respectively. Statistical analysis shows that the difference between reversion rates in the Rhondda Fach and those in the control valley is significant.

The morbidity rates amongst the schoolchildren originally tested in the Rhondda Fach in 1950-1 are 0.6 for those who were "lapses" for Mantoux-testing in 1950-1; 1.4 for those Mantoux-negative in 1950-1; and 4.3 for those Mantoux-positive in 1950-1. This is an unusual finding, and might possibly be related to reduction of tuberculous infectivity in the valley.

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INVESTIGATION AND TREATMENT OF SEPTIC ABORTION

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With the advent of penicillin the treatment of puerperal infections underwent a profound revolution. Post-partum puerperal sepsis has now ceased to be a serious problem, and can usually be treated without removal of the patient to a special puerperal sepsis unit. Post-abortion sepsis, on the other hand, still presents diagnostic and therapeutic problems, and it is the purpose of this paper to review these in the light of our experiences of the past five years. This department may claim to be in a unique position to conduct such a review, as it is primarily intended for the treatment of septic cases.

Classification

A fundamental difficulty in the classification of cases of septic abortion arises from the fact that the uterus is not necessarily involved in the infective process. We have therefore classified the 995 cases occurring in the period under review into the following three groups:

Group 1.—Those with complete or incomplete abortion without uterine infection (421 cases).

Group 2.—Those with local uterine infection (482 cases).

Group 3.—Those with spread of infection to the uterine appendages, peritoneum, blood stream, or viscera (92 cases).

Criteria of Uterine Sepsis

The common criteria of uterine sepsis comprise: (1) general signs of infection, of which pyrexia and tachy-

cardia are the most important; (2) local signs such as tenderness and subinvolution of the uterus and alterations in the lochia; and (3) bacteriological and haematological findings. In our experience none of these are in themselves indisputable evidence of uterine infection. All may be present with infected retained products of conception, and often only after evacuation of the latter can a definite assessment be made. We estimate the relative reliability of these individual criteria as follows.

Pyrexia

Elevation of temperature is traditionally regarded, in Britain at least, as the most reliable general sign of infection, and provides the basis of the definition of the notifiable state of puerperal pyrexia. During the period under review a change was made in this definition, presumably to conform with changing conditions and the ever-increasing emphasis laid upon the need for prompt notification and treatment. Whereas prior to August 1, 1951, the notification of puerperal pyrexia required that, in patients within 21 days of childbirth or miscarriage, a temperature of 100.4° F. (38° C.) should have been maintained for 24 hours or have recurred during that period, subsequent to that date it has been sufficient grounds for notification that the patient, within 14 days of childbirth or miscarriage, should have developed a temperature of 100.4° F. (38° C.). This elimination of the 24-hour qualifying period had the effect of trebling the number of notifiable cases in England and Wales per week, but gave even less indication than before of the incidence of true uterine infection. Attention has already been drawn to the present unsatisfactory position (Gordon, 1951; Calman and Gibson, 1953).

Our experience has shown that both inevitable and incomplete abortions may be accompanied by considerable degrees of pyrexia without demonstrable uterine infection. Fig. 1 shows the chart of a case of inevitable abortion in which not only a temperature of 103° F. (39.4° C.) but also a leucocytosis of 48,000 occurred; yet bacteriological examination was negative, and, following the spontaneous expulsion of the uterine contents, recovery was immediate and uneventful without chemotherapy.

Similarly, many cases of incomplete abortion show degrees of pyrexia which render them notifiable, but in which either spontaneous or assisted evacuation of the uterine contents

FIG. 1.—Inevitable abortion. Negative cultures from cervix, urine, and blood. Pyrexial until the day of abortion (August 3, 1946), and leucocytosis increased to 48,000 on that day. Immediate and uneventful recovery without chemotherapy.

FIG. 2.—Notifiable puerperal pyrexia accompanying incomplete abortion. No evidence of uterine sepsis. Persistent pyrexia until retained products were removed. Then uneventful recovery without chemotherapy.

brings about uneventful resolution. Fig. 2 shows such a case in which chemotherapy was not required. While it may certainly be held that such cases are septic, since organisms are proliferating in the necrotic retained products of conception, they present no evidence of infection of the uterus. The immediate and uneventful resolution of pyrexia after emptying of the uterus supports this view. Moreover, it tends to be overlooked that the degree of pyrexia does not necessarily vary in direct ratio with the severity of the

infection; indeed, cases of severe spreading generalized peritonitis may be accompanied by a low-grade pyrexia which does not even attain the level of notifiability. Two such cases are shown in Figs. 3 and 4. It is clear, therefore, that the selection of an arbitrary level of pyrexia as a criterion for notification is inherently unsound, and we agree with Calman and Gibson (1953) that it might well be abandoned. As from March 1, 1955, however, practitioners have been requested to state the probable cause of the pyrexia. While this is a step in the right direction, the only basis of notification of any value from an epidemiological standpoint is that of uterine infection.

Tachycardia

The unreliability of the temperature as an indication of infection impelled us to pay more attention to the pulse rate, and we have found this to be a more sensitive guide to the progress of infection. In the case shown in Fig. 3 the improvement attendant upon measures adopted to combat complete paralytic

the other hand, shows a wide range of variability, but, in severe post-abortion sepsis at least, is often low-grade.

Tenderness of Uterus

After passage of the foetus, tenderness of the uterus is a fairly reliable sign of infection. When tenderness is present over the lower abdomen and is accompanied by a positive release sign and a rapid pulse, a spreading infection with involvement of the peritoneum should be assumed. In threatened abortions, however, there may be extreme tenderness over the lower abdomen and a positive release sign may be obtained without infection being present. A uterus which is contracting in an attempt to expel the foetus and/or placental fragments can be extremely tender if the os is closed or rigid, and, contrary to what is often stated in textbooks, this is by no means an uncommon phenomenon. The rapidity with which both tenderness and the positive release sign disappear after expulsion of the uterine contents suggests that the signs may result from the powerful contraction of unstriated muscle. A similar condition may be demonstrated with a distended bladder.

Subinvolution of Uterus

Provided the uterus is empty, subinvolution may be taken as a certain sign of infection. So unreliable are the histories relating to duration of pregnancy in abortion cases, and so difficult may it be with a closed os to determine if an abortion is complete, that the value of this sign for immediate assessment is minimized.

Alterations in Lochia

In the absence of any history of chronic vaginal discharge frankly purulent, or even mucopurulent, lochia are valuable evidence of sepsis. Offensive lochia point to infection with bowel-derived organisms, which are the commonest pathogens in abortion cases.

Bacteriological Evidence of Infection

The organisms most commonly found in puerperal infections may be classified as follows: (1) Haemolytic streptococci of Lancefield Group A, which are invariably pathogenic and the presence of which on cervical culture is in itself indicative of infection. (2) Haemolytic streptococci of Lancefield groups other than A, non-haemolytic streptococci (mainly *Streptococcus faecalis* or *enterococcus*), coliforms, the two groups of anaerobes—the sporing type represented by *Cl. welchii*, the non-sporing type by the anaerobic streptococcus—and coagulase-positive staphylococci. These are usually saprophytes but are potential pathogens. The staphylococcus, though small in incidence in this particular series, is particularly apt to produce serious complications when it has become invasive. (3) Coagulase-negative staphylococci and diphtheroids. These are purely commensals and we classify them as negative cultures.

Table I shows the incidence of positive cultures in the three main groups. Positive cultures were found in 89.4% of cases with local uterine sepsis, while cases without uterine

TABLE I.—995 Cases Showing Incidence of Positive Cultures in the Three Main Groups

Group 1		Group 2		Group 3	
Cases	Positive	Cases	Positive	Cases	Positive
421	312 (74%)	482	432 (89.4%)	92	74 (80.5%)

infection had only 74% positive cultures. The rapid inward spread of the organism probably accounts for the fact that cases with invasive complications showed only 80.5% positive cultures.

The incidence of the six organisms principally concerned (and accounting for 98% of all pathogens) is shown in Table II according to their appearance in single or in mixed culture. Their overall percentage incidence in the three

FIG. 3.—Severe *Cl. welchii* peritonitis complicated by complete ileus. Pulse rate a more delicate criterion of progress of infection than temperature. Temperature never reached the level of notifiability.

FIG. 4.—Severe *Cl. welchii* peritonitis. Threat of ileus on September 3, 1948, reflected in the pulse rate but not in the temperature, which did not reach the level of notifiability.

ileus is reflected at once in the steadying of the pulse. In the case shown in Fig. 4 threatened ileus was accompanied by a rise in the pulse rate. In neither case does the temperature chart give any clue to these developments. In spreading infections we have found that the pulse rate is invariably rapid, usually above 110; the temperature, on

main groups is shown in the form of a histogram (Fig. 5). We thus see that in post-abortum sepsis, as opposed to post-partum sepsis, (a) haemolytic streptococci of Lancefield Group A are seldom found; (b) bowel-derived organisms are most commonly found: usually saprophytic, they require favourable factors for conversion to pathogenicity; and (c) mixed infections are common.

TABLE II.—804 Cases of Septic Abortion with Positive Cultures Analysed According to the Findings of Individual Organisms (a) Alone and (b) in Mixed Culture

Group		Total No. of Cases	Total No. of Isolations	Coliforms	<i>Cl. welchii</i>	Non-haem. Streptococci	Anaerobic Streptococci	Staphylococci	Haemolytic Streptococci
1	Alone	191	191	73	18	44	41	12	3 (no group A)
	Mixed	104	219	78	33	65	36	16	1 (,, ,, ,,)
2	Alone	260	260	117	27	31	30	31	24 (6 ,, ,,)
	Mixed	176	365	131	78	66	39	34	17 (1 ,, ,,)
3	Alone	45	45	20	4	11	5	0	5 (3 ,, ,,)
	Mixed	28	58	23	12	13	4	3	2 (no ,, ,,)

Of the 818 cases with positive cultures (pathogens), 14 were due to miscellaneous organisms and are not included in the above main types.

FIG. 5.—Incidence of principal organisms in the three groups.

Conversion of Saprophytic Organisms into Pathogens.—It has been previously shown that even a formidable organism like *Cl. welchii* behaves as a harmless saprophyte in most cases of post-abortum infection (Ramsay, 1949). This can be explained either by a wide variation in the toxigenicity of *Cl. welchii* strains (Butler, 1943) or on the assumption that, in common with other bowel-derived organisms, conversion to pathogenicity requires the presence of certain necessary factors. These factors would appear to be: (a) retention of necrotic products of conception long enough to allow of the proliferation of the common organisms introduced from the bowel; and (b) trauma: cases in which unskilled attempts to procure abortion have resulted in muscle injury provide particularly suitable conditions for the growth of *Cl. welchii*, which, together with coliform organisms, is most commonly associated with the spreading type of infection.

Our experience suggests that, except in the case of infection with haemolytic streptococci of Lancefield Group A, a diagnosis of infection should not be made on bacteriological findings alone.

Haematological Evidence of Infection

In Table III we show the result of the analysis of 715 cases in which a record of the white blood cell count is available. In the group without uterine infection the white blood cell count was between 10,000 and 20,000 in 107 cases (36.8%) and over 20,000 in 15 (5.4%). Haemorrhage (Whitby and Britton, 1953), trauma, and the presence of tissue autolysates from disintegrating products of conception are all factors which may contribute to these high counts. *Cl. welchii* infection is known to show higher white blood cell counts than infection in which other organisms are

TABLE III.—Analysis of 715 Cases According to White Blood Cell Counts in the Three Groups

Group	Less than 5,000	5,000–10,000	10,000–20,000	More than 20,000	Total
1	8	147	107	15 (5 <i>Cl. welchii</i>)	277
2	17	131	168	33 (11 <i>Cl. welchii</i>)	349
3	4	29	36	20 (6 <i>Cl. welchii</i>)	89
	29	307	311	68	715

responsible (Ramsay, 1949). In this series they were isolated from one-third of the cases with counts over 20,000. While useful in the early stages of an infection and before bacteriological results are available, the white blood cell count cannot be relied upon as independent evidence of infection in post-abortum cases, and is of value only when taken in conjunction with physical signs.

Management of Septic Abortion

The management of a case of abortion depends, firstly, on the stage at which it is seen, and, secondly, on the presence of factors such as haemorrhage and infection. Occasional cases of threatened abortion or even of ruptured ectopic gestation are admitted with a diagnosis of septic abortion. In the scope of this review, however, we propose to deal only with the management of the three groups of cases already described.

Common to all three groups is the necessity for early pelvic examination, the taking of cervical swabs and a catheter specimen of urine, and a haemoglobin estimation. These investigations are essential. *The necessity for investigation before therapy cannot be overemphasized, since the result of sensitivity reactions may be the all-important factor in determining the most suitable antibiotic agent; haphazard trials of the various antibiotics is not only unscientific but has, in our experience, endangered life.*

Cases with severe haemorrhage or exsanguination following prolonged haemorrhage require blood replacement. Blood grouping and cross-matching should therefore be carried out at once. The need for transfusion should be based more on the patient's general condition (in particular the state of the peripheral circulation) than upon the actual haemoglobin levels. Should immediate operation be required blood transfusion should be begun before the patient is anaesthetized. We have been impressed with the infrequency of the need for immediate evacuation. The case of septic abortion has usually ceased to bleed when admitted to hospital, and there is time for adequate blood replacement and institution of chemotherapy before surgical intervention is undertaken.

Group 1 (without uterine infection)

In this group chemotherapy is not required unless removal of retained products is thought to be necessary. Since retained products are always potentially infected we cannot confidently recommend their removal without cover of combined sulphonamide and penicillin. "Sulphatriad," 1.5 g., and penicillin, 250,000 units, are given every six hours for five days, making a total course of 30 g. of sulphatriad and 5 mega units of penicillin.

Technique of Operation.—The technique of operation has been repeatedly described by gynaecologists, and we have approximated closely to the method described by Burnett (1952) except in that, if the uterus is flabby, we find it helpful to give ergometrine, 0.5 mg. intravenously, just before the end of the operation both as a haemostatic and in order to reduce the size of the cavity, and so more accurately determine if the uterus is empty.

Group 2 (local uterine infection)

In this group the same principles apply save that all cases require the combined course of sulphonamide and penicillin.

cervical culture a course of chloramphenicol was begun and the patient's general condition showed improvement, but extension of the pelvic mass was noted; subsequently the upper limit of this mass was defined at the level of the umbilicus. Two further exacerbations of pyrexia occurred. A course of tetracycline had no appreciable effect, and it was clear that no more could be expected from antibiotic therapy. There was a discharge of pus both per rectum and per vaginam, which probably accounted for a sudden fall of temperature on the 32nd day after admission, but this coincided also with the transfusion of 2 pints (1.1 litres) of fresh blood. Recovery was thereafter uneventful, and only a minor degree of pelvic thickening was detected at a recent examination.

Modern therapy has largely eliminated infection as a direct cause of death, and renal failure has now become the most dreaded complication of post-abortum sepsis. It was the cause of death in two of our four fatal cases; in the other two death occurred within 24 hours of admission and before chemotherapy could be effective. Bull *et al.* (1949) showed that shock, by causing ischaemia with resultant widespread damage to individual nephrons, is responsible for the renal failure. In the period under review, all cases with renal failure were also severely infected. Two types of renal damage are encountered (*Lancet*, 1954): (1) *massive renal cortical necrosis* in which the changes are irreversible and the prognosis is still hopeless; and (2) *renal tubular necrosis*. The prognosis now is relatively favourable. Limitation of fluid intake and the non-protein diet implicit in the principles of the Bull-Borst regime have made this possible. In practice we have found the fat content of the "Hammersmith cocktail" to be badly tolerated by many patients, and this may be halved without detracting from the value of the treatment. When vomiting persists to the extent of making it impossible to maintain the intake, intravenous administration of 40% glucose via the inferior vena cava has been tried (Russell *et al.*, 1954).

Summary

A review is given of 995 cases of septic abortion treated in a special puerperal sepsis unit. The relative reliability of the common general and local signs of infection in regard to the diagnosis of uterine sepsis is fully discussed.

The bacteriological features of post-abortum, in contradistinction to post-partum, sepsis, are analysed and the value of bacteriological and haematological findings is discussed.

The management of the case of septic abortion is described. The need for adequate investigation before therapy is emphasized.

The value of sound chemotherapeutic control of the infected case is reflected in a considerably reduced mortality. There were four deaths in the series: two of these were wholly attributable to acute renal failure, and in the other two chemotherapy had very little chance to be effective.

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INTESTINAL LENGTH IN MAN

BY

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Every medical student knows that the length of the small intestine is 22 ft. (6.7 m.) or thereabouts, for his textbook has taught him so. Every surgeon knows from his experience that there is great variation in intestinal length, but few realize the magnitude of this variation.

It is the aim of this paper to draw attention to the fact that the accepted measurements are averages and may be grossly misleading in any individual case, since the variation is of the order of 100%. The surgical applications of this fact are discussed. An account is given of the complications which arise when only a very short length of gut remains, and suggestions are made on their management.

Accepted Measurements

The lengths of small and large intestine quoted by well-known textbooks are given in Table I.

TABLE I

Author	Small Intestine	Large Intestine
Cunningham (1940)	Over 20 ft. (6.1 m.)	5 to 6 ft. (1.5 to 1.8 m.)
Grant (1948)	20-odd ft.	Not stated
Gray (1942)	About 6 m. (19.5 ft.)	About 1.5 m. (5 ft.)
Ross (1939)	6.75 m. (22 ft.)	180-195 cm. (70.9-76.8 in.)

These figures are stated without qualification in the books, and no hint is given to the student that great deviations from the mean are not at all uncommon.

This investigation was prompted by a chance observation made in the post-mortem room.

A woman aged 63 had been admitted to Chase Farm Hospital complaining of severe abdominal pain, diarrhoea, and the passage of blood per rectum of two weeks' duration. For the past week vomiting had been severe. The physical signs were those of intestinal obstruction, and the duty registrar had performed a laparotomy. The patient was found to have a mesenteric thrombosis which had caused a long loop of small intestine to become gangrenous. This loop was resected and side-to-side anastomosis performed between the remaining portions of small intestine. The resected portion was found to measure 8 ft. (2.4 m.). The patient did not recover from the operation, and at necropsy it was obvious that an unexpectedly short segment of gut remained. This segment measured only 3 ft. (91 cm.) from pylorus to ileo-caecal valve, allowance having been made for the overlap at the anastomosis. Apart from appendicectomy, she had had no previous operation on the gut, so her total length of small intestine was 11 ft. (3.3 m.). The shortness did not, however, extend to the large gut, as this structure measured 6 ft. (1.8 m.) from ileo-caecal valve to anal canal.

The literature was consulted and records were found of a few series of measurements. Treves, in 1885, measured the small and large intestine in 100 fresh adult bodies and found the average length of the small gut to be 22 ft. 6 in. (6.9 m.) in the male and 23 ft. 4 in. (7 m.) in the female, with extremes of 15 ft. 6 in. (4.7 m.) and 31 ft. 10 in. (9.7 m.), but he does not state the relative numbers of men and women, the ages of the women, or the percentage of subjects whose gut lengths varied greatly from the average. He concluded that the length of the bowel is independent, in the adult at least, of age, of height, and of weight; nor is the ratio between the measurements of the large and small intestine constant.