IS INFANTILE GASTRO-ENTERITIS FUNDAMENTALLY A MILK-BORNE INFECTION?

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In recent years much has been written about infantile gastro-enteritis associated with certain O groups of *Bacterium coli*, and the special problem has been the control of cross-infection within babies' hospitals. Comparatively little of the recent literature deals with infantile gastro-enteritis in the general community.

Severe gastro-enteritis is now uncommon among babies living at home, and one of the important factors contributing to the improvement in infantile mortality is the decline of this disease in the twentieth century. From the seventeenth to the twentieth century, whether the disease was known as 'griping in the guts' *cholera infantum*, 'summer diarrhoea' or 'gastro-enteritis', which are the names used in the four centuries, there has been a heavy toll of infants' lives.

Much has been written about the value of breast milk in protecting babies against gastro-enteritis, and many of the qualities of milk have been analysed to explain this. Very little has been written about the possibility of gastro-enteritis being an exogenous infection conveyed by food, against which a baby would have a measure of protection if it fed exclusively on its mother's milk.

Summer diarrhoea was once a great scourge, and it is possible that this disease was for the most part caused by the recently identified O groups of *Bact. coli*. If babies on the breast are protected, not because of any immunological quality of the milk but because they are less exposed to exogenous infection conveyed by food, the question arises: Is cows' milk, the substitute for human milk, contaminated by these varieties of *Bact. coli*? It is generally suspected that the decline in summer diarrhoea in this country has been associated with improvements in the milk supply during the past forty years or so.

The possibility of contamination of milk by the special O groups of *Bact. coli* associated with gastro-enteritis was investigated.

METHODS

Samples of milk (10 ml.) were taken from churns (10 gal.) as these arrived at a pasteurizing plant from farms. The samples were cultured in various ways: some were placed unopened in the incubator; sometimes 1 ml. samples were placed in MacConkey broth; some samples were incubated at 37° C. and some at 43° C. After incubation the samples were plated on MacConkey agar.

It is unfortunate that no selective culture medium exists to aid the separation of these special O groups from other groups of *Bact. coli*. If normal *Bact. coli* outnumber the pathogenic *Bact. coli* by 100:1 it would be necessary, on the average, to pick and examine 100 colonies before a positive result would be obtained. In work of this kind only patient examination is rewarded.

RESULTS

Strains of *Bact. coli* of the O groups associated with gastro-enteritis were isolated from approximately 1% of samples of milk from farms before it was bulked. In all, 1316 samples were examined and the following strains were identified:

$O_{55}H_{21}$:	4 strains
$O_{26}H_{11}$:	4 strains
$O_{128}H_{12}$:	1 strain
$O_{55}H?$:	2 strains
$O_{119}H_{27}$:	1 strain
Total	12

The strains were identified by agglutination to titre of their O suspensions, and in ten of the twelve strains by agglutination to titre of their H suspensions. All of the ten strains fully identified in this way had antigenic structures of varieties with a known association with gastro-enteritis.

Three strains were selected for the manufacture of O and H antisera for mirror agglutinin-absorption tests and their identity was confirmed by these tests. The three strains selected had the antigenic structures $O_{55}H_{21}$, $O_{119}H_{27}$ and $O_{26}H_{11}$.

It is not easy to separate pathogenic *Bact. coli* from non-pathogenic varieties in the absence of a selective culture medium. When the normal varieties outnumber the pathogens it is necessary to examine almost randomly a large number of colonies, and thus many positives are missed. The isolation of pathogenic varieties of *Bact. coli* from 1% of samples of farm milk means that farm milk must often be contaminated. As milk from many farms is mixed by dealers, and as *Bact. coli* can multiply freely in milk, especially in summer, it is clear that unheated cows' milk is a dangerous food for infants.

Though retrospective assessment of problems is never easy it is tempting to suspect that summer diarrhoea, formerly a great scourge, was a milk-borne infection by special O groups of *Bact. coli*. Summer diarrhoea as a cause of death in babies under 1 year has declined since the beginning of the century, the death rates per 1000 live births in 5-year-periods being:

1901–05, 16·20; 1906–10, 12·37; 1911–15, 19·15; 1916–20, 9·42;
1921–25, 7·95; 1926–30, 6·45; 1931–35, 5·47; 1936–40, 4·94;
1941–45, 4·95; 1946–50, 3·30; 1951–53, 1·10.

Cows' milk as infants' food has progressively improved in bacteriological quality for several reasons, viz. sterilization of milking utensils, pasteurization and replacement of liquid milk by dried milk. It is possible, however, that there was some decline in summer diarrhoea before most of the measures to improve milk supplies had their full effect.

Moreover, Thomson, Watkins & Gray (1956) have recently shown that 1% of babies harbour these special O groups, and many if not all babies are infected in the first year of life even to-day, yet very few of the babies in their survey drank unheated cows' milk. Babies in hospital are a special problem, and it is not implied that hospital outbreaks are milk-borne. What does appear possible, however, is

that hospitals breed, by a process of selection, the more virulent strains of these special O groups (Thomson *et al.* 1956).

Contamination of cows' milk may not be the whole story of the fundamental epidemiology of summer diarrhoea, but it is clear that unheated cows' milk carries the risk of gastro-enteritis.

Reservoir of infection

A few of the varieties of *Bact. coli* associated with infantile gastro-enteritis cause a similar disease in calves, e.g. $O_{26}H_{11}$, and strains of O groups 55 and 119 have also been isolated from bovines. Orskov & Fey (1954) isolated a strain of $O_{55}H_8$ from a chicken but this variety, though belonging to O group 55, has not caused outbreaks of infantile gastro-enteritis. On the whole there is very little evidence that cows or other animals often harbour the varieties associated with human disease.

In an attempt to find out how milk becomes contaminated by varieties of *Bact. coli* associated with human disease, one of the farms, the milk from which had yielded $O_{55}H_{21}$, was visited. There were ten cows, and a sample of milk was taken from each quarter of each udder and 1 ml. samples failed to yield *Bact. coli* of any kind. Samples of dung from every cow were repeatedly examined and found negative. Samples from two horses and a dog were also negative, but samples from sixty chickens yielded six strains of $O_{119}H_{27}$ and seven of $O_{128}H_{12}$. These findings demanded a survey of farm animals, especially chickens.

Samples of manure from 200 cows and fifty horses failed to yield any of the pathogenic O groups of *Bact. coli*.

Samples of chickens' droppings, 270 in all, were taken at different farms and thirty-six (13%) were positive. All batches yielded these special O groups, and the last batch of twenty-one—probably because of an improvement in technique—yielded nine positives (43%).

The varieties identified were:

$O_{55}H_{11}$:	3 strains	$O_{55}H?$:	7 strains
$O_{55}H_{27}$:	2 strains	$O_{111}H?$:	1 strain
$O_{111}H_{20}$:	1 strain	$O_{26}H_{32}$:	3 strains
$O_{26}H?$:	2 strains	$O_{119}H_{27}$:	7 strains
$O_{119}H?$:	2 strains	$O_{128}H_{12}$:	7 strains
$O_{128}H?$:	1 strain	Total	36

The strains were identified by agglutination to titre of their O and H suspensions, and, as in the case of the strains isolated from milk, the identity of several was proven by mirror agglutinin-absorption tests. The antigenic structures of strains proven in this way were $O_{55}H_{11}$, $O_{119}H_{27}$ and $O_{128}H_{12}$.

Many different varieties of the special O groups were identified, but it will be noted that few had H antigens of varieties with a known association with human disease. The only varieties from chickens with a known association with human disease were $O_{128}H_{12}$ and $O_{119}H_{27}$, and both of these have been responsible for outbreaks of comparatively mild disease. Twelve strains of O group 55 were isolated, and H antigens 11 and 27 were identified, but none of these varieties are known

pathogens. It happened also, on a number of occasions, that an organism, agglutinated to full titre by an antiserum, was shown, by mirror agglutinin-absorption tests, to possess minor antigens not possessed by the stock strains.

Much more will have to be known about the O groups of *Bact. coli* before the significance of this finding in chickens can be assessed. It would be unwise to conclude without further evidence that every variety of an incriminated O group is a potential pathogen. By careful search 1 % of babies living at home can be shown to be harbouring known pathogenic varieties of the incriminated O groups, and this may be of greater significance than the demonstration of strains of the incriminated O groups in 14 % of chickens if it happens that only a small proportion of the chicken strains have H antigens of pathogenic varieties. On the other hand, the finding of pathogenic varieties in cows' milk would appear to be important.

SUMMARY

1. One per cent of samples of farm milk were found to contain pathogenic varieties of *Bacterium coli* of the O groups associated with infantile gastro-enteritis.

2. Unheated cows' milk is a dangerous food for babies.

3. Summer diarrhoea was probably, for the most part, milk-borne infection by special O groups of *Bact. coli*.

4. Thirteen per cent of chickens on farms were found to be excreting *Bact. coli* of the O groups associated with infantile gastro-enteritis but only a few of the strains possessed H antigens of varieties known to have an association with human disease.

5. Possible reservoirs of infection cannot be adequately searched for until a selective method is devised to aid the separation of pathogenic O groups of *Bact. coli* from the non-pathogenic.

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