Where myxoedema exists, its treatment would be expected to inhibit the progress of atherosclerosis; but desiccated thyroid must be administered very cautiously in the presence of coronary disease (Bartels and Bell, 1939). Conversely, the induction of hypothyroidism for the relief of angina pectoris would seem to be an unwise procedure because of probable acceleration of the underlying atherosclerotic process.

There is strong evidence from clinical, pathological, and experimental studies that an eminently desirable measure in the prevention of atherosclerosis is the prevention or correction of obesity. The virtues of a low-fat diet in this connexion are well known. A diet particularly low in animal fat has what may prove to be an additional virtue—a low-cholesterol content.

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BACTERIAL FLORA AND BACTERIAL COUNTS OF INFANTS' BOTTLE FEEDS

BY

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An account is given of the bacterial flora and bacterial counts of 300 infants' bottle feeds sampled in London during 1946-8. The feeds were obtained from children's hospitals, an infectious diseases hospital, residential nurseries, the out-patient department of a children's hospital, and an infant welfare clinic. Most of the samples were collected from the feeding-bottles immediately before the feeds were given; some, however, were obtained from bulk feeds prepared in milk kitchens. The feeds were of various composition and included reconstituted dried milk preparations, liquid cow's milk, expressed breast milk, thickened feeds, and clear fluids. The bacterial content may not have been representative of infants' feeds in general. Feed samples brought by mothers to out-patient and infant welfare clinics may have had their bacterial content increased during transport to them; on the other hand, in hospitals and nurseries, advice was often sought, and given, with regard to improved technique in feed preparation, and in two institutions at least this led to a reduction in the bacterial counts.

Sources of the Feed Samples

Children's and Infectious Diseases Hospitals.—Hospital A (66 samples) and hospital B (22 samples) are children's hospitals. Most of the samples were collected in the wards and some in the central milk kitchens. In both hospitals, feeds sufficient for 24 hours were prepared, and were then stored in a refrigerator until required. Feeding-bottles in hospital A were autoclaved and in hospital B they were boiled; in both hospitals teats were boiled between each use. Hospital C (38 samples) is an infectious diseases hospital, and the samples were collected in the gastro-enteritis unit. Feeds were freshly prepared, as required, in the ward kitchen, except that certain thickened feeds were prepared in bulk, boiled, and stored either at room temperature or in the refrigerator for periods depending on the demand. Bottles and teats were boiled between each use.

Residential Nurseries.—Nursery X (22 samples) and nursery Y (32 samples) had central milk kitchens. Nursery Z (37 samples) had a milk kitchen on each infant floor, and practice regarding feed preparation varied in detail from floor to floor and from time to

time. Some feeds were prepared in jugs or feeding-bottles and stored in the refrigerator until required; others were freshly prepared for each feed. In all the nurseries bottles and teats were boiled between each use.

Out-patient Departments.—Bottle feeds, usually wrapped in a towel or napkin, were carried from home by some of the mothers bringing their babies to the out-patient department of hospital A (54 samples). As many of the mothers lived at a distance from the hospital, the interval between preparation of the feeds at home and sampling in the out-patient department was usually from one to three hours, occasionally as long as four hours. To the touch, the temperatures of the feeds varied from hot to cold; some mothers had had the feeds re-heated, at a restaurant or canteen or in the out-patient department, before the samples were taken.

Infant Welfare Clinic.—A few mothers attending the infant welfare clinic (29 samples) brought prepared bottle feeds with them, but the practice was not general. The interval between preparation of the feeds at home and the collection of the samples in the clinic was about half to one hour only, as most of the mothers lived within easy reach of the clinic.

Composition of Feeds and Collection of Samples

Variations in the composition of the feeds, and their added sugars, minerals, and vitamins, were too numerous to allow of more than a broad grouping into the following classes: roller-dried cow's milk, half cream (97 samples) and full cream (84); spray-dried cow's milk (6); liquid cow's milk (13); expressed breast milk (11); thickened feeds—that is, with cereals, flour, etc., added—(35); special products—that is, lactic acid milk, citrated milk, casein hydrolysate, etc.—(18); clear fluids—that is, half-strength Hartmann's solution, saline, water, with or without glucose—(36). Particularly in the case of the hospital samples, milk feeds were often diluted, in varying proportions, with half-strength Hartmann's solution or with water; such diluted feeds have been classified according to their milk constituent.

In 260 of the 300 instances samples of the feeds were collected direct from the infants' feeding-bottles just before the feed was given. The feed therefore had already been warmed and the teat and valve placed in position before the sample was taken. The feed was shaken in the bottle, the teat removed, and a sample poured into a sterile screw-capped bottle. Forty samples were obtained from feeds prepared in bulk and stored in jugs or bottles. All the feeds examined were considered by the nurse or mother to be fit for infant consumption. When samples were collected at a distance from the laboratory they were refrigerated from the time of collection until the time of examination.

Laboratory Methods

Feed samples, after removal from the refrigerator, were warmed to melt the fat and then shaken well.

Bacterial Flora.—A loopful of each feed sample was spread on a horse-blood nutrient-digest-agar plate, which was examined after two days' aerobic incubation at 37° C. In addition, from 235 of the 300 feeds a duplicate horse-blood nutrient-digest-agar plate was inoculated and examined after three days' anaerobic

incubation at 37° C. Thirty-five of the samples were also cultivated on 7.5% NaCl nutrient-digest-agar for the isolation of staphylococci.

Bacterial Count.—Films of the feed samples were made on glass slides; those prepared from milk samples were fixed in methyl alcohol and stained with Newman's triple stain (Wilson, 1935), and those from clear fluids were fixed by heat and stained by Gram's method. The bacterial content was roughly estimated by microscopical examination on a grading from "very abundant" to "very scanty." Tenfold serial dilutions of each sample were made in quarter-strength Ringer's solution, the results of the microscopical examination serving as an indication of the range of the dilutions appropriate to each feed. Roll-tubes were prepared by the addition of 0.1 ml. of each dilution to each of three tubes containing melted "yeastrel" milk agar (Wilson, 1935). Colony counts of the roll-tubes were made after three days' aerobic incubation at 37° C. and the results expressed as the mean of the counts of the three tubes.

Bacterial Flora of Feeds

The bacterial flora of the 300 infant feeds is listed in Table I. The results of the aerobic and anaerobic plates have been combined; in general, the flora of the two plates was the same, the exception being that the anaerobic plates showed a heavier growth of streptococci and a higher incidence of lactobacilli. The results of the bacteriological investigation of the milk feeds and of the clear fluids are shown separately.

TABLE I.—*Bacterial Flora of 300 Infants' Bottle Feeds*

Bacterial Flora	Milk Feeds (264 Samples)	Clear Fluids (36 Samples)	Total (300 Samples)
<i>Micrococcus</i>	142	11	153
Aerobic spore-bearing bacillus	99	2	101
<i>Achromobacterium</i>	66	4	70
<i>Streptococcus</i>	65	2	67
<i>Bact. coli</i>	15	11	26
<i>Lactobacillus</i>	25	1	26
<i>Sarcina</i>	23	1	24
<i>Chromobacterium</i>	8	0	8
Yeasts	2	5	7
<i>Ps. pyocyanea</i>	2	2	4
<i>Staph. aureus</i>	2	0	2
<i>Neisseria</i>	1	1	2
<i>Proteus</i>	1	0	1
No growth	38	18	56

Milk Feeds.—Table I shows that the predominating bacteria in the milk feeds were those commonly associated with milk and milk products—that is, micrococci, aerobic spore-bearing bacilli, achromobacteria, and streptococci. *Staph. aureus* (coagulase-positive) was found in only two of the 264 milk samples, and then in small numbers. Streptococci varied in their haemolytic activity on blood agar; many of them were alpha-haemolytic, some non-haemolytic, and a few beta-haemolytic. Only 13 of the strains were examined for Lancefield group; nine of these belonged to Group D and the remainder were not members of groups A, C, D, or G. *Bact. coli* was isolated from 15 (6%) of the 264 milk feeds examined; in 10 of these 15 feeds a heavy growth of the organisms was obtained. *Ps. pyocyanea* was found in two milk feeds and *Proteus* in one only.

Clear Fluids.—The term "clear fluids" was in certain instances a misnomer, for a number of these feeds were found on inspection to be cloudy with bacterial growth. Odours of fermentation products were emitted from some of the specimens. Yeasts were isolated in one hospital from five samples of half-strength Hartmann's-glucose oral fluid and from two milk feeds diluted with it. Dr. J. T. Duncan kindly examined 12 of these strains and was unable

to find that any of them belonged to a known pathogenic group—for example, *Cryptococcus* or *Candida*. He found several different species among the 12 cultures, and all appeared to be saprophytic types. *Bact. coli* was isolated from 11 (31%) of the 36 clear fluids; 10 of these 11 samples were half-strength Hartmann's fluid, with or without glucose, and the remaining specimen was regarded in the ward as sterile water. From 6 of the 11 samples a heavy growth of *Bact. coli* was obtained.

Bacterial Counts of Feeds

The Chart shows the distribution among the 300 feeds of the colony counts in roll-tubes incubated at 37° C. for

Chart showing distribution of colony counts per ml. of 300 infants' bottle feeds.

three days. Only 50 (17%) of the samples yielded a zero count—that is, no growth in dilution(s) counted. The distribution of the counts rose from 22 (7.3%) samples containing 10 to 100 colonies per ml. to 76 (25%) containing 100 to 1,000 colonies per ml.; it then fell gradually to reach a figure of 10 (3.3%) samples containing 10,000,000 to 100,000,000 colonies per ml. and 2 (0.7%) containing over 100,000,000 colonies per ml. The last two samples, one of diluted expressed breast milk and the other of cow's milk and groats, had colony counts of 880,000,000 and 136,000,000 per ml. respectively.

Colony Counts in Relation to Type of Feed

Table II shows the distribution of the colony counts of the 300 infants' bottle feeds in relation to their composition. As already stated, the constitution of the feeds within certain groups varied considerably, and this, together with the fact that the number of samples

TABLE II.—Colony Count per ml. in Relation to Type of Feed

Type of Infant Feed	No. of Samples Examined	Colony Count per ml.									
		0	0-	10-	102-	103-	104-	105-	106-	107-	108-109
Reconstituted dried cow's milk	187	23	1	18	49	24	27	26	15	4	0
Liquid cow's milk	13	3	0	1	3	2	2	2	0	0	0
Expressed breast milk	11	1	0	0	4	0	2	2	0	0	1
Thickened feeds	35	6	0	1	9	5	3	2	4	4	1
Special products	18	3	0	0	8	2	1	3	1	0	0
Clear fluids	36	14	0	2	3	6	4	3	4	2	0
All types	300	50	1	22	76	39	39	35	26	10	2

in each group was comparatively small, has rendered any attempt at statistical analysis impracticable. A few comments on the results may, however, be made. Among the 187 feeds of reconstituted dried cow's milk, only 23 (12%) gave colony counts of zero; 45 (24%) had colony counts exceeding 100,000 per ml., and 19 (10%) counts exceeding 1,000,000 per ml. One only of the 11 samples of expressed breast milk had a colony count of zero and 3 had counts exceeding 1,000,000 per ml.

Thirty-six samples of clear fluids were examined; only 14 (39%) had colony counts of zero, 7 (19%) had counts exceeding 100,000 per ml., and 6 (17%) counts exceeding 1,000,000 per ml. In several instances abundant bacteria were observed in stained films of clear fluids which, owing to terminal heat-treatment, yielded low counts of viable bacteria. Practice varied considerably regarding the treatment and storage of clear fluids. The type of container used for them included bottles with screw-caps, laboratory flasks with wool or gauze plugs, and discarded lemonade bottles with corks. Heat-treatment consisted of autoclaving, steaming, or boiling of the fluids and their containers. Storage was either in a refrigerator or at room temperature. Sterile fluids resulted where in-bottle autoclaving in screw-capped containers was the practice. Fluids with high colony counts of up to 20,000,000 per ml., and containing abundant *Bact. coli*, were found where storage had been at room temperature in corked bottles boiled (or in some cases washed only) at some uncertain date in the past.

Colony Count in Relation to Place of Sampling

TABLE III.—Colony Count per ml. of Feed in Relation to Place of Sampling

Place of Sampling	No. of Samples Examined	Colony Count per ml.									
		0	0-	10-	102-	103-	104-	105-	106-	107-	108-109
Hospital A	66	11	0	3	20	5	10	4	8	2	1
" B	22	7	1	6	5	7	0	0	0	0	0
" C	38	11	0	2	12	5	5	2	0	1	0
Nursery X	22	3	0	1	12	1	3	2	0	0	0
" Y	32	3	0	4	12	8	0	2	2	1	0
" Z	37	5	0	1	4	5	4	15	3	0	0
Out-patient clinics	54	7	0	0	5	6	12	8	10	5	1
Infant welfare clinic	29	3	0	5	6	4	5	2	3	1	0
Total of feeds	300	50	1	22	76	39	39	35	26	10	2

Table III shows an analysis of the colony counts of the infants' feeds according to the place of sampling. The incidence of feeds with colony counts of zero was low (9-17%) in all the places of sampling except hospitals B and C, which had figures of 32% and 29%

respectively. The reasons for the higher incidence of zero count feeds in hospital B, and also for the absence of counts exceeding 10,000 per ml., may have been that the number of babies catered for was comparatively small and therefore greater care in feed preparation could be exercised. A further reason may have been that the resident medical officer made the milk kitchen technique a matter of particular interest and responsibility.

In nursery Z, bottle feeds from the three infant floors were sampled at intervals over a period of 14 months. It was the practice in this nursery to prepare infant feeds during the night for use at 6 and 10 a.m. They were allowed to cool at room temperature and then stored in the refrigerator until required. Fourteen such feeds were sampled at 10 a.m.—that is, approximately six to eight hours after their preparation. The colony counts of these feeds ranged from 330 to 2,500,000 per ml. with a geometric mean of 40,900 per ml. The high count of certain feeds may have been due to bacterial growth occurring during the period of cooling and storage. The ready growth of organisms in milk feeds was shown by the fact that two feeds with initial colony counts of 500 and 200 per ml. had, after 24 hours' storage at room temperature, counts of 3,700,000 and 1,040,000 per ml. respectively. Storage would not account, however, for the original bacterial content of feeds; 11 milk feeds, sampled on two infant floors immediately after their preparation, had colony counts ranging from 7,700 to 414,000 per ml., with a geometric mean of 141,000 per ml.

It seemed possible that feeds were being prepared in imperfectly sterilized utensils, and jugs ready for use in one milk kitchen were examined bacteriologically. They yielded a heavy growth of micrococci, sarcinae, and achromobacteria. That bacteriologically satisfactory feeds could be prepared under the conditions provided was shown by the fact that the colony count of feeds was zero when the nurse-in-charge prepared them under the supervision of a bacteriologist. Three such feeds, even after storage for 16 hours in a refrigerator, had bacterial counts of only 0, 50, and 130 per ml.

The danger of storage of feeds was illustrated in other institutions also. In nursery Y milk feeds had been found to have colony counts of under 10,000 per ml. During a period of failure of the refrigerator the feeds were still stored in it though not chilled by it, and the counts of three feeds examined at this time were 2,050,000, 3,300,000 and 10,200,000 per ml. In hospital C the highest colony count—that is, 50,000,000 per ml.—was obtained from a thickened feed stored in the kitchen. The high counts which may result from storage of clear fluids have already been noted above.

Of the 54 infant feeds brought by mothers attending out-patient clinics with their babies, only 7 (13%) had colony counts of zero, 16 (30%) had counts of over 1,000,000, and 6 (11%) of over 10,000,000 per ml. Most of the feeds, as already stated, had been made up several hours before the samples were taken. Bacterial multiplication during this period of incubation would, however, seem unlikely to account entirely for such a high degree of contamination, which would more probably be explained by preparation of feeds in inadequately cleansed utensils in the home. One feed, for example, which had been made up only one-and-a-half hours previously, had a colony count of 69,000,000 per ml.

Repeated bacteriological examination of feeds of babies attending the out-patient clinics was not attempted owing to the distance of their homes from the hospital; it was not known, therefore, whether a high bacterial count was an isolated event or a constant feature of any particular baby's feed. Without this information one could not decide whether habitual ingestion of contaminated feeds had led to dietetic difficulties. Thirty-five of the 53 babies who had their feeds examined suffered from some form of digestive disturbance. Vomiting was a complaint in 15 cases, diarrhoea in 8, and both vomiting and diarrhoea in 6. The colony counts of the six feeds of this last group were: 1,870,000, 1,880,000, 8,340,000, 43,000,000, 46,000,000, and 69,000,000 per ml., and numerous *Bact. coli* were grown from four of them.

Colony counts of over 1,000,000 per ml. were found in the feeds of some babies with milder digestive disturbances and in a few instances from those of babies free from such symptoms. The evidence was not sufficient to incriminate contaminated feeds as a cause or contributory factor of digestive disturbance, but this matter would seem worth some further investigation. The milk feed of one habitual vomiter, for instance, yielded a colony count of 12,400,000 per ml. and contained abundant *Bact. coli* and Group D streptococci. Some 1,700 million of these organisms might be ingested, therefore, with each feed, and their fermentative and biochemical action on lactose and other feed constituents within the alimentary tract could conceivably result in gastric or intestinal disturbance.

Compared with the bottle feeds sampled in out-patient clinics, those brought by mothers attending an infant welfare clinic were, on the whole, of a bacteriologically cleaner quality. Even so, however, only 3 (10%) of these 29 feeds had a colony count of zero, and 4 (14%) of them yielded a count of over 1,000,000 per ml. The highest count among the feeds collected in the infant welfare clinic was 32,000,000 per ml.

Observations on Feed Preparation Techniques

Certain errors and breaks in technique, all of which might lead to unsafe or unclean feeds, were observed during the present investigation: (a) absence of proper hand-washing facilities with elbow- or foot-operated taps; (b) failure to gown and mask while preparing feeds; (c) using a general ward kitchen for feed preparation; (d) cleansing of used bottles and teats in close proximity to the feed preparation table; (e) inadequate cleansing of bottles, teats, and utensils; (f) incomplete contact of bottle surfaces with boiling water in the sterilizer; (g) handling of teats with fingers; (h) drying of previously disinfected bottles with a glass-cloth; (i) returning used bottles, without prior disinfection, from the wards to the milk kitchen; (j) leaving warm bulk feeds at room temperature while awaiting distribution into individual feeding-bottles; (k) close packing of bottle feeds while still warm into the refrigerator; (l) storing of unsterilized feeds at room temperature; (m) exposure of bulk feeds, and of previously sterilized bottles and teats, to dust; (n) staff attending sick infants and also preparing feeds; and (o) lack of immediate attention to refrigerator breakdown.

The most important omission, however, was failure to place responsibility for feed preparation in the hands of one person trained in the principles of sterilization and milk hygiene.

Discussion

The bacteriological results of the investigation indicate that infant feeds prepared in hospitals, residential nurseries, and private households may contain bacteria in large numbers. Only 50 (17%) of the 300 feeds yielded a colony count of zero; 73 (24%) had counts of over 100,000 per ml., and 38 (13%) of over 1,000,000 per ml. Recognized pathogens were rarely found, and *Bact. coli*, giving evidence of possible faecal contamination, was present in only 26 (8.7%) of the 300 feeds. Nevertheless, where high bacterial counts are found there is obviously a risk of contamination with pathogenic micro-organisms.

Bacteria may be introduced into a feed by the constituents of the feed, the bottles, the teats, or the utensils used in preparation. In the present study the bacteriology of the feeds was investigated immediately before ingestion by the infants, and no attempt was made to analyse the various factors which had contributed to their bacterial content. The organisms most often found were those commonly associated with milk and milk products—that is, micrococci, aerobic spore-bearing bacilli, achromobacteria, and streptococci. It seems unlikely, however, that bacteria in large numbers were introduced with the dried milk base of the feeds. Roller-dried milk powders taken direct from the plant were found (Higginbottom, 1944) to have a mean plate count below 1,000 per g. and rarely had a count in excess of 20,000 per g. Further, Dr. Constance Higginbottom (in a personal communication) reports that she examined, in 1943-4, 171 samples of roller-dried milk powders as supplied for infant feeding by food offices in different parts of Great Britain; the geometric mean count was 1,070 bacteria per g. with a range of 300 to 3,890 per g. In the case of thickened feeds and special products it was not practicable to assess the bacterial contribution of the various added materials. It is possible that heavy contamination of feeds was due to bacterial multiplication in the feeds before they were offered to the infant. In this connexion it may be noted that Higginbottom (1948) found that the mean plate count of reconstituted dried milk samples was increased 2,000-fold after storage for 24 hours at 22° C. Carriage of bacteria by unsterilized bottles, teats, or utensils may also be a source of contamination.

Other investigators (Lembcke, 1941; Lembcke, Quinlivan and Orchard, 1943; Rubenstein and Foley, 1947; Finley, Smith, and Louder, 1948; Rourke, 1947a; Cumming, 1949) have recorded bacterial contamination of supposedly sterile infant-feeding bottles, teats, and utensils used for feed preparation. Cumming (1949), for example, reported that drainage water from the teat container carried an average of 60,000 bacteria per ml. and that bottles after having been "washed and sterilized" each carried a load of about 80,000 bacteria. In an investigation on the collection of expressed breast milk in maternity hospitals it was found that contamination was mainly due to unboiled collecting-bowls and breast-pumps. The mean bacterial count of 2,230,000 per ml. of expressed breast milk was reduced by 99.3% when boiled collecting-vessels were used (Wright, 1947).

Unless close attention to detail is given at every stage of preparation, unsafe feeds carrying pathogenic bacteria and unclean feeds carrying large numbers of non-pathogenic bacteria may result. Rourke (1947a) found that feeds prepared even by the so-called aseptic

technique had a "high incidence of bacterial growth." He considered that while it should be possible to prepare a sterile feed when personnel are properly trained, a good workroom is available, and equipment and materials are sterile, in actual practice these ideal conditions are rarely found.

American Methods

Considerable interest has been shown in the United States of America in recent years in the problem of hospital milk-kitchen design and of procedures for the preparation of safe infant feeds. In general, there is agreement on the necessity for some form of terminal heat-treatment of feeds, and this process is being adopted by hospitals and health authorities throughout America. A survey of hospital milk-kitchen practice showed that details of the procedure varied considerably (Wallace, Abramson, and Losty, 1948). As a result of the bacteriological work of Rourke (1947a, 1947b), Smith, Finley, Wright, and Louder (1948), Finley, Smith, and Louder (1948), and other workers, methods recommended for terminal heating by the American Hospital Association (1949), and made obligatory by the New York State Health Department (1948a, 1948b) in hospitals and institutions caring for the newborn and in baby formula services, are as follows: (a) non-pressure heating requiring a temperature of 100° C. for 25-30 minutes either with flowing steam or with boiling water and steam in a water-bath, or (b) pressure heating with an exposure to 110° C. (6 lb. pressure) for 10 minutes.

Prior to heat-treatment the feeds are made up by a clean but not aseptic technique, placed in thoroughly cleaned but not necessarily sterilized bottles, and covered with teats and teat-caps; the whole feed unit is then submitted to terminal heating. The method has been shown to produce a high incidence of sterile feeds and teat surfaces. It eliminates pathogens but does not in all cases destroy heat-resistant spores. For this reason, immediate cooling of the feed units and storage in a refrigerator are required. The more drastic operation of exposure to 121° C. (15 lb. pressure) for 15 minutes, though producing sterile feeds, has been shown to cause physical and chemical damage to milk constituents; the two other methods described above, however, produced small losses only of the heat-labile substances, ascorbic acid, thiamin, and lysine (Hodson, 1949).

Scientific data and practical information regarding milk-room lay-out, equipment, and procedures are to be found in the manual by the American Hospital Association (1949), in a summary and review of this manual by Gillam (1949), and in two articles by Perkins (1949a, 1949b). For domestic use in private households, apparatus for terminal heating of bottle feeds by the non-pressure method has been put on the market and ordinary pressure cookers have also been used. In some American towns, sterilized infant feeds are prepared in and delivered by a central baby feed service.

Need for Regular Bacteriological Inspection

Bottle feeds prepared for infant communities should be subject to regular bacteriological inspection in order to ensure that good techniques are constantly maintained. An acceptable standard for the bacterial count of the feeds is a problem for consideration. Cumming (1949) considered that bacterial counts of infant feeds, prepared by the aseptic technique but not subjected to

terminal heat-treatment, should, after 24 hours' storage, not exceed 500 per ml., and that no single count should be more than 10,000 per ml. He found that good procedure resulted in counts of less than 5 per ml. and that counts of over 100,000 per ml. pointed to errors in aseptic or mechanical procedures.

The New York State Department of Health requires that feeds, after terminal heating, shall be sterile upon bacteriological examination. This standard, though desirable, is likely to prove too stringent, as there is probably no method of terminal heating of feeds which can constantly ensure sterility without at the same time deleteriously affecting the chemical and physical properties of the milk. The American Hospital Association (1949) has therefore adopted a feed count of less than 25 organisms per ml. as an acceptable standard. Lowe (1947) used two standards for terminally heated feeds; (a) absence of coliform organisms, and (b) a maximum count of 50 bacterial colonies per ml. Rochester City (U.S.A.) Health Laboratory considered a maximum count of 100 colonies per ml. as satisfactory (see Lowe, 1947).

Maximum acceptable counts already suggested, therefore, are 500 colonies per ml. by Cumming for feeds prepared by an aseptic technique and 100 per ml. by the Rochester City Health Laboratory for terminally heated feeds. It may be noted that 162 (54%) of the 300 infants' bottle feeds examined in the present investigation yielded counts exceeding 500 per ml. and would therefore be unacceptable by the more lenient of these American standards.

Model Milk Kitchens

A useful development in the public health field in this country might be the establishment at certain centres of model milk kitchens in which training of milk-kitchen supervisors could be undertaken. The investigation of improved and standard techniques suitable for infant units of various types and sizes could be a further object of their work. The safety measure of terminal heating is now well established in the United States. The method could with advantage be introduced for the sterilization of clear fluids used for pre-lacteal feeding and for oral administration to sick babies, but pilot studies would possibly be required to ascertain its applicability to the dried milk feeds in current use in this country. Improvement in feed-preparation procedures is also required in private households, and guidance might therefore be offered to infant welfare workers and health visitors at such special centres. While advance in milk hygiene and the introduction of legislation have promoted the supply of good quality liquid and dried milk to the general community, there still remains the problem of ensuring that it reaches the infant consumer in a safe and clean state.

Summary

The bacterial flora and counts of 300 infants' bottle-feeds sampled in two children's hospitals, one infectious diseases hospital, three residential nurseries, one out-patient department, and one infant welfare clinic are recorded.

The composition of the feeds was as follows: roller-dried cow's milk, 181 samples; spray-dried cow's milk, 6; liquid cow's milk, 13; expressed breast milk, 11; thickened feeds, 35; special products, 18; and clear fluids, 36.

The bacteria most commonly isolated were as follows: micrococci and sarcinae, 177; aerobic spore-bearing bacilli, 101; achromobacteria and chromobacteria, 78; streptococci,

67. *Bact. coli* was isolated from 26 feeds, yeasts from 7, *Ps. pyocyanea* from 4, *Staph. aureus* (coagulase-positive) from 2, and *Proteus* from 1.

The distribution of the colony counts of the feeds in roll-tubes incubated for three days at 37° C. was as follows:

No. per ml.	No. of Samples
0	50
0-	1
10-	22
100-	76
1,000-	39
10,000-	39
100,000-	35
1,000,000-	26
10,000,000-	10
100,000,000-1,000,000,000	2

The range of the colony counts was from 0 to 880,000,000 per ml.

Among the 83 feeds prepared in private households and sampled in out-patient and infant welfare clinics only 10 (12%) had colony counts of zero, and 20 (24%) had colony counts in excess of 1,000,000 per ml. Possible association between high-count feeds and digestive disturbance is discussed.

Errors and breaks in the technique of infant-feed preparation in hospitals and nurseries were observed, and figures illustrating the result of preparing feeds in unsterilized utensils and of inadequate cooling and refrigeration of feeds are given.

The discussion deals with: the dangers of bacterial contamination of infant feeds by unsterilized bottles, teats, and utensils, and of bacterial multiplication during storage; a description of American methods of in-bottle terminal heat-treatment and a recommendation for their trial in this country; the need for regular bacteriological inspection of feeds prepared for infant communities; standards for bacterial counts of prepared infant feeds; consideration of the establishment of model milk kitchens for training supervisors, and for investigative work on improved procedures and equipment.

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