
Occasional Review

Communicable disease associated with milk and dairy products in England and Wales 1951-80

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Abstract

In England and Wales between 1951 and 1980 233 reported outbreaks of communicable disease attributed to milk or dairy products affected nearly 10 000 people, of whom four died. Tuberculosis and brucellosis have been controlled, but milk-borne outbreaks of salmonellosis and campylobacter enteritis due to raw or defectively pasteurised milk are common and may be increasing in number. Universal heat treatment of milk is an effective preventive measure, and it is regrettable that the continued sale of untreated milk is to be permitted in England and Wales.

Introduction

Cows' milk is a valuable human food, but its nutrient composition also makes it an excellent medium for the growth of many bacteria, including species pathogenic to man.¹ It is not surprising, therefore, that raw milk has often been implicated as the vehicle of infection in human food-borne disease; indeed, it was once regarded as the most dangerous article in our diet, giving rise in England and Wales between 1912 and 1937 to about 65 000 deaths from bovine tuberculosis and many thousands of cases of brucellosis, typhoid, paratyphoid, food poisoning, and other diseases.² Since then, however, the mortality and morbidity

caused by milk have been greatly reduced by the tuberculosis eradication scheme in cattle, the hygienic production and heat treatment of milk,³ and, more recently, by progress in the eradication of brucellosis in cattle⁴; but heat treatment is not universal in England and Wales and milk-borne diseases continue to arise. We review reported episodes of communicable diseases associated with milk and milk products in England and Wales in the 30 years 1951 to 1980.

Method

In England and Wales most microbiologists contribute to a national laboratory reporting system managed by the Public Health Laboratory Service. To identify episodes of infection associated with milk or dairy products during 1951-80 we studied their reports and also reviewed published reports in these years. Raw, heat-treated, and dried cows' milk, cream, butter, cheese, ice cream, and sheep and goat milk and cheese were included.

These data were analysed by the type of milk or dairy product implicated and by causative organism, and records were examined to determine the number of people infected, the number ill, the place of the outbreak, and the likely cause of contamination of the milk or dairy product. A few single cases of brucellosis and of Q fever were recorded, but in other infections only outbreaks were reported. An outbreak was defined as an episode in which two or more people had symptoms or were shown to be infected after consuming milk or dairy products; in most outbreaks the infecting organism was isolated also from the cattle, milk, or dairy product, although in the few where these were negative or not examined at the time there was strong epidemiological evidence implicating the milk or dairy product.

Results

Between 1951 and 1980 in England and Wales there were 233 outbreaks of communicable disease attributed to milk or dairy products with nearly 10 000 cases and four reported deaths (table). Altogether 179 (77%) of the outbreaks and 7350 (78%) of the cases were due to

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unpasteurised or defectively pasteurised cows' milk or to milk contaminated after pasteurisation; 133 (74%) of these outbreaks were due to salmonellas. Of the 11 (5%) outbreaks due to canned or dried milk, seven were due to salmonellas, although of the 1184 cases, 1170 were in three large outbreaks of staphylococcal food poisoning. Cheese accounted for 25 (11%) outbreaks, 16 of which were due to staphylococcal food poisoning; only one outbreak was due to sheep cheese and one to goat cheese. Of the nine outbreaks due to cream, six were staphylococcal food poisoning; there were nine due to ice cream. There were no outbreaks associated with butter or with sheep or goat milk.

The causative agents in reported outbreaks changed; the last milk-borne outbreak of staphylococcal food poisoning took place in 1962; after the early 1960s most milk-borne outbreaks were due to salmonellas, and since 1978 campylobacters have also become a more frequently recognised cause. Cheese and other dairy products ceased to be important vehicles of infection after the early 1960s; in the decade 1971-80 only three outbreaks comprising 11 cases were reported (table).

MILK

Typhoid and paratyphoid

No milk-borne outbreaks of typhoid were reported between 1951 and 1980, but there were two outbreaks of paratyphoid B after the consumption of raw milk; one outbreak (six cases and six symptomless excretors) was probably due to human faecal contamination in the cowshed²² but the other was due to infection in cattle.²³ In this second outbreak the symptoms were those of gastroenteritis and affected at least 150 people with many symptomless excretors; one died. A third outbreak associated with cattle was reported⁵³ but the human infection was probably water-borne and the episode is not, therefore, included in this analysis.

Salmonella food poisoning

There were 140 milk-borne outbreaks of salmonella food poisoning between 1951 and 1980 (table). There was limited information available about the illnesses, but most of those affected suffered from abdominal pain, diarrhoea, and vomiting of varying severity; there were many symptomless infections; only one death was reported.⁴⁶ Altogether, 2369 were affected in the 132 outbreaks associated with raw milk, an average of 18 per outbreak, but this average declined from 87 per outbreak between 1951 and 1960 to nine per outbreak in 1971 to 1980. This was associated with an increase in small outbreaks affecting farm workers and their families, which accounted for 78 (59%) of all outbreaks, although only 287 (12%) of all cases. The larger

outbreaks were mainly in the North-east and South-west of England, where most of the raw milk producer-retailers are located. There were at least four outbreaks in urban areas,^{9 25 26 28} five in schools or play-groups,^{6 8 32 45 48} and one in a hospital.

Of the seven dried and canned milk outbreaks, six took place in the 1950s and one in 1967, but the raw milk outbreaks increased in number from three in 1951 to 11 in 1980 (fig 1). The trend differed between salmonella serotypes; *Salmonella typhimurium* caused 88 outbreaks and increased over the period; *S dublin* caused 14 outbreaks with a peak in the late 1960s; and 30 outbreaks were due to other salmonella serotypes, half of which took place in 1973 and 1974 (fig 1). Seasonal distribution also changed, an increasing pro-

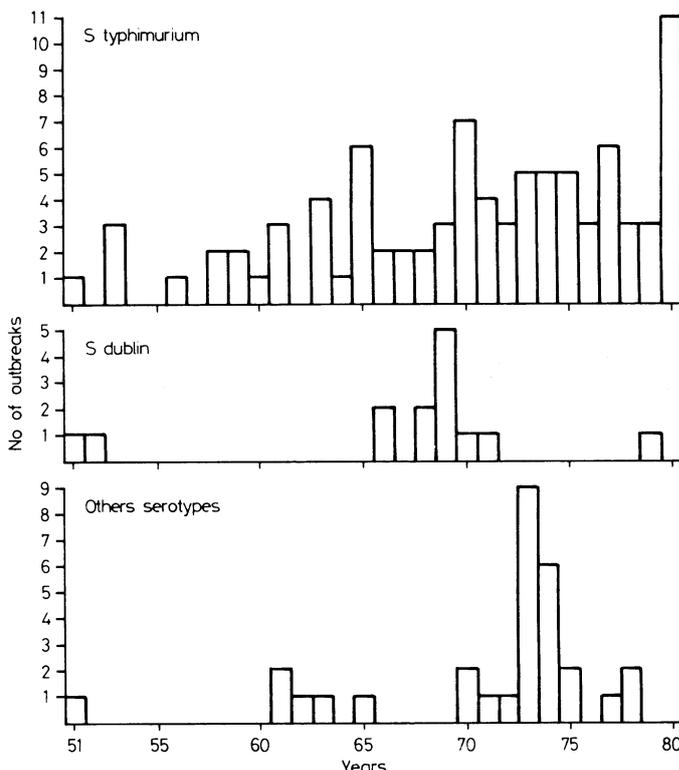


FIG 1—Reported outbreaks of salmonella food poisoning due to raw milk in England and Wales 1951-80.

Recorded outbreaks of communicable disease attributed to milk and dairy products: England and Wales 1951-80. (Number of people known to be ill in parentheses)

Disease	No of outbreaks and cases by vehicle of infection								Total	
	Cows' milk			Cream	Cheese			Ice cream	Outbreaks	Cases
	Raw	Pasteurised	Dried or canned		Cows'	Sheep	Goat			
1951-60										
Salmonella food poisoning ⁵⁻¹⁷	13 (1134)	1 (17)	6 (14)	—	1 (5)	—	—	4 (NK)	25	1170
Staphylococcal intoxication ^{5 7 10-16 18-20}	17 (523**)	—	3 (1170)	6 (131)	11 (299)	—	—	1 (8)	38	2131**
Tuberculosis ²¹	1 (3)	—	—	—	—	—	—	—	1	3
Outbreaks due to other organisms or unknown cause ^{5 7 10 12}	3 (46)	2 (145)	1 (NK)	1 (2)	4 (52)	—	—	4 (100)	15	345
Total	34 (1706)	3 (162)	10 (1184)	7 (133)	16 (356)	—	—	9 (108)	79	3649
1961-70										
Paratyphoid fever ^{22 23}	2 (156*)	—	—	—	—	—	—	—	2	156*
Salmonella food poisoning ²⁴⁻³⁷	47 (596)	—	1 (NK)	1 (55)	1 (NK)	—	—	—	50	651
Staphylococcal intoxication ^{38 39 38 38}	3 (67)	—	—	—	4 (205)	—	—	—	7	272
Brucellosis ^{40 41}	1 (8)	—	—	—	—	1 (7)	—	—	2	15
Q fever ⁴²	1 (29)	—	—	—	—	—	—	—	1	29
Outbreaks due to other organisms or unknown cause ³⁹	—	—	—	—	1 (2)	—	—	—	1	2
Total	54 (856)	—	1 (NK)	1 (55)	6 (207)	1 (7)	—	—	63	1125
1971-80										
Salmonella food poisoning ^{36 43-48}	72 (639*)	—	—	—	—	—	—	—	73	645*
Staphylococcal intoxication ³⁶	12 (453)	—	—	—	1 (3)	—	—	—	14	3983
Campylobacter infection ⁴⁹⁻⁵¹	—	2 (3530)	—	—	—	—	—	—	1	2
B cereus infection	—	—	—	1 (2)	—	—	—	—	1	2
Brucellosis	1 (2)	—	—	—	—	—	—	—	1	2
E coli enteritis ⁵²	1 (2)	—	—	—	—	—	—	—	1	2
Total	86 (1096)	2 (3530)	—	1 (2)	1 (3)	—	—	—	91	4637
1951-80										
Total	174 (3658****)	5 (3692)	11 (1184)	9 (190)	23 (566)	1 (7)	1 (6)	9 (108)	233	9411****

*1 death. NK Not known.

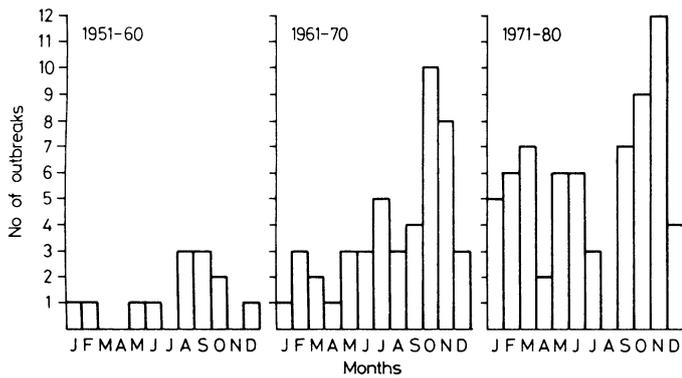


FIG 2—Seasonal distribution of reported outbreaks of salmonella food poisoning due to raw milk in England and Wales 1951-80. In one outbreak 1961-70 the month was not reported.

portion of the outbreaks taking place in the winter months; between 1951 and 1960, five (38%) of 13 outbreaks were between October and March, but between 1971 and 1980 the number was 43 (60%) of 72 outbreaks (fig 2); this seasonal trend was most evident in outbreaks due to *S typhimurium*.

In about three-quarters of outbreaks due to raw milk reports gave some information about the cause of the contamination of the milk; 22 (17%) were attributed to excretion of salmonellas in the milk of one or more cows, while 49 (37%) were associated with faecal excretion in cattle and 16 (12%) with infection in calves; in at least seven outbreaks there was no clinical illness in the herd before the outbreak. The origin of the infection was suggested in six outbreaks; four were attributed to contaminated animal feeding stuffs, one to contaminated water, and one to contaminated effluent flooding on to pasture land. In seven (5%) outbreaks thought to be due to human infection there was insufficient information in six to decide whether the human infection was the cause or the result of the outbreak, but one outbreak of five cases of *S tel-aviv* infection in 1974 was probably of human origin. A farmer's wife had returned from Spain with gastroenteritis before the outbreak and may have acquired the infection there; only three other cases of *S tel-aviv* infection were reported in England and Wales in the same year.

One outbreak of salmonella food poisoning was attributed to pasteurised milk (table), but the milk was probably contaminated during bottling.¹¹ Six outbreaks were attributed to dried milk, five between 1952 and 1956 and one in 1967; *S typhimurium* was the causative organism in four and *S thompson* and *S newington* in the other two. In three of the outbreaks the dried milk was probably contaminated after the can was opened but one comprising three cases of *S typhimurium* infection may have been due to contamination before the tin was opened; in the other two outbreaks the evidence incriminating the milk was poor. One outbreak was associated with canned milk due to *S typhimurium* but the organism was not isolated from the milk, and the evidence that this was the vehicle of infection was not conclusive.

Staphylococcal food poisoning

The 23 outbreaks of staphylococcal food poisoning all took place between 1951 and 1962; 20 were due to raw milk including one due to junket, and three to dried or canned milk. The 20 raw milk outbreaks comprised nearly 600 cases and two deaths, both of which were reported in an outbreak of 58 cases in a hospital in 1956.¹² In 12 of the outbreaks a cow with staphylococcal mastitis was the probable cause, in one a cowman who was a nasal carrier of *Staphylococcus aureus* was thought to be the cause, and the one due to junket was attributed to contamination by a food handler¹¹; no information was available in the other six outbreaks.

In June and July 1953 over 1000 school children were affected in a widespread outbreak of staphylococcal food poisoning in seven different schools due to spray-dried skim milk powder from the same source contaminated with *Staph aureus* and probably containing preformed toxin; a second smaller outbreak of over 100 cases took place in September of the same year, also due to spray-dried milk powder but which came from a different source.¹⁸ A single outbreak due to canned milk was reported in 1955, but the can was opened three days before it was used and was therefore likely to have been contaminated after opening.¹¹

Campylobacter enteritis

Campylobacters were recognised as a common cause of diarrhoeal disease in the mid 1970s.⁵⁴ Although the sources of most infections were undiscovered, several milk-borne outbreaks of disease were reported during the later 1970s.^{50 51} In most of these outbreaks the association with milk was not confirmed bacteriologically, probably because the organism is difficult to isolate from milk and milk filters, but there was strong epidemiological evidence implicating the milk. Twenty outbreaks associated with milk were reported between 1978 and 1980, but in six of these the evidence implicating the milk was considered inadequate and they have been excluded from this analysis; of the 14 outbreaks studied, 12 were due to raw milk affecting over 450 people and two to inadequately pasteurised milk affecting over 3500 (table). The 12 raw milk outbreaks showed a seasonal incidence, eight taking place between March and June; most were in the north of England. Of the two outbreaks due to inadequately pasteurised milk, one affected over 3500,⁵⁰ including about 2500 school children⁵¹; in the other of 30 cases the milk was probably contaminated when it was transferred to unsterilised containers.

Escherichia coli enteritis

One outbreak of two cases in 6-month-old infants was probably due to *Escherichia coli* 026; they developed gastroenteritis soon after weaning when untreated cows' milk was substituted for reconstituted dried milk. Six heifers from the dairy herd supplying the milk were found to have mastitis, and *E coli* 026 was isolated from the milk of one of them.⁵²

Brucellosis

No large outbreaks of brucellosis due to milk were reported, although four small incidents were recorded. The first in August 1960 was a single case in a man who regularly consumed untreated milk⁵⁵; the second was an outbreak affecting eight people who had consumed raw milk between October 1962 and early 1963⁴⁰; the third in October 1962 was a single case of infection with *Brucellosis abortus* type 5 in a 12-year-old boy who had consumed raw milk⁵⁶; the fourth incident of two cases in a farmer and his wife was in 1971. In all four incidents there was evidence of infection in the dairy herds. Twenty laboratory reports of single cases of brucellosis between 1975 and 1980 mentioned the consumptions of raw cows' milk as the possible source of infection, and in a further 12 cases the infection was thought to be due to milk or animals. Most cases of brucellosis, however, are occupationally associated with cattle, and it is difficult to prove that milk was the primary source of infection.^{4 57}

Q fever

One milk-borne outbreak of Q fever reported in Staffordshire in April 1967 affected 29 people supplied with raw milk from a farm where two of 20 cows were found to be excreting *Coxiella burnetti* in their milk.⁴² In the early 1950s 23 sporadic cases were reported in Kent,⁵⁸ and between 1975 and 1980 12 of 640 laboratory reports of Q fever indicated a possible association with raw milk.

Diphtheria

Between 1951 and 1980, there were no cases of diphtheria due to milk, but four incidents of infection with *Corynebacterium ulcerans* were reported. One of these was a girl aged 12 in 1969 who had consumed raw milk; churn samples from the herd were shown to be contaminated; the other three comprised two single cases and a husband and wife. All presented with mild sore throat with membrane; in two of the incidents *C ulcerans* was isolated from the milk.⁵⁹

Tuberculosis

Only one small outbreak of tuberculosis due to raw milk was reported before eradication from cattle was completed. This took place

in 1959 and affected three schoolchildren; altogether 10 of 46 children in the school were found to be tuberculin positive.²¹ It was not possible to determine the incidence of sporadic cases because notified non-respiratory tuberculosis does not distinguish between disease caused by *Mycobacterium bovis* and *M. tuberculosis*. A study of laboratory reports of isolations of *M. bovis* in 1979 and 1980, however, showed no cases that had acquired the infection recently in the United Kingdom.

DAIRY PRODUCTS

Forty-three outbreaks of communicable disease attributed to dairy products affected at least 877 people (table); nine were due to cream, nine to ice cream, 23 to cows' milk cheese, one to sheep cheese, and one to goat cheese. No outbreaks were attributed to butter or to other dairy products and none to sheep or goat milk. Incidents associated with sweets and cakes containing cream or dairy products have been excluded from this analysis.

Cream

There was one outbreak of salmonella food poisoning in 1969, six of staphylococcal food poisoning between 1951 and 1959, one of *Bacillus cereus* food poisoning in 1975, and one of unknown cause in 1954.

An outbreak of food poisoning caused by *Staph. anatum* affected 55 people in 1969 and was thought to have been due to tinned pasteurised cream that was probably contaminated after the tin was opened. Of the six outbreaks of staphylococcal food poisoning, one was due to fresh cream, four to clotted cream, and one to skimmed cream. Over 100 people were affected in the outbreak due to fresh cream; *Staph. aureus* was isolated from the cream which had been stored in an open container kept in a warm kitchen; two of the clotted cream outbreaks and the outbreak due to skimmed cream were due to cream made from the milk of a cow with symptomless *Staph. aureus* mastitis¹⁹; the other two outbreaks due to clotted cream took place earlier and were not related. The outbreak of *B. cereus* food poisoning (2 cases) was due to pasteurised cream; the organism was isolated from the opened carton and another unopened carton, but it was not known how the cream had become contaminated.

Cheese

Of 23 outbreaks associated with cheese made from cows' milk, 22 were reported between 1951 and 1965 and affected at least 563 people. The one outbreak reported since 1965 was due to Rumanian cheese in 1972.

Staph. aureus caused 16 outbreaks affecting 507 people; six outbreaks involved New Zealand cheddar cheese, two of them in hospitals,³⁸ two Australian cheddar cheese, one canned cheese from America, one farmhouse cheshire, one homemade soft cheese, one Stilton, one Rumanian hard cheese, and three cheeses made on a Scottish farm, probably from unpasteurised milk. In 10 of the outbreaks contamination probably occurred during manufacture, in one New Zealand cheddar cheese was thought to have been contaminated in the United Kingdom, and in five the source was not known.

There were two salmonella outbreaks; in one *S. typhimurium* affected five people who became ill after eating curds made at a farm and in the other *S. bovis-morbificans* affected a family who ate cheese from France. There were five other outbreaks; in one of them two people were ill after eating Gorgonzola cheese from which enterococci group D were isolated; in another, also of two cases, Camembert cheese, from which a heavy growth of *Proteus* was obtained, was suspected³⁹; in three outbreaks no organism was found.

One outbreak due to sheep cheese caused by *B. melitensis* type 2 affected seven people after eating Italian Pecorino cheese made from unpasteurised milk,⁴¹ and one due to goat cheese caused by *S. typhimurium* affected six students who developed diarrhoea and vomiting 12-18 hours after eating Turkish goat cheese in brine.

Ice cream

Between 1951 and 1954, nine outbreaks due to ice cream were reported, four of which were due to salmonellas, one to *Staph. aureus*,

and in four the cause was not discovered. No outbreaks were reported after 1954. In five outbreaks only two to four children were affected, suggesting that contamination occurred during retail distribution,⁵ but in a large outbreak affecting 100 of 240 people at risk contamination may have occurred before distribution, although no causative organism was isolated and this was not confirmed. The outbreak due to *Staph. aureus* affected eight people and may have been due to ice cream made from a "cold mix."¹⁰ In none of the incidents was there a record of whether or not it was dairy ice cream.

Discussion

This review of communicable disease associated with milk and dairy products in England and Wales between 1951 and 1980 shows that there were 233 recorded outbreaks, but this figure probably underestimates the true incidence because outbreaks may be unrecognised and if identified may not be reported. Salmonellosis and campylobacter enteritis due to raw or defectively heat-treated milk are now the most important diseases and, indeed, outbreaks may be increasing in frequency (table). No outbreaks due to ice cream were reported after 1954, showing the efficacy of the introduction of statutory heat treatment of ice cream in 1947.⁶⁰ Cheese, cream, and other dairy products and sheep and goat milk and their products no longer appear to be a hazard, probably because most of them are heat treated; however, sales of raw goat milk are increasing and unpasteurised dairy cream and soft cheeses are still available, all of which present a potential risk.

Four main changes in milk-borne salmonellosis were observed: (1) there was a more than fivefold increase in reported outbreaks from 13 between 1951 and 1960 to 72 between 1971 and 1980 (table); (2) the average number of people affected in outbreaks declined from 87 between 1951 and 1960 to nine between 1971 and 1980, so that the total number of people affected in outbreaks fell; (3) the seasonal distribution of outbreaks changed, a greater proportion taking place in the autumn and winter; and (4) the causative organisms changed, outbreaks due to *S. typhimurium* increased, outbreaks due to *S. dublin* declined and those due to other serotypes showed a notable peak in 1973 and 1974 (fig 1). Similar changes were reported in Scotland,⁶¹ but in the 1970s the number of cases as well as the number of outbreaks increased in Scotland, probably because a greater proportion of the population consume raw milk (about 10% compared with about 3% in England and Wales) and the individual producer-retailers of milk in Scotland have on average a larger distribution than in England and Wales. The seasonal pattern of outbreaks may be due to greater animal "stress" in the winter months,⁶¹ to the predominance of autumn and winter calving after which the lactating animals are more susceptible to infection, and to housing of the animals at this time of year rather than free grazing. Sharp and his colleagues⁶¹ directed attention to the similarity between the changing pattern of salmonella serotypes in milk-borne salmonellosis and the pattern in reported incidents of bovine salmonellosis. Particularly notable was the 1973-4 peak of outbreaks in England and Wales due to serotypes other than *S. typhimurium* and *S. dublin*; a similar peak of bovine salmonellosis took place in these years after the distribution of contaminated animal protein in cattle feed.⁶²⁻⁶³ Although the pattern of serotypes in bovine salmonellosis was reflected in human milk-borne disease, there was no overall increase in incidents in cattle to explain the increase in milk-borne outbreaks. This increase is probably partly spurious due to improved reporting, but the large size of the increase and the constant upward trend suggest that there has been a real increase. Sharp and his colleagues⁶¹ described changes in dairying practice such as pipeline systems and bulk tank collection that increase the risk of any contamination, if it does occur, affecting the whole supply. These changes may have contributed to the rise in outbreaks of human disease.

Milk-borne outbreaks of campylobacter enteritis, although only recently recognised, are likely to have taken place in the past; it is surprising, therefore, that so few outbreaks of unknown

cause were reported between 1951 and 1978; only five outbreaks, three due to raw milk and two to pasteurised milk were recorded in the 1950s (table). This is probably because it is difficult to identify outbreaks of unknown cause and because even if recognised they are unlikely to be reported by laboratories, although it is possible that outbreaks of milk-borne campylobacter enteritis may be increasing.

In 1975 the Ministry of Agriculture Fisheries and Food proposed to phase out the sale of untreated milk in the United Kingdom⁶⁴ to prevent the risks to public health reviewed in this paper. Legislation will bring this into effect in Scotland in 1983 but in England and Wales regulations made in 1980⁶⁵ permit the continued sale of farm-bottled untreated milk. If milk-borne outbreaks of salmonellosis and campylobacter enteritis are increasing, as we suggest, this failure to introduce universal heat treatment of milk throughout the United Kingdom may prove to be a costly mistake in terms of human health.

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