An Address

ON

THE NATIONAL INQUIRY INTO THE CAUSES OF OUR HIGH MATERNAL MORTALITY RATE.*

BY

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WHEN the decision of the Ministry of Health to set up a National Committee to investigate the causes of maternal deaths in England and Wales was announced I was one of those who were inclined to think that, except in one direction, no very definite results could be anticipated from such an inquiry. It was clear that an inquiry conducted by the medical officers of health in the districts for which they were responsible might result in improved organization and in a better understanding on the part of doctors and midwives of the assistance which the public health authorities were able and willing to render in such ways as dealing with cases of difficult labour, or with cases in which septic and other complications developed after delivery, or in rendering assistance in the provision of extra food or medicines, or domestic help, to the poorer classes of their patients, or in placing laboratory investigation within the reach of these patients when conditions arose which called for such investigation. The great questions underlying the causation of maternal mortality, such as (a) the conditions which determine the occurrence of puerperal infection, (b) the causation of the toxæmias and the hæmorrhages of pregnancy, (c) the steps required to provide better and longer practical training in midwifery both for medical students and for midwives—these questions could, it appeared, hardly be reached at all, certainly not closely investigated, by this inquiry. And until these three great questions, which lie at the heart of the problem, are seriously grappled with we can hardly expect to make any deep impression upon the figures of maternal mortality which have for so many years caused us, as doctors, the greatest concern, and which have now roused the conscience of the nation itself.

The inquiry set up by the Ministry is now fairly launched, and is, I believe, proceeding smoothly; but it is as yet too early to glean any indications as to the results which may emerge from it. We shall probably have to wait some time for these.

THE ABERDEEN INQUIRY.

It so happens, however, that a large Scottish city, Aberdeen, a town of some 160,000 inhabitants, has anticipated the Ministry of Health, and a similar inquiry has been proceeding there for the last ten years. The objects of the Aberdeen inquiry are identical with those envisaged by our own Ministry of Health, which, it will be remembered, has no jurisdiction in Scotland. The Aberdeen inquiry was conceived and organized by the then medical officer of health for the city—Professor Matthew Hay—who was also professor of medical jurisprudence in the University of Aberdeen when the inquiry was launched in 1917. The first report was published by the Scottish Board of Health in November, 1928, and is written by Dr. Parlanc Kinloch, Dr. F. Smith, and Dr. J. G. Stephen. The information contained in this report is of great importance and interest, and it appears to foreshadow the kind of information which will be gained from the much more extensive inquiry now proceeding in England and Wales. I thought, therefore, that it might be of interest if we went over this report, with the object of gleaning from it such facts, or such conclusions, as may appear to bear a practical value.

The first step taken in the Aberdeen inquiry was to issue special regulations requiring the registrars of births, marriages, and deaths to make an immediate return to the Public Health Department of all maternal deaths occurring within a month (this period was later extended) of confine-

ment, whether the death had been attributed to the confinement or not. This the registrar could do by checking the notified or registered births by the certified deaths of mothers. Occasionally an omission by the registrar was detected by means of information brought to the public health department by the district visitors. The authors of the report believed that such precautions as these were required in order that all cases which properly came within the scope of the inquiry might be disclosed. This view proved, in the event, to be correct, for the methods employed resulted in the disclosure of a considerable number of maternal deaths which would otherwise have remained concealed; in fact, the cases thus disclosed added 15 per cent. to the total number of maternal deaths. This is a very disquieting revelation, and if comparable results should be obtained generally, we shall have to admit that we have underestimated our maternal mortality rate by a considerable figure, and that the problem is of even larger dimensions, and greater gravity, than we supposed.

There are no details in the report as to the nature of the cases which were not certified. It is to be supposed that the investigators satisfied themselves that they were all cases of death properly attributable to child-bearing, although not regarded as such by the individual medical attendants.

I have no information about what is being done in the direction indicated in connexion with the English inquiry, but it would appear to be a point that should not be overlooked. Perhaps we may hear whether Nottingham has taken any similar steps to avoid the escape of cases which ought to be included in the returns.

In Aberdeen the actual inquiries were conducted in much the same manner as, I gather, it is the intention of the Ministry that our own inquiries should be carried out. In the case of both doctor and midwife an inquiry card was first sent out, asking for information under three heads: (a) home conditions and pre-natal health; (b) previous obstetric history; (c) main facts of the confinement. In the case of deaths in the practice of a midwife each midwife was interrogated by a member of the Department of Public Health, and additional information was obtained, if required, through health visitors.

In the case of doctors, we are told that a personal interview was generally requested with the doctor by a member of the health staff, and that the fullest respect was always given to his opinion; it is added that the relations between the doctors and the Health Department have been perfectly friendly in all cases. The medical officer of health often found that he could give useful information to doctors about the facilities which were available for obtaining assistance in necessitous cases, and about other matters. One can readily believe that this would be the case, for it was one of the directions in which it appeared that useful results could be confidently anticipated from an inquiry.

It is emphasized that the inquiries made were *private* inquiries, that no information obtained by the means described was, or would be, made public, and that in the publication of results the greatest care was taken to avoid the escape of any information received in confidence from doctors and midwives. We know that it is the expressed intention of the Ministry that the English inquiry should be conducted in the same scrupulously confidential manner, and that its objective is not to impute blame, but to discover upon what lines preventive work may best proceed.

The report, in fact, contains an interesting item of internal evidence that the relations between medical officers of health and practising doctors in Aberdeen have improved considerably during the period of the inquiry. This is shown by figures which are given as to the notification of cases of puerperal fever. It is well recognized that, over the country generally, only a small proportion of all cases of puerperal fever are actually notified as such; the temptation to call them something else is no doubt difficult to resist, and, further, diagnosis is not always an easy matter. The Aberdeen records show that until quite recently in that city practically only the cases which terminated fatally were notified, as is shown by the fact that the number of deaths roughly equalled the number

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of cases notified. In one quinquennium (1898-1902) the number of certified deaths actually exceeded the number of cases notified. In England and Wales non-certification of cases of puerperal fever has been quite as common as in Aberdeen. During the period of the inquiry there has been a very remarkable change in the attitude of Aberdeen doctors towards notification, and during the quinquennium 1923-27 the number of cases notified was nearly three times as great as the number of certified deaths. If this change is the result of closer contact between the practising doctors and the public health service then it speaks volumes both for the helpfulness of the medical officers of health and for the willing co-operation of the doctors. I regard this as one of the most promising features of the report.

FACTORS INFLUENCING MATERNAL MORTALITY.

We may now consider some of the results of the Aberdeen inquiry into certain factors which may be thought to influence maternal mortality.

First of all, a word as to the effects of *illegitimacy*. The illegitimate birth rate is relatively high in Aberdeen, and the number of cases under consideration is considerable, amounting to one-tenth of the total births during the ten years under consideration (3,331 out of a total of 34,653). The maternal death rate of the unmarried mothers is more than double the total rate, and the mortality from sepsis is three times as high as the total maternal death rate from sepsis. The problem of the care of unmarried mothers is as much a social as a medical problem, and it seems to me that this is a channel into which philanthropic effort might well be guided, for there is surely much to be done, much which cries loudly to be done, in helping these heavily burdened women through the ordeal which is to them infinitely more formidable than it is to their married sisters.

The influence of the *general health* of the mother upon maternal mortality is a question upon which very little information has hitherto been available. The Aberdeen report does not overlook this matter, but it is naturally a difficult subject for investigation. For the purposes of their inquiry "general health" was divided into two classes—"good" and "unsatisfactory." We have, of course, no information as to the proportion of the total adult female population of Aberdeen which suffers from "unsatisfactory" general health, but the investigators found that among the women who died from causes associated with child-bearing 31.8 per cent. (roughly one-third) had been in unsatisfactory general health *before the beginning* of the pregnancy which terminated fatally. This must be much in excess of the general rate of unsatisfactory health among the total adult female population.

With regard to the health of the mother *during* pregnancy, the Aberdeen records from the ante-natal departments show that, generally speaking, 80 per cent. of expectant mothers are classed as being in "good" health. Among those who died in the period covered by the inquiry only 40 per cent. were classed as having "good" health.

I am not suggesting that these findings should be accepted without confirmation, but they certainly seem to imply that more careful attention to the general health of our prospective mothers is a direction in which useful preventive work may be done. Dr. Charles Douglas of Cupar has for several years been preaching the importance of the maternal factor in determining the risks of child-bearing, and this piece of evidence, as far as it goes, justifies his attitude, for it suggests that the expectant mother who is in poor health runs a considerably greater risk than one whose health is good.

There are certain points with regard to which the report confirms what may be termed conventional views—for example, that the risks of the first confinement are the greatest; that housing conditions, such as overcrowding and deficient cleanliness, and what might be called stringency of means, have no apparent influence in increasing the risks of childbirth. The advantages of *ante-natal supervision* are confirmed in the statement that the death rate among those who attended ante-natal clinics was approximately only one-half of the rate among those who did not—3.8 to 7.4 per cent. respectively.

When the report comes to deal with the *venue of the confinement*, the results which emerge are startling: 3,765 confinements (roughly 10 per cent. of the total) took place in institutions, under which term are included hospitals and nursing homes; of these, roughly one-third were cases specially admitted either because of ante-natal complications or from difficulties encountered during the course of labour; the remainder, roughly two-thirds (2,220), were cases for which the institutions had been responsible throughout. It is instructive to compare the results obtained by the institutions in the cases for which they were solely responsible with those obtained privately by practising doctors and midwives. The total maternal death rate for the city from all causes over the ten years was 6.6 per thousand, a figure rather higher than the average for England and Wales. The maternal death rate for the 2,220 cases for which the institutions were directly responsible reached the astonishing figure of 14.9 per thousand; the corresponding rate for patients attended in the hospital districts was 5.6 per thousand, that for patients attended privately by doctors was 6.9 per thousand, and that for cases attended by midwives only—that is, without medical assistance—was 2.8 per thousand; for cases attended by midwives, with medical assistance, the rate was the lowest of all—namely, 2.5 per thousand. The death rate from sepsis was also remarkably high in the cases delivered in institutions, and for which the institutions were solely responsible. The general mortality rate for sepsis in Aberdeen during the period of the inquiry was 1.5 per thousand—about the average for the whole country; in the institutional cases it reached 4.5 per thousand; in the remaining groups just specified it was below the average, attaining the lowest point of all in the cases attended in the hospital districts, for which the rate was only 0.7 per thousand—that is, less than one-half of the general septic rate. The report does not distinguish the results obtained in private nursing homes from those in other institutions.

One cannot help regarding these returns with great disquietude. The old prejudice among mothers in favour of having their babies at home is disappearing, and they are becoming more and more willing, indeed often anxious, to go into an institution instead. We have been urging mothers to do this in the expectation that they would receive better care, and would in consequence be freer from risks in these institutions than at home. In this belief the Ministry of Health has encouraged municipalities to open maternity homes available for all to whom the arrangements for a confinement involve a difficult financial strain. We knew already that the results obtained in these municipal homes were not entirely satisfactory, but the results disclosed in Aberdeen are more than serious, unless there be some special explanation of them which does not appear in the report. A partial explanation of the relatively high maternal death rate in institutions may possibly be found in the more difficult or complex character of the cases dealt with by these institutions, but in compiling the figures I have just given you all *emergency* cases have been eliminated—that is, those transferred to the institution after previous treatment by doctors and midwives. The figures, therefore, apply only to cases for which the institutions had been responsible throughout. Thus the institutional death rate from albuminuria and convulsions is more than two and a half times as high as the general rate for that condition for the city (no emergency cases being included), the rates being 2.7 and 1.0 per thousand respectively. Also the death rate from haemorrhage is more than double the general rate for that condition (1.4 and 0.7 per thousand). The report does not distinguish between ante-partum and post-partum haemorrhage, so that the obstetric significance of the latter figures is not very clear.

We see, then, that the death rate from sepsis in the institutions was exactly three times as high as the death rate for the whole city from that condition (4.5 and 1.5 per thousand); and for this distressing fact no explanatory circumstances are forthcoming in the report.

So far as we have gone the instructive results emerging from this report are: first, the evidence suggesting that the general health, and perhaps also the physique, of the mother have more influence upon maternal mortality than

we have hitherto believed; and secondly, the relatively high mortality from all causes occurring among women whose confinement had been managed throughout in the in-patient departments of hospitals and other institutions.

ETIOLOGY OF PUERPERAL SEPSIS.

A considerable body of work is presented in the report dealing with the causation of puerperal infection. The bacteriological work confirms the view, now almost universally held, that a haemolytic streptococcus is the causative organism in all but a small minority of cases. The question of how this organism gains access to the maternal passages is reviewed. The possibility that streptococci may make their habitat in the cervical and vaginal secretions during pregnancy, and after labour may become active and invade lacerations or the placental site, while admitted, is dismissed as being possible in only a very small proportion of cases. We are told that the natural habitat of the haemolytic streptococcus is the throat. Great importance is attached to the possibility of "droplet infection"—that is, infection of hands, instruments, or appliances by droplets of saliva expelled, in speaking or coughing, from the mouth of a carrier of the haemolytic streptococcus. In support of this view it is mentioned that in January, 1928, an outbreak of puerperal fever occurred in a maternity institution in Aberdeen in which 12 cases became infected, of whom 4 died. The outbreak was found to be due to the haemolytic streptococcus; an outbreak of icterus neonatorum accompanied it, which proved fatal in 7 cases, and in 2 of the fatal cases the haemolytic streptococcus was proved to be the cause of the infants' death from septicæmia. Throat cultures were taken from the twelve nurses in the institution, and in five of them the haemolytic streptococcus was found. Seventeen contacts among patients were also examined, with the result that in eight of them haemolytic streptococci were found in either the throat or the uterus, or in both—that is, eight out of seventeen examined were found to be carriers.

In pursuance of this view it is suggested that many individual doctors and midwives may unconsciously be carriers of the causative organism of puerperal sepsis, and may convey infection to their patients by what is known as the "droplet" method. In support of this the report points out that in Aberdeen, during the period of the inquiry, the death rate from sepsis among women attended privately by doctors was nearly double the rate found in women who had been delivered by midwives, either alone or with medical assistance. Doctors being brought more frequently into contact with other diseases of streptococcal origin, such as scarlet fever, erysipelas, and pyogenic conditions, are more likely, it is suggested, to become carriers of the organism than are midwives, who are relatively immune from risks of contact with these conditions.

It is not necessary for us at this stage to do more than pigeon-hole this theory for future consideration. The medical officer to the Scottish Board of Health (Dr. T. F. Dewar), in a preface to the Aberdeen report, very fairly points out some of the difficulties in accepting the theory of throat infection as the usual channel by which the infecting organisms reach the maternal passages. In the course of the extensive English inquiry now in progress no doubt other theories will be advanced, and it is all to the good that we should be in a position to consider all the possible explanations which research and discussion may bring to light. On the other hand, the theory of throat infection cannot be lightly dismissed. It certainly offers a possible explanation of those rare but puzzling cases of sepsis which occur in patients, who can be proved not to be carriers of streptococci themselves in the cervical or vaginal secretions, and who have been confined in hospitals of repute. If the theory of throat infection as the usual channel were to become established, one feels appalled at the prospect of the consequences which would ensue in the practical work of midwifery. The task of discovering carriers, their suspension from work until freed from the organism, the means which might have to be employed to free them, and the practical impossibility of preventing droplet distribution by any form of mask worn by the medical and nursing attendants, suggest only a few of the complications which the establishment of the theory would entail. Let

us hope that further work may relegate it to a position of rarity among the possible channels of infection.

In considering puerperal sepsis we must, however, face the fact that in institutions this disease still assumes epidemic form; it is true that the outbreaks are not comparable in extent or in severity to those which devastated lying-in hospitals so frequently in pre-antiseptic days. It has to be admitted, however, that we have not got rid of epidemics of puerperal fever in our lying-in institutions, and it appears to me that this is one of the most serious features of the problem of maternal mortality. I have mentioned the outbreak which occurred in an Aberdeen hospital in January, 1928. We are told in the report that "Similar outbreaks of puerperal sepsis, spread by gross contagion, occurred in 1922 and in 1924." The report does not state the total number of deaths for which the two earlier outbreaks were responsible; we know, however, that in the third epidemic 4 died, and the total number of deaths from sepsis in the institution during the ten years of the inquiry was only 10. It is therefore probable that the three epidemics in 1922, 1924, and 1928 accounted for the great majority, possibly for all, of the institutional deaths from sepsis. If these outbreaks could have been prevented a notable reduction of the maternal mortality rate from sepsis in Aberdeen would have resulted.

A good deal of information is available which shows that similar outbreaks have occurred in other centres than Aberdeen, so that the conditions which favour the occurrence of such outbreaks are not peculiar to that city. Through the kindness of Dr. Parlanc Kinloch I have been furnished with details of an outbreak which occurred a few months ago in an English town. In this town there is a small maternity hospital of fourteen beds, staffed by a matron, nurses, and pupil midwives. In December, 1928, an outbreak of puerperal fever occurred in this hospital, in which three women only were affected, and all three died. The throats of all the staff were examined and haemolytic streptococci were found in the case of the matron and several others. The epidemic was controlled by closing the hospital entirely for disinfection, and sending the staff away for a few days' holiday.

In connexion with this hospital a certain small number of women are attended in their homes by a midwife assisted by pupils. The midwife who attends the district cases has no duties in the hospital itself. In January, 1929, three cases of puerperal fever occurred in women attended in their homes by this midwife and a pupil, and again all of them proved fatal. It is known that the midwife's throat was free from the haemolytic streptococcus at the time of the outbreak in the hospital, but unfortunately neither the district midwife nor her pupil was re-examined when the cases occurred in the district. The pupil was one of those whose throat culture gave positive results at the time of the hospital outbreak, and further inquiry showed that this particular pupil had been in actual attendance on the three women who died during the first epidemic. The presence of this pupil seemed to be the only factor common to all six of the cases. The hospital accordingly dispensed with her services, and she decided to give up the idea of qualifying as a midwife. Wherever the infecting organism may have come from, it was evidently one of high virulence, the case mortality of the two outbreaks being 100 per cent.

The evidence so far adduced in support of the theory of throat infection cannot be regarded as conclusive. Probably haemolytic streptococci could be found in the throats of the majority of healthy persons, and proof requires something further than their discovery in the throat of an attendant at the confinement. Assuming that they can be conveyed by "droplet" infection to the parturient canal, is it certain that these throat organisms are capable of setting up an acute blood infection? Or is it possible that in some instances they are capable of so doing, and in other instances they are not? In the latter case, is it practicable to distinguish between throat cultures which are dangerous and those which are not? Assuming that the majority of healthy persons are throat carriers of the haemolytic streptococcus, and that this organism can be borne by droplet infection to the genital canal, would not puerperal infection be very much commoner than it actually

is? One would like to see the theory supplemented by exact experimental observations before accepting it.

If a single case of acute infection occurs in a hospital or other institution, the evidence is conclusive that it is liable to spread by gross contagion from one woman to another, and also to the infants. It is clear that the ordinary methods of isolation and of disinfection, and perhaps also the routine antiseptic technique, of these institutions in which outbreaks have occurred, are not adequate to prevent the occasional occurrence of puerperal infection within their walls, and given the occurrence of a single case they are unable adequately to protect their other patients from the risks of contagion. Now that the English inquiry is fairly launched, any further outbreak which occurs will no doubt be studied as an epidemic phenomenon by the experts of the local health departments.

In its bacteriological aspects the Aberdeen outbreak of 1928 was very closely studied, and the suggestions I have referred to as to throat infection were the direct outcome of this work. No information is given, however, apart from this, about the conditions which permitted the infection to be conveyed from one patient to another in the hospital, or as to how these conditions could be remedied.

ISOLATION OF SEPTIC CASES.

It would appear that the provision of adequate facilities, whether public or private, for the isolation of all septic cases must be regarded as essential; and isolation must be effected immediately, as in the case of all other notifiable infectious fevers, for every day's delay multiplies the risks. In fact, an isolation block is a *sine qua non* of a properly equipped maternity hospital, for the experience I have referred to shows that the less complete methods of segregation which are now employed cannot be relied upon. The isolation block would require its separate building, its separate staff, its separate operating theatre and equipment, and would consequently be very expensive to provide. The numerous small maternity hospitals which now exist, and which have increased so rapidly in recent years owing to the policy of the Ministry of Health in encouraging the provision of municipal maternity homes, have been organized on the simplest lines in order that they may come within the reach of the middle classes, and they have as a rule no effective means of isolating septic cases. The consequence is that there have been a number of outbreaks of puerperal sepsis in them. The difficulties of these small institutions are increased by the fact that when a septic case occurs there is so much difficulty in getting it transferred to another place, although the Poor Law hospitals, and in London the fever hospitals of the Metropolitan Asylums Board, are able and willing to undertake the care of these cases, but patients are not willing to be sent to these hospitals.

The provision of isolation blocks in connexion with all our great maternity hospitals, to which both private cases and others from small institutions could be immediately transferred, would permit of an intensive study of puerperal sepsis by a combined team of obstetricians, bacteriologists, and public health authorities, which up to now has never been carried out on a sufficiently large scale. It may be a long time before we can attain such a system as this, but I am glad to know that an institution to which I have been attached for many years, Queen Charlotte's Hospital in London, has made the erection of an isolation block the first step to be taken in the projected building of the new hospital, which is to take the place of the old one.

DOCTORS' CASES AND MIDWIVES' CASES.

There is one more matter in the Aberdeen report to which I must draw attention. The report has been able to differentiate between the cases attended by doctors and those attended by midwives, and emphasis is laid on a comparison of the results. It appears from this comparison that the doctors' cases showed a general maternal mortality rate of 6.9 per thousand, and the midwives' cases a rate of only 2.8 per thousand. Attention has been called by Dame Janet Campbell, in the Ministry of Health

reports, to the fact that the returns of midwives' cases in many localities show a death rate well below the average maternal death rate; and Dr. Fairbairn has shown that the picked body of midwives who work for the Queen Victoria's Jubilee Institute for Nurses have achieved even better results than those disclosed by the Ministry of Health, and that their results are progressively improving. The Aberdeen report is, however, I believe, the first report in which it has been possible to institute a direct comparison between cases attended privately by doctors and those attended by midwives. I know that the comparison between doctors' and midwives' cases is to some extent an unfair one, because midwives accept none but normal cases, or cases which they believe to be normal; while doctors get a correspondingly large number of abnormal, and therefore more difficult ones.

Now I mention this matter not with the idea of imputing blame or suggesting explanations, but because by the Aberdeen report it is made the basis of a plea for a fresh orientation of midwifery practice, or, in the words of the report, "a new midwifery organization in which midwives conduct all normal deliveries, and in which doctors provide the ante-natal services and deal with obstetrical complications." This, they believe, would result in "a significant reduction in maternal mortality." I have already mentioned that the report attributes greater risks to doctors than to midwives of becoming throat carriers of the streptococcus, and this consideration has no doubt weighed heavily with the authors in making this proposal.

Now I should very much like to know what my colleagues in general practice will think of this proposal. So far as I can judge at present the definite objections to it appear to me to outweigh the more or less problematical advantages. There is a basic objection which I think is of great importance—namely, that the ability of doctors generally to deal with cases of obstetrical complications will steadily deteriorate if experience in normal midwifery is withdrawn from them. An intimate acquaintance with the course of the birth process under normal conditions is the first requisite for dealing with complications, and do we not all know that intimate knowledge can only be acquired, and when acquired can only be maintained, by constant practice? I have always held that it was the duty of an obstetric specialist to maintain touch with normal labour, by undertaking the private care of a certain number of cases each year, as well as by his hospital work. And what is true of the specialist will equally apply to the doctors who, under this new scheme, would be required to deal with the complicated cases. The tendency would be that the work of dealing with these cases would pass into the hands of a few men in each locality, while the remainder of the practising doctors withdrew from midwifery altogether. This, to my mind, would be a deplorable result. Midwifery has long been regarded as an essential subject in the examination for registration as a medical practitioner, and has taken its place alongside medicine and surgery in the foundations of medical education. To withdraw it from the sphere of the general medical practitioner would be to change its status as a basic subject in medical education, and would deprive the practitioner of work which he can undoubtedly be trained to do with success and with advantage to the community.

I think it can be anticipated that other reports will in time appear dealing with the same point—that is, in the way of comparison between doctors' and midwives' cases. It may be that they will not correspond with the data given us from Aberdeen, but if the contrary should be the case—I mean if similar results should appear generally—the medical profession will be brought face to face with a situation so grave that it cannot be ignored. This matter cannot be dealt with in a few words, but I feel that we should all be thinking about it, about its many implications and the consequences which would inevitably follow if this situation persists and is shown to apply generally. It would indeed constitute a serious indictment of our profession if the opinion became established that partly trained women were more successful in the management of normal midwifery than are fully trained members of our profession.

I hope what I have said about the Aberdeen report will show that, although it adds little to our knowledge of the causes of maternal mortality, it is yet of great interest and does a great deal to indicate the direction along which further inquiries may usefully proceed. We do not know what are the intentions of the Ministry of Health with regard to the English report; we may get a series of reports from different centres, or we may have to await the preparation of a national report. The work will occupy many years, and I am sure we shall be prepared to do everything we can to assist the investigators in their tremendous task, realizing how urgently necessary it is in the national interest to reduce our terrible wastage of maternal life.

A Study

OF

THE BACTERICIDAL POWER OF THE BLOOD DURING PREGNANCY AND THE PUERPERIUM, AND ITS RELATIONSHIP TO THE DEVELOPMENT AND COURSE OF PUERPERAL INFECTION.*

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THE introduction of pyogenic organisms into the reproductive tract, with or without trauma as an important contributory agency, is recognized as the commonest and most important factor in the causation of puerperal infection. While this is so, the anomalous nature of its incidence is a commonplace attribute of this disease; the occasional appearance of infection in a case in which delivery has been spontaneous and even free from examination, and on the other hand its failure to develop where trauma and manipulation have made its occurrence probable, constitute a paradox with which everyone engaged in midwifery practice is familiar.

A partial explanation of this phenomenon was suggested by those workers who investigated the cervical and vaginal flora during pregnancy and attempted to relate the occasional unexpected development of sepsis to a pre-existing infective condition of the genital passages. The recent observations of Burt-White and Armstrong,¹ however, would appear to call into question the validity of the conclusions offered by previous observers. Burt-White and Armstrong examined the cervical flora in 55 pregnant women; in 40 per cent. of these cases streptococci of different types were isolated, but in only one did the strain present the characters of the *Streptococcus pyogenes*, the common cause of puerperal fever; they report, moreover, 15 cases of pregnant women whose cervixes harboured haemolytic streptococci, including *Streptococcus pyogenes*, and in none did sepsis occur. These workers conclude that "the presence of the haemolytic streptococcus in the reproductive tract does not necessarily give rise to sepsis in the puerperium," and state further that their results appear "to support definitely an exogenous origin for infection in puerperal sepsis, while leaving unexplained those rare cases of sepsis in which there has been no manipulation during pregnancy or labour." A similar conclusion is suggested by a study of the epidemics of puerperal sepsis with which hospitals in pre-Listerian days were ravaged, and Young² instances in this connexion the long intervals of freedom from fatal sepsis in support of the view that, as compared with trauma and contagion, autogenous infection must at best play a minor part in the etiology of the disease.

* Read at a joint meeting of the Edinburgh Pathological Club and Edinburgh Obstetrical Society, April 17th, 1929.

Bacteriological and clinical evidence seems accordingly to warrant the inference that puerperal sepsis can rarely be explained on the basis of an endogenous infection. It appeared to us possible, however, that the occurrence of sepsis in cases in which there has been a minimum of interference might be related to an abnormally low degree of resistance on the part of the individual; a variation in susceptibility of this nature would readily explain the capricious distribution of puerperal sepsis—for example, in the lying-in wards of a maternity hospital.

To test the validity of this hypothesis it was decided to examine the bactericidal and bacteriostatic* power of the blood in a large series of pregnant and parturient women. Coincidentally with this larger investigation the skin sensitiveness to streptococcal toxin was examined in a small number of those women in whom at the same time the bactericidal power of the blood was tested. The toxin employed in the test of skin sensitiveness was isolated from a culture of a haemolytic streptococcus found in the blood of a woman suffering from puerperal sepsis and was prepared by the method described by Lash and Kaplan.³

For two reasons it was decided not to persevere with the examination of skin sensitiveness as a method of determining individual susceptibility to infection. In the first place, in those cases in which this reaction was tested no relationship was observed between the type of reaction and the incidence of pyrexia in the puerperium. Of the 49 women tested, 10 were toxin-sensitive, while 39 did not react; among the positive reactors the puerperium was morbid in two cases, in one of which delivery was effected by forceps; of the non-reactors six women, one of whom was delivered by forceps, experienced morbid puerperia. The inconsistent character of these results is disappointing in view of the observations of Burt-White,⁴ who found a morbidity rate of 30 per cent. in women who reacted positively to streptococcal toxin. It should be mentioned, however, that Burt-White employed scarlatina toxin and that his investigation was on a scale considerably larger than that here reported. In those cases in which the two tests above referred to were carried out it was found that one had no relationship to the other, the bactericidal power of the blood being in point of fact higher as a rule in those cases in which the skin reaction was positive than in those in which it was negative.

In the second place, although a negative skin reaction of the type referred to may indicate that the patient possesses antitoxic substances to streptococcal toxin, it is probably not in the same sense a measure of resistance on the part of the individual to the important locally invasive as distinct from the toxin-producing property of the organism, a property which, from anatomical considerations, is of special importance in puerperal sepsis. In the expectation that such resistance to organismal invasion might possibly be related to the bactericidal activity of the blood, we decided to employ this test in our investigation, and were influenced further in our choice by its non-specific character (see Table II), and its applicability, therefore, to forms of infection other than streptococcal.

The method employed in the examination of bactericidal and bacteriostatic power was that described by Wright, Colebrook, and Storer,⁵ and consists essentially in mixing whole blood with a known quantity of bacteria on "slide cells," the bactericidal power being gauged by the number of colonies which develop after incubation for twenty-four hours.

One disadvantage of this method may be mentioned: in an investigation of this kind a very large number of individual observations is required to provide the necessary data. This is so in the first place because of the technical impossibility of preparing for the purposes of a series of tests, carried out at different times, inocula each of exactly the same uniform density, with the result that a direct comparison is possible only between units of a group each member of which has been tested with the same inoculum, and not between units of different groups in

* The term "bacteriostatic" implies inhibition of bacterial growth. Wright⁵ has interpreted the results obtained by the method which he originally described as due to a "bactericidal" action; it seems possible that growth inhibition may also be an important factor, but while recognizing this we have in this paper employed the term "bactericidal," as originally used by Wright.