Case 203.—Born in 1911. Started work as a carrier in 1924 for a firm loading lime, cement, tea, and sugar. In 1926 moved to work as storeman to a builder's merchant. Again exposed to lime and cement dust. From 1936 to 1964 worked principally as a plasterer. The histology of this tumour is not known. He never took snuff.

Case 204.—Born in 1898. After working as a packman's boy (1910–12) and an apprentice slaughtering (1912–14), and serving in the Army (1914–17), he worked as a labourer for grain merchants (1917–36) and was exposed to the dust of cereals and beans. From 1946 to 1961, when an anaplastic carcinoma was diagnosed, he worked in the quarry of a cement works but was not much exposed to dust. He never took snuff.

Case 205.—Born in 1896. Started work as a baker's assistant in 1908 and was exposed to flour dust until he left to work at an Army depot in 1914. After service in Army worked at a power station unloading coal trucks (1919–25) and later as boilerman, stoker, and storeman (1925–60), when he was exposed to coal dust and ash. A transitional cell tumour was diagnosed in 1960. He never took snuff.

The Oxford Regional Cancer Registry was the principal source of the data reported in this paper and we gratefully acknowledge

the assistance of Miss C. Hunt and her staff. We are also grateful to the following for supplying valuable information: Mr. G. Rose, Secretary of the High Wycombe Furniture Manufacturers' Association; H.M. Medical Inspectorate of Factories; the Registrars of Births, Deaths, and Marriages for High Wycombe and Banbury; the Registrars General for England and Wales; and the directors and managers of several furniture factories in the area. We also wish to acknowledge the help of the staff of the Birmingham Cancer Register, the South-West Regional Cancer Register, the North-East and North-West Metropolitan Cancer Registers, and the Register of the South-West Metropolitan Cancer Region. Finally we wish to thank the patients and their relatives who took time and trouble to supply occupational histories.

REFERENCES

- Acheson, E. D., Hadfield, E. H., and Macbeth, R. G. (1967). *Lancet*, **1**, 311.
 Doll, R. (1958). *Brit. J. industr. Med.*, **15**, 217.
 General Register Office (1966). *Census of England and Wales, 1961*.
 Hems, G. (1967). *Brit. J. Radiol.*, **40**, 506.
 Macbeth, R. (1965). *J. Laryng.*, **79**, 592.
 Oxford Regional Hospital Board (1966). *Cancer in the Oxford Region, 1953–62*.
 Weil, C. S., Smyth, H. F., and Nale, T. W. (1952). *Arch. industr. Hyg.*, **5**, 535.

Brucella abortus in Fresh Cream and Cream Products

G. I. BARROW,* M.D., M.C.PATH., DIP.BACT.; D. C. MILLER†; D. L. JOHNSON,‡ M.R.C.S., L.R.C.P., D.P.H.
 C. W. J. HINGSTON,§ M.R.C.S., L.R.C.P., D.P.H., D.T.M.&H.

Brit. med. J., 1968, **2**, 596–601

Several samples of cream were examined in addition to milk from herds of cows and goats when seeking the source of brucella infection in two children. The source of these infections was not established, but the samples of heat-treated creams were of poor bacteriological quality. They reduced methylene blue rapidly, contained large numbers of faecal coliform organisms, and showed considerable phosphatase activity. Bacteriological examination of further samples of cream gave similar results. In view of these findings a survey of fresh cream and cream products was undertaken. The laboratory results obtained in this survey, in which 1,161 samples of cream were examined bacteriologically for keeping quality and hygiene, have been described elsewhere (Barrow and Miller, 1967). During the survey *Brucella abortus* was isolated from routine samples of cream or cream products from five different processing dairies. Though it is well known that brucella organisms may be present in milk, and that they usually become concentrated in the cream, we are not aware of any investigations into the presence of *Br. abortus* in cream or cream products. In view of this, and of the current interest in brucellosis in both man and animals, we describe in this paper the circumstances associated with these isolations of *Br. abortus* from creams, together with details of the subsequent investigations.

This account illustrates some of the public health hazards associated with cream, and indicates the need for more frequent sampling, for minimum bacteriological standards, and for improved legislation similar to that at present required for milk and ice-cream.

Bacteriological Methods

Hygiene and Keeping Quality.—All the samples of cream were examined by the methylene blue reduction test and the phosphatase test: the numbers of viable bacteria, coliform organisms, and faecal coli present were also determined. The methylene blue reduction test, volumetric method, described for

cream by a working party of the Public Health Laboratory Service (1958) was used. Phosphatase activity was determined by the Aschaffenburg–Mullen method, as described in the Milk (Special Designation) Regulations, 1963 (Great Britain, 1963). Quantitative estimations of the numbers of coliform organisms and of *Escherichia coli* type 1 present, if any, were made by both surface and pour-plate methods with MacConkey agar medium. Most of the strains of presumptive faecal coli were confirmed as *E. coli* type 1 by their biochemical reactions. The total numbers of bacteria present were estimated by the method of Miles and Misra (1938) with blood agar medium. Further details of the techniques used are given by Barrow and Miller (1967).

Direct Culture for Brucella abortus.—Because of poor initial results with the tests of keeping quality and hygiene, all samples of creams, irrespective of heat treatment, were cultured for *Br. abortus*, usually within one hour of receipt in the laboratory. The samples of cream were stirred with cotton-wool swabs or with wooden spatulae, previously sterilized in bulk. Each swab was rubbed over the surface of one plate of brucella agar medium in a suitably vented Petri dish. The inoculated plates were incubated in an atmosphere of CO₂ at 37° C. for four to five days. The selective brucella agar medium used and the procedure for incubation in CO₂ were the same as those described by Barrow and Peel (1967). Colonies of brucellae were identified by their appearance, sensitivity to dyes, and slide agglutination reaction with antiserum. They were confirmed subsequently by type-identification; all were *Br. abortus* type 1.

Enrichment Culture and Guinea-pig Inoculation.—In addition to direct culture for brucella organisms, some of the

* Director.

† Senior Technician, Public Health Laboratory, Royal Cornwall Hospital (City), Truro, Cornwall.

‡ Medical Officer of Health, Boroughs of Penzance and St. Ives, St. Just Urban District, and West Penwith Rural District.

§ Medical Officer of Health, Truro City, Truro Rural District, and Boroughs of Falmouth and Penryn.

samples of liquid whipping creams were also examined by a brucella broth enrichment technique and by guinea-pig inoculation. The selective broth, in universal containers, was inoculated with approximately 1 ml. volumes of cream from the samples. After addition of CO₂, the bottles were incubated at 37° C. and subcultured on three occasions at weekly intervals on to brucella agar medium. Guinea-pigs were inoculated with 1 ml. of cream in each thigh. They were killed five weeks later; the spleen and heart blood were examined by both direct and enrichment techniques for brucella organisms, and agglutination tests with standard Public Health Laboratory Service brucella antigens were performed on the sera.

Isolation of *Brucella abortus*

Br. abortus was isolated by direct culture from five different samples of clotted cream; and on two separate occasions—which involved different producers—from whipped cream from a total of four fresh-cream cakes. In the subsequent investigations of the two cream-cake incidents 19 further isolations of *Br. abortus* were made from various other samples of cream. Of these isolations eight were made by direct culture, two by both direct culture and guinea-pig inoculation, seven by both enrichment culture and guinea-pig inoculation, and two by guinea-pig inoculation only. Serological evidence of infection was also obtained from all guinea-pigs from which *Br. abortus* was isolated, but not from any others.

Clotted Cream

The first isolation of *Br. abortus* was made in March 1966 from a sample of clotted cream. This was purchased from a retail dairy, and was in a waxed carton sealed with a close-fitting overlapping foil top. This dairy received bulk supplies of clotted cream from a producer. The cream was then dispensed and sealed by the dairy in the waxed cartons. The general hygiene of the dairy needed improvement, and on balance it was assumed that the clotted cream had become contaminated with raw milk at the dairy, even though we were assured that no raw milk was handled on the premises. The producer was informed, but was not inspected at this stage. The possibility that the producer was responsible was not seriously entertained, though subsequent events indicated that this could have been the case.

The second isolation of *Br. abortus* was made in June 1966 from another sample of clotted cream from a different producer. This was obtained from a café which sold cream, and it was in a waxed carton sealed with a close-fitting overlapping foil cap. It was processed and prepacked by a producer in another county. Despite numerous inquiries no satisfactory explanation for the presence of brucella organisms was received. This dairy has now ceased to produce clotted cream, and has been taken over by another firm as a distribution centre for its own clotted cream.

Br. abortus was again isolated later in June 1966 from two samples of clotted cream taken at the same time from yet another producer. One sample was in a retail waxed carton with a machine-sealed overlapping foil top, and the other was taken direct from a bulk tray of clotted cream in a refrigerator on the producer's premises. Subsequent inspection of this establishment, which was well run, gave no direct indication of the mode of contamination. The production of the clotted cream was such that the heat-treatment process should have been adequate, but there were loopholes in supervision and there was a definite possibility that subsequent contamination of the clotted cream with raw milk or cream could have occurred unwittingly. This dairy now uses only pasteurized milk for cream processing.

Br. abortus was isolated from clotted cream in one further instance in July 1967. There was some doubt about the exact origin of this cream, but it could have been processed by the same producer concerned in the first isolation in March 1966. This sample was in a waxed carton, again sealed with a foil cap which bore the name of the retail shop from which the cream had been purchased: no packaging was done on these premises, the shop receiving its supply of prepacked clotted cream from a distribution depot some 40 miles (64 km.) from the producer. This depot, as well as receiving prepacked cartons of clotted cream for distribution, also received large bulk supplies of clotted cream for packaging. This was dispensed into similar cartons and sealed with similar foil caps. Both these supplies formed a common pool of cartons of clotted cream from which distribution was made. It was not possible to determine indisputably whether the carton containing the brucella-contaminated sample was packed in the producer's premises or at the subsidiary depot.

Comment

These five brucella isolations from clotted cream from three different producers represent all the isolations made from 916 samples. In the production methods observed separated raw cream was usually processed in shallow open trays partially suspended in steam-heated water until the surface of the cream assumed a thick wrinkled appearance. The fat content, the depth of cream in trays, and the time-temperature combinations varied considerably from one producer to another, and resulted in products with different characteristic flavours and textures. In practice these methods usually destroy the organisms responsible for souring and off-flavours, and pathogens should therefore also be killed. Environmental conditions, however, varied, and information about the actual temperatures attained in cream during heating was difficult to obtain. One producer stated that the cream was held at 180° F. (82° C.) for about 45 minutes; at another dairy temperatures taken repeatedly by us with a standard thermometer over a period of one hour ranged from 135 to 180° F. (57 to 82° C.) in different trays of cream. There was also a temperature differential within trays, particularly large trays, and the survival of certain organisms in some circumstances cannot be completely excluded. The use of pasteurized cream for processing, subsequently introduced by one manufacturer, would eliminate this hazard, but it would not lessen the risks of contamination of clotted cream during the slow cooling or during packing and bulk distribution.

Though four of the five samples of clotted cream which yielded *Br. abortus* were handled only by the producers, there was no conclusive evidence to indicate whether the organisms survived during heat treatment or were introduced afterwards. All five samples, however, showed considerable phosphatase activity (>42 µg. of *p*-nitrophenol per ml.); all contained *E. coli* type 1, four of them in 0.1 ml.; and only one sample failed to reduce methylene blue in less than two hours.

Liquid Creams

The survey showed that in addition to clotted cream there were several different types of fresh liquid creams available, known in the trade as "market creams." These include "double cream," which has a cream-fat content of 48%, "whipping cream," which contains 40% fat, and "single" or "coffee cream," which contains 18% fat. In addition, in this area a number of dairies prepare other creams with different fat contents to special local order. These market creams are all prepared by dilution of the separated cream with skimmed or whole milk. In the two dairies investigated this was always done before pasteurization, and we understand that this is normal practice in the dairy industry.

Episode 1

It became apparent during the course of our investigations that in this area when "fresh cream" is requested at a shop clotted cream was normally supplied. In view of this we suggested that some products known to contain "liquid" cream should be sampled. As a result, one cream doughnut purchased from a confectioner in May 1966 was examined. *Br. abortus* was isolated from the whipped cream in the doughnut; this cream decolorized methylene blue within one hour, contained faecal coli in 0.1 ml., and showed considerable phosphatase activity. This isolation of *Br. abortus* was followed up at both the bakery and the dairy concerned.

The bakery was at the rear of the confectionery shop. The manager, who was most co-operative, stated that fresh heat-treated whipping cream supplied by a large producer was used in all his cream confectionery. He ordered his requirements each day. The cream was delivered in cans at about 7 a.m. on the next day and was used almost immediately. It was whipped by machine, air was blown through to increase the volume and to give it a light texture and appearance, and it was then used to fill cakes. The cans of cream were always completely used on the day of delivery and there was no question of admixture with other milk or cream. Though clotted cream was also sold over the counter, contamination of the cream cakes in the shop itself was most unlikely.

The confectioner still had the four empty half-gallon (2.3-litre) cans of whipping cream which had been delivered and used that morning. These were "non-returnable" cans with push-in lever lids; from the cream remains in three of the four cans *Br. abortus* was isolated. Since this cream was heat treated at a large dairy, the possibility of inadvertent contamination of the cream at the bakery was considered, but the premises and equipment were of a high standard, the manager was hygiene conscious, and the routine in the bakery provided little for serious criticism on bacteriological grounds. The manager readily agreed to keep one can of cream intact on the following morning until we had sampled the cream. This was done, and *Br. abortus* was isolated. Further samples were taken on a number of occasions from this bakery, and from three other bakeries supplied by the producer concerned. *Br. abortus* was isolated from two intact and six opened half-gallon (2.3-litre) cans of whipping cream out of 11 cans examined, and from one sample of whipped cream ready for use. All the samples of whipping cream taken from the bakeries, as well as the whipped cream in the original cakes, showed considerable phosphatase activity, all contained *E. coli* type 1, and most of them decolorized methylene blue during preincubation at 20° C.

In view of these findings there seemed to be no doubt that, despite heat treatment, brucella-contaminated cream was being supplied by the producer to this bakery, and also to numerous other establishments.

Milk was received by this producer from a wide area, and included milk diverted from brucella-infected herds for heat treatment. It was pooled and used for bottling, for transport in bulk to other centres, and for processing into a number of dairy products, including liquid and clotted creams. For making cream the pooled milk was prewarmed to about 108° F. (42° C.) before separation of the cream by centrifugation. For liquid creams the separated raw cream was pumped into a vat and the fat content then standardized to 48–50% ("double cream") by dilution with whole milk, usually pasteurized, but occasionally raw. After standardization the required amount of this cream, usually about 20 gallons (91 litres), was flash-heated to 185° F. (85° C.) by pumping it at a constant rate through a heat exchanger. A recording thermometer was fitted to the heat exchanger, but there was no flow-diversion valve in the circuit. The heat-treated cream, cooled to about 45° F. (7.2° C.), was conveyed to a small stainless steel container, from which 1- and 2-pint (0.5- and 1-litre) waxed cartons as

well as half- and one-gallon (2.3- and 4.5-litre) non-returnable cans were filled by means of a tap.

The standardized raw cream remaining in the vat was then further diluted with whole milk to give "whipping cream" with a fat content of 40%. The whipping cream, usually about 50 gallons (227 litres), was flash-heated, processed, and packed in cartons and cans in the same way as the double cream. The remainder of the raw whipping cream in the vat was then diluted with whole milk to give "coffee cream" with a fat content of 18%. This was also heated and processed in the same way. The cartons and cans of the three types of liquid cream were kept at 4° C. for distribution the next day.

In subsequent discussions the possibility that the cream might have become contaminated with raw milk or cream after heat treatment was excluded. The high phosphatase content and the presence of coliform and brucella organisms in the whipping cream sampled at bakeries shortly after delivery were therefore presumably due to inadequate heat treatment, though according to the thermograph records a temperature of 185° F. (85° C.) had apparently been attained. Because of this the manager of the dairy immediately agreed to raise the temperature of heat treatment to 190° F. (88° C.), and to submit samples of cream taken after heat treatment to the laboratory. Further samples of cream were also obtained from bakeries. Numerous such samples of cream have since been examined; most of them showed minimal phosphatase activity and the majority gave low bacterial plate counts and were free from coliform organisms, thus confirming that the actual temperature attained previously during heat treatment of the cream had been inadequate. No further isolations of *Br. abortus* have been made from liquid creams from this dairy, though the sample of clotted cream which yielded brucella organisms in July 1967 was probably processed by this producer.

Episode 2

In September 1966 *Br. abortus* was again isolated from three of six fresh cream cakes bought from a confectioner in another local authority area. The cream from these cakes all showed some phosphatase activity (>25 but <42 µg./ml.), contained large numbers of enterococci, and decolorized methylene blue during preincubation at 20° C.; two also contained faecal coli in 0.1 ml. As a result of these brucella isolations detailed investigations were made at the bakery concerned. The confectionery section of the bakery was at the rear of the shop. Though space was limited, the bakery routine was efficient, production was large, and the manager, who was most helpful, was hygiene conscious. As in the previous episode, he ordered his large-scale requirements of whipping cream, ranging from four to seven gallons (18 to 32 litres), each day. It was obtained from a producer different from the one concerned in the previous episode. The whipping cream, which was heat treated and had a fat content of 40%, was delivered at about 6.30 a.m. in returnable one- and two-gallon (4.5- and 9-litre) cans with push-in lever lids. Some of this cream was whipped and used immediately in cakes; the rest of the cream, in unopened cans, was kept at 4° C. in a refrigerator in the bakery until needed. Whipping was done by a whisking machine, but air was not blown through the cream. Cream not used that day in cakes was boiled with chocolate and used in the preparation of other confectionery. Any fresh cream cakes not sold in the shop were given to the staff at the end of the day.

Samples were taken with sterile spoons from one unopened can of cream and from whipped cream ready for use in cakes. *Br. abortus* was isolated from both of these samples. *Br. abortus* was again isolated from a further sample taken three days later from another unopened can of whipping cream. In view of these findings and our experience in the previous episode, the cream producer was investigated immediately.

This dairy received milk only for the production of clotted and liquid creams. Untreated milk, delivered by tanker, was

pumped into a large storage vat. The raw cream, separated directly into churns as required, was used for the preparation of both liquid and clotted creams; these two processes were carried out in different sections of the dairy. The various liquid market creams were prepared and heat treated individually. The separated raw cream was poured from the churns into a steam-heated pasteurizing vat fitted with a lid, paddle agitator, and a recording thermometer. The cream was diluted with the raw skimmed milk, poured from churns, to give the appropriate fat content. The diluted cream was then heated, with agitation, in the pasteurizing vat to 148° F. (64.5° C.), and this temperature was maintained for 30 minutes. The heat-treated cream was drawn off by means of a tap into churns. After in-churn cooling to about 50° F. (10° C.) the cream was ladled from the churns into market cans. These cans were refrigerated at 4° C. overnight for ageing of the cream and were distributed early in the morning.

Numerous potential sources of error were found. The general layout and surroundings of the dairy were far from ideal and there was considerable room for improvement both in the premises and in some of the equipment used. The arrangements for some procedures were not satisfactory; the washing of cans and much of the smaller equipment, for instance, was carried out near the pasteurizing vat. In addition, general hygiene left much to be desired. A number of samples were taken during this and subsequent visits to the dairy, and the following actual instances in which *Br. abortus* was isolated provide good examples.

(1) The unwashed empty cans returned from bakeries after use were allowed to accumulate in the dairy. *Br. abortus* was isolated from the stale cream remains in one such can. The cans were washed as required by rinsing in hot water, without the addition of a detergent or disinfectant, in open galvanized metal troughs, situated near the pasteurizing vat. The washed cans were then stacked upside down to dry in an unheated metal cupboard, and a cream residue was still present in many of the washed cans.

(2) A sample of milk taken at the dairy from the bulk raw milk supply was found to be heavily infected with *Br. abortus*. After separation direct into churns the raw cream from this milk was carried to the pasteurizing vat. It was then diluted by pouring in the skimmed milk, carried in similar churns, to give the appropriate fat content. The churns were washed in hot water and then left standing beside the vat. After heat treatment the cream in the vat was drawn off by pipe into the same churns. *Br. abortus* was isolated from the remains of pasteurized cream taken from one such churn. This sample of cream residue also reduced methylene blue during preincubation at 20° C., showed phosphatase activity, and contained *E. coli* type 1.

(3) The pasteurizing vat was heated by direct steam and was fitted with a recording thermometer only, suspended through the lid of the vat and immersed in the cream. At the time of inspection the recording thermograph marker was broken, and we were told that a replacement part had been on order for several weeks. During this time the temperature of the cream was determined by visual inspection of the thermograph arm against a chart. This was said to have been done by one person keeping watch continuously and manually adjusting the heat controls when necessary. The cream was heated to 148° F. (64.5° C.), and this temperature was said to be maintained for a minimum of 30 minutes, but no records were kept. *Br. abortus* was isolated from a sample of whipping cream taken from this vat after heat treatment, which had been completed just before our arrival. This sample of cream also reduced methylene blue during preincubation at 20° C., showed phosphatase activity of 42 µg./ml., and contained *E. coli* type 1, thus indicating that the heat treatment of that particular batch of cream had been grossly inadequate.

As a result of our visits, and in view of our experience in Episode 1, the temperature for heat treatment of the cream in the vat was raised from 148° F. (64.5° C.) to 158° F. (70° C.), as judged by the thermograph arm, for a minimum of 30 minutes. The procedures for the washing of cans and equipment were improved, and in addition several routine hygiene precautions were recommended. Subsequently a steam chamber was installed and used for other equipment, and the drying cupboard was fitted with a heating system. Samples of cream

from this dairy and from bakeries for some months afterwards were all of good bacteriological quality, and no further isolations of *Br. abortus* have been made.

Discussion

The brucella investigations described in this paper arose during the course of a survey of the bacteriological quality of fresh cream and cream products in Cornwall (Barrow and Miller, 1967). That *Br. abortus* should have been isolated at all from heat-treated cream and cream products is surprising; that so many brucella isolations should have been made after examination of fresh cream cakes is most disturbing. Whatever the pathogenicity of *Br. abortus* for man, its presence in milk or milk products for human consumption, particularly after heat treatment, is clearly unsatisfactory, and the findings recorded in this paper suggest that closer attention should be paid to cream.

The two episodes in which *Br. abortus* was isolated from fresh cream cakes involved different bakeries and different cream producers. In both instances the results of bacteriological investigations at the bakeries directed our attention to the cream producers. In the first episode the dairy concerned was modern, well run, and the heat-treatment procedure used had been thought to be satisfactory. Since the possibility of contamination with raw milk or cream after heat treatment was excluded in discussion, it can only be assumed that either the thermograph was recording inaccurately or some brucella organisms in the cream were able to withstand the flash heating to 185° F. (85° C.). Though the thermograph was checked regularly, the high phosphatase activity and the presence of coliform organisms and *E. coli* type 1 in many of the samples of whipping cream also suggested that the heat treatment given was inadequate. When the temperature of heat treatment was raised to 190° F. (88° C.) the processed cream showed minimal phosphatase activity and was free from coliform organisms, thus confirming that the heat treatment given previously had been inadequate. Numerous subsequent samples of liquid creams produced by this dairy have in general been of good bacteriological quality.

In the second cream-cake episode the conditions in the dairy concerned, which had a large output of cream, were not ideal. The creamery premises were converted from old buildings, and they were altered as necessary to suit production requirements; space was limited and the layout was not satisfactory. The dairy was also associated with a café and a piggery, which was in close proximity to the creamery. Much of the equipment used in cream-processing had previously been employed in the production of ice-cream and other products. After separation, cream was distributed to processing points within the dairy in churns, the hygiene and cleansing of which needed improvement. For the processing of liquid creams the separated cream was diluted in a steam-heated vat by the addition of skimmed milk to give the appropriate fat content.

Though temperature recordings are not required for the heat treatment of cream, an accurate means of checking the temperature is obviously desirable. In this dairy the heat-treatment temperature of 148° F. (64.5° C.) was determined arbitrarily, with subsequent manual adjustment of the heat controls, and human errors clearly occurred from time to time. The manager agreed to several immediate improvements in general hygiene, and, as a safety measure, the temperature of heat treatment was increased to 158° F. (70° C.) for at least 30 minutes. These measures were immediately followed by an improvement in the bacteriological quality of the cream, which was free from coliform organisms and showed minimal phosphatase activity. Subsequent samples of cream produced by this dairy have in general been satisfactory.

As the heat treatment of whipping cream in both these dairies was thought to be adequate until our investigations, it

must be assumed that brucella-infected cream had been supplied to a number of bakeries and hotels from time to time. These two producers were the source of many of the samples of liquid creams examined in the survey of fresh cream and cream products in Cornwall by Barrow and Miller (1967). Inadequate heat treatment, therefore, was presumably one of the causative factors concerned in the poor results obtained.

Other Surveys

In their survey of fresh cream in Worcestershire, Colenso, Court, and Henderson (1966) isolated *Br. abortus* from 3 out of 34 retail samples of raw creams, but they did not examine heat-treated creams for brucella organisms. In the present paper, however, we also record the isolation of *Br. abortus* from 5 out of 916 samples of clotted creams. The presence of brucella organisms in these samples was again presumably due to either contamination after the clotting process, possibly with infected utensils, or to their survival during heat treatment. Clotted cream is traditionally made either by heating thick cream in shallow trays until the surface assumes a typical wrinkled appearance or by heating whole milk in open pans and skimming off the clotted cream after cooling. In each method the cream should reach a temperature of about 180° F. (82° C.) and remain near this temperature for some minutes. The cooling process, however, is slow and may therefore provide opportunities for subsequent contamination. Indeed, the poor results of tests of keeping quality and hygiene given by many of the samples of clotted creams examined by Barrow and Miller (1967) suggested such contamination, presumably due to handling during packing.

Apart from phosphatase activity, the 1,161 samples of liquid and clotted creams examined in this survey gave results in general similar to those of Colenso *et al.* (1966) in Worcestershire, and also to those in a bacteriological study of fresh cream by a working party of the Public Health Laboratory Service (1958). In these three investigations a general correlation was observed between the methylene blue reduction times and the total numbers of bacteria present, including coliform organisms and *E. coli* type 1. The phosphatase test results, however, in the survey of Barrow and Miller (1967), in contrast with those of Colenso *et al.* (1966) and the working party (Public Health Laboratory Service, 1958), showed surprisingly little correlation with the results of any of the other tests performed.

In the survey of Barrow and Miller 305 out of 916 samples of clotted creams showed minimal phosphatase activity (<6 µg. *p*-nitrophenol per ml.), thus confirming that heat treatment of these creams had been adequate. Indeed, clotted cream made by one dairy from flash-heated pasteurized cream, which was subsequently preheated in churns before clotting, gave consistently negative phosphatase results. Phosphatase activity of 42 µg. *p*-nitrophenol per ml. or more was, however, present in 464 samples, and it is difficult to reconcile this with adequate heat treatment. Since there is a considerable temperature differential in cream in trays during clotting, the survival of some brucella organisms, possibly within leucocytes insulated by thick cream, cannot be entirely dismissed. When they do occur in heat-treated cream, they may well survive for a considerable time. In laboratory experiments we have recovered *Br. abortus* from artificially infected creams after 27 days at 4° C., and after 23 days at room temperature.

Regulations

Administratively cream is still regarded with less respect than milk, though it is no longer a luxury commodity. Neither milk nor cream, however, is "food" within the meaning of the Food Hygiene (General) Regulations, 1960 (Great Britain, 1960). Cream is also excluded from the Milk (Special Designation) Regulations, 1963 (Great Britain, 1963), which deal

specifically with licensing and with the laboratory testing of milk samples. Milk producers who retail "Untreated" milk are licensed and supervised by the Ministry of Agriculture, Fisheries and Food; and establishments selling other designated milks are licensed and inspected by food and drug authorities, usually county or county borough councils. Cream is mentioned in the Milk and Dairies (General) Regulations, 1959 (Great Britain, 1959), only by inclusion under the term "milk," and any persons dealing in cream are required to be registered, together with the premises. These regulations, which are administered by local sanitary authorities such as rural district councils, are concerned generally with hygiene and health standards in dairies; laboratory tests for samples are not specifically mentioned. Similarly heat-treatment plants for cream are not strictly controlled by legislation as are milk pasteurization plants; thermograph records and phosphatase tests, required as evidence of the satisfactory pasteurization of milk, are not therefore applicable to cream.

The results are that milk dairies receive far more attention from inspecting authorities than do cream dairies, even where a milk dairy includes a cream section, and that very few samples of cream are submitted for bacteriological examination compared with milk. The hazards to health, however, are just as great, if not greater, than with milk. They will presumably remain as long as all types of raw milk are used directly for processing into cream by a variety of heat-treatment methods which are not subject to independent scrutiny. The physical properties of some creams differ considerably from those of milk, and the combinations of time and temperature used in the pasteurization of milk may not necessarily be adequate for all creams. The pasteurization of all milk at milk pasteurization plants before processing into cream would almost certainly eliminate the brucella risk, and would probably also result in creams of better bacteriological quality.

Need for Legislation

We would regard the regular inspection of creameries and retail shops, particularly those selling cream "loose" from bulk supplies, and the submission of frequent samples of cream for laboratory examination as important. Recommended heat-treatment procedures and minimum bacteriological standards, possibly including some kind of phosphatase test, would be helpful for all concerned. The Canadian Government Specifications Board (1964), for example, require that both producer and retail samples of fresh cream should pass a phosphatase test as evidence of satisfactory heat treatment, contain no coliform organisms in 1 ml., and give a standard plate count of not more than 50,000 organisms. Similar regulations, which specify the heat-treatment procedure and which include the use of pasteurized milk for cream other than farm bottled cream, were recently introduced in Northern Ireland (Northern Ireland, 1966). Provisional standards of keeping quality, based on the methylene blue reduction test, were recommended for cream in 1958 by a working party of the Public Health Laboratory Service. Though Crossley (1948) attached great importance to the absence of coliform organisms in production control, they were present in a large proportion of the samples of heat-treated creams examined by the working party, and this was thought to indicate post-heating contamination. These organisms multiply freely in cream and their numbers in consumer samples do not therefore necessarily reflect their original content. Nevertheless, though not harmful in themselves, the presence of large numbers of coliform organisms, or even small numbers of *E. coli* type 1, in retail cream is undesirable.

In the absence of suitable standards we have found it useful to regard retail samples of heat-treated creams as satisfactory if they contained no coliform organisms in 1 ml. and did not decolorize methylene blue within four hours at 37° C.; and as fairly satisfactory if they did not decolorize methylene blue in less than two hours and contained no *E. coli* type 1. Of

the total of 1,161 samples of cream examined in the survey by Barrow and Miller (1967) only 221 and 119 samples respectively satisfied these criteria.

The findings described in the present paper suggest that closer attention should be paid to cream, and they emphasize the need for at least clear guidance for cream producers and retailers, and for the introduction of minimum bacteriological standards for samples. We would also urge that the date of production or dispatch, and whether or not heat-treated, should be clearly marked on all retail cream containers.

Summary

During a survey in which 1,161 samples of fresh cream and cream products were examined for bacteriological quality *Brucella abortus* was isolated in two separate episodes from whipped cream from four out of seven fresh cream cakes. In the subsequent investigations at the bakeries and dairies concerned 19 isolations of *Br. abortus* were made from various samples of cream. Both these episodes were due to insufficient heat treatment of the cream at the dairies. In one dairy the heat treatment given had been thought to be adequate; in the other dairy there were obvious faults and errors.

In the survey *Br. abortus* was also isolated by direct culture from 5 out of 916 samples of clotted cream. This was presum-

ably due either to survival of these organisms during heat treatment or to contamination after heat treatment.

These findings suggest that closer attention should be paid to cream as a hazard to public health, and they emphasize the need for improved legislation and for the introduction of minimum bacteriological standards for cream.

We are grateful to medical officers of health, public health inspectors, and the managers of dairies in Cornwall for help during this work.

REFERENCES

- Barrow, G. I., and Miller, D. C. (1967). *Mth. Bull. Minist. Hlth Lab. Serv.*, 26, 254.
 Barrow, G. I., and Peel, M. (1967). *Mth. Bull. Minist. Hlth Lab. Serv.*, 26, 192.
 Colenso, R., Court, G., and Henderson, R. J. (1966). *Mth. Bull. Minist. Hlth Lab. Serv.*, 25, 153.
 Canadian Government Specifications Board (1964). *Specification No. 32-GP-170C*. National Research Council, Ottawa.
 Crossley, E. L. (1948). *J. Dairy Res.*, 15, 261.
 Great Britain (1959). The Milk and Dairies (General) Regulations, 1959, S.I. 1959, No. 277. H.M.S.O., London.
 Great Britain (1960). The Food Hygiene (General) Regulations, 1960, S.I. 1960, No. 1601. H.M.S.O., London.
 Great Britain (1963). The Milk (Special Designation) Regulations, 1963, S.I. 1963, No. 1571. H.M.S.O., London.
 Miles, A. A., and Misra, S. S. (1938). *J. Hyg. (Lond.)*, 38, 732.
 Northern Ireland (1966). Marketing of Milk Products Regulations, 1966. Stat. Rules and Orders No. 204. H.M.S.O., Belfast.
 Public Health Laboratory Service (1958). *Mth. Bull. Minist. Hlth Lab. Serv.*, 17, 77.

Ineffectiveness of Propranolol in Hypertensive Jamaicans

G. S. HUMPHREYS,* M.B., B.S., M.R.C.P., M.R.C.P.ED.; D. G. DELVIN,† M.B., B.S., D.OBST.R.C.O.G., D.C.H.

Brit. med. J., 1968, 2, 601-603

It has been suggested that the β -adrenergic blocking agent propranolol is a relatively potent hypotensive agent. In order to prove or disprove this assertion 18 hypertensive Jamaicans underwent a double-blind cross-over trial, preceded by a run-in period.

Patients

Of the 18 patients six (Cases 1-6) were female and 12 (Cases 7-18) were male. Each was an urban Jamaican of predominantly negro extraction. None was on any therapy before the trial, and no other drugs were used throughout. All had been under observation for long enough to ensure that they were genuinely and consistently hypertensive. Patients with heart failure, angina, asthma, a raised blood urea, grade IV retinopathy, or nephritis were excluded from the trial. Those aged 65 and over were also excluded. All patients were between 46 and 63 years old, in practice.

For the purposes of the double-blind section of the trial patients were divided into two groups of nine, each one having a partner of the same sex, age, and, so far as possible, severity of hypertension.

Methods

The trial lasted six months and was divided into three equal terms—the initial term being for run-in purposes in view of the possible danger of side-effects at high dosage. The second and third terms formed the double-blind cross-over trial.

The run-in term was, of course, uncontrolled. Patients were started on 20 mg. of propranolol four times daily, and the dosage was gradually increased over a period of a week to 40 mg. q.d.s. It was then augmented, usually at weekly intervals, still giving four doses a day, until a maximum of 360 mg. daily was reached. From this stage onwards doses were given three times a day.

Two patients were kept at 320 mg. daily because they had become transiently normotensive. In addition, two patients had their dosages reduced to 320 mg. daily, and two others to 240 mg. daily, because of possible, but very mild, side-effects.

At the start of the double-blind terms each patient was assigned either to the drug or to an inert placebo of identical appearance and taste, the same number of tablets being given as that reached on the run-in term. Choice of therapy was made by an independent third party, who was given a list of nine pairs of ciphers and asked to assign one of each pair to the drug and the other to the placebo by random methods. At the end of the second term each patient changed over therapy for the duration of the third term. The third party was the sole possessor of the "code" until after the completion of the trial.

During the double-blind periods patients were seen at fortnightly intervals. The method of recording blood pressure was uniform throughout. Each patient was asked to lie supine for

* Consultant Physician, University of the West Indies and Kingston Public Hospital, Kingston, Jamaica, West Indies.

† Medical Registrar, Kingston Public Hospital, Kingston, Jamaica, West Indies.