly laid down, and to ensure that these conditions are observed the inspectors of the companies regularly visit the farms.

Education.

Under the new Milk and Dairies Bill power will be given to local authorities to establish milk depôts for the sale of milk specially prepared for infants, and for the supply of this milk we may suppose a "model" dairy farm. The institution in Rochdale of such a "model" dairy farm would, in my opinion, achieve the greatest good. Not only would it supply babies with pure milk, but it would educate public opinion; and, most important, it would be an inspiration and stimulus to many farmers and dairymen, who may care to learn the science of their business; while as a corollary it would follow that those who will not learn must gradually succumb for lack of customers.

This educative work might be followed up by the distribution of pamphlets containing suggestions regarding useful literature on farming and dairying, and the value of its study; how dairy farming in Denmark, only a few years ago a decadent industry, is now by the application of science the most prosperous in that country; and how the Dane by embracing the gospel of cleanliness can carry his produce across the sea and out-sell the English farmer at his own door.

By careful selection in breeding and management of his cows, the Danish farmer has quite commonly an average yield of 800 to 900 gallons per annum per cow, and the milk fat never below 3 per cent., but nearer 4 per cent., and above it.

Such valuable experimental results as have been obtained by the Highland and Agricultural Society of Scotland, the Aylesbury Dairy Company, and a few others, ought to be known to every dairy farmer. One set of cows were kept under conditions of "free ventilation" and at ordinary temperature, the other set under "restricted ventilation" and higher temperature. In the Scottish experiments the temperature of the first set of cows averaged 49.82° F., in the second set 59.40, a difference of 9.58°. These experiments have been repeated, and in every case the results, both as regards quantity and quality of milk and higher percentage of milk fat, and freedom of sickness amongst the cows, are distinctly in favour of the cows kept at ordinary temperature and free ventilation. Such results should convince every dairy farmer who is capable of reasoning or even of forming a contrast, of this fallacious and superstitious notion, so deeply ingrained in the minds of many as almost to become a fetish, that the cow kept in a dark ill-ventilated, ill-lighted, hot and vitiated atmosphere, must be a good milker.

A dairy farmer should know something of the natural history of bovines. Cows in early autumn begin to develop a coat which becomes longer and closer as the weather gets colder; and if the cowsheds are kept too hot, such animals begin to perspire freely and shed their hair, because, in the economy of nature, what is not useful is cast off. The present method of housing cows is an inversion of nature's method. In heated, ill-ventilated cowsheds, cows have their thinnest coat in winter, and consequently are more liable to colds, inflammation of the udder and other diseases.

If by this and such other educative means, farmers could be induced to take more intelligent and scientific interest in their business, and recognise their great responsibility, then one would expect some real fundamental progress. Then they would more readily avail themselves of all reasonable recommendations, and appreciate suggestions on all such subjects as ventilation and lighting, drainage and water supplies, cleanliness in cowshed, of cows, of milker, utensils, the pollution of milk by infection, dust, etc., and to discuss all new ideas and standards regarding their business.

The dairy farmer in the end would recognise, that the adoption of new improved and scientific methods all make for more profit and contribute to his credit as an individual. Recently, I had some interesting interviews with some farmers in the environs of Manchester, who a few years ago were slum-farmers, but are now proud to be the leading and most up-to-date in the district.

One would also like to see more utilitarian co-operation, sympathy, and trust between landlord and dairy farmer. The former is often a man who has travelled more and seen more, and, whom we might expect to take some intelligent interest in his farms and to encourage his tenants to introduce more modern and more scientific methods.

Many dairymen readily recognise that, with bad general arrangements and serious structural defects, it is impossible to carry on their business satisfactorily and produce a reasonably pure milk. At the same time they argue that, while the owner will do nothing but exact the highest rent from the highest bidder; and while they have no security of tenancy, they are unable in such cir-

cumstances to carry out improvements, however much this may be desirable; and in genuine cases this argument is reasonable. The milk supply, however, of any community is too serious a matter to be jeopardised by the exigencies of landlord and tenant; and under the new Milk and Dairies Bill, not only the dairyman but the premises have to be registered, and the local authority may remove from the register, or refuse to register, any premises which are unsuitable or which do not comply with the provisions of this Act. In this respect all the cowsheds in the category of "bad" in App. A, will be seriously affected. In the Scottish Bill, dairies are to be held on an annual licence, and any delinquency occurring during the year will be considered before granting a new licence.

At the same time, one must admit that there is a growing tendency, by many in every sphere of life, to placidly sit down waiting and hoping that some one else, or the State, will always do something, instead of determining one's own career by those ancient and traditional British qualities of self-help, self-reliance, and independence; and farmers need only be reminded that, although the State is at present contemplating some beneficial legislation for agriculture, it will avail them little without those qualities of mind and action.

Having made clear to each dairy farmer what is expected of him and how his business should be conducted, it will be necessary to prepare, and to supply each dairyman with, a set of bye-laws or regulations, and for the contravention of which a penalty will be inflicted. Heretofore, local authorities in virtue of powers conferred by the Contagious Diseases (Animals) Acts and relative Orders, have made bye-laws and regulations:—

- (1) For the inspection of cattle in dairies.
- (2) For the prescribing and regulating the lighting, ventilation, cleansing, drainage, and water supply of dairies and cowsheds in the occupation of persons following the trade of cowkeepers or dairymen.
- (3) For securing the cleanliness of milk stores, milk shops, and of milk vessels used for containing milk for sale by persons following the trade of cowkeepers or dairymen.
- (4) For prescribing precautions to be taken by purveyors of milk, and persons selling milk by retail, against infection or contamination.

However, if, as is anticipated, the Milk and Dairies Bill becomes law during the following Session, much of the legislative machinery and procedure will become greatly modified. This Bill promises to place the whole question of the public milk supply on a satisfactory basis, and its main objects are set forth in the memorandum to the Bill (see App. D). Under this Bill registration and uniformity of administration will be more complete. Powers are also given for the prohibition of the sale of tuberculous milk; for the establishment and management of milk depôts for the supply of milk specially prepared for infants, etc.; while the Local Government Board reserve powers for the enforcement of the duties of local authorities.

The accompanying Tuberculosis Order issued by the Board of Agriculture and Fisheries, which comes into operation on the 1st January, 1910, has for its aim the extirpation of bovine tuberculosis from the milking herds of England.

In this Order we have the first evidence of a co-ordinated and comprehensive effort to deal with this difficult and pressing question; and in carrying it out a serious responsibility will rest on every local authority and its officials. In one respect, however, this Order appears defective, inasmuch as the whole compensation to be paid for condemned tubercular cows has to be paid by the local authority. Since the extirpation of bovine tuberculosis is a national question; and if one half or two-thirds of this money was refunded from the National Exchequer, it would ensure a more universal and equitable administration of this Order throughout England. As the Order stands, the more active any local

authority becomes, the greater will be the initial expenditure in compensation, at least for one or two years; while local authorities who remain inactive, the less will be their expenditure and their districts will remain, as at present, the dumping ground for tubercular cows, and in so far as this takes place will the great object of this Order be retarded.

Then there should be a descending scale of compensation, correlated with certain time limits, as farmers must recognise their responsibilities and study their business so as to avoid keeping up the supply of the tubercular cows. Many of the considerations which were before the Local Government Board when these measures were framed are discussed in previous pages.

As illustrating what can be done without the stimulus and driving power of State legislation, it may be added very briefly that in some European countries, especially Denmark, a great deal has already been accomplished by individual enterprise to extirpate tuberculosis from their milking herds; and there are now in that country 600—700 large milking herds, which have been freed from tuberculosis. The method adopted in Denmark was devised by Professor Bang, of Copenhagen; it is simple, very inexpensive, but requires time and watchfulness on the part of the dairy farmer. Briefly, the method depends upon:

- (1) The use of tuberculin to diagnose the disease.
- (2) The complete separation of healthy animals from diseased.
- (3) The gradual rearing up of a healthy non-infected stock. Calves born of tubercular mothers are at once removed to a place free of infection and reared on tubercle-free milk; and, in this way a tubercle-free herd is reared up, even from an infected herd, and ultimately takes the place of the latter.

In North Germany the method in operation was devised by Professor Ostertag, of Berlin. It is very inexpensive, and consists essentially in removing at once all cases of open tuberculosis or advanced cases from dairy herds, since every new case originates from infection thrown off by an open or infectious case of the disease. In this way infection of the healthy is prevented, and the spread of the disease limited.

Then it is of the highest importance that every one concerned should also clearly understand, that these Acts of Parliament, Relative Orders and Bye Laws have to be respected. Regular inspection should be made and any infringement dealt with.

For it is a psychological element in human nature that, as the law is justly and righteously enforced, just in the same ratio will it become respected. While on the other hand, laws that are ostensibly made to be respected but broken with impunity, not only encourage evasion but bring the law itself and its administrators into disrespect.