for an average period of three years after their first attendance at hospital. The results of treatment are analysed, showing that claudication in a large number of patients remained unchanged or improved on conservative treatment only. Angina and coronary thrombosis were common during the follow-up period, and the general mortality of this atherosclerotic group is high. The position of long-term anticoagulant therapy is discussed.

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OBSERVATIONS ON PREVENTION AND DIAGNOSIS OF ANAEMIA IN PREGNANCY

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The high incidence of anaemia in women attending the antenatal clinics of two hospitals in North Staffordshire led, in 1957, to a systematic study, the first results of which have already been published (Giles and Shuttleworth, 1958). They showed that megaloblastic anaemia of pregnancy occurred in at least 2.8% of hospital confinements and that there was almost invariably a good response to folic acid. A megaloblastic bone-marrow, however, was found in only a minority of women who presented with anaemia in pregnancy or the puerperium. In the absence of haemorrhage, iron deficiency accounted for the great majority of anaemias and often complicated a coexistent deficiency of folic acid.

In view of the relatively slight marrow changes in some of the milder cases of megaloblastic anaemia and an unexpectedly high serum iron in a few anaemic women with entirely normoblastic erythropoiesis, those authors surmised that folic-acid deficiency might exist in pregnancy even in the absence of megaloblastic anaemia. That this is in fact the case has now conclusively been demonstrated by Chanarin *et al.* (1958, 1959) by means of tests of folic-acid clearance and absorption.

It was therefore decided to administer folic acid prophylactically to an unselected group of women during

the last 11 weeks of pregnancy—not only in order to prevent the onset of megaloblastic anaemia, but also to compare the haemoglobin level at term of women so treated with that of a comparable group of controls.

For several years the prevalence of iron deficiency had convinced us that all antenatal patients need supplementary iron, but the onus for its administration had rested with the family doctor. Since the incidence of iron-deficiency anaemia remained high we felt it advisable that iron should be administered by the hospital to all patients from the time they first attended the antenatal clinic. This new regimen was timed to coincide with the therapeutic trial of folic acid in order to eliminate iron deficiency as a variable factor in the investigation.

Method

From July 1, 1958, onwards all antenatal patients, as soon as they first attended the hospital, were given a daily dose of 540 mg. of ferrous sulphate and 75 mg. of ascorbic acid. They were also handed a sheet of instructions and explanation of why it was necessary that iron and vitamin C should be taken regularly. The medical and nursing staff did their best at every visit to ensure that patients took their iron, and advised them how best to take it. Ferrous sulphate was chosen, since trials of different iron preparations (Kerr and Davidson, 1958) had shown that this, the cheapest of all iron compounds, was quite as effective in raising the haemoglobin level of the great majority of patients as other more expensive iron preparations. Intolerance to ferrous sulphate could often be minimized by the simple advice that the drug be taken during the course of a meal rather than afterwards, which is the common practice. Rather less than 20% of women developed gastro-intestinal symptoms—constipation, nausea, abdominal pain, and, occasionally, diarrhoea; and in such cases other forms of iron, such as ferrous gluconate, "colliron," and ferrous succinate was substituted for ferrous sulphate. A small number of patients (less than 1%), who could not tolerate oral iron in any form, were given a course of injections of intramuscular iron-dextran complex ("imferon"). Ascorbic acid was routinely administered, as it has been claimed (Fisher and Biggs, 1955; Steinkamp *et al.*, 1955) that this vitamin facilitates absorption of iron and reduces some of the side-effects of oral iron preparations.

The selection of patients for the trial of folic acid was based entirely on the order in which they were booked in the antenatal clinic; thus every other patient was given a daily dose of 15 mg. of folic acid from the 29th week of pregnancy onwards. This is undoubtedly far more than the daily needs of a pregnant woman (Lowenstein *et al.*, 1955), but in such a large group of cases, which included many women of rather low intelligence, it was obviously simpler to prescribe an equal number of tablets of three different kinds. Subsequent findings have shown that depletion of folic acid may occur before the 30th week of pregnancy, and our more recent practice is to begin the administration of folic acid at the 26th week.

The haemoglobin of all patients was determined at every visit, and packed cell volumes were estimated and stained blood films examined whenever the haemoglobin dropped below 67% (100% = 14.8 g./100 ml.). At the same time a careful search was maintained for cases of megaloblastic anaemia on the lines of the previous investigation (Giles and Shuttleworth, 1958).

The medical records of all women delivered between October 8, 1958, and October 7, 1959, were then analysed and those treated with folic acid were compared with those who received iron alone. In order to assess the efficacy of prophylactic iron administration in hospital, the control group was also compared with antenatal patients delivered during the year ended June 30, 1958. Only patients who attended the clinic for six weeks or more prior to confinement were included in the final analysis, and women whose gestation terminated before the 37th week were excluded.

The haemoglobin values used in the final comparison were those obtained on the last antenatal visit before delivery. If no haemoglobin estimations were recorded after the beginning of the 38th week of pregnancy, the haemoglobin on the fourth day of the post-natal period was assumed to be a more representative figure, provided that the patient had been delivered naturally and that the recorded loss of blood did not exceed 8 oz. (230 ml.). If neither of these figures was available the case was excluded from analysis.

Effect of Prophylactic Administration of Folic Acid

During the year ended October 7, 1959, 1,479 cases came within the present survey; 758 patients had been treated with folic acid, 721 were controls. The mean haemoglobin level at term of the group treated with folic acid was 82.2% (12.17 g./100 ml.) and that of the controls, treated with iron alone, was 79.82% (11.81 g./100 ml.). The difference of 2.38% has to be compared with a standard error of 0.43, and is therefore statistically highly significant ($P < 0.01$).

Fig. 1 compares the haemoglobin levels between the two groups and shows the difference even more clearly than the two mean haemoglobins. The incidence of

FIG. 1.—Effect of folic acid on haemoglobin levels.

anaemia in the two groups is set out in Table I and suggests not only that moderate and severe anaemia is less common after administration of folic acid, but that the milder cases with haemoglobins between 70 and 80% are less numerous. An analysis of the higher haemoglobin values demonstrates that out of a total of 466 cases with haemoglobins of 85% and above no

TABLE I.—Anaemia at Term in Cases Treated with Folic Acid and in Controls

Haemoglobin	Treated with Folic Acid	Controls
Below 80%	33.0%	43.6%
.. 75%	16.3%	24.9%
.. 70%	4.8%	7.5%
.. 65%	1.0%	3.3%
.. 60%	0.3%	1.7%

Columns 2 and 3 give the proportion of patients in each group.

fewer than 273 (58%) had been treated with folic acid. This confirms the findings of Chanarin *et al.* (1959) that some degree of folic-acid deficiency exists during the latter half of apparently normal pregnancies. The same authors likewise comment on the pronounced folic-acid depletion in normal twin pregnancies. This, too, is reflected in the present series, which includes 26 twin deliveries, 13 in each group; the mean haemoglobin of those treated with folic acid was 82.1% and that of the controls 74.5%. Despite the small numbers, this difference is statistically significant.

Effect of Routine Administration of Iron

The 721 control cases, treated with iron alone, were compared with 983 antenatal patients delivered during the year ended June 30, 1958, before routine administration of iron in hospital was begun. The latter group of cases included only those in which adequate haematological data were available. The mean haemoglobin at term of these women who had not received iron in hospital was 73.4% (10.86 g./100 ml.), as compared with 79.82% (11.81 g./100 ml.) in the iron-treated group during the current year.

Fig. 2 shows a comparison of haemoglobin levels between the two groups. The reduction of pregnancy

FIG. 2.—Effect of prophylactic iron on haemoglobin levels.

anaemia since routine administration was introduced is strikingly demonstrated. Whereas, in the past, 70% of women were confined with a haemoglobin of less than 80%, the incidence has now fallen to 43%, and haemoglobin values below 70%, which were formerly encountered in 34% of all deliveries, now constitute only just over 7%.

This improvement in the current series was also reflected in the 369 cases in which blood investigations in previous pregnancies were available. In well over 60% of these the haemoglobin during pregnancy and at term was from 5 to 43% higher during the current year than in past pregnancies.

Incidence of Anaemia in Pregnancy and the Response to Treatment

Of the 1,479 patients in the present survey, 978 (66%) had haemoglobin levels below 80% when first seen in the antenatal clinic (Table II). Gatenby and Lillie (1955) have reported a similar incidence.

TABLE II.—Haemoglobin Levels at First Attendance

Haemoglobin	No. of Cases
Below 50%	13
50 to 59%	37
60 to 69%	167
70 to 79%	761

After periods varying from six weeks to six months on treatment with iron, with or without folic acid, 595 of these patients went into labour with a haemoglobin of 80% or more. Of the remaining 383, 160 had been treated with folic acid and 223 were controls.

In some of the women who remained anaemic the period of treatment was probably too short, and it is likely that many others did not take the drugs they were given, or at least not regularly. Only in a small number of cases were other conditions recorded which might have explained the lack of response to haematinic drugs—for example, chronic infection and glomerulonephritis. There were doubtless some instances in which low-grade urinary infection was either missed or not recorded.

An interesting observation in at least 80 patients whose haemoglobin remained between 60 and 79% throughout pregnancy was a marked rise, varying from 5 to 20%, in the haemoglobin level after delivery, whereas the mean overall rise after delivery was only 1.5%. Many of these 80 patients had pre-eclamptic toxæmia and some others were delivered of twins. It is tempting to attribute the low ante-partum haemoglobin in this group of cases to true hydraemia with excessive haemodilution.

Among the remaining 303 patients whose haemoglobin did not reach 80% there was a "hard core" of 214 who showed no response whatever to drug therapy and whose haemoglobin at term stayed roughly as it had been when they first attended. It is perhaps significant that only 77 of these had been receiving folic acid and that 137 cases were in the control series, suggesting that folic-acid deficiency may have been a factor in some instances.

There appeared to be no great difference in the haemoglobin levels in the various age-groups, but multiparae who had borne five children or more had a slightly lower mean haemoglobin. After caesarean section the haemoglobin almost invariably dropped quite considerably, averaging 12.4% in 92 patients thus delivered during the year. For this reason alone no post-partum haemoglobin readings were included in the present survey where caesarean section had been performed.

Incidence of Megaloblastic Anaemia

Altogether 66 cases of megaloblastic anaemia of pregnancy have been diagnosed in our hospitals since the first series of 90 cases already published—a total of 156 cases in about three years. Forty-five cases were

diagnosed during the period of the folic-acid trial. As shown in Table III, 20 of these derived from patients attending the antenatal clinic, but, as expected (Lowenstein *et al.*, 1955), no cases of megaloblastic anaemia occurred in the group receiving prophylactic folic acid.

TABLE III.—Incidence of Megaloblastic Anaemia from October 8, 1958, to October 7, 1959

Type of Case	Antenatal	Post-natal	Total
From the antenatal clinic:			
Treated with folic acid	0	0	0
Controls	16	4	20
Emergency admissions and cases referred direct to laboratory by the family doctor ..	15	10	25
Total ..	31	14	45

The incidence of megaloblastic anaemia of pregnancy during the year of the folic-acid trial was 45 in 3,645 deliveries—that is, 1 in 81 hospital confinements, or 1.2%. This compares with a case incidence of 2.8% in 1957–8, as reported by Giles and Shuttleworth (1958) from the same hospitals. Subsequent paragraphs are based on the case records of all the 66 cases diagnosed since the original series was completed.

Clinical Findings.—As in the first series of cases, there was no evidence of any seasonal distribution (Thompson, 1957). The age incidence was likewise similar, the mean age being 29.0 years; 14 patients were primigravidae. About half the patients complained of a sore tongue or ulceration of the mouth, and in 29 cases there had been some degree of anorexia.

Diet.—Although an attempt was made in the antenatal clinic to stress to patients the importance of a good diet, including plenty of animal protein, many women with megaloblastic anaemia still gave a history of an inadequate diet throughout pregnancy. Nearly half of them ate fewer than three meat meals a week.

Degree of Anaemia.—Fewer instances of severe anaemia were encountered than in the first series, only three patients presenting with a haemoglobin below 30%, while in 48 cases it ranged between 40 and 60%. The great majority of patients responded to folic acid with a reticulocyte count exceeding 15%.

Serum Iron.—In 56 cases the serum iron was above 150 µg./100 ml., and in 12 it exceeded 300 µg./100 ml.

Achlorhydria.—The incidence of histamine-fast achlorhydria remained approximately the same as before—namely, 35%.

Fat-absorption.—The faecal fat content and daily fat-excretion on an ordinary hospital diet was estimated in a further 18 cases, a total of 41 patients having now been studied in this way since the original investigation was begun in 1957. The same tests were also carried out in 17 women in late pregnancy who were not anaemic. In Fig. 3, cases as well as normal controls are plotted on a two-dimensional graph showing both the faecal fat concentration and the daily fat excretion. Out of 41 patients, 13 excreted more than 5 g. of fat a day, which is regarded by Frazer (1956) as suggestive of defective fat-absorption; in 14 cases the faecal concentration of fat exceeded 20%. A study of Fig. 3 shows that pregnant women without anaemia tend to excrete much less fat in their faeces than some of the patients with megaloblastic anaemia.

Blood-group Distribution.—After an inquiry by Forshaw (1959), the blood-group distribution in 173 patients with megaloblastic anaemia of pregnancy diagnosed in our hospitals during the past five years

was compared with that of 2,500 random antenatal patients who were not known to be suffering from the disease. The results are seen in Table IV. It shows an apparent increase in the incidence of group A in the

FIG. 3.—Fat-excretion on a normal diet. Values within shaded area are considered normal.

combined series of cases, but the difference is of doubtful statistical significance, and definite conclusions on blood-group distribution must await the analysis of larger numbers of cases. It may be a coincidence that 9 out of 13 patients with megaloblastic anaemia who also showed a raised faecal fat excretion belonged to group A.

TABLE IV.—Blood-group Distribution

Blood Group	Megaloblastic Anaemia	Controls
O	43.4%	45.7%
A	49.7%	42.8%
B	4.6%	8.2%
AB	2.3%	3.3%

Discussion

In the past it has been customary to attribute the well-known fall in haemoglobin levels of pregnant women to hydraemia and to accept haemoglobins as low as 67% (10 g./100 ml.) as physiological (Greenhill, 1951; Whitby and Britton, 1957). This view is based on the blood-volume studies by Dieckmann and Wegner (1934) and others, which revealed that, with advancing pregnancy, the increase in plasma volume outstrips a similar increase in the red-cell mass. Since it was shown, however (Benstead and Theobald, 1952; Fisher and Biggs, 1955; Kerr and Davidson, 1958), that a majority of such "physiological" anaemias respond to iron therapy, it has become necessary to revise the definition of pregnancy anaemia (Holland and Bourne, 1955; Camilleri, 1958). In our opinion the haemoglobin of a normal woman in late pregnancy should be at least 80% (11.81 g./100 ml.).

In the present series intensive iron prophylaxis alone has raised the mean haemoglobin at term by 6.4% and has produced an impressive reduction in the incidence of pregnancy anaemia. It would appear that the time has now come for supplementary iron to be issued free of charge to all pregnant women in the way that vitamin preparations have long been made available.

Possibly the most interesting result of the present study has been the obvious benefit derived from the prophylactic administration of folic acid. Not only has it completely prevented the occurrence of megaloblastic anaemia, but it has also raised the haemoglobin at all levels, even in the absence of megaloblastic changes in the marrow. Chanarin *et al.* (1959) have shown that even the normal pregnant woman suffers a relative depletion of folic acid during the last trimester of pregnancy. As might be expected from their findings, the present investigation demonstrates that the haemoglobin level can be raised even in women who by no definition can be called anaemic.

It is clear, however, that deficiency of iron and of folic acid are not the only factors producing pregnancy anaemia. The abrupt rise of haemoglobin levels after delivery in at least 20% of women who remained anaemic despite treatment would seem to show that excessive haemodilution must play a part in some patients with pregnancy anaemia. Fisher and Biggs (1955) noted a similar post-partum rise and came to the same conclusion. The role of infection in the aetiology of anaemia in pregnancy has probably been underrated in the past and will be a subject of further study.

The incidence of megaloblastic anaemia in the present series was 1.2% of all hospital confinements, compared with 2.8% as previously reported by one of us in the same hospitals. This fall is more than could have been expected from folic-acid prophylaxis in the group selected for treatment. Previous workers, including Nichol and Welch (1950), have suggested that ascorbic acid might increase the utilization of folic acid by its reduction to folinic acid. One might therefore conjecture that the lessened incidence among patients not receiving supplementary folic acid is due to the fact that they were treated with large daily doses of vitamin C in addition to iron. On the other hand, without any conclusive evidence that pregnant women commonly suffer from vitamin-C deficiency it would be premature thus to account for the lessened case incidence.

This latest study confirms that an inadequate diet plays an important part in the aetiology of megaloblastic anaemia of pregnancy. It is equally plain that a deficiency of folic acid in the diet is not the sole cause of the disease. Evidence has now been presented which points to an element of malabsorption in a number of cases: 14 out of 41 patients exhibited a much higher faecal fat-concentration or fat-excretion than any of the normal pregnant women who were investigated as controls. If these findings are confirmed in a larger number of cases they might well be explained by latent or mild steatorrhoea, in which megaloblastic anaemia is a well-recognized complication. Since the growing foetus causes a relative depletion of folic acid even in normal pregnancy, a woman with defective intestinal absorption might be expected to develop megaloblastic anaemia in the last trimester. This hypothesis would also explain the recurrence of the disease in subsequent pregnancies.

The blood-group distribution in our series of megaloblastic anaemias is of interest, for an increased incidence of group A is already known to exist in Addisonian anaemia (Aird *et al.*, 1956), but, obviously, further studies are needed to establish a similar blood-group distribution in megaloblastic anaemia of pregnancy.

The present investigation has confirmed that a deficiency of folic acid is very common in late pregnancy, and can readily be prevented by prophylactic administration of this vitamin. The risk of inducing neurological changes in an unrecognized case of Addisonian anaemia, in this age-group and with such a short course of treatment, is exceedingly slight. We therefore have not thought it necessary to add vitamin B₁₂ to our prophylactic regimen. Over the age of 30, however, patients with megaloblastic anaemia of pregnancy should be investigated with Addisonian anaemia in mind. In the two hospitals concerned no case has been found in association with pregnancy during the last three years. Francis and Scott (1959) appear to have reached similar conclusions.

Summary

In order to study the routine administration of folic acid during the last trimester of pregnancy, the haemoglobin levels at term of 758 women treated with folic acid and iron have been compared with 721 controls treated with iron alone. The mean haemoglobin in the group treated with folic acid was 82.2%, as against 79.82% in the controls. The difference of 2.38% is statistically significant ($P < 0.01$). Folic acid appeared to raise the haemoglobin not only of anaemic patients but also of normal women, resulting in a higher haemoglobin value at all levels.

A comparison of the 721 controls with 983 pregnant women who attended the antenatal clinic before routine iron prophylaxis in hospital was begun has shown a rise in the haemoglobin at term from 73.4 to 79.82%.

66% of women had haemoglobins of less than 80% when they first attended hospital, but in the majority the anaemia responded to treatment even in the control group. In at least 20% of patients who remained anaemic despite treatment there was a sharp rise in the haemoglobin after delivery.

A further 66 cases of megaloblastic anaemia of pregnancy have been reported, 45 of which were diagnosed during the period of the folic-acid trial. There were no cases of the disease in the group treated with folic acid, but the incidence in the control group was also somewhat lower than in the past. The overall incidence was 1.2% of all hospital confinements. In 14 out of 41 cases of megaloblastic anaemia there was evidence of diminished fat-absorption.

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NATURAL HISTORY OF STREPTOCOCCUS FAECALIS ENDOCARDITIS

BY

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Bacterial endocarditis due to *Streptococcus faecalis* has certain distinct features. These must be recognized so that an early diagnosis can be made and effective treatment given. Andrewes and Horder (1906) and Horder (1909) were the first in this country to draw attention to bacterial endocarditis due to this organism. In recent years the importance of this condition has grown because of its resistance to antibiotic therapy. Geraci and Martin (1954) reviewed 33 cases and noted that in 15 there was no underlying heart lesion and that many followed operations on the genito-urinary and gastrointestinal tracts. They emphasized the high mortality with inadequate treatment. Rantz and Kirby (1943) found that the human infections usually caused by this organism were acute suppurative otitis media, infections of the urinary tract, terminal peritonitis in association with coliform bacillus, and subacute bacterial endocarditis. The incidence of this infection in bacterial endocarditis is variously reported as 3.2% (Sirota *et al.*, 1947), 3.8% (Loewe *et al.*, 1951), and 5–10% (Robbins and Tompsett, 1951). Geraci and Martin (1954) thought that there might have been a relative rise in incidence in the past ten years.

Present Investigation

We here give a review of eight patients with bacterial endocarditis due to *Str. faecalis* (or enterococcus) out of a total of 49 proved cases of bacterial endocarditis admitted to this hospital in the past nine years. In addition, there was one patient with bacterial endarteritis due to this organism. The course of the disease and the problems of treatment are discussed.

Only bacteriologically proved cases are included. Table I gives a list of the various organisms identified. The three cases with a non-haemolytic streptococcus are considered separately because of the different bacteriological properties of that organism and because it is less resistant to penicillin and streptomycin than the average *Str. faecalis*.