the observations of Gay, suggesting either the possible mobilization or passive transfer of the tissue macrocytes. In addition, the influence, however uncertain, of the bacteriophage demands attention; in five of our series of cases it was noted that following treatment the specific organisms were undergoing bacteriophagy; recovery occurred in these cases. In four cases with a fatal termination, when it was possible to obtain the organism from a focus, there was no evidence that a bacteriophage for the causative bacteria was present. According to d'Herelle, if a bacteriophage for a micro-organism causing infection is active *in vivo*, then the prognosis becomes more favourable.

It must not be overlooked that some cases of septicaemia offer little hope from the therapeutic standpoint. The destruction of tissue in scattered lesions caused by direct bacterial action is frequently beyond functional repair; especially does this apply to lesions in the brain or heart. Particularly, an infection engrafted on a previously injured heart and giving rise to a septicaemia generally signifies a permanently damaged endocardium resulting in cardiac incompetence that no method of therapy based on immunological studies will rectify. This latter problem suggests some other method of approach, and since a subacute bacterial endocarditis with an associated bacteraemia is prone to develop in an individual with valvular lesions, then the possible prophylactic immunization of a person with a damaged endocardium by means of a polyvalent streptococcus vaccine deserves consideration.

Immunity problems of septicaemia naturally concern all the sciences represented in this Section of the Annual Meeting; possibly correlation of the results obtained through the various lines of approach, either clinical or experimental, may furnish some solution. Admittedly, up

to the present, the clearing hewed out of the gloom of immunology by Pasteur, Ehrlich, and their disciples has been well and hopefully tilled, only to produce, in septicaemia, limited therapeutic results. The quickening light afforded by the efforts of those early workers now becomes shaded with the growing clouds of doubt, and some predict barren returns from further efforts in that field. They say we must seek or make new clearings. In advancing some of these problems for discussion to-day it is with the hope that the old furrows retilled, or possibly the turning of a new furrow, may prove the field still fruitful.

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THE PLACE OF PASTEURIZATION IN A SCHEME OF MILK DISTRIBUTION.*

BY

A. S. M. MACGREGOR, M.D., F.R.F.P.S.,
 MEDICAL OFFICER OF HEALTH, GLASGOW.

THE heating of ordinary milk during distribution is generally admitted to be an imperative necessity and is in fact demanded by many city ordinances. In other quarters pasteurization is looked upon as a temporary measure, advisable under present conditions, which it will in time be possible to discard like other methods of preserving milk, and which will cease to be employed in proportion as highly organized and efficient methods of production and distribution become general. Some nutritionists take a more positive view, and think that the sooner this time arrives the better it will be for the consumers, especially children. Some of the evidence on which an opinion may be based is clear enough; in other respects, it is still in an experimental stage.

My experience leads me to adopt the view that milk supplied in bulk for consumption in large urban areas should be submitted to pasteurization by approved methods, the most powerful argument being that the menace of milk-borne infections is thereby largely eliminated, and is restricted to such relatively infrequent incidents as may cause infection during or subsequent to pasteurization. Glasgow is no exception to the general experience that the increasing practice of this procedure has caused a corresponding decline in the capacity of milk to convey specific infection to the consumer. The pasteurizing of milk is now applied to between 80 and 90 per cent. of the city's milk, while about 70 per cent. of the supply is delivered in bottles. The history of milk outbreaks of disease, where the source of infection was at the farm, is entirely concerned with this diminishing portion of unpasteurized milk in the city's general supply.

As regards the history of pasteurization, this process was first practised in Glasgow in the late nineties of last century,

when the "flash" system was introduced by the large distributors, that is, heating to about 160° F., followed by immediate cooling. Prior to this, the scalding or "scadding" of milk (to use a Scotticism) was resorted to by immersing cans of milk in open boilers at temperatures of 160° F. to 180° F., and thereafter cooling in running water. Subsequent to 1900, the rapid growth of the city demanded further supplies from greater distances, and pasteurization became more and more extensively employed to enhance the keeping qualities of the milk. The old flash system has been entirely superseded by modern methods, a change greatly assisted by the educative effect of the Special Designations Order of 1923, the transition to the positive holder type of pasteurizing machine as recommended becoming practically universal. There is a general reluctance to exceed a temperature of 145° F. and the United States standard of 142° F. is sometimes adopted.

Pasteurization grew up and was widely adopted for commercial reasons, as it augmented the keeping quality of milk. It preceded, but did not, as was sometimes feared, prevent the undoubtedly great improvements which have taken place in recent years in the standards of production of raw milk, a large proportion (at least 70 per cent.) of ordinary market milk being now comparable with that of grade "A" quality. "Those who are producing and retailing graded milk have made it clear that, with proper control, it is possible to produce and sell unheated milk successfully, even in the poorer quarters of London." This remark occurs in Research Monograph No. 1 of the Ministry of Agriculture and Fisheries (1929), and might be applied to any city. It is quoted to show the trend of progress in the domain of milk production, and may be taken to mean that the argument of "commercial necessity" in support of pasteurization has lost much of its force, except in relation to the transport of milk over long distances.

There is no doubt that pasteurization of milk has added to the security of cities against the danger of milk-borne infections. This is a matter of great importance, and the following local illustrations may be quoted from experience in Glasgow. All the outbreaks of infectious disease whose source was traceable to farms were associated with supplies delivered direct and untreated from the farm to the consumer, or formed that part of the supply of a particular centre of

* A paper read in opening a discussion in the Section of Preventive Medicine at the Annual Meeting of the British Medical Association, Winnipeg, 1930.

distribution not subjected to pasteurization. The following incidents are taken from the records of recent years :

In 1912, a group of 19 cases of enteric fever on a milk supply delivered direct from farm to dairy was traced to a carrier at the farm. In 1927, an outbreak of 67 cases of paratyphoid B infection broke out on a similar direct supply. Five of the dairy farm hands gave positive blood reactions and two of them ultimately admitted having had mild and trivial recent illness. In 1913, there occurred 31 cases of scarlet fever due to a milker who had a mild sore throat and was not off work ; she infected the dairy keeper with scarlet fever. In 1916, a group of 11 cases of scarlet fever originated from a girl, aged 12 years, at the farm, preceded by two cases of " tonsillitis " without rash. In 1918, a series of 19 cases of scarlet fever occurred on the early morning direct supply from a farm, the probable source being a suspicious sore throat in a girl milker at the farm. In 1919, there occurred 32 cases of scarlet fever on a direct supply, the source of which was not definitely ascertained. In 1923, a series of 23 cases of scarlet fever on milk direct from a dairy farm was traced to a missed infection in a child of the dairyman, who infected the milk during the convalescent desquamating stage of her illness. In 1925, a group of 6 cases of scarlet fever occurred on a farm supply where a young child was found with double otorrhœa following an apparently undetected attack of scarlet fever. In the same year, a series of 15 cases on a direct milk cart and dairy supply was connected with (a) scarlet fever in a farm labourer's child, and (b) otorrhœa following an unrecognized attack in one of the farmer's children. As regards diphtheria, in 1913 a group of 13 cases originated from a child at a farm who had had no definite illness but whose throat harboured the bacillus. In 1915, there occurred 115 mild cases in the neighbourhood of Glasgow, related to sores on the knuckles of three milkers and lesions on the udders and teats of eight of the cows. One of the milkers ultimately developed diphtheria, while " diphtheroid " bacilli were recovered from four of the cows and from the sores on the hands of the milkers. In 1922, a group of 10 cases on a direct supply was traced to a milker with enlarged tonsils harbouring the bacillus of diphtheria. There have also occurred two considerable and severe outbreaks of septic sore throat due to undetected mastitis in dairy herds. In one of these, pasteurization of the supply pending full investigation cut short the outbreak.

In all these instances the milk was delivered in its natural state, and was contaminated through the medium of an infected person on a farm supplying a local dairy in a suburban area. No similar incident has occurred on the main pasteurized supplies of the city. It has been pointed out that the purveying of milk is becoming concentrated in the hands of large distributors, supplies from numerous farms being mixed in wholesale fashion, so that the possibilities of spread from chance infections, such as those instanced above, would be greatly enhanced in the absence of an effective safeguard. Infections occur with sufficient frequency on the comparatively small proportion of raw milk to make one wonder what would happen if the protection of pasteurization were removed. When scarlet fever reached a high degree of prevalence three years ago, several patients were removed from dairy farms sending milk to the city from a neighbouring county.

As regards the possibility of eliminating these risks by more effective public health control, it must be confessed that this is a matter of considerable difficulty. The utmost precautions are defeated by such chance infections as those due to the very mildest cases of scarlet fever or diphtheria or paratyphoid fever, which are apt to be missed entirely. What is called " a chance risk of infection from some accidental carrier " is a real risk in populous areas. Many opportunities of infection occur among the personnel of farms in rural areas dotted with small townships and in proximity to a large city. Farms are no longer isolated communities ; transport makes it easy for farm servants and their families to mix with the general population, and when infectious disease is prevalent in the district the dairying community does not escape its share. It is, in fact, far from being immune. Epidemiological considerations do not suggest that the safeguard of pasteurization could be substituted for preventive control, however rigorously applied. In times of epidemic prevalence of infectious disease and in the present circumstances of milk distribution in large areas, the source of an outbreak might have to be sought for among numerous farms. The fact is that no one who is not in perfect health should milk cows or handle milk, so mild and elusive are the forms which infection may assume. It would be extremely difficult for this standard to be reached by the several hundred individual farms supplying a large city.

How much dependence can be placed on pasteurization in the prevention of tuberculosis and to what extent bovine tubercle bacilli may survive this process are difficult questions to which answers are being eagerly sought. Investigations into the thermal death point of tubercle bacilli in naturally infected milk by L. J. Meanwell are referred to in the review of this subject contained in the Research Monograph of the Ministry of Agriculture and Fisheries issued last year. In view of the importance of correlating the experimental results with the ordinary commercial practice of heating milk, the conclusions reached are worth quoting in full.

" L. J. Meanwell carried out a long series of experiments in which he studied the thermal death point, at different temperatures, of *Bacillus tuberculosis* in naturally infected milk, and has published his results. In addition he has made an epitome of his own work and that of other people from which the following conclusions are drawn :

" First, that Meanwell himself carried out 39 experiments, in which naturally infected and apparently normal tuberculous milk was heated to 145° F. for 30 minutes, and found living tubercle bacilli present on one occasion. In a second series of 19 experiments he heated naturally infected tuberculous milk which did not appear to be normal to the same temperature for the same time and again found living tubercle bacilli on one occasion. Secondly, that an epitome of recent work upon this subject demonstrated that of the four workers who employed naturally infected milk for their experiments, three found living tubercle bacilli after heating the milk to 145° F. for thirty minutes. Thirdly, that negative results were obtained by those workers who employed cultures of tubercle bacilli or pathological material which required chemical treatment before it could be inoculated. Fourthly, Meanwell's work demonstrated that tubercle bacilli in naturally infected milk which had been heated to 140° F. for twenty minutes were usually destroyed, but that this combination of time and temperature left no margin of safety.

" Meanwell finally concluded that commercial pasteurization of milk at 145° F. for thirty minutes, when efficiently carried out, is usually effective in destroying the tubercle bacillus, but that milk subjected to this process cannot always be guaranteed to be entirely free from this organism, especially when one takes into account the fluctuations in temperature, possible mechanical defects in the plant, and the natural desire to hold the milk at as low a temperature as possible in order to conserve the cream line. These factors are all liable to be present when working under ordinary conditions."

It therefore appears that, from an experimental point of view, pasteurization is effective in destroying tubercle bacilli in milk in proportion to the efficiency with which it is conducted. The question arises whether the positive holder method of heating milk, which, if carefully applied, fulfils the time-temperature conditions laid down, and which is now universally employed, does in fact constitute a safeguard against infection. Definite positive evidence on this point would be difficult to obtain. On the epidemiological side, there are certain suggestive features about the remarkable decline in the incidence of non-pulmonary tuberculosis which lend support to the view that pasteurization may have been a far from negligible factor.

During the last twenty years the death rate from non-pulmonary tuberculosis in Glasgow has fallen much more rapidly than has the corresponding rate for tuberculosis of the lung. Tracing the former rate since 1915, it is found that the decline in abdominal tuberculosis—that is, that form of the disease which is generally accepted as being caused by the bovine bacillus—has proceeded at an accelerated rate as compared with disease of other organs. Contrasting the five-yearly periods 1915-19 and 1925-29, the total decline for all ages is from 59 to 30 per 100,000 of the population, or 49 per cent., while for the three constituent groups, tuberculous meningitis, abdominal tuberculosis, and other forms of tuberculosis combined, the fall is from 24 to 16 (46 per cent.), 17 to 7 (59 per cent.), and 19 to 10 (47 per cent.) respectively. Taking the age period under 1 year, the fall in abdominal disease is from 106 to 22 (79 per cent.), in tuberculous meningitis from 177 to 80 (55 per cent.), in other forms 41 to 21 (49 per cent.). For children between 1 and 5 years, the fall is respectively 65 per cent., 36 per cent., and 60 per cent. There has thus taken place a decided reduction in the incidence of fatal non-pulmonary tuberculosis, a fact which is also associated with an increasing mildness in its various clinical manifestations. It will be observed that the decline in the abdominal form, especially at the younger ages, has been outstandingly rapid. These figures should, however, be accepted with some reserve, owing to the fact that in children, especially infants under 1 year, confusion

may readily arise in death certification as between abdominal and meningeal tuberculosis, both of which may be manifestations of a generalized tuberculous infection.

It is clear that some powerful protective influence has been at work, the nature of which can only be surmised. As regards abdominal tuberculosis, this affection has become more difficult to recognize and more amenable to treatment, while tuberculosis of the glands of the neck, also regarded as mostly a product of the bovine bacillus, has markedly declined in incidence and severity. This reduction in bovine infections cannot be definitely ascribed to any particular underlying cause, but, in the absence of a satisfactory alternative explanation, it appears to me that pasteurization should be included among the likely factors and that public health administration should, for this reason, support the efficient pasteurization of ordinary market milk, excluding, of course, the designated milks from duly attested and inspected herds.

There is, however, another and highly important aspect of the matter, namely, the relative value of raw and heated milk as an article of food especially for children. Little is known about the chemical changes which take place in milk heated to comparatively low temperatures, although certain suggestive observations have been made indicating that pasteurization may assail the delicate nutritive qualities of raw milk to a material degree, and that fresh milk of high quality from accredited herds is best for young children. Such evidence as exists is conflicting, but should it be clearly demonstrated that pasteurization deprives milk of an essential constituent, there will arise the question of a radical change of policy in milk distribution in the interests of the young.

In conclusion, the systematic pasteurization of ordinary market milk intended for consumption in large urban areas is, in my opinion, unavoidable under present conditions where milk is collected and mixed from widely scattered and varied sources, not under such scrupulous control as to eliminate the risk of chance infections—a danger which experience shows to be very real. It is difficult to resist the view, which is supported by experimental evidence, that efficient pasteurization is of real protective value against bovine tuberculosis, and that this practice could not be dispensed with until tuberculosis in dairy herds has been reduced to a minimum.

THE EARLY DIAGNOSIS OF INFECTIVE LATERAL SINUS THROMBOSIS.*

BY

FRANCIS MUECKE, C.B.E., F.R.C.S.,
SURGEON, EAR, NOSE, AND THROAT DEPARTMENT, LONDON HOSPITAL;
CONSULTING SURGEON, LONDON COUNTY COUNCIL.

INFECTIVE lateral sinus thrombosis has for many years been one of the most dreaded complications of suppurative middle ear and mastoid antrum disease. The very high mortality resulting from this condition has of late years been largely reduced owing to the gradually increasing knowledge of the earlier symptoms and consequent earlier surgical intervention, so much so that the prognosis may now be said to be distinctly favourable in all cases of operation previous to the breaking up of the infected clot.

I have thoroughly examined the notes of the last hundred cases recorded at the London Hospital, and it is remarkable how seldom I have found the more serious or later symptoms, such as rigors and alterations of the central nervous system, mentioned in the notes of the more recent cases; the mortality also has dropped over 50 per cent. in the last ten years. It is therefore of the greatest importance to the patient that the earliest symptoms should be most carefully investigated.

Of the 100 cases, 44 were associated with acute aural conditions (six months being taken as the acute period) and 56 with chronic suppurative aural conditions. Six of these cases were admitted to and eventually diagnosed in the medical wards, and one remained undiscovered till the post-mortem examination. The admission diagnoses were pneu-

monia 2, pyrexia of unknown origin 3, typhoid 1, and septicaemia.

It appears that children are more liable than adults, in the proportion of three to one, and males than females in the proportion of two to one.

Aural discharge previous to admission is almost universal, only 5 of the acute cases having no discharge: among the chronic cases 9 are noted as having no apparent discharge, though a history of previous discharge was obtainable in all of the cases.

Herpes and sordes about the lips and gums are extremely common symptoms and were present in almost all the cases. I consider this to be a very early indication.

Severe general malaise is another almost universal symptom of lateral sinus infection. It is probably the earliest of all. In only 3 cases was a positive blood culture obtained out of 42 cases where mention is made in the notes. Examination of the state of the blood does not help diagnosis, as mastoid infection alone would give similar results.

Downey's spinal test is only of value when the sinus clot has completely formed, and is of no assistance in the early stages.

Pain about the ear is another almost constant symptom; in only 2 of the acute and 8 of the chronic cases was this symptom not mentioned, although deep-seated discomfort rather than actual pain is frequently mentioned in many of the chronic cases.

Headache is specially noted in 24 acute and 29 chronic cases, while a feeling of general malaise and ill-being is noted in almost all cases as having occurred in the earlier stages of the illness. Vomiting occurred in 16 acute and 31 chronic cases. The notes prove this to be almost invariably a late symptom, occurring in very acute or advanced conditions. Giddiness was noted only in 3 acute and 8 chronic cases, and I do not think that it is of any special significance in lateral sinus infection.

Temperature on the first day of admission was generally high. It was above normal in 36 and subnormal in 8 acute cases, while in the chronic the numbers were 46 and 8. In 68 per cent. of the cases the high night and low morning temperature predominated. Rigors were noted in 26 acute and 31 chronic cases. An early rigor or shivering fit was noted as an early symptom in almost 30 per cent. of all cases, but the subsequent frequent rigors were invariably a late and ominous symptom.

Signs.

Tenderness over the mastoid process occurred in 38 of the acute and 36 of the chronic cases, the most frequent sites mentioned being the tip and directly over the antrum. It was specially noted that in several chronic conditions tenderness was found only on deep pressure.

Tenderness down the neck along the course of the jugular vein was specially mentioned in 11 cases, two only being of the acute variety; all except one chronic case were in advanced conditions.

Swelling about the mastoid or oedema was noticed in 27 cases, 9 being chronic. It is interesting to note that all these were in children, and it certainly seems that while the path of infection in the young tends to early involvement of the superficial mastoid cells and therefore a more ready diagnosis, in the less frequently affected adult the infection tends to remain in the deeper mastoid cells.

On examining the meatus, no discharge was discovered in six of the acute cases, though in all these the drum is mentioned as red and in four as bulging. Similar signs are mentioned in three chronic cases.

Redness or oedema of the posterior part of the meatal wall (post-meatal spot) near the drum is mentioned in 31 acute and 39 chronic cases. This I regard as the most important sign of mastoid disease and is alone a certain indication for operation. The presence of this "spot" is invariably mentioned in all cases during the last six years. As an indication of the great value of this sign, nine of the above cases were unsuspected and were found during the course of operation for chronic mastoid on patients with prolonged ear discharge and general seediness, and in whom the meatal spot was the main indicating sign for operation. Where this sign is definitely established I regard operation as imperative, even in

* The opening paper of a discussion in the Section of Laryngology and Otology at the Annual Meeting of the British Medical Association, Winnipeg, 1930.