AN INVESTIGATION INTO THE TYPE, INCIDENCE, AND PROPHYLAXIS OF GESTATIONAL ANAEMIA IN AN INDUSTRIAL POPULATION, BASED ON A STUDY OF AETIOLOGICAL FACTORS AND NORMAL BLOOD VALUES IN PREGNANCY.

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Chapter I. Introduction.

Chapter II. Classification and Aetiology of Anaemia of Pregnancy.

Chapter III. Pernicious Anaemia of Pregnancy.

Chapter IV. Normal Haematological Values in Non-Pregnant and Pregnant Women, and Criteria of Anaemia of Pregnancy.

Chapter V. Present Investigation.

Chapter VI. Results.

Chapter VII. Discussion.

Chapter VIII. Summary.

CHAPTER I.

Introduction:

Anaemia associated with the pregnant state is now generally accepted as a clinical entity, and although its incidence has been variously stated, it is undoubtedly a common condition which has been widely recognised for many years. Nasse in 1836 was the first to observe that the number of red blood corpuscles was reduced in the pregnant woman, but nearly a century was to pass before the subject received the interest it deserved. Indeed, until the turn of the century, little interest in the condition was aroused, and even as recently as 1929 Galloway (a) could find only ninety references relative to the subject, and all but ten of these, dealt with the pernicious variety. Henderson (1902) stated that the anaemia of pregnancy was a subject which up till that time had received little attention, and observed that the literature was very scanty, chiefly continental, and of a remote date. We are, however, indebted to him for a summary of the chief contributions prior to the beginning of this century.

Caseaux (1850) considered that the pregnant state was one essentially analogous to chlorosis, and believed it should be treated as such, but Willcocks (1881) disagreed with this theory. He showed that the blood picture in pregnancy differed from that of chlorosis in that, while the haemoglobin was reduced in both conditions, the red blood cells were diminished in number only and were not impoverished as in chlorosis. He referred also to the increase in the water content of the plasma. Spiegelberg and Gscheidlin (1872), in an examination of pregnent dogs reported a similar increase in the water content of the blood and also a diminution of the red blood corpuscles, and Becquerel and Rodier (1884) in a study of nine cases, confirmed these findings. Lusk (1882) described the anaemia of pregnancy as a condition of "serous plethora", with a diminution of red blood corpuscles and an increase in the water content of the blood. He attributed these changes to the demand of the foetus on the maternal system. Playfair (1893), referring to the deductions drawn by Caseaux, concluded that "the general blood state is tending to poverty and anaemia." Channing first drew attention to the condition in America in 1842 and other contributions were recorded by Kiswisch (1848), Scanzoni (1867), Lebert (1876) and Cabot (1900).

With the turn of the century, the anaemia of pregnancy began to receive wider recognition and more frequent reference to the condition began to appear in the literature. In one such reference, Given (1906) stated that so far as he could discover, no English observer up till that time, had investigated the haematology of pregnancy and the puerperium. While this may be true of the English literature, it certainly did not apply to Scotland, where Henderson (1902) had already published his "observations on the Maternal Blood at Term and during the Puerperium," from the Glasgow Royal Maternity Hospital. He demonstrated a fall in haemoglobin, red blood corpuscles and a lowered colour index during pregnancy. In America, Thomson (1904) published the results of a similar study, and Blumenthal in Germany (1907) recorded his observations on a series of cases. Gram (1920) pointed out that it was probably not generally known that the blood of pregnant women had a lower content of haemoglobin than that of other normal women, but he stated that this observation had already been made by Andral in 1845. Alder in 1924 commented that the anaemia of pregnancy was so common that it was surprising how little was known about it. In this country, however, real interest in the subject was stimulated by the publication in 1919 of a paper entitled "The Severe Anaemia of Pregnancy and the Post-Partum State" by Osler, who is credited with the first real contribution to the English literature. In spite of this increasing interest in the subject, no large scale investigations had as yet been carried out, and no records were available of statistical studies of a large series of cases. The reason, however, for this apparent lack of interest in a common malady was probably the mildness of the symptoms produced, and the comparative rarity of serious complications. As Whitby (1932) observed, "anaemia of itself, severe enough to be an alarming symptom, is in this country, so rare a complication of pregnancy, that the subject has been little studied."

After the end of the first world war, anaemia of pregnancy began to occupy a position of ever increasing prominence in the literature, both in this and in many other countries, until at the present time a vast and varied literature has accumulated, demonstrating the wide prevalence of the condition. Many contributions from well-known authorities, and other workers, in this field, have appeared. These will be referred to later. That a wide interest in the subject became evident at this time was probably due to the 1914 - 1918 War with its aftermath of poverty, malnutrition and lowered standards of living. Large-scale investigations of the health standards of the population were carried out, and it was natural that these investigations should include the health of the expectant mother on whom must depend the health of the future generation. Anaemia of pregnancy, therefore, came to be widely studied and much valuable information has been obtained regarding the aetiology, incidence and severity of the condition, not only at this period, but also during the recent world war which offered a valuable opportunity for comparison with pre-war investigations. One would mention especially, in this connection, a publication of the Medical Research Council, "Haemoglobin Levels in Great Britain in 1943 by the Committee on Haemoglobin Surveys." This publication emphasized the need for a continual check of the nation's health, pointing out, in particular, that there were still too many women with haemoglobin values below the normal level. It will be the object of the present investigation to attempt a post-war study of the hypochromic or iron-deficiency anaemia of pregnancy and to draw a comparison with results published in this country both before and during the recent war.

Although this increased interest in the subject, and the publication of detailed results have greatly increased our knowledge of the condition, many factors concerning the anaemia of pregnancy are still obscure and controversial. Alder, as already quoted, commented on our lack of knowledge, and Irving in America (1935) stated that examination of the literature revealed a divergence and confusion of opinion regarding classification, cause and treatment. This statement is amply borne out when one attempts to compare results published by various workers in this and other countries. Among other things, this state of affairs is undoubtedly due to the many different standards and criteria of anaemia employed in clinical investigations. Further reference will be made to this aspect of the subject later. At the moment it may be said that until an international standard of haemoglobinometry has been established and definite haematological criteria for the anaemia of pregnancy accepted, no comparison of results can be attempted with a reliable degree of accuracy. In spite of this, however, a study of the literature, leaves no doubt as to the prevalence and frequency of the anaemia of pregnancy. It is generally agreed also by all authorities on the subject, that the predominant anaemia of pregnancy is the secondary or hypochromic type which will form the subject of the present study.

It will be seen from the foregoing, that anaemia associated with pregnancy is by no means a recent discovery, although its recognition has only been acclaimed in comparatively recent years. Indeed, Brindeau and Theodorides (1935) quote reference to the subject in the works of Hippocrates. Since the time of Nasse, however, interest in the condition has steadily increased, and the literature enriched by many valuable contributions, which have helped to clarify many of the more obscure and controversial points. Nevertheless, it would appear that the subject demands an interest even greater than that at present shown. Although Nasse's original observations were made in 1836, it is interesting to read a century later in the Transactions of the Edinburgh Obstetrical Society that "until 1919 when Osler made his survey, there was no publication of note in this country, and even now, textbooks on obstetrics or haematology devote very little space to this subject." (Stevenson 1938).

CHAPTER II.

CLASSIFICATION AND AETIOLOGY OF ANAEMIA OF PREGNANCY.

A study of the literature dealing with the aetiology and classification of the anaemia of pregnancy bears out the truth of Irving's statement that there is a divergence and confusion of opinion on these points. Although much light has been thrown on the aetiology of the condition since this statement was made, many factors are still obscure, such as, for example, the part played by protein and vitamin deficiency in the production of the iron-deficiency type of anaemia, and until a precise aetiology has been established there can be no final classification of the pregnancy anaemias. Since the subject was first studied various classifications have been put forward, and it would be of interest to summarise these briefly as they demonstrate how ideas have changed with a better knowledge of the condition.

The first classification from a clinical standpoint was suggested by Osler in 1919. He divided the anaemias into (1) Anaemia from post-partum haemorrhage; (2) The Severe Anaemia of pregnancy; (3) Post-Partum Anaemia, and (4) The Acute Anaemia of post-partum sepsis. It will be noted that iron-deficiency anaemia was not included in this classification, nor was it included by Schultz (1933) who classified the anaemias as (1) Pseudo-anaemia (hydraemia); (2) True anaemia of pregnancy, and (3) Pernicious Anaemia. That iron-deficiency, however, was a factor in the production of the anaemia, had already been recognised by Whitby (1932) who put forward the following classification: (1) The Pernicious type, (further sub-divided into a Plastic and Hypoplastic variety); (2) The Iron-deficient or Chlorotic type, and (3) The Atypical, dependent on the primary blood disease; and from this time iron-deficiency became generally accepted as a causative factor in the production of anaemia of pregnancy. Green-Armytage (1935) described six different varieties, three of which he considered important viz: (1) A mild type associated with hydraemia; (2) Hypochromic anaemia, and (3) Severe Anaemia, and Witts (1935) divided the anaemias into (1) Simple Anaemia of pregnancy; (2) Pernicious Anaemia of pregnancy; (3) Anaemia from haemorrhage, and (4) Anaemia from puerperal infection. He did not specifically include the iron-deficiency type, but stressed the importance of iron and iron-containing foods as prophylactic measures. Brindeau and Theodorides (1935) described two distinct types, the physiological and the pathological, the latter being further sub-divided into (a) The common anaemia of pregnancy which might be mild or severe, and (b) Pernicious Anaemia.

American workers have suggested classifications very similar to those in this country, and the continent.

Adair et al (1936) placed the anaemias in three simple categories, (1) Physiological Anaemia; (2) Microcytic Anaemia, which he described as the predominant type, and (3) Pernicious Anaemia. Bethell (1936) produced a somewhat different but interesting classification. He classified the anaemias into three main groups. In the first he included those cases with blood values within accepted normal limits, but showing a slight reduction in haemoglobin and red blood cells. He attributed this reduction to plasma dilution. In the second group he included cases with small red blood corpuscles and a low colour index, attributing these changes to iron-deficiency. The third group comprised those cases with a normal colour index and red blood corpuscles of high normal, or definitely increased volume. He considered this latter type of anaemia to be due to a protein deficiency. While this is an attractive classification it is difficult to draw a clear distinction between Bethell's first and third groups. Alder (1924) drew a similar distinction in a detailed study of a series of cases and concluded that four out of fifteen cases of pregnancy anaemia, which had higher blood values than the others, and did not respond to iron, were cases of physiological anaemia. While protein deficiency as a causative factor cannot be dismissed, the cases included by Bethell in his third group, also had higher blood values than would be expected if an anaemia were present, and also did not respond to iron therapy. It is difficult, therefore, to avoid the conclusion that the blood picture in Bethell's third group might be explained by a physiological anaemia.

In more recent years, with an increasing knowledge of the aetiology of the condition, more comprehensive classifications have been suggested. Evans (1937) described five different types. (1) Deficiency Anaemias; (2) Anaemia due to haemorrhage; (3) Anaemia due to sepsis; (4) Haemolytic Anaemia, and (5) Anaemia in which pregnancy itself was a complicating factor. Under deficiency anaemias he included the microcytic and macrocytic types and differentiated these according as to whether there was (a) a normal or only temporary deficiency of gastric secretion or (b) a permanent deficiency of gastric secretion. From this time, as had been evident for some years previously, there was a growing recognition of the part played by defective gastric secretion in the production of anaemia of pregnancy. Indeed, as will be seen later, it has been regarded by some workers as the principal predisposing cause. Classifications of the pregnancy anaemias still continued to expand and Stevenson (1938) produced one of the most comprehensive classifications to date. This was as follows:-

I. PERNICIOUS ANAEMIA:

1. Addisonian Anaemia.
2. Pseudo-pernicious Anaemia.
   (a) Plastic.
   (b) Hypoplastic.

3. Tropical Macrocytic Anaemia.

II. SECONDARY ANAEMIA:

1. Idiopathic Hypochromic Anaemia, due to iron deficiency.
2. Microcytic Hypochromic Anaemia, due to temporary iron deficiency.
3. Microcytic Hypochromic Anaemia, due to some known cause, e.g. haemorrhage, sepsis.

III. PERNICIOUS SECONDARY ANAEMIA:

A combination of I and II.

IV. Various types of anaemia associated with some condition other than pregnancy, e.g. Malaria, Syphilis, Tuberculosis, Neoplasm, Leukaemia.

While this classification would appear to cover most of the recognised anaemias of pregnancy, the fact that aetiological factors were not yet exhausted was shown by Meyer-Wedell (1943) who studied a series of cases and classified them as follows:- (1) Hypochromic Iron-deficiency Anaemia; (2) Megalocytic Anaemia; (3) Pernicious Anaemia and (4) Vitamin C. deficiency Anaemia, and this classification was taken a stage further by Elliott (1944) who described the anaemias as (1) Physiological Anaemia; (2) Deficiency Anaemia, (3) Unproven Anaemias, which included Acute Haemolytic, Protein-deficiency and Vitamin B. deficiency anaemias;

(4) Unclassified Anaemias, and (5) Anaemia complicated by pregnancy including Tropical Megalocytic Anaemia. Evans included under the Deficiency Anaemias, iron-deficiency anaemia, megaloblastic anaemia, including the pernicious and myeloblastic varieties, and a mixed iron and pernicious type, as described by Stevenson.

The above summary shows how the classification of the anaemias of pregnancy has been extended and enlarged as new aetiological factors have come under review, but generally speaking the two most clearly defined and predominant types of anaemia of pregnancy are the Iron-deficiency and Pernicious varieties, the latter being now commonly referred to as the Megaloblastic Anaemia of Pregnancy (Davidson et al 1942). There is little doubt also that by far the commonest type of anaemia found in the pregnant woman is the iron-deficiency type. In the present investigation not one case of the pernicious variety was found so that further discussion will be confined to iron-deficiency anaemia, with which will be considered the Physiological Anaemia of pregnancy. As frequent reference, however, is made in the literature to the pernicious variety in connection with iron-deficiency, a further reference will be made later to the so-called Pernicious Anaemia of pregnancy, concerning chiefly its reputed prevalence and severity. Evans and Stevenson were of the opinion that the two varieties might sometimes co-exist.

PHYSIOLOGICAL ANAEMIA OF PREGNANCY:

Although physiological anaemia of pregnancy is now generally accepted as a factor having a definite influence on the blood picture, this has long been a controversial subject. Its existence was supported by some of the earliest contributors to the literature, (Caseaux 1850, Spiegelberg and Gscheidlin 1872, Fehling 1886, Willcocks 1881, Bernhard 1892), but others equally denied that it played any part in the production of an anaemia during pregnancy. (Peter 1875, Ingerslav 1879, Meyer 1887, Reinl 1889, Dubner 1890, Schroeder 1891). Since then the occurrence of a physiological anaemia or hydraemia, and its relation to, and influence upon, the normal haematological values during pregnancy, has been widely discussed.

The aetiology of the condition is based on the theory that there is a dilution of the blood during pregnancy due to an increase in the blood and plasma volume, so that a state of hydraemia exists. This was first pointed out by Keith, Rowntree and Geraghty (1915) who showed that the blood mass during pregnancy increased from a normal of 8·8% in proportion to the body weight to 9·56%, with a corresponding increase in plasma volume from 50 cc. to 58·4 cc per kilogramme of body weight. Later Dieckmann and Wegner (1934) proved conclusively that the blood and plasma volume were increased during pregnancy.

They showed that this increase began in the first trimester and by the thirteenth week amounted to 16% and 18% respectively, until at term the average increase in the blood volume was 23%, and plasma 25%. They considered that a state of physiological anaemia existed during pregnancy as long as the haemoglobin level was maintained at 10 grammes per 100 cc of blood or more. This level was regarded as the lower limit of normality, below which a pathological or true anaemia existed. The work of Richter, Meyer and Bennett (1934) also supported the dilution theory, and Thomson et al (1938) in an examination of fourteen normal pregnant women found an increase in plasma volume of 65% above the average normal non-pregnant value, and a corresponding increase of 45.4% in total blood volume. They considered the disproportionate increase in plasma volume to be primarily accountable for the phenomenon of "hydration" of the blood in pregnancy. Bethell (1936) examined sixty six normal healthy pregnant women in the last trimester and found the plasma volume to be increased by about 25%, but in a previous contribution (1935), he considered that the resulting anaemia merely persisted during pregnancy because of the absence of stimulus to increased blood formation together with a relative lack of iron. The phenomenon of a state of hydraemia existing during pregnancy has also been confirmed by animal experimentation. Van Donk et al (1934) in an analysis of anaemia of pregnancy in the rat, found that the percentage of water in the blood increased by about 4% during the latter stages of pregnancy. Mitchell and Miller (1931) in a previous examination of pregnant rats had suggested that the anaemia was probably physiological in nature.

This theory of a physiological anaemia existing during pregnancy has not always met with universal acceptance. Esch (1932) in an examination of 800 patients attending an antenatal clinic did not find much evidence of hydraemia in the last month of pregnancy and Witts (1935) did not believe the condition existed in normal healthy pregnant women. Irving (1935) in a study of 60 cases concluded that the anaemia of pregnancy was not physiological but was due to the drain on the iron reserve of the mother by the growing foetus, and Toverud (1935) examined 181 pregnant women in the last trimester and concluded that the anaemia was not physiological but was due to an iron deficiency in the diet. Again, the results of animal experimentation have been put forward as evidence against the physiological theory. Beard and Myers (1933) examined 87 pregnant rats through 138 pregnancies and came to the conclusion that the anaemia could not be wholly accounted for on the basis of hydraemia. They considered that the drop in haemoglobin in fully one third of the cases was too great to be explained in this way. Nevertheless the general consensus of opinion supports the theory that hydraemia is a factor which influences the blood picture in pregnancy and one finds frequent reference to it in the literature. (Vaughan 1934, Davidson et al 1935, Wills 1935, Green-Armytage 1935, Fullerton 1936, Boycott 1936, Smallwood 1936, Browne 1944, Whitby 1946). Frequent reference to the condition is also found in the literature of America and other countries. (Bland and Goldstein 1929, Bland, Goldstein and First 1930a., Nalle 1930, Strauss 1932, Strauss and Castle 1932, Wintrobe 1933, Strauss 1934, Feldman et al 1936, Burwell 1936, Burwell et al 1938, Watson 1938). In Canada, Adamson and Smith (1932), drew attention to the condition, and in New Zealand, McGeorge (1935) regarded the mild variety of anaemia in a series of cases studied, as due to hydraemia. In the continental literature many writers make reference to the condition including Alder (1924), Kuhnel (1927) and Brindeau and Theodorides (1935). In the treatment of anaemia of pregnancy with iron, many workers, notably Alder, considered that those cases which did not respond to this form of therapy, were probably suffering from the physiological variety of anaemia, and Adamson and Smith went as far as to suggest that the anaemia being physiological in nature, iron might conceivably do harm. Galloway (1929 b), on the basis of response to iron therapy alone, dismissed the dilution theory as an aetiological factor.

From the foregoing review of the literature, it is concluded, in spite of the evidence to the contrary, that a physiological state of anaemia does exist during the course of pregnancy, and this fact must be borne in mind in any assessment of the incidence of anaemia associated with the pregnant state. The importance of this will be appreciated when one attempts to establish normal haematological standards for the pregnant woman. As Keith, Rowntree and Geraghty pointed out, this physiological state might make an anaemia more apparent than real. While recognising the significance of the condition, Browne (1944) stated that the term "Physiological Anaemia" had some historic interest, but should be abandoned for the term "physiological Hydraemia of Pregnancy." He affirmed that the latter condition can and does coexist with the true anaemia of pregnancy. It would appear, however, that an increase in the water content of the blood is not confined only to the pregnant state. Keith (1923) in an examination of twenty four cases of chronic anaemia, found that the highest plasma values were found in patients with low haemoglobin percentages, although he could not demonstrate any absolute relationship. He stated that "early in a slowly progressing anaemia, the usual mechanism for maintaining an adequate blood volume may be called into play, with a resulting high plasma content." Keith's results raise the interesting speculation that if anaemia is the exciting factor in the causation of an increased plasma volume, this might be an argument against pregnancy per se being responsible for the increase, which might merely be due to the incidental anaemia. In other words, is an increase in plasma volume peculiar to the pregnant state, or is this increase the effect of anaemia irrespective of pregnancy? Whatever may be the ultimate cause of the hydraemia, there is no doubt that in the examination of a large number of cases, one frequently finds blood values below the accepted normal standards in patients showing no signs or symptoms of anaemia. In these cases, particularly where the colour index remains around unity, and stained blood-films reveal no abnormality, one is inevitably drawn to the conclusion that physiological factors, perhaps peculiar to the pregnant state, are responsible for these changes.

IRON-DEFICIENCY ANAEMIA:

Iron-deficiency anaemia of pregnancy has been variously described in the literature as Physiological Anaemia of Pregnancy, Chlorotic Anaemia of Pregnancy and Secondary Anaemia of Pregnancy (Vaughan 1934). Davidson and Fullerton (1938) in a discussion of the nomenclature of the condition, referred to the terms Chloranaemia, Chronic Microcytic Anaemia, Idiopathic Hypochromic Anaemia, and Simple Achlorhydric Anaemia. They considered that the condition was best described as Chronic Nutritional Hypochromic Anaemia. Irving (1935) also preferred the term Nutritional Anaemia of Pregnancy. It is obvious that the title adopted must depend on the precise aetiological factors accepted, but iron-deficiency is common to all, and moreover this type of anaemia is now recognised as the predominant and most frequent variety found during pregnancy. This statement is borne out by reference to the work of well-known authorities and other workers in this field. The haematological characters of this anaemia are not peculiar to the pregnant state and indeed are no different to those found in iron-deficiency anaemia apart from pregnancy. Strauss and Castle (1933) described thirty cases of this type in which the blood picture resembled that of a hypochromic anaemia. Although true microcytes were not observed in any of the cases, the red cells were small and deficiant in haemoglobin, and the average colour index was around 0.5. An important diagnostic feature of this anaemia also, and one which has already been referred to (page 17), is the response to iron therapy. Treatment will be discussed later; at the moment it is proposed to discuss the main aetiological factors concerned in the production of the iron-deficiency anaemia of pregnancy.

The aetiology of iron-deficiency anaemia can best be discussed under the following headings:-

(1) Pre-existing anaemia.

(2) Foetal demand for iron.

(3) Defective Digestion.

(4) Deficient iron intake associated with economic and social factors.

(5) Number of previous pregnancies.

PRE-EXISTING ANAEMIA:

In a study of anaemia developing during pregnancy, it is difficult to prove in any particular case, whether a state of anaemia existed prior to conception. If, in the study of a series of normal healthy individuals, one assumes that no such state of anaemia existed previously, the only criterion on which one can base this assumption is the fact that the haemoglobin in the majority of cases, returns to normal after delivery. This has been shown to take place in women manifesting a moderate, and in some cases, a severe degree of anaemia, during pregnancy, and has been adduced as evidence against a pre-existing anaemia. (Bland and Goldstein 1929, First and Goldstein 1930, Bland Goldstein and First 1930b. Watson 1938). Alder (1924) stated that there was never a pre-existing anaemia and that the anaemia was always due to pregnancy per se. Meyer-Wedell (1943) could find evidence of pre-existing anaemia in only nine out of ninety four patients, and only five of these showed anaemia during pregnancy.

On the other hand, Fullerton (1936) was of the opinion that anaemia probably existed prior to the pregnancy, becoming more evident as a result of the hydraemia incidental to the pregnant state. Strauss and Castle (1932), while recognising the possibility of a pre-existing anaemia, did not consider that this would produce any greater degree of anaemia during pregnancy provided that the diet was adequate. Other workers who have studied the condition also refer to the possibility of the anaemia antedating the pregnancy, although no positive proof is put forward in support of this theory. (Lyon 1929, Mussey et al 1932, Schultz 1933, Brindeau and Theodorides 1935, Bethell 1936, Hamilton and Wright 1942).

While it is important in any investigation into the incidence of anaemia of pregnancy to establish whether such a state of anaemia did in fact exist prior to the onset of pregnancy, this is a point on which it is difficult to come to a definite conclusion. In the present series careful case histories were taken in each individual case under review, in order to exclude the possibility of the condition antedating the pregnancy.

FOETAL DEMAND FOR IRON:

There is definite experimental evidence to prove that during pregnancy an increased strain is thrown on the maternal iron reserves by the foetus, which stores up iron especially during the last three months at the expense of the mother. The earlier literature dealing with this aspect of the subject has been summarised by Mackay (1931).

Bunge (1889) showed that the mineral content of the milk of a dog was identical with the mineral content of the body of the young dog with the exception of iron, which, in the body of the young dog, was six times as concentrated as in the milk of the mother. Abderhalden (1898) showed that the iron content of young mammals was highest at birth, progressively diminished during the milk-feeding period, and did not increase again until the animal took mixed food, and that weight for weight, there was five times more iron in the liver of the new-born than in the liver of adult animals. He believed that this immense store of iron could only be derived from the mother. Hugounenq (1899) showed that in the human foetus, two thirds of the iron present in the foetal body at term, was laid down in the last three months of intra-uterine life.

This theory as a factor in the production of iron-deficiency anaemia is now generally accepted, but most authorities point out that this demand by the foetus for iron is often combined with other defects such as defective diet and gastric disturbance in the mother. Strauss and Castle (1933) stated that the foetal demand for blood-building materials was usually accompanied by "direct dietary deficiency or indirect dietary deficiency, conditioned by gastric anacidity and hypoacidity, or a factor associated with these defects and foetal blood requirement." Fullerton (1936) on the other hand, believed that only a moderate degree of anaemia could result from the iron demands of the foetus. He based this belief on the fact that most of the published work demonstrated the presence of a hypochromic anaemia at or before the end of the second trimester, and recorded 21 cases with an average gestation of 6·9 months and all with a haemoglobin level below 70% Haldane (9·6 grammes). Similarly Bland Goldstein and First (1930 b) showed that 58% of 45 cases had a red cell count below 3·5 mills per cmm before the end of the second trimester. These results would tend to refute the theory that anaemia develops in the last three months of pregnancy as a result of the increased demand for iron by the foetus at this time.

In view of the evidence produced, one cannot deny that the foetus must produce a drain on the iron reserves of the mother, and this demand is probably more marked in the last trimester. While this foetal demand for iron must obviously play an important part in the production of an iron-deficiency anaemia during pregnancy, its importance per se should not be unduly stressed, but should be considered in relation to dietary defect and digestive disturbance in the mother. Moreover it must be remembered that any drain on the maternal iron reserves produced by the foetus, must be offset to a greater or lesser degree by the cessation of menstruation at this time.

DEFECTIVE DIGESTION:

It has been shown by Mettier and Minot (1931) that iron is more readily absorbed from an acid than an alkaline medium, therefore it has been suggested that achlorhydria or hypochlorhydria might be factors favouring the development of an iron-deficiency anaemia. The association of anaemia with achlorhydria in women of child-bearing age, however, was first pointed out by Faber in 1909. Haden (1932) and Wintrobe (1933) referred to defective gastric secretion as a causative factor in the production of idiopathic hypochromic anaemia apart from pregnancy. Since then many workers have particularly stressed the importance of digestive disturbance in the production of the iron-deficiency anaemia of pregnancy.

Strauss and Castle (1933) in a detailed study of thirty cases of hypochromic anaemia of pregnancy, showed that 17 of these cases had achlorhydria and 10 had hypochlorhydria, and concluded that these factors combined with foetal blood requirements, were the cause of the anaemia, although they also pointed out that 21 of their patients had been taking a poor diet. In an earlier study of the aetiology and treatment of anaemia in pregnancy, Strauss (1932) found that more than half his patients showed a marked decrease or absence of free hydrochloric acid in the gastric juice during pregnancy, with a return to normal after delivery. These patients, along with others who had been taking a poor diet, showed an average loss of 12% haemoglobin during pregnancy, whereas those with a less marked decrease in free hydrochloric acid and a satisfactory diet lost an average of only 5% haemoglobin. Three cases with a permanent gastric anacidity had an average loss of 18% haemoglobin during pregnancy. As already stated (page 23), Strauss and Castle were of the opinion that anaemia of pregnancy occurred only in those women who had had for a considerable time a defective diet or dietary deficiencies conditioned by gastric anacidity or related gastro-intestinal disturbances.

In this country, Davis and Shelley (1934), examined 51 normal pregnant women, 6 of whom developed anaemia. Of these, 5 showed a disturbed gastric secretion, and one had been taking a poor diet, although the secretion was normal. In the same study they observed 20 cases frankly anaemic following a previous confinement. Of these, 18 showed a disturbed gastric function in the form of achlorhydria or hypochlorhydria and fourteen had been taking a poor diet. In the combined groups there were 45 patients with a normal gastric secretion, only three of whom had been taking unsatisfactory diets. Of the 26 anaemic patients examined, 15 had achlorhydria, 8 had hypochlorhydria and 18 had been taking a poor diet. Davis and Shelley concluded that in the development of hypochromic anaemia of pregnancy, gastric secretory defect had been proved to be the most important single aetiological factor.

These results produced by Strauss and Castle, and Davis and Shelley are convincing, and have been confirmed by other workers who have investigated this aspect of the subject. Vaughan (1934) reported on 35 patients who developed anaemia during pregnancy. Of these, 19 had a post-histamine anacidity and 12 had little or no free hydrochloric acid following alchohol test meals. Green-Armytage (1935) in a discussion of the aetiology of anaemia of pregnancy, referred to the reduction in the free hydrochloric acid and total acidity of the gastric juice, and Witts (1935) observed that hydrochloric acid had been found absent from the gastric juice in 80% of women with anaemia. He pointed out that the acid secretion was particularly liable to fail because of the gastritis from which many women suffer during pregnancy. It may be added here, that to anyone continuously engaged in the routine examination of large numbers of antenatal patients, the prevalence of this "pregnancy gastritis" is especially obvious. Toverud (1935) found that 60% of 47 pregnant women examined during the last three months showed a hypoacidity, and Goodall and Gottlieb (1936) described a diminution or even complete disappearance of free hydrochloric acid during the third trimester. Stevenson (1938) also referred to achlorhydria as a common finding in the anaemia of pregnancy. Out of 100 consecutive cases studied by McGeorge (1938), only two severe anaemias were found and one of these showed a complete post-histamine achlorhydria.

In spite of the foregoing apparently convincing evidence, other authorities do not place such importance on gastric disturbance as the chief aetiological factor in the production of iron-deficiency anaemia of pregnancy. Davidson et al (1933) while admitting its importance, stated that it was a moot point whether the achlorhydria led to the anaemia, or whether the anaemia by itself caused the achlorhydria as a result of poor blood supply to the gastric glands. In a further contribution, Davidson and Fullerton (1938) considered that the anaemia itself was a secondary factor in the production of achlorhydria and found little evidence to support the theory that achlorhydria was the cause of hypochromic anaemia, which in their opinion was due to a long-standing dietary deficiency. Bethell (1936) examined the relationship of anaemia to gastric acidity in 15 pregnant women and concluded that the temporary reduction of gastric acidity during pregnancy was not a direct cause of lowered blood values, and Garry and Stiven (1936) considered that achlorhydria was not a major factor in the production of anaemia of pregnancy on the basis that all achlorhydrics were not anaemic. Watson (1938) carried out gastric analyses on 24 pregnant women. He found four patients with achlorhydria and four with a normal gastric secretion. Seventy three point four per cent of the total had a low hydrochloric acid secretion. He did not consider, however, that gastric analysis proved a diagnostic aid in predicting the course of the haemoglobin level during pregnancy, and could find no correlation between hypochlorhydria and low haemoglobin levels.

From the above observations it is concluded that digestive defect, i.e. a diminution or absence of gastric secretion whether temporary or permanent, must be considered among the important aetiological factors favouring the production of an iron-deficiency of pregnancy, as a result of its effect on the digestion and absorption of dietary iron. It should be considered, however, more as a contributory, than as a principal aetiological factor, in view of the many other possible causes involved. Moreover, it must be remembered, that in a study of iron-deficiency anaemia of pregnancy, the performance of gastric analysis is not always a practicable proposition, especially when one is dealing with large numbers of normal healthy pregnant women, most of whom are examined in busy antenatal clinics. It is not surprising, therefore, that in a study of the literature, the total number of these examinations is found to be comparatively small, and results, however convincing, probably do not warrant the conclusion that defective gastric secretion is a factor of major aetiological importance. It is not suggested that series of cases reported in the literature have been in any way selected, but the results of routine gastric analysis on a much larger number of normal pregnant women, will be necessary, before the relationship between gastric defect and anaemia of pregnancy, can be accurately assessed.

DEFECTIVE IRON INTAKE ASSOCIATED WITH ECONOMIC AND SOCIAL FACTORS:

Iron deficiency has been discussed in relation to the demands of the foetus and digestive defect in the mother. It is now necessary to consider this deficiency in relation to direct dietary defect and to establish whether a deficient diet is an important contributory factor in the production of iron-deficiency anaemia during pregnancy. In this connection also, the importance of economic and social factors will be considered.

Widdowson and McCance (1936), quoting Sherman's figure of 15 mgms of iron per day as the average daily intake of iron for women, showed in a study of 63 women that the total iron intake was only 11·4 mgms. per day, and the available iron in the diet 7·9 mgms. per day. Davidson and his co-workers (1933) found a similar low iron intake for women, viz. 11·3 mgms. per day, and Davidson and Fullerton (1938), in an analysis of the diets of 115 poor families, found that the daily average intake of iron was 7·3 mgms. per day. More recently

Wills et al (1942) in a study of "Anaemia in Women and Children on War-time Diets," found the iron intake for women to be 11 mgms. total iron and 7·7 mgms. available iron per day.

The daily iron requirements during pregnancy have been variously assessed. The League of Nations Dietary Scheme as quoted by McCance et al (1938) allowed 12·7 mgms. per day. Garry and Stiven (1936), while advocating a figure of 11·5 mgms. per day as the standard requirement for women, concluded from a review of dietary requirements in pregnancy and lactation, that the necessary iron intake during pregnancy was 18 mgms. per day, and Davidson et al (1935) in a study of nutritional iron-deficiency anaemia in pregnant and non-pregnant women, considered that the optimum iron content of the diet should be 15 - 20 mgms. per day. McCance considered that the League of Nations figure was not sufficient for optimum nutrition during pregnancy and suggested that the daily iron intake should be between 18 and 20 mgms. per day. Assuming then that pregnant women should have an iron intake of 15 mgms. per day or more, a diet which would favour the production of an iron-deficiency anaemia, must presumably fall below this level. How far is this assumption substantiated in a consideration of iron-deficiency anaemia of pregnancy in relation to dietary requirements?

Davidson and Fullerton (1933) in an investigation of the iron intake in 49 families, calculated that the average intake for women was 7·71 mgms. per day. They considered that since 75% of this iron was available and about 50% absorbed, the total amount absorbed was about 2·5 mgms. daily. This was less than half the amount required to maintain a positive balance in the reproductive period. On the other hand, Coons (1932, 1935) studied 23 iron balances in women at different stages of pregnancy. She found an average iron intake of 14·72 mgms. per day, and concluded that under fairly ideal conditions of diet and well-being, it seemed possible for the maternal organism to assimilate during the period of pregnancy enough iron from the food to supply the new-born infant with the necessary reserves. She calculated that an iron intake of 14·7 mgms. per day gave a positive balance of 3·16 mgms. Toverud (1935), however, stated that the iron requirements of the foetus were exactly one third of an adult person's daily requirements. He carried out iron metabolism studies on 10 pregnant women between the sixth and the ninth months. These women were kept under observation in a home and were given a liberal diet. In 8 of the cases the retention of iron was found to be below the calculated needs of the foetus. Toverud concluded that there was an iron deficiency in the food during the last three months of pregnancy. Fullerton (1936), in a detailed study of the iron requirements during pregnancy, concluded that the extra demand for iron amounted to 2 mgms per day. He did not consider that the mother required more iron than in the non-pregnant state, the extra amount being necessary for the foetus, and to make up for the blood lost at delivery. It will be noted that although an iron intake of 15 - 20 mgms. per day is quoted as the optimum requirement during pregnancy, none of the authorities referred to, quote values up to this level, in fact in most cases, with the exception of Coons, they are considerably less. One must assume, therefore, that the average diet taken by the pregnant woman is deficient in iron. On the other hand, it is conceivable that the suggested daily iron requirement of 15 - 20 mgms. during pregnancy may be too high and not attainable under existing conditions, but in view of the widespread prevalence of iron-deficiency anaemia during pregnancy, one would hardly be justified in setting a lower minimum requirement.

In the discussion of dietetic deficiency as an aetiological factor in the production of iron-deficiency anaemia, most authorities have drawn attention to the importance of economic and social circumstances. Davidson et al (1935) in a study of nutritional iron-deficiency anaemia found that the incidence of this type of anaemia in the population was highest among pregnant women. They believed this to be due to the fact that the physiological demand for iron during pregnancy was not satisfactorily supplied by the diets of many of the women of the poorer classes. Davidson and his colleagues considered that these women as a result of their financial circumstances, could not meet the increased demands of pregnancy, and in their view, poverty was the principal cause in the production of this form of anaemia. They described the diet of these women of the poorest classes as the "bread and tea diet", deficient in every constituent, particularly minerals vitamins and animal proteins, and showed that it was among this class of people that the highest incidence of chronic nutritional anaemia was found. Fullerton (1936) made a detailed study of dietetic deficiency in relation to income levels. In an examination of 232 pregnant women, he found that 164 in a low income group had an average haemoglobin level of 73·1% Haldane (10 gms), whereas 168 in a higher income group had an average haemoglobin level of 79·1% Haldane (10·9 gms). There was a difference of 6% haemoglobin (·9 gms) between the low and high income groups. In an appreciation of these findings it must be remembered that the women examined were among the poorest classes and could hardly be considered representative of the population as a whole. Moreover, the investigations were carried out at a time when unemployment and poverty were widespread throughout the country and living conditions below average level. However, economic and social circumstances have been widely studied among other classes of the community and they undoubtedly exert an

influence to a greater or lesser degree on the incidence of nutritional anaemia during pregnancy. Adair et al (1936) found that a group of hospital class women were slightly more anaemic than a group of private patients, and Reid and Mackintosh (1937) in an examination of 1,108 pregnant women found that the incidence of low haemoglobin levels was greatest in the lower income groups.
McCance (1938) reported the results of a detailed and interesting study on this aspect of the subject. One hundred and sixteen pregnant women were divided into six groups according to income, which varied between a figure of less than six shillings per head per week to a figure of forty shillings and over, per head per week. In the lowest income group it was found that the average haemoglobin level was 76% Haldane (10·4 gms), and the iron intake 8 mgms. per day. In the highest income group the corresponding figures were 90% Haldane (12·4 gms) and 14 mgms. per day. These figures clearly demonstrate the rise in haemoglobin level and iron intake with increase in income.

In spite of the above findings, anaemia of pregnancy is not always confined to the poorest classes of the population. Galloway (1929 b) examined 222 private patients living in a residential community in Chicago, and showed that 144 (65%) developed anaemia, and Bland, Goldstein and First (1930 b) in a similar study of 200 ward patients and 100 private patients, found that 80% of the former and 62% of the latter group, had haemoglobin levels below 75% Dare (10·3 gms). They concluded that while better environment and living conditions might have had a beneficial effect, the fact that so many private patients as well as ward patients were affected, suggested that factors concerned directly with the pregnant state, might have been responsible for the anaemia. In recent years Hamilton and Wright (1942) in this country, examined 392 pregnant women, (none of whom, they stated, could be considered poor), and found the incidence of iron-deficiency anaemia to be 40·3% in their untreated cases. (Haemoglobin below 70% Haldane = 9·6 gms). Watson (1938) did not believe that economic or social factors had much bearing on the incidence of the anaemia. He considered that only extremes of poverty and adverse living conditions were appreciably reflected in the blood picture of pregnancy. One cannot, however, dismiss the economic factor in a consideration of the aetiology of iron-deficiency anaemia of pregnancy. Poverty and reduced financial circumstances, by bringing about a limitation of the purchase of the essential foodstuffs, must necessarily contribute to a degree of malnutrition which would ultimately be reflected in the blood picture. One must remember, however, when attempting to assess the incidence of the anaemia, that among the poorest classes, these same conditions would tend to produce a state of anaemia apart altogether from the coincidental effect of pregnancy.

Many other workers have drawn attention to defective dietary and economic factors in the production of pregnancy anaemia. Their views may be briefly summarised as follows. Mellanby (1933), expressing concern about the prevalence of this type of anaemia, stressed the importance of an iron rich diet during pregnancy, especially one including meat, egg-yolk, green vegetables and calf-liver, and Green-Armytage (1935) in a paper, "The Influence of Food on Child-bearing," expressed a similar opinion. Witts (1935) considered that a defective diet, especially one deficient in iron, was the commonest cause of anaemia in pregnancy, and believed that the underlying factor was poverty. He stated that among the poorest classes of this country 50% of mothers were anaemic, and that no woman could go through a series of pregnancies on a diet of tea, bread, jam and potatoes, and remain well. Wills (1935) pointed out the prevalence of iron-deficiency anaemia among women of the lower income groups, and concluded that the prevention of this condition depended on the availability of an iron rich diet, which was not within the means of all classes of the population. Browne (1937) similarly stressed the importance of the iron-containing foods during pregnancy and pointed out that, among working women, a diet consisting mostly of bread, tea, margarine, potatoes and fish, was all too common. He stated that the average diet in this country contained about 10 mgms. of iron daily, and considered that at least 20 mgms. were necessary during pregnancy. Reference has already been made to the work of Strauss and Castle (p.25), and Davis and Shelley (p.26), who studied the incidence of anaemia in pregnancy in relation to faulty diet. Also, the American workers, Richter, Meyer and Bennett (1934), in a series of 99 antenatal cases, found that 70 - 80% had faulty dietary habits, due to poverty or restricted food rations. The diets were deficient chiefly in meats, fresh fruit and vegetables and mainly consisted of excessive amounts of carbohydrate in the form of bread, potatoes, cereals and sweets. McGeorge (1935) in New Zealand, in his study of 100 antenatal cases, found that, of those in the anaemic group, 16% were living on very inadequate diets in conditions of poverty and malnutrition.

The recent war afforded an admirable opportunity of studying the dietary requirements of pregnant women in relation to anaemia, as the rationing of the essential foods would have been expected to allow of a more equitable distribution among the whole population, with a corresponding improvement in nutrition among the poorer classes. The effect of war-time rationing in relation to the anaemia of pregnancy would not, however, appear to be altogether encouraging. Kay and Alston (1941) examined a series of 819 pregnant women in London and compared their results with a similar series, investigated during the years 1937 - 1939. They found that the pre-war incidence of anaemia of 5·3% had increased to 39% in 1941, and concluded that the food taken by pregnant women in North London in 1941 had been inadequate in iron. Thomas (1942) came to a similar conclusion, finding an incidence of anaemia of 52% in 140 pregnant women examined in London. (Haemoglobin less than 70% Haldane = 9·6 gms). He stated that it was unlikely that this iron deficiency was confined to the London area. Hamilton and Wright (1942) suggested that women of the artisan class were more anaemic during pregnancy than before the war, and attributed this to war-time dietary. The effect of war-time conditions on the incidence of pregnancy anaemia was also investigated by Mackay et al (1942). She concluded that there had been a levelling down of haemoglobin levels in many classes of the community during the war, possibly due to a levelling down of nutrition. She considered that there might be a levelling up of haemoglobin levels among the poorest classes of the community, due to the disappearance of unemployment, rationing, and food priorities, but she found no evidence of this in her investigations to date. Sinclair (1942) considered that war-time diets contained less available iron than they did before the war. Also, Wills et al (1942) in their study of anaemia in women and children on war-time diets, found that the mean haemoglobin values in women were lower than the pre-war level and suggested a real increase in anaemia among women.

These war-time studies, therefore, tend to show a marked increase in iron-deficiency anaemia of pregnancy, in comparison with pre-war results. As one would expect, however, these findings have not been confirmed by other workers. Davidson and Fullerton and their co-workers carried out a series of investigations on pregnant women during the war years. (Davidson and Donaldson 1944, Fullerton, Mair and Unsworth 1944, Davidson, Donaldson, Lindsay and Roscoe 1944). They found by comparison with their own pre-war results that the degree of anaemia among pregnant women during the war had decreased. In particular, Davidson, Donaldson, Lindsay and Roscoe showed an improvement between the years 1942 and 1944. They found that the average haemoglobin level among pregnant women in 1942 was 77% Haldane (10·6 gms), as compared with 86·8% Haldane (11·9 gms) in 1944. They attributed this improvement to the introduction of the national wheat-meal bread (85% extraction flour) with an iron content of 0·7 mgms per oz., as compared with white bread (70% extraction flour) with an iron content of 0·3 mgms. per oz. They calculated that an average daily intake of 6 ozs. of national wheat meal bread would result in an additional intake of 2 mgms. of iron daily. These findings are of particular interest when studied in conjunction with the war-time experiments of Widdowson and his colleagues, and it might be profitable to digress for a moment to consider these experiments, if only to demonstrate still further the wide divergence of opinion which still exists with regard to the part played by dietetic factors in the production of the iron-deficiency anaemia of pregnancy.

Widdowson and Allington (1941) in a study of "Middle-class Diets in Peace and War," found that the iron consumption of the diet had increased during the war. They showed that the total iron in the diet in 1935 and 1941 was 11·4 mgms. and 12·2 mgms. respectively, the corresponding figures for inorganic iron being 7·9 mgms. and 9·2 mgms. They considered that the iron acquired from the increased bread and vegetables, more than made up for the iron sacrificed by the shortage of meat. In addition, however, Widdowson and McCance (1942) studied the iron intake on diets of white bread and brown bread in eight subjects, four women and four men. The white flour used, contained 1·41 mgms. of iron per 100 gms. and the brown 3·55 mgms. of iron per 100 gms., so that the iron intake on the brown bread diet was considerably higher than that on the white bread. They found that their subjects absorbed more iron from the white bread than from the brown, in spite of the fact that intakes were 50% higher in the brown bread experiments. They thought that the explanation of this discrepancy might be the indigestible branny particles in the brown bread, and their laxative action, or the presence in large amounts of phytic acid in the brown bread, which precipitated the iron in the gut as an insoluble salt. Whatever the explanation, the experiment showed that iron was absorbed from diets in which white flour constituted 40 - 50% of the total calories, and that iron was not absorbed from similar diets when the white flour was replaced by one of 92% extraction. Widdowson and McCance suggested that in spite of the large amounts of iron in whole wheat, bread made from it might not be as good a source of iron as is generally supposed. Sinclair (1942), in a reference to these experiments, put forward the opinion, that the adoption of national wheat meal bread had increased the liability to iron-deficiency anaemia. These findings would seem to refute the conclusions drawn by Davidson, Fullerton and their colleagues that the adoption of the national wheat meal bread had reduced the incidence of iron-deficiency anaemia in pregnancy. Indeed, in spite of these conclusions, Davidson, Donaldson et al (1943) found that the haemoglobin levels of pregnant women examined in Edinburgh in 1942, were slightly lower than those of a similar group examined in Aberdeen in 1935. The 1935 group had an average haemoglobin of 78·1% Haldane (10·7 gms) and the 1942 group, an average haemoglobin of 75·8% Haldane (10·4 gms). As a result, therefore, of the experiments of Widdowson and McCance, it would be unwise to place too much reliance on the beneficial effects of whole meal bread as a preventive factor against the production of iron-deficiency anaemia of pregnancy, as suggested by Davidson and Fullerton, unless further experimental work should establish its value.

After a consideration of the evidence, there would seem to be little doubt that deficient iron intake in the diet of the pregnant woman, plays a large part in the production of the iron-deficiency anaemia so frequently found in association with the pregnant state. What is not so certain, however, is whether available experimental evidence conclusively proves that iron-deficiency is the principal aetiological factor. The results of most dietary surveys which tend to indicate an iron-deficient diet as a concomitant of anaemia of pregnancy, have been found in populations, among which one would expect to find a degree of anaemia apart altogether from pregnancy. It has already been pointed out (p.34) that, in this country, these surveys were carried out among the poorest classes of the community where poverty was widespread, and the standard of living well below average, chiefly as a result of the unemployment and industrial depression of the inter-war years. These conditions would naturally have their most severe effect on the working-class community. The clinical material studied, therefore, can hardly be regarded as representative of the country as a whole under normal conditions. Moreover, the results do not always justify the conclusions. For example, Davidson and Fullerton (1933) examined a large series of women, pregnant and non-pregnant alike, from the poorest classes of the population. They found that the pregnant women had an average haemoglobin level only 5% lower than the non-pregnant, for the different age-groups. Considering the many aetiological factors concerned in the production of iron-deficiency anaemia of pregnancy, one of these alone, viz. hydraemia, might easily account for the small difference in the haemoglobin levels, quite apart from economic, social or dietetic factors. However, for the reasons already stated (p.36), it is considered that economic conditions tending to a state of poverty must necessarily be a contributory factor in the production of iron-deficiency anaemia developing during pregnancy. Among the poorest classes, the diet, previous to the advent of war-time rationing and priorities, must have been deficient in all its constituents, and its quality governed by the financial status of this class of the community. But iron deficiency, as has been shown (p.36), is not only confined to the poorer classes, and one must find an explanation for the continued prevalence, and in some cases, increase, of this type of anaemia during the recent war, when the iron-content of the diet improved as compared with pre-war years. There is also the additional factor that during the war years unemployment and poverty as it was known before the war in this country, largely disappeared, and there was a raising of income levels combined with a more equable distribution of the essential foodstuffs, especially those rich in iron, so that a diet of a reasonable standard was certainly within the means of every member of the community. The explanation may be found in the fact that the recognised optimal intake of iron in the average diet of this country has never reached the accepted standard. A more probable explanation, however, may be the general ignorance among the population of the simple dietetic requirements of pregnancy and the means of procuring these. Hamilton and Wright (1942) drew attention to this fact, and suggested that training in simple dietetics should form part of the routine antenatal care of pregnant women. On the other hand, Davidson et al (1942) have suggested a different explanation for the continued prevalence of iron-deficiency anaemia during the war years. In one of their many contributions on this subject, "Nutritional Iron-deficiency Anaemia in War-time", they considered that while in peace-time, economic status was the chief factor influencing the nutrition of individuals, "rationing, and the difficulty in obtaining some unrationed foods, constitute the chief limitations, which broadly speaking, are operative, irrespective of income." While it is considered, therefore, that dietary defects in association with economic and social circumstances play a very important part in the production of iron-deficiency anaemia of pregnancy, other factors are definitely operative. Some of these have been considered in this discussion of aetiology. Others of more obscure origin, still require further elucidation.

NUMBER OF PREVIOUS PREGNANCIES:

The effect of an increasing number of pregnancies on the degree of iron-deficiency anaemia is again a subject on which there is considerable disagreement. Davidson et al (1933, 1944) concluded that the anaemia was most marked in women with three pregnancies or more, and suggested that frequent pregnancies constituted one of the main aetiological factors. Fullerton (1936) considered an excessive number of pregnancies to be a contributory factor, operating chiefly as a result of excessive blood-loss at parturition. He believed, however, that the effect of parity was really the effect of age, the number of pregnancies being likely to be greater in the older age-group. Davis and Shelley (1934) likewise considered parity as a contributory factor. Reid and Mackintosh (1937) believed that while multiparity in good social circumstances was without effect, except in women with five or more pregnancies, it was associated with increased anaemia in the lower income groups. Evans (1937) was more definite on this point, stating that "pregnancy and particularly a rapid succession of pregnancies, has been shown frequently to precipitate such an anaemia." Other workers in this country and in Canada and America have supported this view. (Kerwin and Collins 1926, Pepper 1929, Goodall and Gottlieb 1936, Gottlieb and Strean 1939, Stevenson 1938, Whitby 1946).

It is comparatively easy, however, to produce apparently conclusive evidence in support of the opposite view. Davidson et al (1935) in their mass survey on nutritional iron-deficiency anaemia, found that haemoglobin levels were lower and the incidence of anaemia higher, in pregnant as compared with non-pregnant women of the same age group, but they thought that the difference might be explained by the physiological hydraemia of pregnancy rather than by age or parity. Boycott (1936) concluded that neither social status, age or parity bore any relation to the cause of the anaemia. This lack of relationship between parity and the incidence of the anaemia has also been observed by many American and continental workers, most of whom have found no difference in the incidence of anaemia between primiparae and multiparae. (Galloway 1929b, Lyon 1929). Bland, Goldstein and First (1930) in two papers, "The Physiological Anaemia of Pregnancy" and "Secondary Anaemia in Pregnancy and the Puerperium", reported on the investigation of 1,300 pregnant women, and showed that parity was not related to the anaemia. In one of these papers 54% of primiparae and 58% of multiparae were shown to be anaemic, and in the other the incidence was 78·3% and 82·8% respectively. Other American workers have expressed similar views (Nalle 1930, Moore 1930, Strauss and Castle 1932). Bethell et al (1939) could find "no evident relationship between parity and the incidence or severity of the anaemia," a view which also finds support in the German literature in observations by Kühnel (1927) and Esch (1932).

From the foregoing review it is difficult to make any definite pronouncement on this very controversial subject, but one is inclined to the view expressed by Reid and Mackintosh that parity is likely to exert an influence on the incidence of anaemia among the lower income groups. It is in this class of the population that one would expect to find the lowest standard of nutrition, and it is in this same group that one finds the largest number of pregnancies, but whether parity or malnutrition or possibly a combination of both, are to be regarded as principal aetiological factors, is still a debatable point and one which is not easily settled.

DISCUSSION ON AETIOLOGY OF IRON-DEFICIENCY ANAEMIA OF PREGNANCY:

The aetiology of the iron-deficiency anaemia of pregnancy has now been considered with reference to the more important and generally accepted aetiological factors, viz: Pre-existing Anaemia, Foetal Demand for Iron, Defective Digestion, Deficient Iron Intake associated with Economic and Social Factors and Number of Previous Pregnancies. At the same time, while considering each of these factors individually, one must always bear in mind the normal effect of blood dilution, or hydraemia, during pregnancy, which in itself may be a cause of the anaemia. It is clear that the effect of no single aetiological factor can be accurately assessed without considering this phenomenon. It is equally clear that many cases of iron-deficiency anaemia discovered during pregnancy, may have existed prior to conception, and are in fact iron-deficiency anaemias of long standing, which have only been discovered on routine antenatal examination. While a combination of all these factors is undoubtedly responsible for the prevalence of the condition, there would appear to be other predisposing causes or deficiencies operative, if only by reason of the fact that not all cases respond to treatment indicated by acceptance of the above aetiological principles. For instance, reference is to be found in the literature to other mineral deficiencies, and also vitamin deficiencies. (Irving 1935, Meyer-Wedell 1943), but their effect, if any, on the iron metabolism during pregnancy, is not sufficiently conclusive to warrant their inclusion among the principal causes of this type of anaemia. Moreover, it has been pointed out as recently as 1947 by Bransby and Magee, that for expectant mothers "the rationed foods provide enough or more of proteins, calcium, iron and vitamins A. and C." Until further investigation has been carried out on these and other aspects of the subject, one must be content with the conclusion that the iron-deficiency anaemia of pregnancy is due to a combination of one or more of the factors already mentioned, none of which can be regarded per se as the principal aetiological factor. Other mineral and vitamin deficiencies may yet be proved to play an important contributory role.

CHAPTER III.

PERNICIOUS ANAEMIA OF PREGNANCY.

As already pointed out, (p.13) not one case of the pernicious variety of anaemia was found in the present investigation and it is not proposed, therefore, to discuss this condition in any detail. However, in view of the widely reported prevalence of the iron-deficiency type of anaemia, added to the fact that all cases of anaemia in the present series were found to be of this type, it is considered necessary to discuss the relative incidence of iron-deficiency anaemia of pregnancy and pernicious anaemia of pregnancy, and to assess the preponderance of the former as compared with the rarity of the latter condition.

The title, or titles, adopted for this variety of anaemia of pregnancy, has led to a certain amount of confusion, the condition having been variously referred to as pernicious anaemia of pregnancy, severe anaemia of pregnancy, and megaloblastic anaemia of pregnancy. The first term is unsatisfactory as the anaemia is not of the true Addisonian type, and the second confusing, because some writers refer to the severe anaemia of pregnancy when describing a well-marked secondary anaemia. Indeed, Osler (1919) pointed out that although a high colour index is the rule in the severe type, cases have been reported where this value was well below unity.

Davidson et al (1942) in a study of the condition, concluded that it should be recognised that a severe megaloblastic anaemia may occur during pregnancy or the puerperium, although the colour index be unity or less. In view, therefore, of the difficulty in assessing the significance of the colour index in the diagnosis of the anaemias, it is considered that the term, "megaloblastic anaemia of pregnancy", as adopted by Davidson and his colleagues, is the most satisfactory terminology, as the ultimate diagnosis must be determined by the examination of the blood film.

A study of the literature confirms the view expressed by many other workers that the iron-deficiency anaemia is by far the commonest variety met with in the course of pregnancy. Evans (1929) investigated the records of Queen Charlotte's Maternity Hospital for the years 1926 - 1927, and failed to find a single case of the pernicious variety in 4,083 labours. He himself reported two cases and summarised the literature as follows. Channing (1842)reported 10 cases, Rowland (1924) 2 cases and Smith (1925), 8 cases. Larrabee in 1925 reported 17 cases and, to refer again to the question of terminology, 7 of these had colour indices less than unity. In 1927 Hoskin and Ceiriog-Cadle reported only one case, Neale 2 and Murdoch 2. In the same year Balfour and McSweeney reported 150 and 43 cases respectively, in India, where the condition is much more prevalent. Balfour, however, drew attention to the rarity of the condition in this country, quoting the incidence in the Rotunda Hospital, Dublin for the years 1921 - 1923, as 1 in 12,000 cases, in Queen Charlotte's Hospital (1923) as

1 in 1,800 cases, and in the Simpson Memorial Hospital Edinburgh (1923) as none in 1,600 cases.

Whitby (1932) also drew attention to the rarity of this type of anaemia in pregnancy and quoted the work of other authorities in support of his conclusions. Esch (1921) collected only 23 cases from the German literature of the previous twenty years, and Beckman (1921) reported only 6 cases occurring in 60,000 labours. Bardy (1924) reviewed 68 cases occurring during a period of thirty eight years and collected from the literature of Europe and America. In 1930 Wills and Mehta reviewed 50 cases and Mitra (1931) investigated 86 cases occurring in the course of 1,883 labours during a period of four years.

From the above results one can conclude that the pernicious variety of anaemia, occurring during the course of pregnancy, is a rare condition in this and other countries, with the exception of India, and recent contributions to the literature support this view. (Wilkinson 1932, Bethell 1936, Musser 1940, Davidson et al 1942, Fullerton 1943, Davidson et al 1948). It has been suggested, however, that this type of anaemia of pregnancy might not be so infrequent as is generally supposed. Stevenson (1938) reported the first large series of cases in this country. Thirty cases were investigated during a six year period, in Glasgow. Davidson (1948) and his colleagues, however, pointed out that all Stevenson's cases might not have been of the pernicious variety, as they were investigated before sternal puncture hospital practice have been studied, it must be concluded that available evidence supports the generally accepted view, confirmed in the present investigation, that pernicious or megaloblastic anaemia is but rarely encountered during the course of pregnancy.

CHAPTER IV.

NORMAL HAEMATOLOGICAL VALUES IN NON-PREGNANT AND PREGNANT WOMEN AND CRITERIA OF ANAEMIA OF PREGNANCY.

NORMAL NON-PREGNANT WOMEN:

Haematological standards for normal healthy women have been determined by many authorities both in this country and abroad, and a consideration of these accepted normal values is obviously necessary before an apprecia-tion can be made of a deviation from these standards during pregnancy. The discussion of these haematological values in normal healthy women will be confined to haemoglobin value, red cell count and colour index.

HAEMOGLOBIN:

Few clinical methods of investigation have led to such confusion as haemoglobinometry, and it is astonishing, that although this anomaly has long been recognised, it is only in comparatively recent years, that its importance has been stressed. Williamson (1916) wrote: "It has long been a matter of keen regret that the very examina-tion of the blood which is perhaps most frequently made in routine practice, viz. the estimation of the percentage of haemoglobin, is the one from which we generally derive the most unsatisfactory results;" and ten years later Brown and Rowntree (1925) commented that "the normal standard for haemoglobin is as yet unsettled; this is somewhat surprising in a substance so important."

The unsatisfactory results of haemoglobinometry from the investigator's point of view have undoubtedly been due to the many different types of haemoglobinometer on the market, and the failure of many investigators to state the exact methods of haemoglobinometry used, in their published results. Osgood and Haskins (1935) drew attention to this fact and pointed out that so many figures were used by manufacturers of haemoglobinometers, as 100% haemoglobin, that the percentage figure was almost meaningless. They advocated the calculation of all results as grammes of haemoglobin per 100 cc. of blood ahd stressed the importance of always stating the method of haemoglobinometry used. Similar observations have been made by other workers (Haden 1922, 1923, Kern 1924, Wintrobe 1930, Harvey 1931).

In this country, the Haldane scale (13·8 grammes = 100%) is the generally accepted standard, and will be used for purposes of comparison in the present investigation as it is the standard which has been chiefly used in the determination of the haemoglobin value in normal healthy women. Price-Jones (1931) in a study "The Concentration of Haemoglobin in the Human Blood", estimated the haemoglobin level in 100 healthy women. He found an average haemoglobin value of

98·26% Haldane, equivalent to 13·6 grammes haemoglobin per 100 cc. of blood with a range of 90% - 110% (12·42 grammes - 15·18 grammes). In a similar investigation Jenkins and Don (1933) found an average haemoglobin value of 99·66% Haldane, equivalent to 13·8 grammes per 100 cc., with a range of 77% - 121% (10·62 grammes - 16·69 grammes) in 116 normal English women; Davidson et al (1935) in agreement with Price-Jones' figure, quoted the value of 98% Haldane (13·5 grammes) as the normal haemoglobin level for adult females. Wills et al (1942) also accepted this value which can be accepted as the "normal" for healthy adult women in this country.

American workers have found haemoglobin levels in women to be very similar to those in this country. Osgood and Haskins (1927) examined 100 normal young women using the acid haematin method (14·3 grammes = 100%) and found a mean haemoglobin value of 13·69 grammes per 100 cc. of blood with a range of 10·98 - 16·49 grammes. Wintrobe (1930) in a similar study found a mean value of 13·76 grammes with a range of 12·77 - 14·75 grammes, but in a later and much more comprehensive study (1933), he found a mean value of 14·1 grammes and quoted the results of various authorities all over the world, including the United States of America, Denmark, Germany, England and "various parts of the world." Taking an average of all these results, he gave a world average value for normal healthy women of 13·9 grammes haemoglobin per 100 cc. of blood. He referred to the confusion in the expression of the haemoglobin value, to which attention has already been drawn, stating that "the great variation in the values employed as the equivalent of 100 per cent. haemoglobin by the different haemoglobinometers, reflects the inadequate basis on which these standards have been chosen." Wintrobe strongly recommended the expression of haemoglobin in grammes rather than as a percentage, and suggested the adoption of the figure of 14·5 grammes as equivalent to 100 per cent haemoglobin. Similar figures have been published by other American investigators notably Haden (1922, 1923), Bethell (1936, 1939) and Adair et al (1936), the latter, however, giving a slightly lower figure, viz. a mean of 12·76 grammes in an examination of 2,399 non-pregnant women. Incidentally, Jenkins and Don in the investigation just referred to, concluded that there was no foundation in the belief that English haemoglobin levels differed materially from those in America. In New Zealand McGeorge (1935) in an examination of 95 patients admitted to a gynaecological ward found a mean haemoglobin level of 13·7 grammes per 100 cc. of blood.

Many continental workers have published results showing mean haemoglobin levels in normal adult women but, as in a great number of cases no mention is made of the actual method of haemoglobinometry used, the figures are difficult to assess. Gram (1920) found an average haemoglobin level of 12·0 grammes in 40 normal adult women and Gram and Norgaard (1923) investigated a small series of cases. Their results unfortunately were expressed as a percentage and the figure used as 100% haemoglobin was not stated, although the authors drew attention to the considerable confusion in the expression of haemoglobin; but assuming that the standard used was similar to that of Gram (1920), just quoted, viz.14·3 grammes = 100%, their mean haemoglobin value was 13·5 grammes. A small control series examined by Kühnel (1927) gave a fairly similar figure of 13·1 grammes. A higher value was given by Brindeau and Theodorides (1935), viz. 15·34 grammes.

From a review of the above results, which can be considered fairly representative, it is concluded that the average haemoglobin level for normal healthy women is in the region of 13·6 grammes per 100 cc. of blood. It has been shown that where reliable standards of comparison are available, independent British and American authorities are in very near agreement as to this figure, which will be taken as the normal value for the purpose of this investigation. The importance of reliable standards of comparison cannot be too strongly stressed, and such standards will only be available when a uniform method of haemoglobinometry, adopted internationally, is in use. It is indeed surprising in view of the many modern advances in all branches of clinical investigation that haemoglobinometry as an exact method has not yet been established and standardized in all countries, and although this obvious disadvantage has been pointed out by various workers since the beginning of the present century, we find Elliott writing in 1944 that "it is realized that the comparison of haemoglobin estimations made by different methods is unsatisfactory, but until a standardized instrument is used all over the world, there appears to be no alternative." Such an unsatisfactory state of affairs calls for little further comment.

RED CELL COUNT:

While it is difficult to arrive at an exact conclusion as to the average red cell count in normal adult women, results published in this and other countries are in fairly close agreement; American figures tend to be slightly lower than the mean of 5·0 millions per c.m.m, the generally accepted value in this country. A very brief review of the literature will help to demonstrate this point.

Haden (1922, 1923) in a study of accurate criteria in differentiating anaemias gave the average red cell count for normal healthy women as 4·26 millions per c.m.m., and Gram and Norgaard (1923) in an examination of 10 normal female subjects found an average count of 4·65, with a range of 4·36 - 5·05 millions. In a similar number of cases of non-pregnant healthy women Kühnel (1927) found an average red cell count of 4·7 millions with a range of 4·42 - 5·14 millions. These last two findings show a very close similarity. Osgood and Haskins (1927) recorded a result in fairly close agreement with these figures, viz. 4·8 millions, with a range of 4·07 - 5·55 millions, and Wintrobe (1930) recorded a slightly higher value of 4·93 millions, with a range of 4·64 - 5·22 millions. The latter, however, in his later study (1933) referred to on page 56, found a mean red cell count of 4·82 millions, and gave a "world value" of 4·85 millions.

In this country, Price-Jones (1931) found somewhat higher red cell counts for normal healthy women. In his study of 100 cases he recorded a mean figure of 5·0 millions per c.mm., with a range of 3·9 - 6·0 millions and McGeorge in New Zealand (1938) gave a similar mean value with a range of 4·14 - 5·88 millions. These figures are the highest recorded in this short review, but results published by other workers more or less conform to the average values already quoted. (Brindeau and Theodorides 1935, Bethell 1936, 1939, Elliott 1944).

Apart from the results recorded by Price-Jones and

McGeorge, the above figures are in fairly close agreement. It is felt, however, that the generally accepted mean red cell count for normal healthy women found quoted in most text books on haematology, namely 5·0 millions per c.m.m., is probably too high. The true figure probably lies somewhere between 4·5 and 5·0 millions, and an arbitrary mean of 4·8 millions has been accepted for the purpose of this investigation. The above review, although short, is fairly comprehensive, and it will be noted that the lowest recorded red cell count is 3·9 millions and the highest 6·0 millions (Price-Jones). No other workers, above quoted, with the exception of McGeorge, approach these extreme values, and although these are not considered far outside the bounds of normality, nevertheless it is thought that not only does a mean value of 4·8 millions agree with the results of the majority of other investigators, but also agrees with Wintrobe's "world value" of 4·85 millions. It may be added that Wintrobe concluded from his studies, that there appeared to be no geographic variation in normal blood values which might preclude the establishment of a world-wide "normal". Kern (1924) assumed a normal value of 4·7 millions.

COLOUR INDEX:

A colour index of unity has always been accepted as the normal standard in health, but a study of the literature shows that a considerable deviation from this figure is compatible with an otherwise normal blood picture. Haden (1923) commenting on this aspect of haematological investigation, stated that very few careful studies of colour index had been made, and it was not universally agreed that the colour index of normal blood was always unity. He gave the normal value in women as 1·00 but in a later contribution (1932), he indicated that a range between 0·9 and 1·10 could be considered as normal. In their much smaller series Gram and Norgaard (1923) found the range of normality to be 0.97 - 1·04 with an average value of 1·01.

Price-Jones (1931) found an average colour index of 0·98 for normal healthy women with a range of 0·91 - 1·08, and in America Bethell (1936) recorded a mean value of 1·00 with a range of ·93 - 1·14. In more recent studies Davidson et al (1942) stated that it was generally agreed that the normal colour index range was 0·9 - 1·09, and Elliott (1944) found a range of 0·8 - 1·00 in an investigation of 20 control cases. Whitby (1946) was of the accepted opinion that the normal colour index was unity, but quoted Osgood (1935) who concluded that figures from ·85 - 1·15 were not abnormal. In the series studied by Osgood and Haskins (1927) 90% of the results fell between 0·9 and 1·10 with a range of 0·83 - 1·13. They pointed out that caution must be used in interpreting results between 0·8 and 0·9 and between 1·1 and 1·2, because up to 10% of normal persons gave indices in these ranges in spite of careful technique and accurate methods. Wintrobe (1930) found an average colour index of ·98 in 50 normal women and Kühnel (1927) found a comparable value of ·96 in a smaller series.

Obviously there is a very wide variation in the colour index of normal healthy women and considerable discretion must be used in assessing the normal value in individual cases. Indeed, such is the variation in published results, that one is almost led to doubt the value of the colour index as a haematological standard except in those cases where the value is around unity. However, in agreement with the general consensus of opinion, a range of 0·9 - 1·09 has been taken as representing the normal in healthy adult women.

Haematological values for normal healthy non-pregnant women have now been briefly reviewed and discussed, and the following standards of normality accepted for the purpose of the present investigation:

Haemoglobin	=	98·26% Haldane, equivalent to 13·6 grams haemoglobin per 100 cc. of blood.
Red Blood Cells	=	4,800,000 per c.m.m.
Colour Index	=	0·9 - 1·09.

These values will be used as a basis in a discussion of the results of the present investigation, but it is now a generally accepted principle that one is not entitled to consider the normal pregnant woman anaemic merely because the blood picture fails to conform to these standards. It is necessary to consider, therefore, and to try and determine if possible, the normal haematological values of pregnancy.

NORMAL HAEMATOLOGICAL VALUES IN PREGNANCY:

While haematological standards for normal healthy non-pregnant women can be assessed with a fair degree of accuracy, the assessment of normal values during pregnancy presents a much more difficult problem, but an attempt must be made to establish such values before the incidence of any particular form of anaemia of pregnancy can be ascertained. The wide variation in the recorded incidence of the iron-deficiency anaemia of pregnancy is probably due to the fact that too little attention has been paid to this particular difficulty, although its importance has been stressed by many writers even in most recent times. Many physiological factors associated with the pregnant state, some of which have been discussed in the chapter on aetiology, contribute to this difficulty, but to refer to only one of these factors, one may quote Elliott (1944) who stated that "accepted normal haematological standards for women do not apply to women in the pregnant state owing to the profound physiological alterations in the blood volume, which occur during pregnancy." Again, even if normal values are accepted, one must expect considerable variations, as observed many years ago by Blumenthal (1907), who stated that in the blood examination during pregnancy, there was no normal value, and supported his argument by quoting various authorities who differed in the interpretation of this value. Similar observations have been made by other workers. (Harvey 1931, Strauss and Castle 1932, Schultz 1934, Brindeau and Theodorides 1935). In this country Garry and Stiven (1936) reiterated the statement that the diagnosis of anaemia of pregnancy depended on the normal haematological values for pregnant women, and pointed out that this value was difficult to define owing to the wide variations encountered. Nevertheless no accurate diagnosis can be made unless one can establish acceptable normal values on which to base such a diagnosis. Similarly no true incidence of the condition can be determined as long as different investigators set different standards, and a study of the literature shows this to be a not infrequent practice.

HAEMOGLOBIN:

A review of mean haemoglobin levels in normal pregnancy as recorded by various investigators, demonstrates considerable variation in this value, but generally speaking the differences are not as great as one might be led to expect. While one cannot say that all workers are in close agreement, it might be possible, from a review of their results, to arrive at an acceptable normal mean value. A comparison of results, ofcourse, can only be made where investigations are truly comparable, i.e., where exactly similar methods of haemoglobinometry have been used, or where results have been expressed as grammes haemoglobin per 100 c.c. of blood. All investigations where these conditions have not been observed, have been discarded for the purposes of comparison. The following representative selection from the many investigations carried out in this country will serve to demonstrate the degree of variation in the mean haemoglobin levels of normal pregnant women.

Mackay (1931) in an examination of 83 unmarried pregnant women found an average haemoglobin value of 78% Haldane, equivalent to 10·7 grammes per 100 cc. of blood, and in a similar study (1935) of 109 cases, recorded an average value of 83·5% Haldane (11·5 grammes). The range of values in both investigations was practically the same. Davidson et al (1935) estimated the mean haemoglobin level in 819 pregnant women, recording a mean value of 78·1% Haldane (10·7 grammes) and in a similar series of investigations Davidson and his co-workers (1942, 1943, 1944) recorded mean values of 77% Haldane (10·6 grammes), 75·8% Haldane (10·4 grammes) and 86·8% Haldane (12·0 grammes) respectively. In an investigation carried out by Fullerton (1936) the average haemoglobin level at all stages of pregnancy was 77·9% Haldane (10·7 grammes) and in London, Kay and Alston (1937 - 39) in a study of 2,005 antenatal cases, recorded a mean value of 84·7% Haldane (11·6 grammes), although in a later study during the war years (1941), they found that this figure had been reduced to 70·8% Haldane (9·7 grammes). A similar war-time study by Sinclair (1942) did not demonstrate a like reduction in haemoglobin levels in pregnant women during the war years, his mean value being 85% Haldane (11·7 grammes), but Hamilton and Wright (1942), like Kay and Alston, found a similar falling off in the average haemoglobin level to 74·5% Haldane (10·2 grammes). The Committee on Haemoglobin Surveys (1943) made some interesting observations on the subject. They stated that the normal haemoglobin level during pregnancy was difficult to estimate because of the variable increase in plasma volume and were of the opinion that the haemoglobin level in pregnancy varied with (a) the duration of pregnancy; (b) the number of previous pregnancies, and (c) the age of the patient. A mean level of 84·6%

Haldane (11·6 grammes) was recorded for all pregnant women irrespective of age, parity or stage of pregnancy. A very similar figure was recorded by Fullerton et al (1944) who found a mean value of 83·6% Haldane (11·3 grammes) in an examination of 301 pregnant women, but again Meyer-Wedell (1943) recorded a somewhat lower figure viz. 76·5% Haldane (10·5 grammes). In a very recent study, carried out subsequent to the present investigation Adcock et al (1948) examined two series of antenatal cases, one in Manchester and the other in London. In both series the average haemoglobin level for all stages of pregnancy was practically the same in their untreated cases, viz. 87% Haldane (12·0 grammes) in London and 86·6% Haldane (11·95 grammes) in Manchester.

It will be seen from the above results of investigations carried out in this country that it would be difficult to arrive at an agreed figure which could be taken to represent the mean haemoglobin level during pregnancy. Not only do different investigators produce different results, but the same investigators record variable figures in separate investigations. One, of course, must allow for differences in dietary in pre-war years as compared with war-time conditions , but here again there is not universal agreement that a levelling down of haemoglobin levels occurred during the war. It will be noticed that average haemoglobin levels during pregnancy, recorded in this country between the years 1931 and 1948 range between 9·7 grammes (Kay and Alston), and 12·0 grammes (Davidson et al and Adcock et al). One would not be justified in striking an approximate mean of 11·0 grammes from these two values, but in point of fact, if all the values quoted above are averaged, one arrives precisely at this figure. It is realised that the investigations referred to above are not large in number, but as already stated, they are considered to be representative. Therefore, while it is recognised that an agreed figure cannot be precisely defined, it has been decided to adopt the value of 11·0 grammes haemoglobin per 100 cc. of blood as an accepted average haemoglobin level during pregnancy. The figure is an arbitrary one and has no statistical basis, but probably approaches near enough to a mean value which, most authorities agree, is extremely difficult to determine.

A study of the American literature shows that a vast amount of work has been carried out in the United States on the subject of haemoglobin levels in pregnancy. Unfortunately the results of many of these investigations are not acceptable for the purposes of comparison because the methods of haemoglobinometry have not been clearly stated, and results have been expressed in percentage values. One also finds another disadvantage which, however, is not wholly confined to American workers, viz., groups of mean values for different trimesters with no attempt to follow individual cases throughout the entire pregnancy. It is unfortunate that out of such a vast literature comparatively few workers can be usefully quoted, but the following studies should suffice to show a comparison with investigations carried out in this country.

Galloway (1929b), using the Sahli haemoglobinometer (17·2 gms. = 100%) examined 382 private antenatal patients including treated and untreated, anaemic and non-anaemic, and found a mean haemoglobin value of 73·1% (12·5 grammes) in the first trimester and 66% (11·3 grammes) in the third trimester, making an average haemoglobin value of 11·9 grammes for the whole pregnancy. Lyon (1929) using exactly similar methods, found an average figure of 75·3% Sahli (12·9 grammes) in 177 clinic cases examined during the third trimester, but Moore (1929, 1930), using the Dare haemoglobinometer (13·8 gms = 100%), recorded lower values in two separate investigations viz. 77·7% (10·7 grammes) and 79% (10·9 grammes) in two series of 100 and 300 cases respectively. Strauss and Castle (1932) examined 200 cases in the various months of pregnancy, and using the Sahli haemoglobinometer (15·6 grammes= 100%) found average values of 12·1 grammes at the end of the second month, 10·7 grammes at the end of the seventh month, and 11·0 grammes at term, giving an average value during the whole pregnancy of 11·26 grammes; Dieckmann and Wegner (1934) in a similar study found a higher mean value of 12·6 grammes. A much lower figure, however, was recorded by Richter et al (1934), using the Sahli haemoglobinometer (14·8 grammes = 100%) viz. an average haemoglobin level of 65% (9·6 grammes) in a study of 61 untreated cases. A comparison was drawn between hospital-class and private patients by Adair et al (1936). In an examination of 7,835 cases in the former group, they found a mean haemoglobin value of 11·56 grammes, and 170 cases in the latter group gave an average level of 11·79 grammes. In a further study of 66 normal pregnant women, Bethell (1936), using the Sahli haemoglobinometer (15·8 grammes = 100%), recorded a mean value of 10·6 grammes during the last three months of pregnancy. Goodall and Gottlieb (1936) found a mean value throughout pregnancy of 10·5 grammes in 200 consecutive non-selected cases.

In dealing with these investigations carried out by American workers, an attempt has been made, even in cases where the type of haemoglobinometer has not been stated, to reduce accurately, all haemoglobin values to a standard value viz. grammes haemoglobin per 100 cc. of blood, and although, as already stated, it has not been possible to quote a much larger number of workers, it will be noted that American figures do not differ materially from those recorded in this country. It is realised, of course, that not all of the American investigations cover the whole duration of pregnancy and results, therefore, are not strictly comparable, but a mean value of 11·0 grammes per 100 cc. of blood or slightly higher, would seem to be a reasonable estimate of the average haemoglobin level found in normal pregnant women in America, if one can assume that the investigations, above reported, are representative. On the small number of results quoted, however, this might be considered to be an unreasonable assumption.

The value of results recorded in the continental literature is again difficult to assess on account of difficulties, similar to those encountered in the American literature. In the absence of definite standards of haemoglobinometry, the results of only a few workers can be usefully quoted. Jerlov (1929) in an examination of 1,143 pregnant women, found mean haemoglobin values of 12·4 grammes and 10·7 grammes at the end of the third and ninth months respectively, giving a mean of 11·5 grammes for the whole pregnancy, and in Germany, Esch (1932) using the Sahli haemoglobinometer (17·2 grammes = 100%), although not stating a mean value for his series, recorded values ranging from 7·7 to 15·4 grammes haemoglobin per 100 cc. of blood, in an investigation of 700 antenatal patients. In France, Brindeau and Theodòrides (1935) recorded considerably higher figures, although in a much smaller number of cases. In 30 normal pregnant women, 15 primiparae and 15 multiparae, the average haemoglobin value was 98% Haldane (13·5 grammes). Other mean haemoglobin values in pregnancy recorded by workers in countries not already included, can be briefly stated as follows. In Canada, Adamson and Smith (1932), using the Sahli haemoglobinometer (17·2 gms. = 100%), recorded a mean value for their series, of 12 grammes, but Gottlieb and Strean (1939) in the same country found a much lower average level, viz. 10·5 grammes in 275 untreated cases. In New Zealand McGeorge (1935) found mean values of 95% Haldane (13·0 grammes) in 19 cases during the first half of pregnancy and 87% Haldane (11·9 grammes) in 46 cases during the last month.

From a study of the above results which are comparable by conversion to a common standard viz. grammes haemoglobin per 100 cc. of blood, it is clear, as other authorities have observed, that a normal haemoglobin value for pregnancy is one which presents considerable difficulty in establishing with accuracy. There are several reasons for this. As already stated, (p. 64 and 65) Elliott was of the opinion that it was due to the physiological alterations in the blood volume.

There are, however, other factors to be considered, such as the duration of pregnancy, and there is fairly wide agreement that there is a progressive fall in the haemoglobin level during the course of pregnancy. Whether, however, this variation is affected by the number of previous pregnancies and also by the age of the patient, as suggested by the Committee on Haemoglobin Surveys, is a view which has been much disputed. In conclusion, one might say that while it is not possible to assess with a sufficient degree of accuracy, a normal haemoglobin level for pregnancy. one can agree with Elliott's statement that accepted normal standards for women do not apply to women in the pregnant state. In the latter case these standards are undoubtedly lower. For the purpose of the present investigation, it has been considered necessary to arrive at a figure which might be considered acceptable, even although it may be an arbitrary one, and from a study of haemoglobin levels during pregnancy in this and other countries, it would probably be not too far wide of the mark to assume that a haemoglobin level of 11·0 grammes per 100 cc. of blood might be taken as representing a fairly normal average. This figure also is comparable with that found by the Committee on Haemoglobin Surveys (p. 67).

RED CELL COUNT IN PREGNANCY:

Among the earliest references to the red cell count in pregnancy is that of Henderson (Glasgow 1902), who recorded an average red cell count of 3·9 millions per c.m.m. in 43 cases examined at term, and in recent years Meyer and Weddell (London 1943) found an average count of 4·3 millions in a series of untreated cases. Elliott (1944) discussed the lowest limit of normality during pregnancy and referred to the work of Adair et al (1936), who considered this value to be 3·36 millions. Elliott, however, pointed out that most authorities considered this figure to be too low, and preferred one in the region of 4·0 millions. This value is in very close agreement with the average red cell count found in the present investigation.

Most of the published work on the subject of red cell counts in pregnancy is to be found in the American literature. Thompson (1904) in a careful study of 12 normal pregnant women, found an average red cell count, between the second and ninth months, of 5·0 millions, a figure considerably higher than that subsequently recorded by other workers in his own country, but the number of cases, of course, was very small. Lyon (1929) found an average count of 4·0 millions in an examination of 177 cases, and Galloway (1929 b) in a similar study of 382 private patients, found that 233 gave an average value of 4·05 millions in the first trimester, and 353 a value of 3·88 millions in the third trimester. In another contribution published during the same year (1929 a), he recorded a mean value of 3·6 millions in an investigation of a series of private patients, studied during all months of pregnancy. Bland, Goldstein and First (1930 a) examined 1000 normal pregnant women and found that in the whole series, regardless of the period of gestation, only 16% had a red cell count over 4·0 millions, and in a further investigation of 300 cases (1930 b) found that 42% gave red cell counts below 3·5 millions. In an examination of 200 treated cases Nalle (1930) recorded a mean value of 4·0 millions and Moore (1929, 1930) in an investigation of two separate series, which included pathological cases, found mean values of 4·1 and 4·3 millions in groups of 100 and 300 cases respectively. A comprehensive investigation of 4,345 hospital-class patients was carried out by Adair et al (1936) and a mean value of 3·77 millions was recorded. A very similar result was recorded by the same workers in a smaller series of private patients viz. 3·80 millions. Other American workers have published results in fairly close agreement with those already quoted (Richter et al 1934, Bethell 1936, Bethell et al 1939, Corrigan and Strauss 1936). In Canada, Adamson and Smith (1932) recorded a mean red cell count of 4·0 millions in 116 cases during the third trimester. A very similar result was recorded by Goodall and Gottlieb (1936) in the same country. Continental workers in this field have found results very similar to those published in this country and America, or at least with similar ranges of variation. Blumenthal (1907) in a very small series of cases recorded a mean red cell count of 4·0 millions within fourteen days of term, and Alder (1924) in a similar investigation, found an average value of 3·6 millions with a range of 3·0 - 4·1 millions. Schultz (1933) investigated a larger series and found that in half his cases, the red cell count dropped to 3·0 millions between the sixth and tenth month of pregnancy. In France, Brindeau and Theodorides (1935), in the thirty patients examined by them, found a mean red cell count of 4·1 millions and considered the lowest limit of normality for pregnant women to be 3·5 millions.

While the foregoing figures are not strictly comparable, as some refer to specific periods of pregnancy and others to the whole period of gestation, they serve to demonstrate that the normally accepted value for the red cell count in normal non-pregnant women, is not attained during the pregnant state, even allowing for a drop in value during the later months. While it is difficult, as in the case of haemoglobin levels, to arrive at any fixed value which might apply to all normal pregnant women, from the above review of results published in this country, America and the continent, it would seem reasonable to assume that a red cell count of 4·0 millions per c.m.m. is a very near estimate of the expected mean value during the gestational period. It is felt that any series of unselected cases in which an average red cell count of less than 3·5 millions is recorded, must include an unusually high proportion of pre-existing anaemias. For the purpose of the present investigation the figure of 4·0 million red cells per c.m.m. has been accepted as an average value during pregnancy.

COLOUR INDEX IN PREGNANCY:

While a colour index range of 0·9 - 1·09 can be taken as normal for healthy non-pregnant women, with an average value around unity, it is generally accepted that, as the reduction in haemoglobin during pregnancy is correspondingly greater than the reduction in the red cells, the colour index is less than unity in the majority of cases. It is again, however, extremely difficult to establish a normal colour index during pregnancy, and owing to the wide variation in this value, even in non-pregnant women, it is doubtful if there would be any real advantage in attempting to do so. A very wide variation in this value during the pregnant state has been recorded in the literature. In the investigation carried out by Henderson (1902) the average colour index was 0·78 in cases examined at term, but Meyer-Weddell (1943) recorded a mean value of 0·93 between the 27th and 32nd week and 0·86 between the 33rd. and 38th. week. A control series studied by Elliott (1944) showed a range of 0·8 to 1·00. On the other hand, Carey-Smallwood (1936) was of the opinion that the haemoglobin and red blood cells were reduced proportionately during pregnancy, the colour index remaining around unity, a conclusion which was supported by Whitby (1946).

In America Strauss and Castle (1930) examined 200 cases with an average colour index throughout pregnancy of 0·87 and Bland, Goldstein and First (1930 b) in an examination of 50 cases recorded a mean value of 0·94. The latter in their series of 1,000 patients, already referred to (p.76) found that the colour index was below unity in every single case. Many other contributions have been published by American authors on this subject, showing in the great majority of cases, a colour index of less than unity. (Nalle 1930, Moore 1929, 1930, Richter et al 1934, Goodall and Gottlieb, Canada 1936, Bethell et al 1935, 1936, 1939). Experimental evidence was produced by Van Donk et al (1934) who showed that the colour index in pregnant rats remained around unity. Also in Germany, Alder (1924) in his study of eleven cases of physiological anaemia, found a mean colour index of 1·00 with a range of 0·9 - 1·05, and Blumenthal (1907) in a much smaller number of cases, reported a very similar result, namely 0·97.

The colour index during pregnancy, as in any other condition, must depend firstly on the degree of reduction of haemoglobin and red blood cells and secondly, whether or not this reduction is proportionate or disproportionate. As shown above, Whitby and Carey-Smallwood were of the opinion that the haemoglobin and red cells were equally reduced, but Meyer-Wedell concluded that while the fall in haemoglobin and red blood cells was parallel during the first six months, there was a greater reduction in haemoglobin between the 33rd. and 38th weeks, with a correspondingly lower colour index. Whatever be the normal colour index during pregnancy, and it is doubtful if such a normal can be shown to exist, a study of the literature shows very little unanimity on this subject. Without, therefore, hazarding a mean colour index value for normal pregnancy, it is proposed to accept the fact that in the majority of cases, the colour index, at least in the later months, is below unity, although such a contention might not be universally accepted.

Normal haematological values for healthy non-pregnant women have now been discussed and established, and an attempt has been made to establish similar standards of normality during the pregnant state. Although in the latter case, it has not been possible to arrive at fixed normal values which would be universally accepted, the recorded results of various authorities in this and other countries, are of considerable value in attempting to establish reliable criteria on which to base a diagnosis of anaemia of pregnancy. As will be shown, it is the absence of universally accepted criteria of anaemia of pregnancy which has led to such a wide variation in the recorded incidence of the condition and which makes comparisons difficult, and in some cases impossible.

CRITERIA OF ANAEMIA OF PREGNANCY:

As already stated, a vast amount of work has been done on the subject of anaemia of pregnancy, and in the case of the iron-deficiency type, innumerable papers have been published dealing especially with its incidence and severity. A study of the literature, however, fails to reveal established criteria on which a diagnosis of anaemia of pregnancy can be based, and this is no doubt due, to a large extent, to the difficulty in establishing normal haematological values for the pregnant woman. It has already been mentioned that this difficulty is further increased by the many types of haemoglobinometer in use. Again, some investigators, in arriving at their conclusions, lay special stress on one particular line of investigation, such as the haemoglobin level, red cell count and the colour index, while other factors must obviously be taken into account, such as examination of the blood film and clinical signs and symptoms, not to mention other more technical examinations, beyond the scope of this investigation. As stated by the Committee on Haemoglobin Surveys (1943), many observers believe it is unwise to interpret the significance of haemoglobin levels in pregnancy without a complete blood examination, (Boycott 1936, Fullerton 1936, Meyer-Wedell 1943, Elliott 1944), and attention is drawn to the variable relationship between the haemoglobin level and the colour index. It is desirable, therefore, that in a study of anaemia of pregnancy, both the blood film and clinical observations should be included, but it is equally essential that each separate line of investigation should be studied with a view to establishing the lowest standard of normality. Only by establishing beforehand, the lowest normal haematological value, is it possible to arrive at a diagnosis of anaemia of pregnancy, a diagnosis which can reasonably be made in cases where haematological values fall below an accepted minimum. It cannot be too strongly emphasized that no national or international evaluation of the incidence of anaemia of pregnancy can be made, until such minimum values have been agreed upon and accepted. In spite of the long period during which the subject has been studied, it is indeed surprising that one finds at the present time, that minimum haematological values have not yet been universally established. As Bethell et al (1939) stated, "the recognition and classification of anaemia in association with any physiologic state such as pregnancy, requires the preliminary establishment of standards of normality for that state." He went on to show that no wholly satisfactory standards for the blood values in pregnancy had been formulated, and drew attention to the considerable divergence of opinion among investigators regarding the minimum levels of the red cell count and haemoglobin, which might be considered normal for the pregnant woman. Anyone who has studied the subject of anaemia of pregnancy, cannot but be in entire agreement with Bethell's observations, and it is for this reason that such considerable time has been given to the study of this important aspect of the subject.

With reference to the lowest normal limit of the haemoglobin level in pregnancy, Dieckmann and Wegner (1934) concluded that values below 10 grammes haemoglobin per 100 cc. of blood should be regarded as unphysiological and this value has also been accepted in this country.

(Davidson et al 1935, Mackay 1935, Reid and Mackintosh 1937, Hamilton and Wright 1942). In America, Bethell et al (1939), also accepted this figure as the lowest limit of normality. Unfortunately, this value, as such, has not found general acceptance, and one finds higher values quoted by different authors, thus leading to the acceptance of various degrees of anaemia of pregnancy, and a certain amount of confusion, when attempting to assess the over-all incidence of the condition. On the other hand, Browne (1944) and Whitby (1946) quoted slightly lower figures, being of the opinion that all values below 70% Haldane (9·6 grammes), constituted anaemia. Stevenson (1938) considered that a haemoglobin level of 60% Haldane constituted "a fairly severe anaemia." On the scale, 13·8 grammes haemoglobin = 100 cc. of blood, this would be equivalent to a level of 8·28 grammes. An even lower limit of normality was suggested by Watson (1938), who investigated 500 cases, using a Sahli haemoglobinometer (14 grammes = 100%), and recorded the figure of 50 - 60% (7·00 grammes - 8·4 grammes). It will be seen, therefore, that the figure, 10 grammes haemoglobin per 100 cc. of blood, cannot be taken as a generally accepted value representing the lowest limit of normality in pregnancy, but for the purpose of the present investigation, it has been taken as the figure, below which a diagnosis of anaemia has been made.

The lowest normal limit for the red cell count during pregnancy has not been definitely defined, and various authorities have given different values. Whitby (1946) considered a value below 4 millions per c.m.m. as constituting anaemia, and while some American authorities agree with this figure, others record lower values. Galloway (1929 b.) adopted the standard of 4 millions in classifying his anaemic cases, but First and Goldstein (1930) set the lowest normal limit at 3·5 millions, although other papers published by the same authors quoted the higher figure of 4 millions. (Bland and Goldstein 1929, Bland Goldstein and First 1930 a.). An even lower value was recorded by Adair et al (1936) who calculated the minimum red cell count for normal pregnancy to be 3·36 millions, and Bethell et al (1936, 1939) gave values of 3·7 millions and 3·5 millions. Of the continental workers, Schultz (1933) considered that a drop in the red cell count to 3·0 millions during pregnancy, was not dangerous and required no treatment. He believed that a true anaemia had developed when the red cell count fell below this figure. In France, Brindeau and Theodorides (1935) regarded the figure of 3·5 millions per c.m.m. as the lowest limit of normality for pregnant women. It is clear that no definite lower limit for the red cell count during pregnancy has been established and accepted, and any value considered as such would necessarily be an arbitrary one. However, the figures just quoted do help to give some indication, and taking them in conjunction with the mean red cell count established for normal non-pregnant women and the similar value accepted for normal pregnant women, it has been decided that, in the present series under investigation, all cases who gave a red cell count of 3·5 millions per c.m.m. or less, would be classified anaemic. While this is an arbitrary limit, and may be considered too low, it has been felt that its adoption would give a truer assessment of the incidence of anaemia of pregnancy as judged by the red cell count, by excluding the milder degrees of anaemia which are often of little consequence and rarely cause serious discomfort to the patient.

In a discussion of the colour index in normal non-pregnant women it has been shown that there is a wide range of variation, and that discretion must be used in interpreting its significance. In pregnancy an even greater amount of discretion must be used, in view of the variation which has been shown to exist in the relationship between the haemoglobin level and the red cell count during the gestational period. The question, therefore, as to what might be considered the lowest limit of normality for the colour index during pregnancy, is not one on which one would expect to find universal agreement. This value per se would in any case be of no major diagnostic significance in the absence of other clinical signs and symptoms, an opinion which is supported by Wintrobe and Schumacher (1933) who referred to the colour index as "a notoriously inadequate criterion." However, as a recognised and established haematological value, one cannot dismiss it entirely as a criterion of anaemia.

Boycott (1936). in his study of 222 unselected antenatal patients, found 26 to be suffering from anaemia. Thirteen of these, with a moderate degree of anaemia had a colour index range of 0·91 - 1·07, corresponding favourably with the generally accepted range for normal healthy non-pregnant women, but the remaining thirteen cases which showed a severe degree of anaemia had a range of 0·89 - .06. In the latter group, which Boycott considered to be a true anaemia due to iron-deficiency, there is obviously no fixed limit to which the colour index might fall, but in the former, which he considered to be probably due to a hydraemia, incidental to the pregnant state, the range was not outside the normal. On this basis one might reasonably assume a lower limit of 0·9, in the investigation of a series of unselected cases. On the other hand, if one is to accept the assumption of Carey-Smallwood (1936), that the physiological decrease in the haemoglobin and red cells during pregnancy is proportionate, one would expect the colour index to remain around unity. This writer stated, however, that in the iron-deficiency anaemia of pregnancy, which he did not consider to be physiological, the colour index was definitely below unity, and might be as low as 0·4. This is in agreement with the results of Boycott's investigation and supports a similar opinion expressed by Whitby (1946). Schultz (1933), in his study of 439 antenatal cases, arrived at a conclusion similar to that of Boycott, finding an average lower limit of 0·9, again similar to that of normal non-pregnant women. While it is, therefore, not possible to arrive at a fixed colour index value which could be taken as representing the lowest limit of normality during pregnancy, it has been decided to consider all those cases in which this value has dropped below 0·9, as suffering from a degree of anaemia, justifying at least, further investigation. Indeed, one might accept an even lower figure, but since 10 grammes (72% Haldane) has been accepted as the lowest limit of normality for the haemoglobin and 3·5 millions as the lowest limit for the red blood cells, one must expect an average colour index value around unity, a value which has already been considered by Whitby and Carey-Smallwood to be the normal during pregnancy.

In a large number of the investigations already referred to, a complete blood examination has been done, including the examination of stained blood films, and it has been accepted by leading authorities on the subject, that the common iron-deficiency anaemia of pregnancy presents the same characteristic appearances of this condition as in the non-pregnant state. As Vaughan (1934) stated, the anaemia is hypochromic throughout, and this conclusion, together with the other common changes, present in varying degree, such as microcytosis, anisocytosis and poikilocytosis, has been accepted without question, by most workers. (Green Armytage 1935, McGeorge 1935, Moore et al 1936, Boycott 1936, Carey-Smallwood 1936, Reid and Mackintosh 1937, Stevenson 1938). Meyer-Wedell)1943) however, showed that when a diagnosis of anaemia of pregnancy had been made on grounds, other than the blood film, it did not necessarily follow that hypochromasia was present, a fact which again stresses the importance of not relying on the haemoglobin value alone, as is so often done in a study of this type of anaemia. He found that out of 16 cases of established anaemia in his series, only eight (50%) showed evidence of hypochromic anaemia on examination of the blood film. As will be seen from a study of the results of the present investigation, an appreciable number of those cases which were not adjudged anaemic on the basis of the haemoglobin level, did in fact show evidence of iron-deficiency anaemia on examination of the blood film. In the same connection Elliott (1944) found that an abnormal degree of anisocytosis was found in patients with a haemoglobin level over 80% Haldane (11 grammes) who would not be regarded usually as showing evidence of anaemia, and rightly pointed out that if one accepted Boycott's suggestion that anisocytosis is a more important sign of abnormal haematopoiesis than a low haemoglobin level, then certain cases classified as normal should be placed in the anaemic group. As in so many other aspects of the subject of anaemia of pregnancy, once again one is faced with the problem of exact criteria on which to base a firm diagnosis.

Generally speaking, American and Continental workers have reported changes in the blood film similar to those observed by investigators in this country. (Galloway 1929 b., 1930, Bland, Goldstein and First 1930 a, Haden 1932, Mussey et al 1932, Strauss 1930, 1934, Irving 1935), but again one finds divergence of opinion. Adamson and Smith (1932) considered that the common secondary anaemia of pregnancy was not pathological, and supported their argument by showing that in their series of 116 normal pregnant women, the blood film was normal, although a moderate degree of clinical anaemia was apparent. Also, while Esch (1932) in Germany in an examination of a large series, found that 61 established cases of anaemia presented a blood film characteristic of the hypochromic variety, Schultz (1933) reported a result precisely similar to that of Adamson and Smith, namely, no changes in the blood film in his anaemic cases. It should be pointed out, however, that the incidence of anaemia in his series of 439 cases was unusually low (2·6%) and in Adamson and Smith's investigation only a moderate degree of anaemia was found.

It can be assumed that hypochromasia is an established feature of the common iron-deficiency anaemia of pregnancy. Other signs such as microcytosis, anisocytosis and poikilocytosis can likewise be accepted as findings of more variable frequency, depending on the severity of the anaemia. When all these features are present the diagnosis cannot be in doubt, but as so often happens, hypochromasia may be the only abnormality present. One could not justifiably diagnose iron-deficiency anaemia in pregnancy on the grounds of hypochromasia alone, in an otherwise normal healthy pregnant women, although it would necessarily be a confirmatory factor in conjunction with a low haemoglobin level, low red cell count or low colour index. Price-Jones, Vaughan and Goddard (1935) made some interesting comments on the subject of hypochromasia. They stated that they were not aware that the number of hypochromic cells present in healthy blood had ever been estimated, and in an examination of 81 cases recorded a figure of

0·6%. It would be of interest to know what the corresponding figure for normal healthy pregnant women would be, but in view of the iron demands on the maternal system during pregnancy, it would probably be considerably higher. In the present investigation, hypochromasia was the only abnormality found in the majority of blood films examined, and in the absence of any definite criteria, it was not considered that this feature could be adjudged, by itself, of major diagnostic significance if unaccompanied by other abnormalities in the blood film referred to above.

Clinical evidence of iron-deficiency anaemia of pregnancy is difficult to assess and is of doubtful diagnostic significance. One need only refer again to Whitby's statement that anaemia of itself severe enough to be an alarming symptom, is in this country a rare complication of pregnancy, and again, Witts has pointed out that the symptoms of anaemia when present, are often regarded as the inevitable concomitants of pregnancy and rarely regarded per se as evidence of anaemia. In the series investigated by Galloway (1929 a.), diagnosis was made only by investigation of the blood, and although he referred to the appearance of pallor in his patients, he pointed out that pallor and anaemia were not always associated, and that many pregnant women with a well-developed anaemia showed no pallor. Vaughan (1934) stated that the clinical signs of hypochromic anaemia of pregnancy were not usually severe, and that apart from some pallor of the mucous membranes, the signs, other than the blood picture were not definite, a view supported by the assertion of Evans (1937) that "the occasional impossibility of detecting a considerable degree of anaemia without haematological examination, must be emphasized." Davidson and Fullerton (1938) likewise pointed out that it was unwise to rely on the appearance of the skin in the diagnosis of anaemia, and Stevenson (1938) stated categorically that "the only standard of anaemia was the blood count; one could not judge the anaemia by the appearance of the patient." Also in the series of 140 cases studied by Thomas (1942), many of the 86 patients classed as anaemic showed no clinical evidence of anaemia and Elliott (1944) concluded that there was clearly no symptomatology specific for the anaemia of pregnancy.

Many authorities have referred to a definite syndrome of symptoms present to a greater or lesser degree. Strauss (1934) considered the chief symptoms to be pallor, lack of a sense of well-being and excessive fatigability, and Witts (1935) described similar symptoms with, in addition, dyspnoea, swelling of the ankles and muscular pains on exertion. Similar observations have been made by other writers (Richter et al 1934, Fullerton 1936, Carey-Smallwood 1936, Hamilton and Wright 1942, Davidson and Donaldson 1944), but in practice it is often extremely difficult to differentiate these symptoms from similar disabilities so frequently found associated with the pregnant state. On the other hand, Boycott (1936) found symptoms present in those cases which showed a low colour index, but Adamson and Smith (1932) found that their patients neither looked anaemic nor showed any signs of real anaemia. Brindeau and Theodorides (1935) were of a similar opinion with regard to the milder form of secondary anaemia of pregnancy, but stated that definite clinical symptoms appeared in the more severe cases.

It is obvious from the above evidence that an attempt to diagnose iron-deficiency anaemia of pregnancy (at least, in its milder forms), on clinical symptoms alone, would be of very doubtful value, and yet it has been the writer's experience in large antenatal clinics where iron was prescribed as a routine procedure, without preliminary haematological investigation, that many cases were found to have been treated unnecessarily. It is not suggested that this treatment did any harm, but it was an unnecessary procedure, and on the patient's part, often gave cause for unjustifiable anxiety. This does not mean, of course, that symptoms, when present, should be disregarded. They are of value when considered in conjunction with other evidence. However, the object of this discussion is not only to point out the limitations of the diagnosis of anaemia of pregnancy on clinical grounds, but to stress the necessity for a haematological examination in every pregnant woman at some time during her pregnancy, but preferably in the early months, and to institute treatment where indicated. The fallacy of relying only on the clinical appearance of the patient must inevitably result in many "missed" cases going untreated throughout pregnancy.

It is now proposed to describe in detail, the present investigation and to go on to an evaluation of the results. An attempt has been made to establish criteria on which to base a diagnosis of anaemia of pregnancy, and the importance of this aspect of the subject has been stressed, in view of the many and varied haematological standards which have been accepted in the past, with the consequent variation in the recorded incidence of the condition. These criteria have been based on a study of normal haematological values for pregnant and non-pregnant women, and in all future reference to the iron-deficiency or secondary anaemia of pregnancy, the following haematological values have been accepted as representing the lowest limits of normality:

Haemoglobin below 10 grammes per 100 cc.of blood.

Red Cell Count below 3·6 millions per c.m.m.

Colour Index below 0·9.

These values are put forward and suggested as reasonable limits, after consideration and discussion of the opinions expressed by authorities and workers on this subject, and in the present investigation all cases showing values below these limits have been considered anaemic, although this principle has not been rigidly adhered to in the case of the colour index, which is liable to vary so considerably even in the non-pregnant state.

Blood films have only been considered of definite diagnostic significance if hypochromasia when present, has been found to be accompanied by other abnormalities of the red cells, indicating the characteristic changes of iron-deficiency anaemia.

It is not considered that clinical evidence of the common iron-deficiency anaemia of pregnancy, still sometimes referred to as physiological anaemia, is of diagnostic significance, except, of course, in those cases where this evidence is so marked as to indicate the diagnosis before haematological investigation has been carried out. The importance, however, of a proper evaluation of this evidence, has been stressed.

CHAPTER V.

PRESENT INVESTIGATION.

The present investigation records the results of blood examination and clinical observation of 450 pregnant women attending antenatal clinics in the industrial area of South Staffordshire. Of these, 150 cases received an iron-containing supplement to the ordinary diet. No form of iron or other treatment was given to the remaining 300 cases. The results have been analysed to show the effect of the iron treatment on the blood picture during pregnancy, and the bearing this treatment may have had on the nature of the labour and puerperium, the weight and condition of the child at birth, and the still-birth rate.

Blood examination was done on two occasions during pregnancy, first at the beginning of the fourth month and secondly at the end of the eighth month. All patients were given a thorough physical examination when first seen, and any not considered to be absolutely normal in health were not included in the investigation, special importance being attached to any condition which might directly or indirectly affect the blood picture during pregnancy. Those patients who showed clinical evidence of anaemia on first presenting themselves at the clinic for examination were not excluded, as it is the object of the investigation to assess the incidence of anaemia in this series of otherwise normal pregnant women. No patients who had ever been under treatment for anaemia, or who gave any previous history of the condition, or who had suffered from haemorrhage in a previous pregnancy, were accepted. A careful medical history was taken in each case to exclude all patients in these categories. Similarly, any patient developing a pathological condition in the course of pregnancy, which might directly or indirectly affect the blood picture, e.g., antepartum haemorrhage, albuminuria, pyelitis nephritis, was rejected. Moore (1929, 1930), in his examination of 300 unselected antenatal patients, found the lowest haemoglobin values and red cell counts in nephritic patients, and O'Sullivan (1936) found that 15 out of 19 cases of albuminuria and 21 out of 32 cases of pyelitis, showed hypochromic anaemia on blood examination. For other reasons, such as non-attendance at the antenatal clinic after first examination and lack of co-operation in carrying out treatment, some cases had to be rejected, so that the series is not strictly consecutive, but no selection of cases was made. The investigation covered the period November 1946 to April 1948.

The area of South Staffordshire, chosen for the investigation, the "Black Country", is essentially industrial, and the population mainly of the artisan class, engaged in the heavy industries such as coal-mining, iron and steel manufacture, engineering, constructional steelwork, iron founding and kindred trades. An attempt has been made to obtain a representative cross-section of this population, and all cases have been drawn from antenatal clinics scattered throughout this area, covering a radius of roughly ten miles, and including eight antenatal clinics.

Information on the financial and social circumstances of the patients and their home conditions, which were obtained from visiting midwives and health-visitors, showed some variation, but none of them could be considered poor. Unemployment was practically non-existent, indeed a number of the women examined were themselves actively engaged in industry up till the sixth month of pregnancy.

METHODS AND TECHNIQUE:

Blood examinations carried out at the beginning of the fourth and end of the eighth months, included haemoglobin estimations, red blood cell counts, calculation of the colour index, and examination of stained blood films. Other investigations, involving a more skilled technique or special apparatus could not be undertaken, owing to the time involved and the limited accommodation available for laboratory work in the ordinary antenatal clinic.

Examination of stained blood films was not done in every case, but was carried out at the fourth or eighth months or at both periods if (1) the haemoglobin level was below 10 grammes per 100 cc. of blood or (2) the colour index was below 0·9 or (3) clinical evidence of anaemia was observed. All observations were recorded in antenatal clinics with the exception of blood films, which were taken in the clinic and later stained and examined in the laboratory of the Royal Hospital, Wolverhampton. Blood for examination was obtained in all cases by thumb puncture, only free-flowing blood being used. The merits of capillary and venous blood for the purpose of haematological investigation have been discussed by various authorities. Osgood (1926) advised the use of oxalated venous blood for all haematological studies, including red cell counts, and considered that separate drops from the ear or finger did not give an assurance of uniformity, but other authorities have demonstrated that there is no essential difference between red cell counts and haemoglobin estimations made from capillary or venous blood. (Wintrobe 1930, Price-Jones 1931, Harvey 1931, Price-Jones et al 1935).

HAEMOGLOBIN ESTIMATIONS:

The instrument used for the determination of the haemoglobin value was a Sahli haemoglobinometer supplied by Hawksley, London, in which 14 grammes of haemoglobin was equivalent to 100 cc. of blood, and all observed readings were corrected to 14·5 grammes haemoglobin per 100 cc. of blood. Three diluting tubes and three pipettes which were found to give exactly similar readings with the same sample of blood, were used throughout the investigation. Before commencing the investigation the accuracy of the haemoglobinometer was tested against the Spekker-Photo-electric-Absorbo-ometer, used in the laboratory of Ruchill Fever Hospital, Glasgow, and during the period of the experiment, blood from a normal male subject was examined at monthly intervals, the same subject being used on each occasion. The latter examinations were done in order to detect any fading in the colour tube, but no variation in these monthly readings was found. Finally, at the conclusion of the investigation, the accuracy of the instrument was again tested by independent observers at the laboratory of the Royal Hospital, Wolverhampton, and the laboratory of Ruchill Fever Hospital, Glasgow. The final test was done in the following manner. The haemoglobin value of an "unknown" blood was estimated at the laboratory of the Royal Hospital, Wolverhampton, using the Sahli haemoglobinometer, and the haemoglobin level was recorded. A sample of this blood in a heparin tube was sent to the laboratory of Ruchill Fever Hospital, Glasgow, and the haemoglobin level was again estimated with the spectrophotometric apparatus, against which the instrument was originally tested. The difference in the two haemoglobin estimations, as recorded by independent observers, was found to be less than 0·5%.

Considerable care, therefore, has been taken to ensure the accuracy of the Sahli haemoglobinometer, and as a result of the above tests, it is considered that the instrument gave uniform and reliable readings during the period of the experiment. In accordance with the recommendations made by Whitby (1946), final readings, in all cases, were not taken until the diluted blood had been allowed to stand for a period of forty minutes at room temperature, in order to allow complete conversion of oxyhaemoglobin into acid haematin. A freshly prepared solution of N/10 HCL was used throughout.

RED BLOOD CELL COUNT:

Red cells were counted on a Thoma-Zeiss counting chamber. In all cases, two counts were made and each individual result shown, is the average of these two counts. Where a difference of more than 200,000 red cells per c.m.m. was found, both counts were rejected, the chamber re-charged, and fresh counts made. Freshly prepared red cell diluting fluid was used throughout the investigation.

COLOUR INDEX:

The colour index has been calculated in the usual way from the haemoglobin value and the red cell count. Wintrobe (1933) stated that in order that the colour index, as calculated from the haemoglobin value, be 1·00 in normal individuals, it is necessary to choose that value of haemoglobin which corresponds to 5·0 million red cells. Consequently a haemoglobin value of 14·5 grammes has been employed as equivalent to 100% haemoglobin in the present investigation, this being the value suggested by Wintrobe.

BLOOD FILMS:

As already stated, blood films were prepared in the antenatal clinic, stained with Leishman's stain, and examined in the laboratory of the Royal Hospital, Wolverhampton. It was not considered necessary to carry out this examination in all cases, many of whom were normal pregnant women, presenting no signs or symptoms of anaemia. Blood films have been prepared and examined, therefore, only in those cases who showed one or more of the signs of anaemia already described (p.100). The value of this examination in the diagnosis of the common iron-deficiency anaemia found in pregnant women, and the grounds on which the blood film has been considered to be of diagnostic significance, have already been discussed (p. 91 and 92). All blood films shown in the results as positive indicate the presence of hypochromasia with or without other changes characteristic of iron-deficiency anaemia. The number of films actually considered of diagnostic significance, will be discussed later.

CLINICAL EVIDENCE OF ANAEMIA:

As already pointed out (p.92) clinical evidence of anaemia is a most unreliable diagnostic criterion in dealing with otherwise normal pregnant women. However, since all the patients under investigation were under regular observation throughout pregnancy, it was possible by clinical observation, to detect any signs of a developing anaemia, or an increase in those signs, if already present on first examination. Whether signs, when present on first examination, developed during the first three months of conception, it was in many cases, difficult to elucidate, and even in spite of careful enquiry, it was equally difficult to exclude completely the possibility of a pre-existing anaemia. A syndrome of signs and symptoms has been described by several workers and has already been referred to (p. 93), but owing to the difficulty in differentiating these signs and symptoms from those so frequently found associated with the pregnant state, they have largely been discarded for the purpose of diagnosis in this investigation. Only those patients, therefore, who have shown specific clinical evidence of anaemia, namely general pallor of the skin and mucous membranes, have been classified as "positive." No other signs or symptoms have been taken into account. The reliability of this method of assessment will be referred to later in evaluation of the results.

ADMINISTRATION OF IRON:

The beneficial effect of therapeutic doses of iron in iron-deficiency anaemia of pregnancy is well known and has been demonstrated in numerous investigations. In carrying out the present survey, therefore, it was felt that the results of the administration of iron in therapeutic doses would merely serve to confirm the findings of many other workers in this field. Consequently, iron in therapeutic doses has not been given to any of the treated cases, but prophylactic doses of iron have been administered in the form of an iron-containing food. The preparation chosen for the purpose was Prenatalac, produced by Cow and Gate Ltd., containing 63 grains of iron and ammonium citrate to the pound, or 50 mmgms. of iron per oz. This preparation was chosen for two reasons. First, it had been in use for several years in some of the antenatal clinics in which this investigation was conducted, and was popular with the expectant mothers who attended these clinics. Secondly, it was felt, that in dealing with normal pregnant women, more co-operation would be obtained with this prophylactic form of treatment which, in many cases, was prescribed where no evidence of anaemia was found throughout the pregnancy. This impression was obtained in a preliminary investigation, prior to the commencement of this experiment, when iron in the form of ferrous sulphate tablets, was prescribed, with results which could not be considered reliable, owing to the lack of co-operation in carrying out the treatment. By using a preparation which was already well-known to many of the expectant mothers attending the antenatal clinics and which was regarded as a food rather than a form of medicine, a much greater degree of co-operation was possible. At several of the clinics where the patients were investigated, Prenatalac was on sale and available to all who wished to purchase it. It was, therefore, necessary to keep a check of all patients who bought the preparation at the clinics, in order that none of them were accepted for the control series. This was a comparatively simple matter, and was done without the knowledge of the patients concerned, by enlisting the help of the clinic nursing staff. It was thus ensured that none of the three hundred cases in the control series received any form of iron apart from that contained in the normal diet. Prophylactic iron had never been administered in any form as a routine procedure in the antenatal clinics concerned in this investigation, a practice which obtains in some clinics in other parts of the country. It has, therefore, been possible to observe the results of the administration of iron in prophylactic doses during pregnancy, in this investigation.

All patients were under observation from the fourth month of pregnancy and were seen monthly until the end of the seventh month and thereafter fortnightly till the end of the eighth month. A one pound packet of Prenatalac was given to each patient at the beginning of the 4th, 5th and 6th months with instructions to take the preparation daily in equal amounts during the month. At the beginning of the 7th and 8th months two packets of Prenatalac were given with instructions to double the daily amount. Thus each patient in the treated series was given seven one pound packets of Prenatalac during the pregnancy, containing a total iron content of 441 grains of iron and ammonium citrate. In order to avoid selection, groups of fifty treated cases were investigated alternately with fifty untreated cases.

In dealing with large numbers of out-patients, the difficulty in ensuring co-operation in carrying out treatment, has been recognised by other investigators. (Davidson and Fullerton 1938, Davis and Walker 1934, Galloway 1929 a, Toland 1936, Hamilton and Wright 1942, Mackay 1931). This difficulty was anticipated prior to the commencement of the investigation and no case was included in the treated group if there was any reason to believe that treatment was not being carried out. All patients in the treated group were encouraged to keep up treatment during the five month period and were carefully questioned on this matter at each routine examination at the antenatal clinic. Health visitors and midwives who visited the patients' homes also observed and reported on co-operation, and although a number of cases were rejected as a result of these reports, the 150 cases presented, were known to have carried out the treatment prescribed and to have adhered to the instructions issued. Finally, it should be emphasized that although reference is made to "treated" cases, the treatment prescribed was purely of a prophylactic nature, no patient receiving therapeutic doses of medicinal iron.

No other examinations or investigations, apart from those mentioned above, have been carried out. No test-meals have been done, as this form of investigation was obviously impracticable in antenatal clinics. Also no detailed investigation of family incomes was instituted. As already stated, none of the patients could be considered to be in poor circumstances, and unemployment could be ruled out. It was not within the scope of this work to carry out a dietary survey in the present series. All the patients had equal opportunities of procuring the rationed foods under the existing rationing system, and as the price of the essential foods was controlled, financial considerations presented no deterrent to a reasonably nourishing, and balanced diet for all. Also, in the industrial area covered by the investigation, the "extras", more readily available to those living in rural districts, were not so easily obtainable, so that it was felt that there were very few discrepancies in individual diets. This was borne out by reports received by visiting midwives and health visitors.

CHAPTER VI.

R E S U L T S.

HAEMOGLOBIN.

The result of haemoglobin estimations in the treated and untreated groups are shown in Plate I. It will be noted that the average initial haemoglobin levels in both groups are practically identical and that at the end of the eighth month, there is very little increase in the treated group as compared with the controls, showing that the prophylactic administration of iron has had very little effect in raising the average haemoglobin level during the pregnancy. Following the tabulation of Hamilton and Wright (1942), the two groups have been further subdivided to show (A), those who improved, (B) those who showed no change, and (C), those who showed a fall in haemoglobin level between the beginning of the fourth and the end of the eighth months. The percentage number of cases falling into these subgroups are shown. Forty-six point six per cent of those cases receiving prophylactic iron treatment showed an improvement as against only 11·33% of the controls, and of those showing no change, 22·67% were treated cases and 8·00% were controls. Subgroup C. shows a more striking and significant change. In the control group 80·67% of cases showed a fall in haemoglobin level during the pregnancy, whereas only 30·66% of the cases receiving

EFFECT OF IRON TREATMENT [B]

		Treated Cases	Controls
Average Initial Hb. gm/100ml.		11·80	11·81
Average Terminal Hb. gm/100ml		11·72	11·18
Proportion Below	10 g% Hb initially	2·67%	4·67%
	10 g% Hb Finally	8·67%	14·00%
Proportion Showing	Improvement "A"	46·67%	11·33%
	No Change "B"	22·67%	8·00%
	Deterioration "C"	30·66%	80·67%
Average Hb increase in "A" [gm%]		0·67	0·87
Average Hb decrease in "C" [gm%]		1·20	1·19

prophylactic iron treatment showed this deterioration. It will be noted, however, that in both the treated and untreated groups, the average increase in the haemoglobin level in subgroup A. and the average decrease in haemoglobin level in subgroup B., show no significant change, in fact the average increase in the control group is slightly higher than that in the treated group. Plate I. also shows the proportion of cases in the treated and control groups, falling below 10 grammes haemoglobin per 100 cc. of blood at both the first and second examinations. While the control series shows an increase at the second examination of 9·23% of cases falling into this category, there is also an increase of 6·00% in the treated series; these figures are of no statistical significance. There was no great difference in the percentage number of cases below 10 grammes per cent haemoglobin initially, in the treated and untreated groups.

In Plate II. the treated and untreated groups have been subdivided according to the initial haemoglobin levels, and the changes in the haemoglobin levels are shown both in those two groups and in the combined series. The number of cases in the three lowest selected haemoglobin groups is too small to admit of conclusions, but it will be noted that in the groups of 10 grammes per cent haemoglobin and over, there is a drop in the haemoglobin level in each group of the control series.

CHANGE IN HAEMOGLOBIN

Haemoglobin (gm/100ml)		-7·25	7·25-8·55	8·70-10·0	10·15-11·45	11·60-12·9	13+
Controls	No of Cases	2	4	11	90	136	57
	Average Change in Hb	-·363	+·145	-1·160	-·551	-·625	-1·290
Treated Cases	Nº of Cases	1	2	5	53	67	22
	Average Change in Hb	0	-·435	+·580	+·130	-·290	-·725
Combined Series	No. of Cases	3	6	16	143	203	79
	Average Change in Hb	-·145	-·043	-·610	-·290	-·420	-1·130

In only one such group of the treated cases is there an average increase in the haemoglobin level, and this increase is too small to be of any significance. It will be seen that in the combined series there is an average drop in the haemoglobin level in all groups irrespective of the initial level. Also the average rise or fall in the various haemoglobin groups shown, is of no great significance in either the treated or untreated cases and the prophylactic administration of iron has shown no useful effect in raising the haemoglobin level during the pregnancy.

In Plate III. with a different grouping of initial haemoglobin levels the general result is still the same, namely a decrease in the average haemoglobin level during pregnancy in the control group, while in the treated group there is an arrest in the fall of haemoglobin (except in cases where the average initial haemoglobin level was 12·5 grammes per cent or over), but with very little increase over the initial average value. In the majority of cases an average fall of haemoglobin during pregnancy has been converted into a rise by prophylactic iron treatment, but the increase is too small to be of any significance.

Plates IV. to IX. show average haemoglobin levels throughout the period of observation, i.e. the mean of the initial and final haemoglobin estimations. It will

EFFECT OF IRON TREATMENT. [A]

Initial Hb. Level gm/100 ml.	CONTROLS.		IRON TREATED CASES.	
	Av. Initial Hb.	Av 2nd Hb.	Av Initial Hb	Av. 2nd Hb.
-9·4	8·25	7·20	8·20	8·25
No. of Cases	10		4	
9·5 - 10·9	10·35	9·90	10·50	10·90
No. of Cases.	40		33	
11·0 ~ 12·3	11·60	10·90	11·70	11·80
No. of Cases	128		67	
12·5 +	13·10	12·00	13·30	11·90
No. of Cases	122		46	

be noted in Plate IV. that in neither the treated nor the untreated series does the mean haemoglobin value approach a level at which a diagnosis of anaemia could be made. There is again very little difference in the mean haemoglobin level between the controls and the treated cases. There is also very little difference between the highest and lowest mean values in the two groups. The number of cases falling into the anaemic category is shown as 15 (5%) in the control group and 5 (3·3%) in the treated group, and it is of interest to observe that 285 (95%) of the control cases had a mean haemoglobin level during the period of pregnancy under review, of 10 grammes per cent haemoglobin or more. The corresponding figure in the treated group was 145 (96·6%). The distribution of values is shown among the non-anaemic cases in both groups. It will be noted that in the control group, 125 (41·6%) cases have haemoglobin values between 11·6 and 12·9 grammes per cent and that the corresponding figure in the treated group is 63 (21%). The distribution of values will be further considered when assessing the incidence of anaemia. The mean haemoglobin estimations during the course of the pregnancy in the treated and untreated groups are also shown in the form of a chart in Plate V.

HAEMOGLOBIN ESTIMATIONS.

No. of Cases	Average	Highest	Lowest	Haemoglobin [gms per 100 ml.]			
				Under 10	10 ~ 11·5	11·6 ~ 12·9	Over 13
300	11·49	15·08	6·38	15	78	125	82
150	11·76	14·5	6·53	5	45	63	37
450	11·63	15·08	6·38	20	123	188	119

INCIDENCE OF ANAEMIA BASED ON HAEMOGLOBIN VALUES:

Plate I. shows that the average initial haemoglobin level of the whole series was 11·80 grammes per cent. The average terminal haemoglobin level in both the treated and untreated groups is below this level, thus demonstrating a tendency to anaemia during pregnancy in both groups. Although there was a greater percentage of cases initially below 10 grammes per cent in the control group as compared with the treated group, both groups show an increase in the percentage of anaemic cases at the final examination, the increase being greater in the control group.

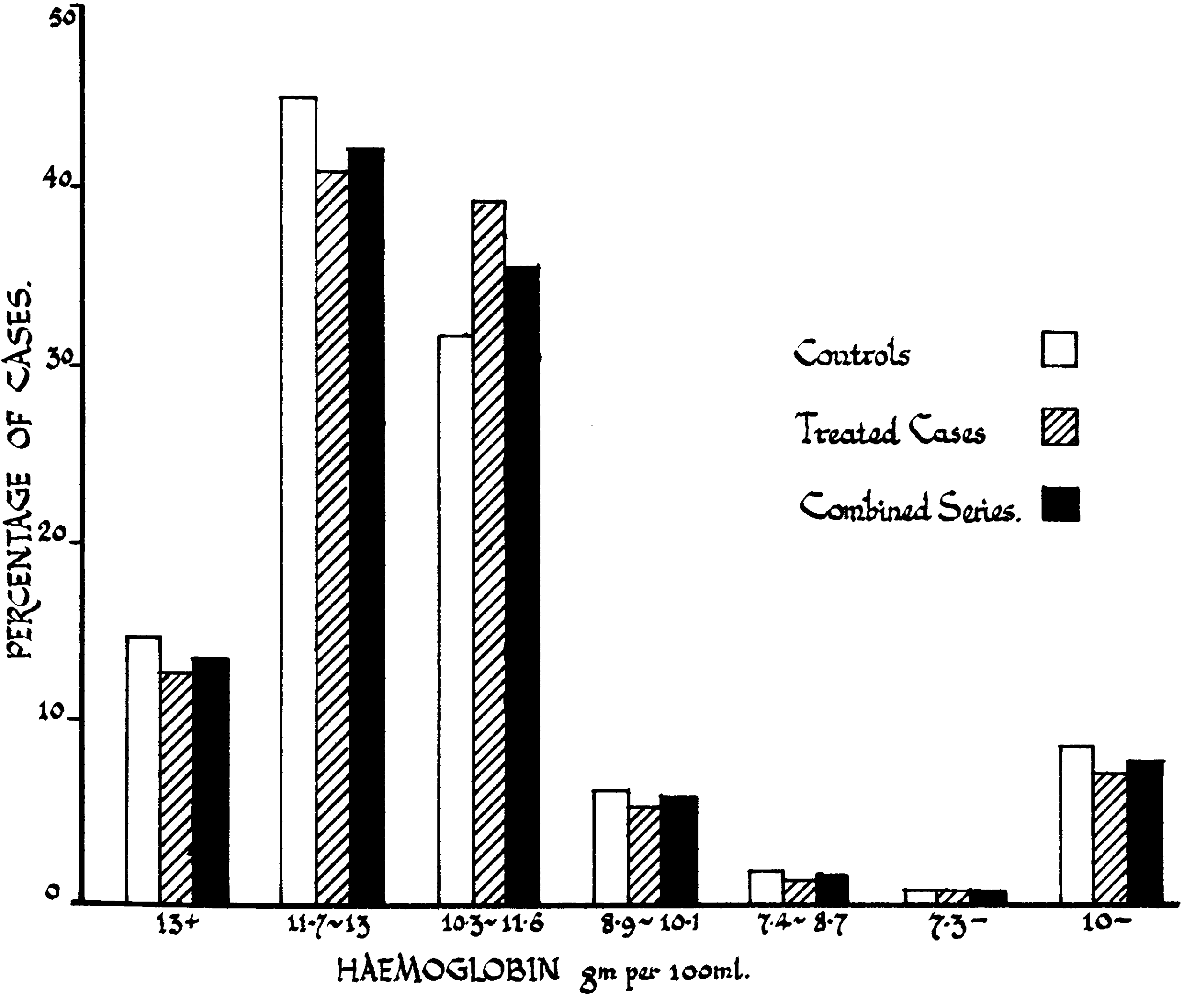
In Plate IV. it will be seen that among the 300 cases receiving no form of iron treatment during pregnancy, the incidence of anaemia, as shown by the average reading during the period under observation was 5% (15 cases) i.e., 5% of this group had haemoglobin values under 10 grammes per 100 cc. of blood, the value below which it has been decided that a true anaemia is presumed to exist.

Plate IV. also shows the following distribution of values in the untreated group. The Haldane equivalents have been inserted:

5% (15) of cases had a haemoglobin value below 10 gms. per 100 cc. (72% Haldane).

26% (78) of cases had a haemoglobin value between 10 and 11·5 gms. (72 - 83% Haldane).

GRAPH OF HAEMOGLOBIN ESTIMATIONS.



41·6% (125) of cases had a haemoglobin value between 11·6 and 12·9 gms. (84 - 93% Haldane).

27·3% (82) of cases had a haemoglobin value over 13 gms. per 100 cc. (94% Haldane).

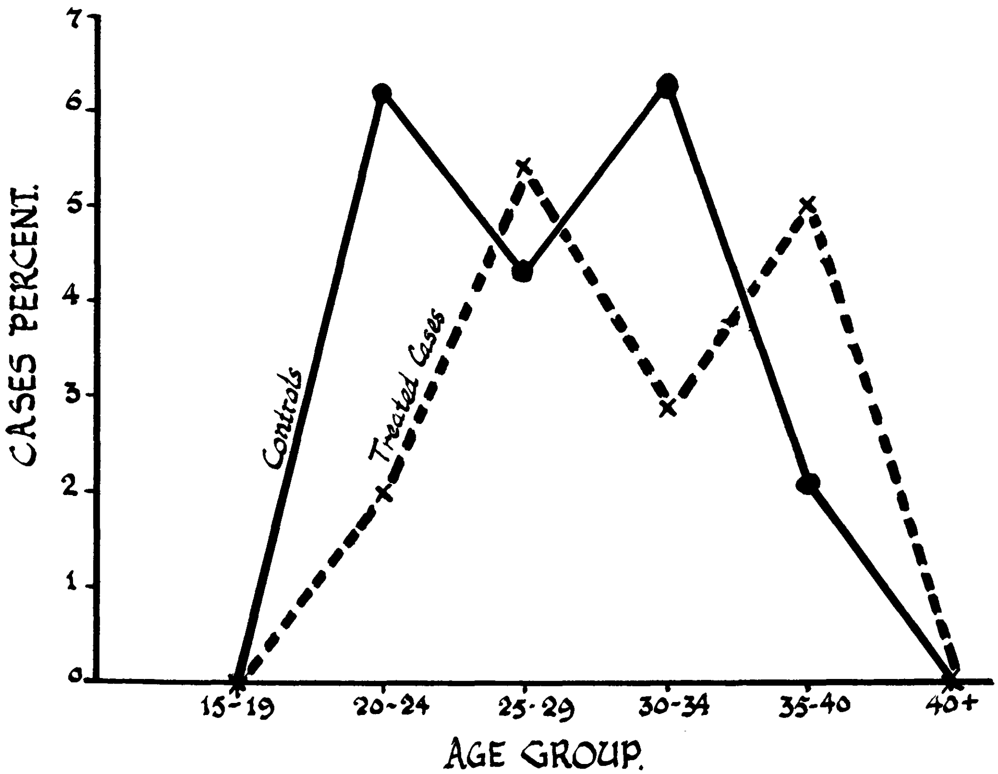
HAEMOGLOBIN VALUES BY AGE GROUPS:

In order to ascertain whether the age of the patient had any influence on the haemoglobin level, the average haemoglobin value during the period under observation, was studied in relation to the age groups between fifteen and over forty years of age. Plate VII. shows graphically that the age of the patient has had no significant influence on the haemoglobin level in either the treated or the untreated group.

HAEMOGLOBIN VALUES BY AGE AND NUMBER OF PREGNANCIES:

Mean haemoglobin values are again shown in Plates VIII. and IX, in which the cases in both the treated and untreated groups have been subdivided according to the age and the number of previous pregnancies. Plate VIII. shows, that in the control group, there is no significant relationship between the haemoglobin level and the age and number of previous pregnancies. With increasing age and an increase in the number of previous pregnancies there is a tendency, by no means consistent, to a gradual fall in the mean haemoglobin level. This fall, however, is not great nor is it regular, for example, in the 20 - 29 age group the average haemoglobin level is

GRAPH SHOWING PERCENTAGE OF CASES HAVING HAEMOGLOBIN BELOW 10gm/100ml.

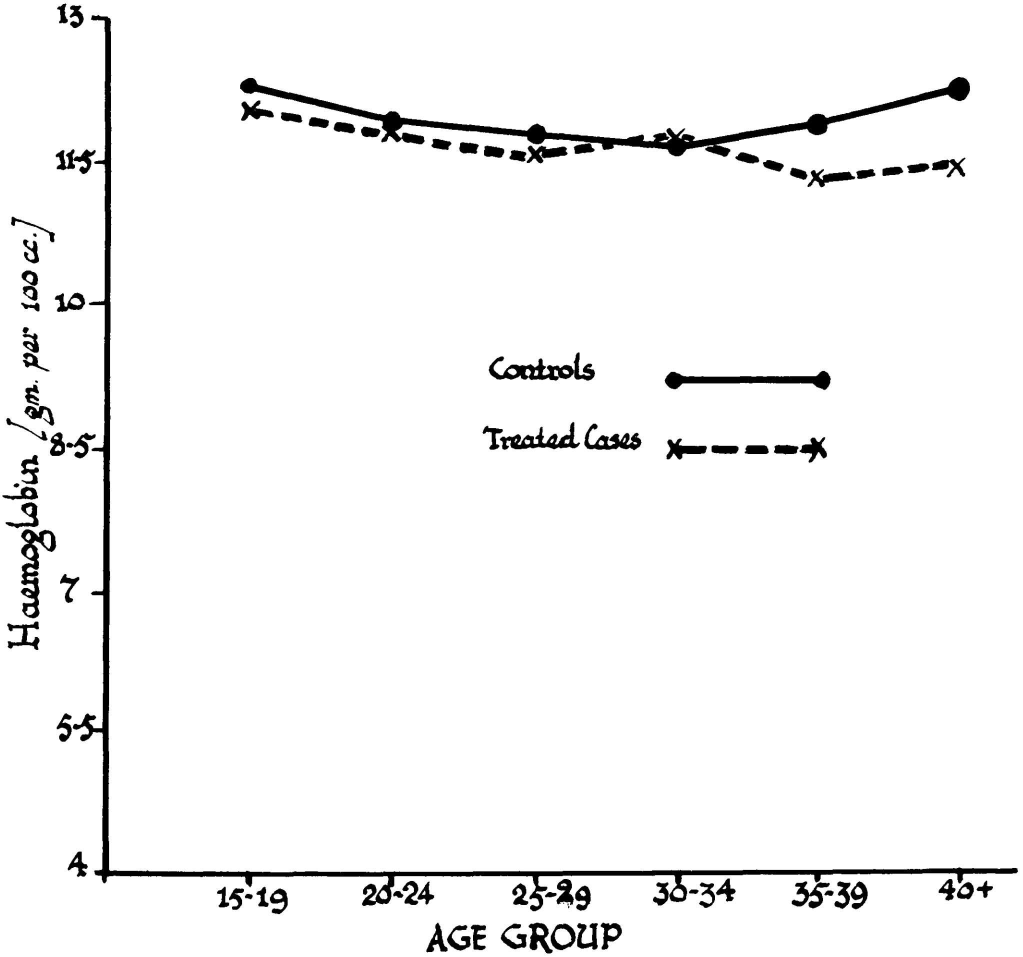


11·9 grammes per cent after one previous pregnancy, but has only dropped to 11·4 grammes per cent after five previous pregnancies. In the 30 - 40 age group the mean level of 12·2 grammes per cent after one previous pregnancy is precisely the same after five previous pregnancies. It will be noted in the over 40 age group, one patient with ten previous pregnancies had a mean haemoglobin value during the period under observation, of 12·5 grammes per cent.

In the treated group (Plate IX) results are even more inconclusive and inconsistent. In the 20 - 29 age group and the over 40 age group there is again a tendency to a fall in the mean haemoglobin level with an increase in the age and number of pregnancies, but a study of the 30 - 40 age group shows that this tendency would appear to be reversed.

In the total series of cases under investigation the results show that there is a tendency for the haemoglobin level to fall with the progress of the pregnancy. This fall in the average haemoglobin level would appear to be uninfluenced by either the age of the patient or the number of previous pregnancies. The average age of the control series was 28·25 years and the average age of the treated series was 28·35 years. Of the control series 113 cases (37·6%) were primiparae and 187 (62·3%) were multiparae. Of the treated series,

GRAPH SHOWING HAEMOGLOBIN BY AGE GROUPS.



61 (40·6%) were primiparae and 89 (59·3%) were multiparae.

RED BLOOD CELLS:

The average initial red cell count in the control series was 4·39 millions per c.m.m. and the average terminal red cell count was 4·02 millions, showing a negligible average drop during the period of observation, of 0·37 millions.

The average initial red cell count for the treated group was 4·37 millions per c.m.m. and the average terminal red cell count was 4·23 millions, again showing a negligible average drop of 0·14 millions, and demonstrating the negative effect of the prophylactic iron treatment.

Plate X. shows a detailed analysis of the red cell counts. In the control group it will be seen that 243 (81%) cases had initially, red cell counts over 4·0 millions. Of these, 183 (75·3%) showed a decrease of 0·2 millions or more red cells during the course of pregnancy and 17 (7%) showed an increase of 0·2 millions red cells or more. In the treated group, out of 114 (76%) cases who had initial red cell counts of 4·0 millions or more only 48 (42%) cases showed a decrease of 0·2 million red cells or more and 25 (21·9%) showed an increase. Again, in the control group 42 (14%) cases had red cell counts initially between 3·9 and 3·6 millions,

HAEMOGLOBIN VALUES BY AGE AND NUMBER OF PREGNANCIES.

[CONTROLS]

Nº of Pregnancies	AGES.														
	Under 20			20 ~ 29			30 ~ 40			Over 40			All Ages.		
	Nº	Mean	S.D.	Nº	Mean	S.D.	Nº	Mean	S.D.	Nº	Mean	S.D.	Nº	Mean	S.D.
1	9	12·5	0·79	91	11·9	1·01	13	12·2	1·40	~	~	~	113	12·0	0·16
2	~	~	~	52	11·9	1·26	35	11·8	1·17	~	~	~	87	11·9	0·35
3	~	~	~	20	12·0	0·93	28	11·9	1·43	~	~	~	48	12·0	0·22
4	~	~	~	4	10·4	2·35	10	12·0	1·42	2	12·7	0·73	16	11·7	0·77
5	~	~	~	5	11·4	0·90	9	12·2	1·07	1	13·2	~	15	12·0	0·48
6	~	~	~	1	11·5	~	9	11·6	1·75	1	11·0	~	11	11·5	0·17
7	~	~	~	~	~	~	6	11·7	1·58	~	~	~	6	11·7	1·58
8	~	~	~	~	~	~	2	11·2	0·07	~	~	~	2	11·2	0·07
9	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
10	~	~	~	~	~	~	~	~	~	1	12·5	~	1	12·5	~
11	~	~	~	~	~	~	1	9·1	~	~	~	~	1	9·1	~

and of these, 14 (8·5%) showed a decrease of 0·2 million red cells or more during the course of the pregnancy, and 8 (19%) showed an increase. The corresponding figures for the treated group are 4 (14·28%) cases showing a decrease of 0·2 million red cells or more, but 17 (60·7%) cases show an increase.

Plate X. would appear to indicate that the lower the red cell count in the early months of pregnancy, the greater the increase towards term, both in the treated and the untreated groups, with a greater increase in the red cell count in the treated cases. It will be seen, however, that the number of cases in the treated group who show an increase in the red cell count is very little different from the number showing no change.

INCIDENCE OF ANAEMIA BASED ON THE RED CELL COUNT:

As shown in Plate X. 15 cases in the control series had red cell counts below 3·6 millions per c.m.m., the lower limit of normality already agreed upon. This would give an incidence of anaemia based on the red cell count, of 5%, an incidence exactly similar to that based on a haemoglobin level below 10 grammes per 100 cc. of blood.

Plate XI. shows the results of the red cell counts in the form of a chart, indicating the distribution of values in the treated and untreated groups, and the combined series.

HAEMOGLOBIN VALUES BY AGE AND NUMBER OF PREGNANCIES. [TREATED CASES]

No. of Pregnancies	AGES														
	Under 20			20 ~ 29			30 ~ 40			Over 40			All Ages.		
	No.	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D.	No.	Mean	S.D
1	2	12·2	1·8	54	11·9	0·97	5	11·4	1·00	~	~	~	61	11·9	0·61
2	~	~	~	19	12·1	1·12	19	11·7	1·06	1	12·3	~	39	11·9	0·15
3	~	~	~	8	11·7	1·03	17	11·9	1·39	2	11·4	1·45	27	11·8	0·15
4	~	~	~	4	10·7	1·51	4	10·3	2·18	1	11·7	~	9	10·6	0·43
5	~	~	~	2	10·2	0·80	5	11·3	0·91	1	11·9	~	8	11·1	0·55
6	~	~	~	~	~	~	2	13·2	~	1	10·6	~	3	12·3	1·23
7	~	~	~	~	~	~	2	12·2	0·73	~	~	~	2	12·2	0·73
8	~	~	~	~	~	~	~	~	~	~	~	~	~	~	~
9	~	~	~	~	~	~	1	12·2	~	~	~	~	1	12·2	~

COLOUR INDEX:

The initial average colour index for the control series was 0·94 and the average final colour index was 0·93, a difference of no statistical significance. The mean colour index of the control series for the period of pregnancy under observation was 0·93. All these results are within the expected normal limits for pregnant women and are not considered to be of any particular significance.

The initial average colour index of the treated group was 0·93 and the average final colour index showed a slight rise to 0·95. The mean colour index of the treated group for the period of pregnancy under observation was 0·94.

Apart from drawing attention to the fact that the above average colour index values are within expected normal limits for pregnancy, no detailed analysis of these values has been made in this series. Reference has already been made (p.87) to the inadequacy of this value as a criterion on which to base a diagnosis of anaemia and the doubtful significance which can be attached to its interpretation. Owing to the wide range of variability which one must expect in each individual case, and the difficulty in establishing a normal value for pregnancy, it has not been considered that any useful purpose would be served by attempting

RED BLOOD CELL COUNT

Nº of Cases	R.B.C. (Millions)	Red Cell Counts, Unchanged	Decreased ·2m+	Increased ·2m+
300	4+	43	183	17
	3·9~3·6	20	14	8
	3·5~3·1	6	2	6
	-3·1	1	~	~
150	4+	41	48	25
	3·9~3·6	7	4	17
	3·5~3·1	2	5	1
450	4+	84	231	42
	3·9~3·6	27	18	25
	3·5~3·1	8	7	7

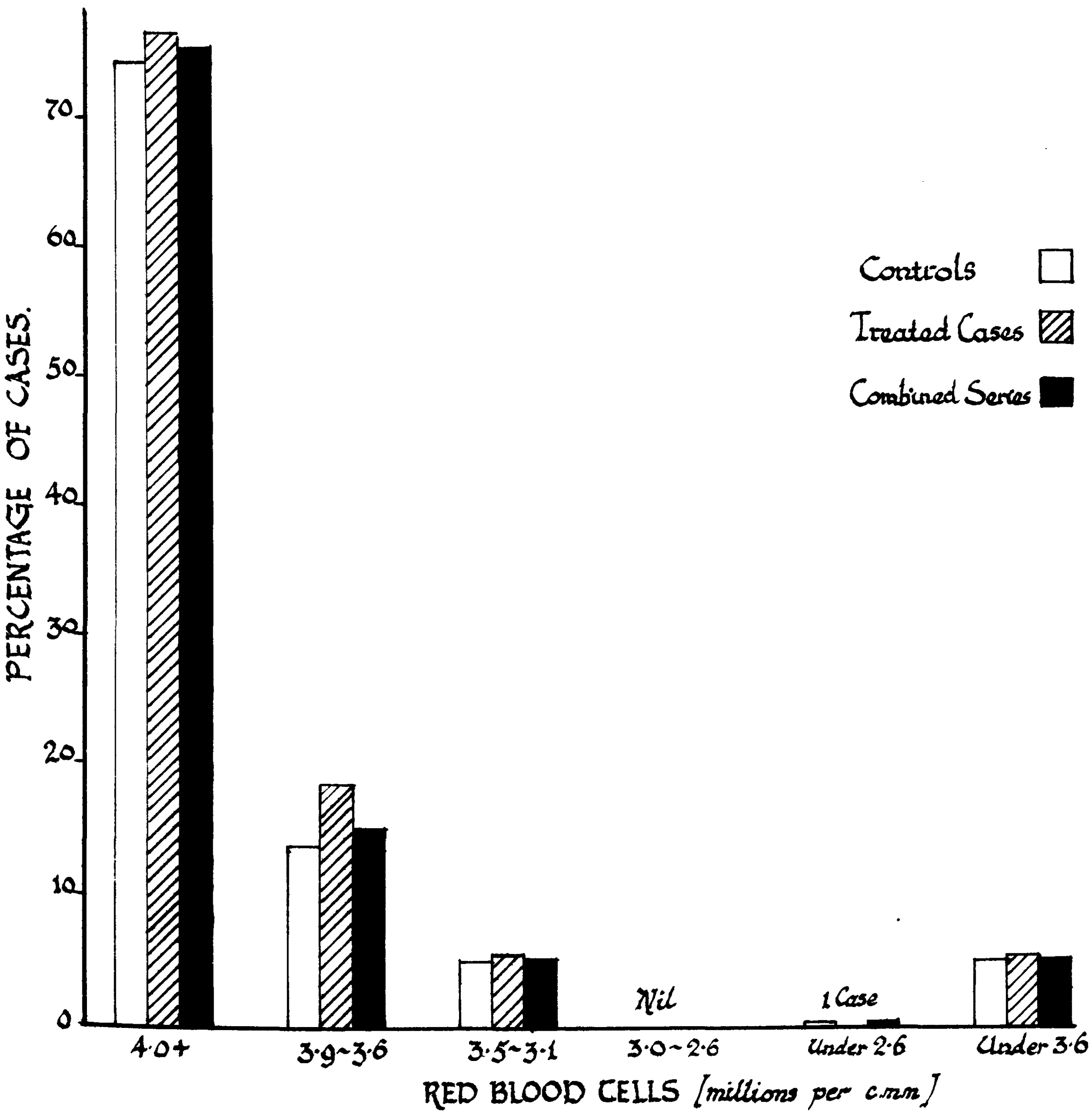
to assess the incidence of anaemia on this basis. Only average values, therefore, have been shown.

BLOOD FILMS:

In the control series, as will be seen in Plate XII, 50 (16·6%) cases showed hypochromasia. The corresponding number in the treated group was 22 (16%). On the basis of hypochromasia alone, therefore, 72 (16%) cases out of the combined series of 450 cases, showed this abnormality at some time during pregnancy. The significance of hypochromasia alone, as a diagnostic criterion of iron-deficiency anaemia of pregnancy, has already been referred to (p. 91), and if the number of cases showing positive blood films is further studied by reference to the appendix, it will be seen that the total number of cases who showed further confirmatory evidence of anaemia on examination of the blood film was 11 (2·4%).

The number of cases in the control group who showed, in addition to hypochromasia, other definite evidence of anaemia in the blood film, was 7 (2·3%). If these conditions, therefore, are accepted as criteria for the diagnosis of anaemia of pregnancy on blood film examination, the incidence of anaemia among the untreated cases is 2·3%, a figure more in keeping with the incidence based on the haemoglobin level and the red cell count.

RED BLOOD CELL COUNTS.



It will be noted that in the control series 15 out of 16 cases (93·75%) in the anaemic group, showed evidence of iron-deficiency anaemia on examination of the blood film, while only 35 out of 284 cases (12·3%) in the non-anaemic group showed this change. The corresponding figures for the treated series will be seen to be 4 (80%) and 18 (12·4%) respectively. There is no evidence that the prophylactic administration of iron had any effect on the blood picture presented by examination of the film.

CLINICAL EVIDENCE OF ANAEMIA:

Plate XII. shows the number of cases in whom clinical evidence of anaemia was observed during the period of pregnancy under observation. In the control series, 15 (93·75%) patients in the anaemic group come into this category and 47 (16·5%) in the non-anaemic group. In the treated group 4 (80%) of the anaemic patients are in this category and 28 (19·3%) of the non-anaemic patients. There was no evidence to suggest that the prophylactic administration of iron effected any appreciable improvement in the observed clinical condition of the patients during the course of the pregnancy.

A total number of 62 cases in the control series showed clinical evidence of anaemia during the course of pregnancy. This would give an incidence of anaemia

COMPARISON OF ANAEMIC & NON-ANAEMIC GROUPS.

	Haemoglobin (gm%)	No. of Cases	Forceps	Post-partum Haemorrhage	Puerperal Pyrexia	Positive Film	Clinical Evidence of Anaemia	Still Births	Wt. of Child
Controls	5·8~9·9	16	1	3	2	15	15	1	7 lb - 4 ozs
	10·0+	284	17	11	7	35	47	4	7 lb - 10 ozs.
Treated Cases	5·8~9·9	5	1	1	1	4	4	0	7 lb - 3 ozs.
	10·0+	145	5	6	4	18	28	2	7 lb - 8 ozs.
Combined	5·8~9·9	21	2	4	3	19	19	1	7 lb 4 ozs
	10·0+	429	22	17	11	53	75	6	7 lb 9 ozs.

of 20·6%. an incidence much higher than that based on the haemoglobin level, the red cell count, and the blood film. This higher incidence is not surprising in view of the complete unreliability of this sign as a diagnostic criterion (p. 92 and 93) and is not considered therefore, to give an accurate picture of the true incidence of iron-deficiency anaemia occurring in women during the course of pregnancy. It does, however, draw attention to the possibility of an existing anaemia, and as such is of value in stimulating further investigation and, where necessary, the institution of early treatment.

INCIDENCE OF ABNORMAL LABOUR:

In Plate XIII. a further analysis has been made to show the incidence of abnormal confinements in the treated and untreated groups, abnormalities including, forceps delivery, retained placenta or membranes, post-partum haemorrhage and pyrexia in the puerperium.

Plate XIII. shows that in the whole series there were 21 abnormalities of labour and the puerperium. Among the 300 cases in the control group the incidence of abnormality was 10·1%, but in those cases with a haemoglobin level below 10 grammes per cent, it was 25%. A slightly lower incidence of abnormality was found among the 150 treated cases (8·6%), but where the haemoglobin level was below 10 grammes per cent, the incidence of abnormality was 40%. It would appear,

INCIDENCE OF ABNORMAL LABOUR

[Forceps, Retained Placenta, Post-partum Haems.]

	No. in Group.	Hb. below 10g%	Percentage Abnormal Labour.	
			Whole Group	Hb. below 10g%
Controls	300	16	10·1 %	25 %
Treated Cases	150	5	8·6%	40 %
Combined Series.	450	21.	9·6%	28·6 %

therefore, that a low haemoglobin level during pregnancy has a bearing on the incidence of abnormality during labour and the puerperium, and also that the administration of prophylactic iron during pregnancy has no effect in reducing this incidence.

INCIDENCE OF PYREXIA IN THE PUERPERIUM:

As anaemia of pregnancy has been considered to have a bearing on the development of pyrexia during the puerperium, an analysis of the cases of pyrexia in the present series, is shown in Plate XIV. All cases in which a temperature over 100·4°F. developed during the puerperium have been included, whether notifiable or not, so that Plate XIV. does not show the true incidence of puerperal pyrexia, but only the number of cases in which a rise of temperature to 100·4°F. or over, from any cause, was known to have developed.

It will be noted that in the control series the incidence of pyrexia in the whole group was 3·0%, but in those cases with a haemoglobin level below 10 grammes per cent, it was 12·5%. The incidence among the whole group of the treated cases was 3·3% but where the haemoglobin level was below 10 grammes per cent, it was 20·0%. The incidence of anaemia, therefore, would appear to have had some influence on the development of pyrexia during the puerperium, and the administration of prophylactic iron has had no effect in reducing this

INCIDENCE OF PUERPERAL PYREXIA.

	Nº in Group	Hb. below 10 g%	Percentage Pyrexia	
			Whole Group	Hb. below 10 g%.
Controls	300	16	3·0%	12·5%
Treated Cases	150	5	3·3%	20·0%
Combined Series.	450	21	3·1%	15·0%

EFFECT ON THE STILL-BIRTH RATE:

Plate XV. shows the effect of the anaemia on the still-birth rate per 1,000 live births. In the control group as a whole the still-birth rate was 16·7, whereas among the anaemic cases it was 62·5. In the treated series, the figure for the whole group was 13·3, there being no still-births among the anaemic cases in this group. Anaemia during pregnancy may have had some effect on the still-birth rate in the control group, but owing to the small number of cases, no definite conclusions can be drawn from the results either in this or the treated group. Similarly no conclusions can be drawn as to the effect of the prophylactic administration of iron, but it is unlikely that it had any effect.

EFFECT ON WEIGHT OF THE CHILD:

Plate XVI. shows the average weight of the child in the anaemic and non-anaemic groups. Among the 300 control cases the average weight was 7 lbs. 4 oz. in the 16 cases where the mother's mean haemoglobin level during the pregnancy was below 10 grammes per cent. Where the mother's haemoglobin level was above 10 grammes per cent, the average weight of the child was 7 lbs. 10 oz., a difference of only 6 ozs. In the treated group the average weights in the anaemic and non-anaemic patients were 7 lbs. 3 ozs. and

EFFECT ON STILL-BIRTH RATE. [Per 1000 live births.]

	No. in Group.	Hb. below 10 g%	Still-birth rate per 1000.	
			Whole Group	Hb. below 10 g%
Controls	300	16	16·7	62·5
Treated Cases.	150	5	13·3	Nil
Combined Series	450	21	15·6	47·6

and 7 lbs. 8 ozs. respectively, a difference of only 5 ozs. There is thus no evidence to show that anaemia during pregnancy has had any influence on the weight of the child or that the baby's weight has been affected by the prophylactic administration of iron.

INCIDENCE OF FORCEPS DELIVERY:

In the control group, as will be seen in Plate XII, one out of 16 anaemic cases required forceps delivery, an incidence of 6·25%. In the non-anaemic group of the control series the incidence was 17 in 284 cases or 5·98%. Among the treated cases the corresponding incidence was 20% and 3·4% respectively. In the combined series of treated and non-treated cases, 2 out of 21 anaemic cases (9·5%) required forceps delivery and 22 out of 429 (5·1%) of the non-anaemic cases. The forceps cases include only those where the position of the child was normal and no other abnormality of the mother or child existed apart from anaemia of the mother. It will be noted that the use of forceps has been slightly more frequent in the anaemic as compared with the non-anaemic mothers, but there is no evidence to show that the prophylactic administration of iron has had any appreciable effect in reducing the incidence of forceps delivery among the small number of anaemic cases in the treated group.

EFFECT ON WEIGHT OF CHILD

	No. of Cases		Average Weight of Child.	
	Hb.-10 gm%	Hb. 10+gm%	Hb-10gm%	Hb. 10+gm%
Controls	16	284	7lb-4ozs	7lb-10ozs
Treated Cases	5	145	7lb-3ozs	7lb. 8ozs
Combined Series.	21	429	7lb 4ozs	7lb 9ozs

INCIDENCE OF POST-PARTUM HAEMORRHAGE:

As will be seen in Plate XII, 3 out of 16 anaemic cases in the control group suffered from post-partum haemorrhage, an incidence of 18·75%. Among the non-anaemic cases in the control group the incidence was 11 out of 284 cases, or 3·87%. Among the treated patients 20% of the anaemic cases suffered from post-partum haemorrhage and 4·1% of the non-anaemic patients. In the combined series of treated and untreated patients 4 out of 21 (19%) anaemic patients and 17 out of 429 (3·96%) non-anaemic patients suffered from post-partum haemorrhage. In only one case was the post-partum haemorrhage due to a retained placenta.

These results show that post-partum haemorrhage occurred more frequently in the anaemic as compared with the non-anaemic patients, and the anaemia may have had some influence on the incidence of this condition. There is, however, no evidence to show that the prophylactic administration of iron had any effect in reducing this incidence.

CHAPTER VII.

D I S C U S S I O N.

HAEMOGLOBIN LEVELS IN PREGNANCY.

In a review of the published work on anaemia of pregnancy, attention has already been drawn to the difficulties encountered when an attempt is made to draw a comparison between the recorded results of different workers. The difficulties already enumerated include the many different methods used in estimating the haemoglobin level and the failure to state the standard used. Again one is often left in doubt as to the period of pregnancy to which the samples refer, and as to whether mean values refer to single examinations of a series of patients at a fixed period, or to the mean of several examinations made throughout the pregnancy. Also, as has already been stated, in reviewing the incidence of anaemia of pregnancy, a further difficulty arises due to the adoption of different criteria of anaemia by many workers, with a corresponding variation in the recorded incidence of the condition. In the present series an attempt has been made to meet these difficulties by reducing all haemoglobin values to grammes haemoglobin per 100 cc. of blood, by stating the exact period of pregnancy to which samples refer, by indicating whether mean values refer to the mean of all readings at a fixed period of pregnancy or to the mean of one or more readings observed throughout the course of the pregnancy, and by establishing a fixed value, below which a true anaemia of pregnancy is presumed to exist. On these lines an attempt will be made to draw a comparison between the results recorded by previous workers, and those found in the present investigation, with relevant comments on the significance or otherwise of the differences found.

Among the untreated cases studied in the present investigation, the mean haemoglobin value during the period of pregnancy under observation, i.e. the mean of the two readings taken at the beginning of the fourth and the end of the eighth month, was 11·49 grammes haemoglobin per 100 cc. of blood, and the number of cases showing a mean haemoglobin level below 10 grammes haemoglobin per 100 cc. of blood was 15, thus giving an incidence of anaemia of 5%. The corresponding incidence among the treated cases was 3·3%. The average initial haemoglobin level for the entire series was 11·80 grammes per cent with an incidence of anaemia at the beginning of the fourth month of 4·67% among the controls, and 2·67% among the treated cases. At the end of the eighth month the average terminal haemoglobin value in the control group was 11·18 grammes per cent and that of the treated group 11·72 grammes per cent, with an incidence of anaemia of 14·00% and 8·67% respectively. It is of interest to note that all the average haemoglobin values recorded are above the average value which has already been considered to be about the average value for healthy pregnant women, viz. 11·00 grammes per cent (p. 74).

The following average haemoglobin values during pregnancy recorded by other workers and already referred to (p. 66 and 67) can now be compared with the above results bearing in mind the limitations of such a comparison, attention to which has been drawn at the beginning of this chapter. Where possible, the incidence of anaemia is also given. Mackay (1931, 1935) in two investigations, recorded average values of 10·76 grammes per cent (78% Haldane) and 11·5 grammes per cent (83·5% Haldane). In the second investigation there were five cases with a haemoglobin level below 70% Haldane (9·6 grammes) giving an incidence of anaemia of approximately 4·6%, based on the lowest limit of normality (10 grammes per cent) accepted in the present investigation. The results of Mackay's second investigation (1935) show a striking resemblance to those recorded in the present series. The average values in her earlier investigation are lower than those found in the present series, but the cases might not be considered representative, all being unmarried pregnant women. Lower average values were recorded by Davidson et al (1935) and also a higher incidence of anaemia viz. 10·76 grammes per cent (78·1% Haldane) with 17·5% of their cases showing a haemoglobin level below 70% Haldane (9·6 grammes). These results, however, were found among the poorer classes of the population at a time of unemployment and economic stress between the two world wars. Higher values, however, were recorded by McGeorge (1935), viz. 13·0 grammes (95% Haldane) between the 8th and 20th week of pregnancy, and 11·9 grammes (87% Haldane) between the 35th and 38th weeks. The incidence of anaemia, however, was higher, 17% of the total number of cases examined showing a drop of haemoglobin at some time during pregnancy, below 10·2 grammes (75% Haldane), a finding somewhat similar to that of Boycott (1936) who recorded 11% of his cases with haemoglobin levels below 70% Haldane (9·6 grammes). Fullerton (1936) found that the average value at the 12th week of pregnancy was 11·45 grammes (83% Haldane), a result practically the same as that found in the present investigation. This level, however, fell to 10·25 grammes (74·3% Haldane) at the 37th week. A higher incidence of anaemia was recorded by Reid and Mackintosh (1937) and Davidson and Fullerton (1938) who found that 10·2% and 18·4% of cases in their respective investigations, had haemoglobin levels below 70% Haldane (9·6 grammes). Apart from the average haemoglobin values during pregnancy, this higher incidence of anaemia seems to have been fairly general in the pre-war period. Meyer-Wedell (1943) found not only an average haemoglobin value of 10·37 grammes (75·2% Haldane), but also an incidence of 16% of cases with a level below 70% Haldane (9·6 grammes), although during the same period Kay and Alston recorded results almost exactly similar to those found in the present investigation, viz. an average haemoglobin level of 11·68 grammes (84·7% Haldane) with 5·3% of their cases showing levels below 70% Haldane (9·6 grammes).

It will be of interest now to compare the results of the present series with the results of investigations carried out during the war. Kay and Alston (1941) in a further investigation during the war years found that the average haemoglobin level of their patients had dropped to 9·69 grammes (70·8% Haldane) and 39% of cases had levels below 70% Haldane (9·6 grammes), thus demonstrating a marked increase of anaemia during the war years. Sinclair (1942), however, did not confirm this trend, recording results again almost the same as those found in the present series, viz. an average haemoglobin level of 11·64 grammes (85% Haldane) with 5·9% showing levels below 70% Haldane (9·6 grammes), and Wills et al (1942) found a mean value of 12·35 grammes (89·5% Haldane). The latter, however, found a higher incidence of anaemia viz. 10% but this was based on a lower limit of normality of 80% Haldane (11·0 grammes), so that the actual incidence may not have been much greater than that found in the present series. Continuing with war-time studies we find much lower values recorded by Hamilton and Wright (1942). The average haemoglobin value between the 3rd. and 5th. month of pregnancy was found to be 10·62 grammes (77% Haldane), 16·8% of the cases having a level below 70% Haldane (9·6 grammes), while at term the average value was 9·6 grammes (70% Haldane), 40·3% being below this level, an incidence of anaemia well above that of the present series. An even higher incidence was recorded by Thomas (1942) who found that 52% of cases examined during the last twelve weeks of pregnancy had haemoglobin levels below 70% Haldane (9·6 grammes). This is the highest incidence of anaemia of pregnancy so far recorded, but the results published by the Committee on Haemoglobin Surveys (1943) again correspond very closely with the results of the present investigation. The Committee found a mean haemoglobin level of 11·67 grammes (84·6% Haldane) for all pregnant women, irrespective of age, parity or stage of pregnancy and an incidence of 6·7% of cases with a level below 70% Haldane (9·6 grammes). Lower figures were recorded by Davidson et al (1943) viz. an average haemoglobin level of 10·46 grammes (75·8% Haldane) for all stages of pregnancy, with an incidence of 24% of the cases falling below 70% Haldane (9·6 grammes), but Fullerton et al (1944) found results corresponding very closely with those of the present series, viz. an average haemoglobin value of 11·39 grammes (82·6% Haldane) with an incidence of 3·9% of cases showing levels below 70% Haldane (9·6 grammes). Davidson et al (1944) in a further investigation found a somewhat higher average value of 11·97 grammes (86·8% Haldane).

For the reasons already stated, the mean haemoglobin levels and the incidence of anaemia just quoted are not in all cases strictly comparable with the results recorded in the present survey, but a reasonably accurate comparison has been possible and the results of this investigation compare favourably with those of both pre-war and war-time investigations. In the majority of cases, it is found by comparison, that the incidence of anaemia of pregnancy has diminished and certainly does not approach the incidence recorded by Hamilton and Wright (1942) and Thomas (1942). The average haemoglobin levels found during pregnancy and the incidence of anaemia, based on the number of cases with levels below 10 grammes per cent, compare favourably with the results recorded by Mackay (1931), Fullerton (1936), Kay and Alston 1941 (pre-war investigation), Sinclair (1942), Committee on Haemoglobin Surveys (1943), Fullerton et al (1944) and Davidson et al (1944). They show an improvement on the results recorded in the other investigations quoted. On the whole, the average haemoglobin values during pregnancy and the incidence of anaemia found in the present survey are more satisfactory than those found before and during the war. There is also no evidence of a high incidence of anaemia in the series of cases investigated if a true anaemia of pregnancy is only considered to exist when the haemoglobin value falls below 10 grammes of haemoglobin per 100 cc. of blood.

On the assumption that there is no great difference between average haemoglobin values in this country and those in America, a comparison of the results of the present investigation with those found by American workers, is worthy of consideration. Galloway (1929 b.) found an average haemoglobin value of 12·5 grammes during the first trimester and 11·3 grammes during the third trimester, but his results referred to both treated and untreated cases. These results are higher than those found in the present investigation, but he recorded an incidence of anaemia of 65%, based however on a lower limit of normality of 11·0 grammes per cent. Notwithstanding, the incidence must still be considered high, and is supported by the findings of Bland, Goldstein, and First (1930 a.) who reported that 58·6% of their patients had haemoglobin values below 9·6 grammes per cent. In a further study (1930 b.), these workers found that 62% of a group of private patients had levels below 10·3 grammes at term, while the corresponding incidence among a group of ward patients rose to 80%. These figures are much higher than any of those recorded by workers in this country. Nalle (1930) in his study of treated cases, found an average haemoglobin value throughout pregnancy of only 9·6 grammes and Moore (1930) in two separate investigations found that, in the first, the mean haemoglobin value was 10·9 grammes with 16% of cases showing levels below 9·6 grammes, and in the second, the average value was 10·7 grammes with 19% of cases below 9·6 grammes. A similar average value was recorded by Richter et al (1934) viz. 9·6 grammes two weeks before term. However, results somewhat similar to those found in the present investigation, were recorded by Corrigan and Strauss (1936). They found that during the last four months of pregnancy, the average haemoglobin value was 11·7 grammes, and Adair et al (1936) recorded average values of 11·56 grammes and 11·79 grammes in a group of hospital class patients and private patients respectively. They found, however, that 11·6% of the hospital class patients had values below 10·00 grammes per cent, with a corresponding incidence of 7% among the private patients. Few of the American workers, however, record average haemoglobin values during pregnancy as high as those found in this country. Bethell (1936) recorded an average value of

10·6 grammes with an overall incidence of anaemia of 70%, but this incidence was based on a lower limit of normality of 11·3 grammes. In a subsequent investigation by Bethell et al (1939) the incidence of anaemia had dropped to 26·6% when a diagnosis was made only in those cases where the haemoglobin dropped to less than 10 grammes per cent at some time during pregnancy. The lowest incidence of anaemia recorded by an American worker was 5% (Watson, 1938), but his results could not be compared with those of the present investigation as he considered the lower limit of normality for the haemoglobin value during pregnancy, to be 7·7 grammes per cent and 81% of his cases had values between 7·7 and 10·5 grammes. A lower limit of normality of 7·7 grammes is considered to be much too low. An average haemoglobin value very similar to that found by most of the American investigators was recorded by the Canadian workers, Gottlieb and Strean (1939) viz. an average value of 10·5 grammes per cent.

From the above results it will be seen that the average haemoglobin values and the incidence of anaemia found among pregnant women in America do not correspond to results recorded in this country. On the whole, the average haemoglobin level among pregnant women in America is lower and the incidence of anaemia is certainly much higher. It is difficult to put forward an explanation for this. The only comparable British figures are those of Hamilton and Wright and Thomas, and these must be considered unusually high when compared with those of their co-workers in this country.

Few continental results can be compared with those of British and American workers on account of the absence of comparable standards of haemoglobinometry, but Kühnel (1927) recorded an average value of 13·7 grammes at the end of the first month and 12·2 grammes four weeks before delivery. Jerlov (1929) found that 25·9% of his cases had haemoglobin levels below 70% Autenrieth, a standard equivalent, as far as can be ascertained to 10·4 grammes per cent. At the end of the third month the average level was 12·4 grammes and at term 10·7 grammes. A lower incidence was recorded by Esch (1932) who found that 9·28% of his patients had average haemoglobin levels of 10·3 grammes per cent or less, but the lowest incidence so far recorded was that of Schultz (1933) who found that only 2·6% of his cases had levels below 10·3 grammes per cent. A higher incidence of 31·5% was recorded by Toverud (1935), based on a lower limit of normality of 75% Sahli, but unfortunately the standard used was not stated.

The number of Continental results recorded above is too small to permit of drawing a reliable comparison between the average haemoglobin levels and the incidence of anaemia of pregnancy among Continental women, and those in this country and America. However, these results recorded by workers on the Continent do bear some resemblance to those found in this country although, with one exception the incidence of anaemia is higher than that found in the present investigation. As in this country, the incidence of anaemia among pregnant women on the Continent, as far as can be demonstrated by a small number of investigations, does not approach the high incidence reported by many investigators in America.

RED BLOOD CELLS:

Fortunately, the methods used for the determination of the red cell count are uniform, and do not present the same difficulties when comparisons are attempted. The average initial red cell count for the control-series, as stated in the previous chapter, was 4·39 millions, and the average terminal count was 4·02 millions. The average red cell count for the whole period of pregnancy under observation was 4·2 millions. The lowest limit of normality for the red cell count during pregnancy having been accepted as 3·5 per c.m.m. or less, the incidence of anaemia for the control series was 5%, based on the average of the red cell counts estimated during the pregnancy. These results can now be compared with those of other workers.

Unfortunately, not many studies of the red cell count have been reported by British workers, and for the purposes of comparison, one is confined almost entirely to results of American investigations. Thomson (1904) recorded an average count of 5·0 millions between the second and the 9th month, a higher value than that found in the present series. Galloway (1929 b) reported a very high incidence of anaemia based on the red cell count, viz. 65%, but he calculated this incidence on a lower limit of normality of 4·0 millions, although he found that his patients in the anaemic group had red cell counts well below this figure. The average count for the first trimester was 4·05 millions, and for the third trimester 3·87 millions, average values which do not show a wide variation from those found in the present investigation. Again, Lyon (1929) reported a high incidence of anaemia based on the red cell count, 32·2% of his patients having counts below 3·6 millions during the third trimester, and Bland, Goldstein and First (1930 b.) found that 50% of their series of ward patients had counts below 3·5 millions. The corresponding incidence in private patients was 26%. Their samples in both series referred to various periods of pregnancy. The same workers in a further investigation (1930 a.) found that 47·4% of their patients had red cell counts between 2·6 and 3·5 millions per c.m.m. an incidence of anaemia well beyond that found in the present series. Nalle (1930), however, recorded results more in keeping with those of the present series. The average red cell count during the third month was 4·3 millions, and during the ninth month, 4·2 millions, but the incidence of anaemia was again higher, 22% of his patients having counts below 3·5 millions. Moore (1929, 1930) in his two separate investigations recorded comparable values viz. average red cell counts of 4·1 millions and 4·3 millions. Lower values, however, were reported by Davis and Walker (1934) who found that 43% of their series of treated and untreated cases had counts below 3·5 millions, the average count during the second trimester being 3·53 millions, and during the third trimester 3·45 millions, and Richter et al (1934) found an average count of 3·86 millions at the end of the first trimester and 3·72 millions two weeks before term. An average value of 3·98 millions was found by Irving (1935) in a series of untreated patients examined at various stages of pregnancy. Similar figures were recorded by Corrigan and Strauss (1936) who found a mean red cell count of 3·88 millions during the last four months of pregnancy and by Adair et al (1936), whose mean value during pregnancy was found to be 3·77 millions and Bethell (1936) recorded an average count of 3·94 millions during the last three months of pregnancy. McGeorge (NZ 1935) found a higher average value of 4·79 millions during pregnancy, and in this country Meyer-Wedell (1943) in his series of untreated cases found that the average red cell count between the 27th and 32nd. week was 4·18 millions and between the 33rd. and 38th week, 4·45 millions. None of the cases in this series, however, had haemoglobin values below 70% Haldane (9·6 grammes) and therefore do not compare with an unselected group.

In reviewing the above results, which, with the exception of the last two investigations referred to, have all been recorded by American workers, one arrives at a somewhat similar conclusion to that found in making a comparison of haemoglobin values. While the average red cell counts, whether for the whole period of the pregnancy, or for specific periods, are roughly comparable with the average red cell counts found in the present investigation, they are on the whole somewhat lower, but the striking difference is in the incidence of anaemia, based on the red cell count. This incidence, as recorded by these workers, is considerably higher, and bears no relation to, the incidence of anaemia found in the present series, in which over 70% of cases in the untreated group had average red cell counts of 4·0 millions or more throughout the period of pregnancy under observation. It is again difficult to find any adequate explanation for this discrepancy, but the results in the present series show, by comparison with those of American workers, higher average red cell counts among pregnant women in this country and a very much lower incidence of anaemia based on the red cell count, which by itself, shows no evidence of a serious degree of anaemia among the patients investigated.

An exactly similar conclusion can be drawn from a review of a few of the results recorded by Continental workers. Alder (1934) recorded an average count of 3·6 millions during pregnancy, and Esch (1932) found an average value of 3·7 millions in cases examined between the fifth and ninth months, but in his series the haemoglobin level was below 10·3 grammes in every case. A high incidence of anaemia was reported by Schultz (1933), who found that 50% of his cases showed a drop in the red cell count to 3·0 millions between the sixth and 10th month. However, an exception to this high incidence is to be found in the series examined by Toverud (1935) who found that only 7% of his cases had red cell counts below 4·3millions, and Brindeau and Theodorides (1935) found an average count similar to that of the present series viz. 4·19 millions.

COLOUR INDEX:

The initial average colour index among the control group in the present investigation was 0·94 and the average terminal colour index was 0·93, both values being within the normal range for pregnant women. There is probably no other haematological value, however, which can show such a wide individual variation, and while comparison with the values found by other investigators would be of interest, the colour index value is not one on which definite conclusions should be drawn.

Average colour index values during pregnancy have already been referred to (p. 78 and 79), but a few of these may be repeated to show how they compare with the results of the present investigation. Henderson (1902) reported an average colour index during pregnancy of 0·78 and Blumenthal (1907) found that the range of values extended between 0·7 and 1·2 while the average value recorded by Gram (1920) was 0·9. Results published by other workers, however, correspond on the whole, more closely with those found in the present series, for example, Alder (1924) found an average value of 1·00 with a range between 0·9 and 1·05. Bland, Goldstein and First (1930 b) found a mean value of 0·94, but Strauss and Castle (1930) recorded a lower value of 0·87. Somewhat similar figures were recorded by Nalle (1930) and Moore (1930). Esch's figure of 0·74 referred only to definite anaemic cases, but even among anaemic cases, Schultz (1933) found that the colour index range was between 0·9 and 1·00, i.e. within normal limits, and Richter et al (1934) found that more than half of their cases were within the same range. Also, in the series of untreated anaemic cases studied by Davis and Walker (1934), the average colour index during the second and third trimester was found to be 0·93 and 0·96 respectively. Other results corresponding very closely with the average values found in the present series, have been recorded by Corrigan and Strauss (1936), Bethell (1936), Hellstrom (1937) and Stevenson (1938). Meyer-Wedell (1943) found that the average colour index in his series of untreated cases, was 0·93 between the 27th and 32nd. week and 0·86 between 33rd. and 38th week.

Without commenting again on the wide variation to be expected in the colour index value during pregnancy and on the interpretation and significance of any average value, it may be said that the mean colour index and the range of values found in the present series correspond favourably with those recorded by other investigators. Although it has not been considered of any value to make an assessment of the incidence of anaemia based on the colour index value, there is no evidence, in the results of the present investigation, to show any serious increase in the incidence of the anaemia or lowering of the colour index during pregnancy, beyond minimum values recorded by the majority of other workers.

TREATMENT:

Although, in the treatment of iron-deficiency anaemia of pregnancy with medicinal doses of iron, some writers have reported unsatisfactory results, (Mackay 1931, Esch 1932, Adair et al 1936, Adcock et al 1948), the great majority of workers in this field, have conclusively proved the advantages of this form of treatment, especially in raising the haemoglobin level during pregnancy. (Alder 1924, Jerlov 1929, Strauss and Castle 1932, 1933, 1934, Wills 1935, Fullerton 1936, Toland 1936, Bethell 1935, 1936, 1939, Widdowson 1939, Gottlieb and Strean 1939, Hamilton and Wright 1942, Elliott 1944). There can be little doubt of its beneficial effects. Similarly a large number of writers, including many of those quoted, have reported on the beneficial effects of iron administered in prophylactic doses during pregnancy, although Browne (1944) was of the opinion that the incidence of anaemia of pregnancy in this country did not justify the administration of iron during pregnancy as a routine measure, an opinion supported by the results of the present investigation. This practice, however, has been a fairly general one throughout the country.

In the present investigation, a departure from the usual routine practice has been made by treating patients during pregnancy with prophylactic doses of iron in the form of one of the proprietory preparations which have become popular in antenatal clinics in recent years. The results of this type of treatment show that while the average haemoglobin level of pregnant women can be raised by this means, the increase is so small as to be of little significance, and there is no evidence of any substantial benefit. One might assume that the same, if not better, results would have been achieved by the use of a much cheaper and possibly more effective form of prophylactic iron, e.g. ferrous sulphate tablets. It must be remembered, of course, that constant supervision could not be exercised over the patients in the treated series, although every effort was made to ensure their co-operation, and it is possible that the maximum benefit from the prophylactic iron treatment used, has not been achieved. The same conditions, however, would apply to investigations carried out by other workers, where the usual iron medicaments have been employed. Nevertheless, it is not considered that the form of prophylactic iron treatment adopted in this investigation, has been without value, as a study of the results will show. Although the average increase in the haemoglobin level has been small in the treated group, there has been a definite prophylactic effect in checking the fall in the haemoglobin level during pregnancy, noticeable in the control group. The same trend is evidenced in the red cell counts of the treated cases. Another advantage attributable to this form of treatment, and to which attention has already been drawn, is the fact that it has become a "popular" method of ingesting iron, and in the writer's experience has been more acceptable to many antenatal patients who would otherwise refuse purely medicinal treatment as a routine practice, in the belief that it was unnecessary.

The general effect of the prophylactic administration of iron in the present investigation has been a beneficial one in that it has diminished the tendency to the development of an iron-deficiency anaemia during pregnancy. Also, in view of the comparatively low incidence of anaemia recorded, it is not considered justifiable to institute prophylactic measures as a routine practice in antenatal clinics although the need for the detection of a developing anaemia during pregnancy by a simple routine investigation in every case, is essential. The low incidence of anaemia of pregnancy revealed by the present survey is in striking contrast to the general incidence recorded before and during the war. This improvement is considered to be due to the more enlightened appreciation of dietary requirements during pregnancy and to the more equitable distribution of the essential foods which has taken place in this country during and since the war. As

Davidson and Fullerton (1938) pointed out, the main line to follow in the prophylaxis of iron-deficiency anaemia is to increase the iron-containing foods in the diet. Only when such a diet fails to maintain a normal blood level should medicinal iron be given. This is sound policy both from a nutritional and economic point of view and in this direction lies the possibility of a further reduction in the incidence of iron-deficiency anaemia among pregnant women in this country.

ANAEMIA OF PREGNANCY IN RELATION TO AGE:

It has already been shown in an analysis of results that very little relationship has been found between the age of the patient and the incidence of anaemia. Williamson (1916) stated that the amount of haemoglobin in the blood of normal persons, varied greatly at different ages, and one might assume that the same would apply to the pregnant woman, but it is worth noting that he found the greatest variations were between birth and the sixteenth year, and not during the reproductive period. Davidson et al (1935) found that anaemia of pregnancy was more prevalent during the later child-bearing years, but this increased incidence might also be equally attributable to multiparity. The Committee on Haemoglobin Surveys (1943), however, expressed the opinion that the haemoglobin level during pregnancy varied with the age of the patient, although other workers have found no relationship between age and incidence of anaemia, (Bland, Goldstein and First 1930 a, Mackay 1935, McGeorge 1935, Boycott 1936, Reid and Mackintosh 1937) and, as already stated, the results of the present investigation confirm these findings.

ANAEMIA IN RELATION TO PARITY:

The relationship between anaemia of pregnancy and the number of previous pregnancies has already been discussed (p.46) and as has been pointed out, it is difficult to come to any definite conclusion on this point. A study of the results of the present investigation does not help to clarify matters, as the results tend not only to be inconclusive, but apparently inconsistent. There is no evidence to suggest, however, that there exists any definite relationship between the incidence of anaemia of pregnancy and the number of previous pregnancies, in the series of cases which has been investigated, no greater tendency towards anaemia having been found among those with three children or more, as compared with women in their first or second pregnancies.

EFFECT OF ANAEMIA OF PREGNANCY ON THE MOTHER:

POST-PARTUM HAEMORRHAGE.

The relationship between anaemia of pregnancy and post-partum haemorrhage has been studied by several workers. Galloway (1929 b) in his study of the condition, found that 16 recognised anaemic cases, out of 382 examined, all lost more blood than the average patient, but Bland and Goldstein (1929) who examined 50 anaemic cases during pregnancy, found that only one had excessive post-partum bleeding at delivery. On the other hand, Jerlov (1929) stressed the importance of the prevention of anaemia of pregnancy, because he considered that the pregnancy in these cases always terminated in more or less pronounced bleeding. Exactly the opposite conclusion was arrived at by Adamson and Smith (1932) who found that the incidence of abnormal bleeding after delivery was most marked in the higher haemoglobin group of patients, and Boycott (1936) found no relationship between the anaemia and any other abnormality of pregnancy. Only two of his cases had severe post-partum bleeding. Stevenson (1938) was of a similar opinion. Meyer-Wedell (1943), however, found that, of eight cases of post-partum haemorrhage in his series, five had pernicious anaemia and three a vitamin C. deficiency anaemia, a result which would suggest some connection between the two conditions, but Elliott (1944) did not find evidence of the existence of any such relationship.

It is not possible to arrive at any definite conclusion from the above results, but in the present investigation it appeared that there was a greater tendency towards post-partum haemorrhage among the anaemic group of patients, and one is inclined to the view of Galloway and Meyer-Wedell that some connection exists between the two conditions. What this connection is, might be difficult to explain in every case, but is probably related to the uterine inertia resulting from the general muscular atony brought about by the anaemia.

EFFECT ON THE INCIDENCE OF PYREXIA:

There was found to be a greater incidence of pyrexia during the puerperium, from all causes, among the anaemic, as compared with the non-anaemic group of patients, and this finding is in agreement with the results of most other workers, and might be expected as a result of the general ill health and lowered resistance brought about by the anaemic condition. Mackay (1931, 1935) found that there were 11 infections causing pyrexia in a series of 44 treated patients and 7 infections in 39 control cases, an incidence of 21·6% for the combined series. Mellanby (1933) was of the opinion that anaemia of pregnancy probably increased the susceptibility to puerperal sepsis and Davidson et al (1933) were quite definite on this point. Further evidence in support of this opinion was furnished by Davis and Walker (1934) who recorded results very similar to those of Mackay, viz. an incidence 27·9% in their untreated series and 11·2% in the treated group. These figures and also those of Mackay, show an incidence of pyrexia during the puerperium higher than that found in the present investigation. The importance of this aspect of the anaemia of pregnancy has also been referred to by other workers, (Boycott 1936, Carey-Smallwood 1936, Reid and Mackintosh 1937, Ramsay and Dolphin 1946), and there is evidence to show that anaemia of pregnancy still plays an important part in producing an increased susceptibility towards the development of pyrexia during the puerperium. This factor must always be borne in mind as indicating yet again, the necessity for the early detection and treatment of pregnancy anaemia.

EFFECT ON THE INCIDENCE OF FORCEPS DELIVERY:

The difference in the rate of forceps delivery between the anaemic and non-anaemic groups does not admit of any definite conclusions, although in the combined series of treated and untreated cases, the use of forceps was slightly more frequent in the anaemic group. The absence of any striking difference between the two groups is not surprising in view of the many factors which are brought to bear, in deciding whether or not to terminate delivery by forceps in those cases which presented no definite obstetric abnormality. The forceps rate in the control group, at least, is no higher than that found among normal healthy pregnant women. Galloway (1929 b.) found that only two of his sixteen anaemic cases developed uterine inertia, and although Adamson and Smith (1932) found a higher forceps rate in the lower haemoglobin group of patients, Reid and Mackintosh (1937) found that anaemia of pregnancy appeared to have no influence on abnormal labour as a whole, and there is no evidence in the present series to suggest that anaemia had any significant bearing on the forceps rate.

MATERNAL MORTALITY:

There were no maternal deaths in the series of cases investigated. One death, due to anaemia of pregnancy, has been reported by McLeod and Wilson (1932), but Douglas and McKinlay (1935) reported that maternal mortality is probably unaffected by the presence of anaemia, other than the severe megalocytic forms. Although Adair et al (1936) reported two maternal deaths in an examination of 906 anaemic women over a period of 3 years 8 months, chronic anaemia was only suggested as a probable factor in the cause of death, and one of the cases was found to have had cardiac disease at post-mortem examination. Other large series of cases have been studied without revealing a maternal death due to anaemia (Reid and Mackintosh 1937, Stevenson 1938), and the anaemia of pregnancy, in the form commonly found in this country, cannot be considered a serious factor in maternal mortality.

EFFECT OF ANAEMIA OF PREGNANCY ON THE CHILD:

WEIGHT:

Whether or not the anaemia of pregnancy has any effect on the health of the infant or whether measures taken to combat the anaemia have any beneficial effect on the child, is a question which has been considered by various workers. Mackay (1931) came to the conclusion that there was no evidence that such treatment affected the haemoglobin level of the infant, its susceptibility to infection or its weight, and Adamson and Smith (1932) found that the average weight of the child was slightly higher in anaemic, as compared with non-anaemic mothers. Davis and Walker (1934) found very little difference in the average weight of the child in a treated series of patients as compared with an untreated series, the average weight for the treated series being 7·6 lbs. and for the untreated series 7·4 lbs. Galloway (1929 b.) recorded results similar to those of Adamson and Smith, but even more striking. The average weight of the child in the total of 382 cases studied was 7 lbs. 6 ozs., but the average weight in the 16 cases of definite anaemia in the mother was 8 lbs.

Garry and Stiven (1936) and Reid and Mackintosh (1937) also reported no definite relationship between the anaemia of pregnancy and the weight of the child.

A study of the literature does not reveal that the anaemia of pregnancy has any definite influence on the weight of the infant, and the results of the present investigation support this finding. No significant difference in the average weight of the child was found in the anaemic and non-anaemic groups, nor did the prophylactic administration of iron appear to exert any influence on the child's weight.

STILL-BIRTHS:

No conclusions can be drawn from the results of the present investigation as to the effect of the anaemia of pregnancy or its treatment, on the still-birth rate. Carey-Smallwood (1936) stated that the foetal mortality was said to be higher among anaemic mothers, but one can find little evidence of this. Reid and Mackintosh (1937) found very little difference in the incidence of still-births among anaemic and non-anaemic mothers. Stevenson (1938) found an incidence of 7% in 100 cases of pregnancy anaemia and Meyer-Wedell (1943) recorded an incidence of 6·8% out of a total of 94 pregnant women attending an antenatal clinic, this total including both anaemic and non-anaemic cases. It would appear, however, from a study of the small number of published results that the anaemia of pregnancy has little or no influence on the still-birth rate and the results of the present investigation, although inconclusive, tend to support this opinion.

PREMATURITY:

Nalle (1930) considered that anaemia during pregnancy was likely to predispose to prematurity in the child, and Carey-Smallwood (1936) was of a similar opinion. More definite results were reported by Davis and Walker (1934) who found that 4·9% of the infants were premature in an untreated group as compared with only 1·1% in a treated group of patients, and the incidence recorded by Meyer-Wedell (1943) in his series of 94 cases, was 3·2%. There may, therefore, be some relationship between anaemia of pregnancy and prematurity and iron treatment may have some influence in this respect. As will be seen in the Appendix 14 (4·6%) of the infants in the untreated group were premature (birth-weight under 5 lbs. 8 oz.) whereas the incidence was only 2·6% (4 cases) in the treated group. These figures compare favourably with those of Davis and Walker. However, one cannot draw a definite conclusion from the results found in the present investigation, because, as will be noted, four of the premature infants in the control group were twin babies, while there were no twin pregnancies in the treated group. The question of the relationship between anaemia of pregnancy and prematurity is one which will require further study of a large series of cases.

The results of this investigation raise the question of the importance of iron-deficiency anaemia of pregnancy as a factor to be seriously considered within the broad scope of antenatal care. The prevalence of the condition has only received full recognition in comparatively recent years, and it is possible that the interest aroused, and the subsequent large-scale investigations which have been carried out, may have led to an over-emphasis of its severity. This criticism becomes more evident when one accepts fixed and reasonable criteria for the purpose of comparing the results published by many investigators. In this respect, the main conclusions which can be drawn from the fore-going discussion, are worthy of note. Among those cases which received no form of iron therapy during the pregnancy, the following significant facts emerge.

(1) The average initial and average terminal haemoglobin levels were above 11·0 grammes haemoglobin per 100 cc. of blood, the standard accepted in this investigation as the normal for healthy pregnant women.

(2) The incidence of anaemia, based on the haemoglobin level was 4·67% at the initial examination and 14·00% at

the final examination. The incidence based on the mean of the two examinations during the course of the pregnancy, was only 5%.

(3) The average initial and average terminal red blood cell counts were above 4·0 millions per c.m.m. the normal value accepted in this investigation for healthy pregnant women.

(4) The incidence of anaemia based on the mean of the red blood cells counts during the pregnancy was only 5%.

(5) The average initial and average terminal colour index values were both within the range of normality for healthy pregnant women.

(6) The incidence of anaemia based on the number of blood films showing definite evidence of iron-deficiency anaemia, apart from hypochromasia, was only 2·3%.

These figures do not indicate a serious degree of iron-deficiency anaemia in the series of cases investigated, and the incidence of anaemia based on the haemoglobin level, red blood cell count and blood film, is a considerable improvement on the results of many similar investigations carried out before and during the war. Moreover, there is no reason to believe that this improvement would not be found in other parts of the country, since it is considered to be due to a raising of basic dietary standards necessitated by the war and compulsorily imposed by the rationing system. The improved financial status of the industrial classes may also have played a part. It is felt, therefore, that while it is of importance to carry out a haematological examination in every pregnant woman at an early stage of her pregnancy, in order to detect an existing or developing anaemia, the prevalence of the condition has probably decreased. It is certainly not one of the major disabilities of pregnancy as might be indicated by the results of investigations carried out in this and other countries.

Among those cases which received prophylactic iron, the results have already been discussed (p.145). While the general effect has been a beneficial one in raising, or arresting a fall, in the initial haemoglobin level, the limited extent of the improvement produced, raises another important question, viz. the advisability of instituting prophylactic iron therapy as a routine measure in antenatal clinics. The comparatively low incidence of iron-deficiency anaemia found in the present investigation would appear to indicate that this is a measure which is neither justified nor essential. A good mixed diet made up of the essential iron-containing foods should be sufficient to carry a healthy woman through a normal pregnancy without the development of an iron-deficiency anaemia, apart from the lowering of blood values brought about by the normal physiological processes of parturition. Iron therapy should be confined to those cases in which a routine haematological examination has shown a condition of definite anaemia to exist, or be developing.

The effects of the anaemia of pregnancy on the mother were not striking. There did appear to be some relationship between the anaemia and the incidence of post-partum haemorrhage and pyrexia in the puerperium. Also there was a tendency towards an increased forceps rate among the anaemic cases, but results were not conclusive. There was no relationship between the incidence of anaemia and the age of the patient and the number of previous pregnancies. There were no maternal deaths.

There was no evidence that anaemia in the mother had any effect on the health of the child in relation to prematurity, weight at birth, still birth rate, or the other abnormalities shown in the Appendix.

CHAPTER VIII.

S U M M A R Y.

(1) The classification and the aetiology of the anaemia of pregnancy have been reviewed and discussed in relation to the factors operative in the production of the prevalent type of iron-deficiency anaemia. No single aetiological factor was considered to be responsible for the development of the condition. A combination of factors, combined with the normal effect of blood dilution or hydraemia during pregnancy, would seem to be responsible for this type of anaemia.

(2) Normal haematological standards have been discussed and reasonable normal values established as applicable to the non-pregnant and pregnant state.

(3) The defects of haemoglobinometry have been pointed out and a plea made for the introduction of an internationally standardised instrument, and for the expression of all haemoglobin readings in grammes haemoglobin per 100 cc. of blood.

(4) Criteria of anaemia of pregnancy have been discussed and minimum haematological values for the pregnant state, suggested. These criteria have been applied as a basis for diagnosis in an investigation of a

series of cases.

(5) Four hundred and fifty expectant mothers attending antenatal clinics were examined on two occasions during pregnancy, initially at the beginning of the 4th month and finally at the end of the 8th month. Three hundred of the patients received no form of iron treatment. One hundred and fifty received an iron supplement to the ordinary diet.

(6) Among the 300 patients in the untreated series 4·67% were found to be anaemic on initial examination with a haemoglobin level below 10 grammes per 100 cc. of blood. At the final examination the incidence was 14·00%. The incidence based on the mean of the two readings during the course of the pregnancy, was 5%. The average haemoglobin level at both the initial and final examinations was over 11·00 grammes per 100 cc. of blood.

(7) The incidence of anaemia in the untreated series, based on the mean of the red blood cell counts at the initial and final examinations was 5%. Anaemia was presumed to exist only when the mean red cell count fell below 3·6 millions per c.m.m. The average red blood cell count at both the initial and final examinations was over 4·0 millions per c.m.m.

(8) The average colour index value throughout the

pregnancy in the untreated series was within the range for normal healthy pregnant women.

(9) Of the 300 untreated cases, only 2·3% showed definite evidence of iron-deficiency anaemia on examination of the blood film.

(10) Clinical evidence of anaemia was observed in 20·6% of the untreated cases. This evidence was not considered to be a reliable criterion on which to base a diagnosis of anaemia.

(11) The anaemia was found to be of the iron-deficiency or hypochromic type in every case. No case of the pernicious variety of anaemia was found.

(12) Neither the age of the patient nor the number of previous pregnancies appeared to have any influence on the incidence of the anaemia.

(13) There appeared to be a greater tendency towards post partum haemorrhage among the anaemic patients.

(14) The incidence of the anaemia appeared to be related to the incidence of pyrexia during the puerperium. There was a higher incidence of pyrexia among the anaemic patients.

(15) The use of forceps was slightly more frequent in the anaemic as compared with the non-anaemic patients.

(16) Abnormalities of labour and the puerperium were generally more frequent among the anaemic patients,

(17) Anaemia in the mother appeared to have no effect on the health of the child in relation to prematurity, birth-weight, still-birth rate or other abnormalities of birth.

(18) While the general effect of the prophylactic administration of iron was a beneficial one, the extent of the improvement did not justify its use as a routine measure in antenatal clinics in view of the comparatively low incidence of anaemia found in this investigation. It had no influence on the incidence of abnormalities of labour or the puerperium, nor had it any effect on the health of the child at birth.

(19) The incidence of anaemia found in this investigation showed a considerable improvement on the results of pre-war and war-time investigations. Iron-deficiency anaemia is not considered to be one of the major disabilities of pregnancy at the present time. The incidence of the condition is probably decreasing as a result of the raising of basic dietary standards.

(20) The importance of carrying out a simple haematological examination in every pregnant woman at an early stage of pregnancy has been stressed.

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APPENDIX

C O N T R O L S

CONTROLS

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth.	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
1	26	2	83	77	3.9 mills.	3.8 mills.	1.06	1.01	-	-	Normal	Normal	7 lbs. 8 ozs.
2	23	1	79	72	4.1 "	3.6 "	0.96	1.00	-	-	Normal	Premature. Still Birth	
3	25	1	72	72	3.6 "	3.7 "	1.00	0.97	-	-	Normal	Normal	8. " 0. "
4	29	1	78	71	4.9 "	4.1 "	0.86	0.86	Neg.	-	Normal	Normal	9 " 0 "
5	24	2	84	78	4.6 "	3.8 "	0.91	1.02	-	-	Normal	Normal	7 " 2 "
6	22	1	76	67	4.1 "	4.0 "	0.92	0.83	Neg.	-	Normal	Normal	8 " 8 "
7	31	2	76	80	4.2 "	4.4 "	0.90	0.90	-	-	Normal	Normal	7 " 8 "
8	24	2	78	72	4.0 "	3.6 "	0.97	1.00	-	-	Normal	Premature. Died	
9	33	4	92	83	4.8 "	4.0 "	0.95	1.03	-	-	Forceps	Normal	8 " 0 "
10	27	5	85	85	4.0 "	3.9 "	1.06	1.08	Neg.	+	Normal	Normal	8 " 12 "
11	28	1	89	92	4.1 "	4.9 "	1.08	0.93	-	-	Normal	Normal	8 " 8 "
12	30	2	76	61	3.7 "	3.2 "	1.02	0.95	Pos.	+	Puerperal Pyrexia	Normal	8 " 8 "
13	29	2	90	79	5.0 "	3.7 "	0.90	1.06	-	-	Normal	Normal	7 " 8 "
14	36	1	91	85	4.8 "	4.1 "	0.94	1.03	-	-	Normal	Normal	7 " 8 "
15	31	3	82	78	4.1 "	4.1 "	1.00	0.95	-	-	Normal	Normal	6 " 12 "
16	21	1	88	80	4.1 "	3.7 "	1.07	1.07	-	-	Normal	Normal	6 " 0 "
17	36	3	78	64	4.8 "	4.0 "	0.81	0.80	Pos.	+	Normal	Normal	9 " 0 "
18	32	2	81	79	4.2 "	3.7 "	0.96	1.06	-	-	Normal	Normal	7 " 8 "
19	19	1	88	86	4.8 "	4.1 "	0.91	1.04	-	-	Normal	Normal	6 " 0 "
20	25	2	80	74	4.7 "	4.1 "	0.85	0.90	Neg.	-	Normal	Normal	7 " 0 "
21	25	2	87	79	4.2 "	3.7 "	1.03	1.06	Neg.	+	Caes. Section	Normal	7 " 2 "

No.	Age	Para	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
22	25	1	87	81	5.1 mills.	4.4 mills.	0.85	0.92	Neg.	-	Normal	Normal	8 lbs. 8 ozs
23	37	7	94	84	5.2 "	4.6 "	0.90	0.91	-	-	Normal	Normal	8 " 0 "
24	20	1	88	84	4.6 "	4.0 "	0.95	1.05	-	-	Normal	Normal	7 " 8 "
25	45	4	93	80	5.1 "	4.4 "	0.91	0.90	-	-	Normal	Normal	7 " 0 "
26	30	2	86	75	5.0 "	4.3 "	0.86	0.88	Neg.	-	Normal	Normal	8 " 8 "
27	22	1	83	82	4.6 "	4.3 "	0.90	0.95	-	-	Normal	Normal	7 " 0 "
28	30	1	76	71	3.6 "	3.7 "	1.05	0.95	-	-	Forceps. P.P.H.	Normal	9 " 4 "
29	18	1	80	69	5.5 "	4.3 "	0.78	0.80	Pos.	+	Normal	Normal	7 " 5 "
30	25	2	87	90	4.5 "	5.0 "	0.98	0.90	-	-	Forceps	Normal	8 " 8 "
31	30	5	96	79	5.0 "	3.8 "	0.96	1.03	Neg.	+	Normal	Normal	9 " 0 "
32	38	5	82	84	4.2 "	4.2 "	0.98	1.00	-	-	Normal	Premature. Died	4 " 8 "
33	26	1	70	60	5.0 "	4.1 "	0.70	0.73	Pos.	+	Normal	Normal	8 " 0 "
34	40	3	86	80	4.9 "	4.6 "	0.87	0.86	Neg.	-	Normal	Normal	7 " 12 "
35	26	1	94	86	4.6 "	4.0 "	1.02	1.07	-	-	Normal	Normal	8 " 8 "
36	28	2	100	92	5.0 "	4.3 "	1.00	1.06	-	-	Normal	Premature	5 " 4 "
37	21	1	85	76	4.5 "	3.9 "	0.94	0.97	-	-	Normal	Normal	6 " 8 "
38	22	2	88	76	4.4 "	3.6 "	1.00	1.05	-	-	Normal	Normal	9 " 12 "
39	25	2	90	73	5.0 "	3.5 "	0.90	1.03	-	-	Normal	Normal	9 " 8 "
40	20	1	90	80	4.6 "	4.6 "	0.97	0.86	Neg.	-	Normal	Normal	8 " 0 "
41	23	3	91	83	4.8 "	4.1 "	0.94	1.01	-	-	Normal	Normal	10 " 0 "
42	29	1	88	76	4.3 "	3.6 "	1.03	1.05	-	-	Forceps	Normal	8 " 3 "
43	25	3	88	61	5.1 "	3.3 "	0.86	0.92	Neg.	-	Normal	Normal	9 " 0 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
44	24	2	90	78	4.4 mills.	3.9 mills.	1.02	1.00	-	-	Forceps	Still Birth.Anencephaly	
45	26	2	100	89	5.1 "	4.7 "	0.98	0.94	-	-	Normal	Normal	8 lbs. 8 ozs.
46	43	5	91	85	4.6 "	4.3 "	0.98	0.98	-	-	Normal	Normal	8 " 0 "
47	38	1	91	95	4.4 "	5.1 "	1.03	0.93	-	-	Forceps	Normal	9 " 0 "
48	31	5	97	97	6.2 "	6.1 "	0.93	0.95	-	-	Normal	Normal	7 " 4 "
49	29	5	86	66	5.8 "	4.2 "	0.74	0.78	Pos.	+	Forceps	Hydrocephalic	9 " 8 "
50	25	1	94	93	4.5 "	4.5 "	1.04	1.03	-	-	Normal	Normal	5 " 12 "
51	37	1	90	82	4.3 "	3.8 "	1.04	1.07	-	-	Forceps	Normal	7 " 0 "
52	34	2	90	87	4.5 "	4.2 "	1.00	1.03	-	-	Normal	Normal	8 " 0 "
53	24	2	85	78	4.5 "	3.8 "	0.94	1.02	-	-	Normal	Normal	6 " 0 "
54	31	2	83	83	4.6 "	4.5 "	0.90	0.92	-	-	Normal	Normal	7 " 8 "
55	23	1	77	77	3.7 "	3.7 "	1.04	1.04	Neg.	+	Forceps	Normal	7 " 6 "
56	19	1	94	76	4.6 "	3.6 "	1.02	1.05	-	-	Normal	Normal	7 " 0 "
57	35	3	94	79	5.7 "	4.7 "	0.82	0.84	Pos.	+	Normal	Normal	8 " 1 "
58	23	1	87	80	4.1 "	4.3 "	1.06	.93	-	-	Normal	Normal	7 " 8 "
59	39	2	88	88	4.5 "	4.4 "	0.97	1.00	-	-	Normal	Normal	8 " 8 "
60	37	3	95	71	5.3 "	4.4 "	0.89	0.80	Pos.	+	Post Partum Haem.	Normal	8 " 0 "
61	34	3	75	76	3.5 "	4.0 "	1.06	.95	-	-	Normal	Normal	8 " 4 "
62	27	4	44		3.1 "		0.70		Pos.	+			
63	32	7	79	75	3.7 "	3.6 "	1.06	1.04	-	-	Normal	Normal	9 " 8 "
64	30	4	80	70	4.5 "	3.8 "	0.88	0.92	Neg.	-	Normal	Normal	8 " 0 "
65	36	2	83	85	4.3 "	4.1 "	0.96	1.03	-	-	Normal	Normal	7 " 0 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
66	25	1	87	81	4.3 mills.	4.4 mills.	1.01	0.92	-	-	Normal	Normal	7 lbs. 12 ozs.
67	26	2	89	86	4.9 "	4.2 "	0.90	1.02	-	-	Normal	Normal	10 " 0 "
68	22	1	79	70	4.8 "	4.5 "	0.82	0.77	Pos.	+	Normal	Premature	5 " 0 "
69	22	1	83	79	5.0 "	4.2 "	0.83	0.94	Neg.	+	Normal	Normal	6 " 8 "
70	28	4	85	77	5.0 "	4.5 "	0.85	0.85	Neg.	-	Normal	Normal	8 " 0 "
71	23	2	93	89	5.1 "	4.6 "	0.91	0.96	-	-	Puerperal Pyrexia	Normal	8 " 0 "
72	17	1	92	84	4.8 "	4.0 "	0.95	1.05	-	-	Normal	Normal	7 " 4 "
73	26	2	57	45	4.3 "	3.4 "	0.66	0.66	Pos.	+	Forceps	Normal	6 " 0 "
74	22	1	94	88	5.1 "	4.5 "	0.92	0.97	-	-	Normal	Normal	7 " 0 "
75	39	3	90	86	4.6 "	4.6 "	0.97	0.93	-	-	Normal	Normal	7 " 5 "
76	23	2	94	85	4.6 "	4.1 "	1.02	1.03	-	-	Normal	Normal	5 " 8 "
77	29	2	80	84	4.3 "	4.2 "	0.93	1.00	-	-	Normal	Normal	7 " 12 "
78	23	1	68	55	4.0 "	3.4 "	0.85	0.80	Pos.	+	Puerperal Pyrexia	Normal	7 " 8 "
79	22	1	91	83	5.0 "	4.6 "	0.91	0.90	-	-	Normal	Normal	8 " 0 "
80	44	4	83	81	4.1 "	4.1 "	1.01	0.98	-	-	Normal	Normal	8 " 0 "
81	26	1	80	74	4.4 "	4.1 "	0.90	0.90	-	-	Normal	Normal	7 " 0 "
82	28	1	79	81	4.4 "	4.5 "	0.89	0.90	Neg.	-	Normal	Normal	9 " 0 "
83	30	1	76	69	3.8 "	3.7 "	1.00	0.93	Neg.	-	Normal	Normal	8 " 4 "
84	28	1	83	77	4.4 "	3.6 "	0.94	1.06	-	-	Normal	Normal	7 " 0 "
85	20	2	68	62	4.1 "	3.8 "	0.82	0.81	Pos.	+	Normal	Normal	6 " 0 "
86	28	3	80	76	4.6 "	4.1 "	0.87	0.92	Neg.	-	Normal	Normal	7 " 13 "
87	20	1	86	74	4.1 "	3.6 "	1.04	1.02	-	-	Post Partum Haem.	Normal	7 " 13 "

No.	Age	Para	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
88	31	2	84	74	4.1 mills.	3.5 mills.	1.02	1.05	-	-	Normal	Normal	7 lbs. 0 ozs.
89	24	2	85	83	4.5 "	4.0 "	0.94	1.03	-	-	Normal	Normal	7 " 12 "
90	26	2	92	71	5.0 "	3.9 "	0.92	0.91	-	-	Normal	Normal	7 " 0 "
91	30	3	84	74	4.2 "	3.5 "	1.00	1.05	-	-	Normal	Normal	7 " 8 "
92	26	1	84	78	4.3 "	4.0 "	0.97	0.97	-	-	Normal	Normal	6 " 14 "
93	34	3	90	84	5.0 "	4.4 "	0.90	0.95	-	-	Normal	Normal	10 " 3 "
94	28	5	78	68	4.4 "	4.0 "	0.88	0.85	Pos.	-	Normal	Normal	11 " 0 "
95	21	2	78	70	4.1 "	3.5 "	0.95	1.00	Neg.	+	Normal	Normal	8 " 0 "
96	26	1	88	74	4.5 "	4.0 "	0.97	0.92	-	-	Normal	Normal	8 " 11 "
97	27	2	89	85	4.7 "	4.0 "	0.94	1.06	-	-	Normal	Normal	5 " 11 "
98	21	1	75	67	3.5 "	3.5 "	1.07	0.95	Neg.	-	Normal	Normal	5 " 14 "
99	27	2	86	78	4.6 "	4.2 "	0.93	0.92	-	-	Normal	Normal	9 " 0 "
100	22	2	88	81	4.6 "	4.4 "	0.95	0.92	Neg.	+	Normal	Normal	8 " 0 "
101	33	1	93	93	5.3 "	5.1 "	0.87	0.91	Neg.	-	Forceps	Normal	6 " 11 "
102	37	6	78	69	3.8 "	3.2 "	1.02	1.07	Pos.	+	Normal	Normal	8 " 0 "
103	25	2	77	78	4.0 "	4.1 "	0.96	0.95	-	-	Normal	Premature	5 " 4 "
104	33	3	98	97	5.3 "	5.0 "	0.94	0.97	-	-	Normal	Normal	8 " 8 "
105	29	2	77	77	3.8 "	4.2 "	1.01	0.91	-	-	Normal	Normal	8 " 8 "
106	28	1	89	91	4.5 "	5.0 "	0.98	0.91	-	-	Normal	Still Birth. Sp.Bif.	
107	31	2	86	74	4.6 "	4.1 "	0.93	0.90	-	-	Normal	Normal	8 " 0 "
108	35	2	81	72	4.2 "	4.0 "	0.96	0.90	-	-	Normal	Normal	8 " 0 "
109	31	3	82	76	4.2 "	4.2 "	0.97	0.90	-	-	Normal	Normal	8 " 0 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
110	19	1	80	71	4.2 mills.	3.8 mills.	0.95	0.93	-	-	Normal	Normal	6 lbs. 8 ozs.
111	32	6	93	80	5.1 "	4.4 "	0.91	0.90	-	-	Normal	Normal	7 " 0 "
112	35	2	71	75	3.9 "	3.6 "	0.91	1.04	-	-	Normal	Normal	7 " 0 "
113	27	3	87	69	5.4 "	5.0 "	0.80	0.69	Pos.	+	Post Partum haem.	Normal	7 " 0 "
114	35	3	90	78	5.0 "	4.1 "	0.90	0.95	Neg.	+	Normal	Normal	7 " 10 "
115	23	2	83	82	4.6 "	4.5 "	0.90	0.91	-	-	Normal	Normal	9 " 0 "
116	23	1	68	64	4.2 "	3.8 "	0.80	0.84	Pos.	+	Normal	Normal	7 " 4 "
117	32	2	94	86	5.2 "	4.1 "	0.90	1.04	-	-	Normal	Normal	7 " 0 "
118	34	1	64	52	4.5 "	3.0 "	0.71	0.86	Pos.	+	Normal	Normal	8 " 0 "
119	36	6	76	72	4.1 "	4.0 "	0.92	0.90	-	-	Normal	Normal	6 " 4 "
120	25	1	82	74	4.3 "	3.7 "	0.96	1.00	-	-	Normal	Normal	6 " 8 "
121	25	1	84	84	4.2 "	3.9 "	1.00	1.07	-	-	Normal	Normal	8 " 0 "
122	31	2	84	74	4.1 "	3.3 "	1.02	1.08	-	-	Normal	Normal	7 " 0 "
123	28	1	86	88	4.0 "	4.1 "	1.07	1.07	-	-	Puerperal Pyrexia	Normal	5 " 8 "
124	23	1	87	79	4.1 "	3.7 "	1.06	1.06	-	-	Normal	Normal	9 " 0 "
125	26	2	73	78	3.8 "	4.0 "	0.96	0.97	-	-	Puerperal Pyrexia	Normal	8 " 6 "
126	31	2	64	58	4.7 "	4.5 "	0.68	0.64	Pos.	+	Normal	Normal	5 " 8 "
x127	24	2	60	50	4.0 "	3.2 "	0.75	0.80	POS. Anisocytosis Poikilocytosis	+	Normal	Normal	8 " 14 "
128	30	2	80	77	4.3 "	4.2 "	0.93	0.91	-	-	Normal	Normal	8 " 0 "
129	28	6	79	78	4.3 "	4.5 "	0.91	0.86	Neg.	-	Normal	Normal	9 " 8 "
130	27	1	90	89	5.0 "	4.6 "	0.90	0.96	-	-	Normal	Normal	8 " 2 "
131	30	2	98	81	5.4 "	4.0 "	0.90	1.01	-	-	Normal	Normal	8 " 8 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
132	28	1	76	72	3.5 mills.	3.4 mills.	1.08	1.05	Neg.	+	Normal	Normal	8 lbs. 12 ozs.
133	22	2	72	70	3.3 "	3.6 "	1.09	0.97	Neg.	+	Normal	Normal	7 " 4 "
134	31	3	80	75	3.7 "	3.4 "	1.08	1.09	-	-	Normal	Normal	9 " 4 "
135	37	5	73	58	4.2 "	4.4 "	0.87	0.65	Pos.	+	Normal	Normal	8 " 0 "
136	17	1	89	89	4.8 "	4.8 "	0.92	0.92	-	-	Normal	Normal	8 " 4 "
137	27	2	81	68	3.6 "	3.0 "	1.12	1.13	Neg.	-	Normal	Normal	7 " 0 "
138	36	3	79	85	4.2 "	4.7 "	0.96	0.90	-	-	Normal	Normal	6 " 0 "
139	28	1	79	76	4.5 "	4.2 "	0.87	0.90	Neg.	-	Forceps	Normal	6 " 0 "
140	22	1	78	78	4.3 "	4.0 "	0.90	0.97	-	-	Normal	Normal	8 " 8 "
141	22	1	79	78	3.9 "	3.8 "	1.01	1.02	-	-	Normal	Normal	9 " 8 "
142	35	3	90	83	5.3 "	4.5 "	0.84	0.92	Neg.	-	Normal	Normal	8 " 0 "
143	24	1	87	81	4.0 "	4.1 "	1.08	0.98	-	-	Normal	Normal	8 " 8 "
144	21	2	80	76	4.0 "	3.3 "	1.00	1.15	Neg.	-	Normal	Normal	8 " 8 "
145	29	1	74	67	4.1 "	3.8 "	0.90	0.88	Pos.	+	Normal	Normal	6 " 6 "
146	32	1	81	74	4.5 "	4.2 "	0.90	0.87	Neg.	-	Normal	Normal	8 " 8 "
147	25	5	74	71	4.0 "	3.9 "	0.92	0.91	-	-	Normal	Normal	6 " 8 "
148	27	1	81	86	4.2 "	3.8 "	0.96	1.13	Neg.	-	Post Partum. Haem.	Normal	8 " 8 "
149	21	1	70	70	3.5 "	3.6 "	1.00	0.97	-	-	Normal	Normal	8 " 0 "
150	28	1	87	81	4.7 "	4.2 "	0.92	0.96	-	-	Normal	Normal	6 " 14 "
x 151	27	2	55	49	5.4 "	4.6 "	0.50	0.53	Pos. Microcytosis	+	Post Partum. Haem.	Normal	7 " 0 "
152	22	1	76	80	3.7 "	3.8 "	1.02	1.05	-	-	Normal	Normal	6 " 12 "
153	31	3	74	68	3.5 "	3.1 "	1.05	1.09	Neg.	-	Normal	Normal	8 " 0 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
154	25	1	77	72	3.6 mills.	3.6 mills.	1.06	1.00	-	-	Post Partum Haem.	Normal	7 lbs. 4 ozs.
155	36	2	70	61	3.9 "	3.6 "	0.89	0.84	Pos.	-	Normal	Normal	9 " 8 "
156	36	4	93	81	4.3 "	4.0 "	1.08	1.01	-	-	Normal	Normal	6 " 12 "
157	38	6	69	48	4.3 "	3.6 "	0.80	0.66	Pos.	+	Normal	Normal	7 " 2 "
158	27	2	80	73	3.7 "	3.7 "	1.08	0.98	-	-	Normal	Normal	7 " 0 "
159	28	2	78	75	4.3 "	3.8 "	0.90	0.99	-	-	Normal	Normal	7 " 12 "
160	28	1	82	82	4.1 "	4.2 "	1.00	0.97	-	-	Normal	Normal	6 " 0 "
161	27	3	77	68	4.1 "	3.1 "	0.93	1.09	Neg.	-	Normal	Normal	7 " 8 "
162	25	3	68	61	4.4 "	3.9 "	0.77	0.78	Pos.	+	Normal	Normal	8 " 0 "
163	25	1	73	65	3.4 "	3.6 "	1.07	0.90	Neg.	-	Normal	Normal	6 " 12 "
164	20	1	72	72	3.7 "	3.6 "	0.97	1.00	Neg.	+	Normal	Normal	7 " 8 "
165	24	1	88	76	4.2 "	3.5 "	1.04	1.08	-	-	Normal	Normal	7 " 8 "
166	30	3	88	79	4.8 "	4.3 "	0.91	0.91	-	-	Normal	Normal	8 " 8 "
167	23	2	83	82	4.4 "	4.5 "	0.94	0.90	-	-	Normal	Normal	8 " 8 "
168	20	1	72	66	3.7 "	4.0 "	0.97	0.82	Pos.	+	Normal	Normal	7 " 0 "
169	21	1	91	88	4.4 "	4.1 "	1.03	1.07	-	-	Normal	Normal	9 " 4 "
170	35	5	84	77	4.5 "	4.1 "	0.93	0.93	-	-	Normal	Normal	7 " 8 "
171	24	1	81	75	3.5 "	3.5 "	1.15	1.07	Neg.	-	Normal	Normal	6 " 7 "
172	25	1	84	74	4.5 "	4.0 "	0.93	0.92	-	-	Normal	Normal	9 " 5 "
173	27	1	81	79	4.4 "	4.8 "	0.92	0.82	Neg.	-	Forceps	Normal	8 " 0 "
174	37	2	80	80	5.0 "	4.2 "	0.80	0.95	Neg.	-	Normal	Normal	8 " 0 "
175	23	1	78	78	4.1 "	3.9 "	0.95	1.00	-	-	Normal	Normal	7 " 0 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
176	29	3	88	92	4.1 mills.	4.3 mills.	1.07	1.06	-	-	Normal	Normal (Twins)	5 lbs. 0 ozs. 5 " 1 "
177	39	2	89	85	4.6 "	4.0 "	0.96	1.06	-	-	Normal	Premature	5 " 0 "
178	29	1	75	84	3.6 "	4.1 "	1.04	1.02	-	-	Post Partum Haem.	Normal	7 " 0 "
179	28	3	76	71	3.7 "	3.6 "	1.02	0.98	-	-	Normal	Normal	6 " 8 "
180	22	1	75	75	4.5 "	3.7 "	0.83	1.01	Neg.	+	Normal	Normal	9 " 0 "
181	34	3	70	71	3.5 "	3.5 "	1.00	1.01	-	-	Puerperal Pyrexia	Normal	7 " 4 "
182	39	8	77	72	3.7 "	3.5 "	1.04	1.02	-	-	Normal	Normal	8 " 0 "
183	38	3	81	79	4.2 "	4.0 "	0.96	0.98	-	-	Forceps	Normal	7 " 8 "
184	22	3	77	53	5.5 "	4.2 "	0.70	0.63	Pos.	+	Normal	Normal (Twins)	4 " 2 " 4 " 4 "
185	35	6	86	75	4.6 "	4.1 "	0.93	0.91	-	-	Normal	Normal	8 " 4 "
186	25	2	82	69	4.4 "	3.4 "	0.93	1.01	Pos.	+	Normal	Normal	8 " 2 "
187	35	6	84	75	4.0 "	3.8 "	1.05	0.98	-	-	Normal	Normal	7 " 0 "
188	37	2	82	72	4.0 "	4.1 "	1.02	0.88	Neg.	+	Normal	Normal	7 " 12 "
189	37	6	53	76	3.3 "	4.7 "	0.80	0.80	POS.Microcytosis	+	Post.Partum. Haem.	Normal	9 " 0 "
190	27	3	77	80	3.9 "	4.7 "	0.98	0.85	Neg.	+	Normal	Normal	8 " 0 "
191	40	6	89	91	4.5 "	4.7 "	0.98	0.96	-	-	Puerperal pyrexia	Normal	7 " 0 "
192	31	4	88	73	4.5 "	3.6 "	0.97	1.01	Neg.	+	Normal	Normal	8 " 4 "
193	32	3	70	86	3.5 "	4.5 "	1.00	0.95	-	-	Normal	Normal	9 " 0 "
194	24	1	74	79	3.6 "	4.0 "	1.02	0.98	-	-	Normal	Normal	7 " 6 "
195	30	1	86	79	5.0 "	4.9 "	0.86	0.80	Neg.	-	Normal	Normal	8 " 8 "
196	35	2	70	70	3.6 "	3.5 "	0.97	1.00	-	-			

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth.
197	23	2	73	71	4.0 mills.	3.9 mills.	0.91	0.91	-	-	Normal	Normal	7 lbs. 8 ozs.
198	34	2	88	78	5.2 "	4.4 "	0.85	0.88	Neg.	-	Normal	Normal	6 " 7 "
199	30	2	76	72	3.7 "	4.0 "	1.02	0.90	-	-	Normal	Normal	9 " 0 "
200	36	5	85	73	4.6 "	4.5 "	0.92	0.81	Pos.	+	Normal	Normal	7 " 0 "
201	26	1	83	74	4.5 "	4.1 "	0.92	0.90	-	-	Normal	Normal	8 " 0 "
202	27	1	77	72	4.1 "	4.0 "	0.93	0.90	-	-			
203	33	3	81	76	4.2 "	4.3 "	0.96	0.88	Pos.	-	Normal	Normal (Twins)	6 " 4 " 6 " 12 "
204	27	3	84	79	4.6 "	4.0 "	0.91	0.98	-	-	Normal	Normal	8 " 8 "
205	29	5	70	73	3.7 "	3.6 "	0.94	1.01	-	-	Normal	Normal	8 " 0 "
206	33	2	72	76	3.9 "	4.2 "	0.92	0.90	-	-	Normal	Normal	6 " 0 "
207	21	1	89	89	4.4 "	4.3 "	1.01	1.03	-	-	Normal	Normal	8 " 0 "
208	31	2	81	69	4.3 "	4.3 "	0.94	0.80	Neg.	-	Normal	Normal	8 " 8 "
209	35	4	96	89	5.5 "	4.3 "	0.87	1.03	Neg.	-	Normal	Normal	7 " 0 "
210	22	1	77	71	3.9 "	3.8 "	0.98	0.93	-	-	Normal	Normal	7 " 12 "
211	35	2	74	68	4.6 "	4.1 "	0.80	0.83	Pos.	+	Normal	Normal	8 " 0 "
212	24	2	88	80	4.2 "	3.9 "	1.04	1.02	-	-	Retained Placenta Post Partum Haem.	Normal	9 " 0 "
213	27	3	80	73	4.5 "	4.0 "	0.88	0.91	Neg.	-	Normal	Normal	7 " 0 "
214	17	1	83	79	4.4 "	3.8 "	0.94	1.03	-	-	Normal	Normal	6 " 6 "
215	24	1	77	75	4.2 "	3.9 "	0.91	0.96	-	-	Normal	Normal	7 " 8 "
216	28	3	87	87	4.0 "	4.3 "	1.08	1.01	-	-	Normal	Normal	7 " 8 "
217	21	1	89	78	4.6 "	4.3 "	0.96	0.90	-	-	Normal	Normal	9 " 0 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film.	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth.	Weight of Child at Birth.
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
218	30	5	72	70	4.2 mills.	4.0 mills.	0.85	0.87	Neg.	-	Normal	Normal	6 lbs. 4 ozs
219	25	1	86	81	4.7 "	4.3 "	0.91	0.94	-	-	Normal	Normal	5 " 12 "
220	23	1	78	78	4.1 "	4.3 "	0.95	0.90	-	-	Normal	Normal	6 " 8 "
221	25	3	79	71	4.3 "	3.6 "	0.91	0.98	-	-	Normal	Normal	6 " 4 "
222	34	11	65	61	4.1 "	3.9 "	0.79	0.78	Pos.	+	Post Partum Haem. Puerperal Pyrexia	Still Birth	
223	34	4	78	78	3.9 "	3.8 "	1.00	1.02	-	-	Normal	Normal	6 " 8 "
224	22	1	66	74	4.0 "	4.2 "	0.82	0.88	Neg.	+	Normal	Normal (Twins)	5 " 8 " 6 " 0 "
225	26	1	87	81	4.3 "	3.8 "	1.01	1.06	-	-	Normal	Normal	6 " 0 "
226	34	2	88	80	4.3 "	4.5 "	1.02	0.88	Neg.	-	Normal	Normal	7 " 0 "
227	36	1	87	67	4.3 "	3.5 "	1.01	0.95	Neg.	-	Normal	Normal	7 " 0 "
228	34	2	71	79	3.5 "	3.9 "	1.01	1.01	Pos.	+	Normal	Normal	6 " 0 "
x229	28	2	71	52	3.7 "	3.5 "	0.95	0.74	Pos. Microcytosis	+	Normal	Normal	8 " 8 "
230	27	2	89	69	4.8 "	3.4 "	0.91	1.01	Neg.	-	Normal	Normal	8 " 0 "
231	20	1	96	89	4.9 "	4.3 "	0.97	1.03	-	-	Normal	Normal	9 " 2 "
232	25	1	79	75	4.1 "	3.7 "	0.96	1.01	-	-	Normal	Normal	9 " 0 "
233	25	3	89	70	4.9 "	3.6 "	0.90	0.97	Pos.	-	Normal	Normal	7 " 4 "
234	26	2	77	80	4.5 "	4.0 "	0.85	1.00	Neg.	-	Normal	Normal	9 " 12 "
235	21	3	94	74	4.7 "	3.6 "	1.00	1.02	-	-	Post Partum Haem.	Premature	5 " 0 "
236	24	1	90	85	4.5 "	4.4 "	1.00	0.96	-	-	Normal	Normal	6 " 12 "
237	24	1	89	80	4.5 "	4.2 "	0.98	0.95	-	-	Normal	Normal	8 " 2 "
238	32	2	90	78	4.1 "	3.8 "	1.09	1.02	-	-	Normal	Normal	8 " 8 "
239	29	1	86	72	4.6 "	4.0 "	0.93	0.90	-	-	Normal	Normal	7 " 8 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth.	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
240	35	5	81	72	4.1 mills.	3.8 mills.	0.98	0.94	-	-	Normal	Normal	10 lbs. 8 ozs.
241	27	2	77	74	3.6 "	3.6 "	1.06	1.02	-	-	Normal	Normal	8 " 0 "
242	30	1	78	76	4.4 "	3.8 "	0.88	1.00	Neg.	-	Normal	Normal	8 " 0 "
243	24	1	92	80	4.9 "	4.3 "	0.93	0.93	-	-	Normal	Normal	8 " 8 "
244	32	1	79	71	4.3 "	3.8 "	0.91	0.93	-	-	Normal	Normal	7 " 3 "
245	30	2	87	73	4.5 "	3.7 "	0.98	0.98	-	-	Normal	Normal	8 " 0 "
246	36	8	78	64	4.8 "	3.8 "	0.81	0.84	Pos.	+	Normal	Normal	9 " 0 "
247	41	6	76	72	3.9 "	3.9 "	0.97	0.92	-	-	Normal	Normal	8 " 0 "
248	27	3	82	68	4.0 "	3.8 "	1.02	0.89	Pos.	+	Normal	Normal	7 " 8 "
249	24	2	85	82	4.7 "	4.4 "	0.90	0.93	-	-	Normal	Normal	7 " 8 "
250	21	1	92	84	5.2 "	4.8 "	0.88	0.87	Neg.	-	Normal	Normal	6 " 12 "
251	21	1	77	58	4.3 "	3.6 "	0.89	0.94	Neg.	+	Retained Placenta	Normal	9 " 0 "
x252	31	5	78	73	4.5 "	4.5 "	0.86	0.81	POS. Anisocytosis Poikilocytosis	+	Normal	Normal	8 " 0 "
253	30	4	70	70	3.8 "	3.2 "	0.92	1.09	Neg.	+	Normal	Normal	7 " 8 "
254	22	1	95	88	4.9 "	4.6 "	0.96	0.95	-	-	Normal	Premature	5 " 6 "
255	21	1	89	83	4.5 "	3.9 "	0.98	1.06	-	-	Normal	Normal	8 " 8 "
256	23	1	81	73	4.0 "	4.4 "	1.01	0.82	Pos.	-	Normal	Normal	5 " 8 "
257	38	7	87	82	4.3 "	4.3 "	1.01	0.95	-	-	Normal	Normal	8 " 0 "
258	25	2	88	86	4.2 "	4.3 "	1.04	1.00	-	-	Normal	Normal	7 " 8 "
259	36	3	79	72	3.7 "	3.6 "	1.01	1.00	-	-	Normal	Normal	10 " 10 "
260	21	2	92	87	4.6 "	4.4 "	1.00	0.98	-	-	Normal	Normal	6 " 12 "
261	25	2	89	86	4.4 "	4.2 "	1.01	1.02	-	-	Normal	Normal	6 " 4 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
262	42	10	86	89	4.6 mills.	4.4 mills.	0.93	1.01	-	-	Normal	Normal	9 lbs. 2 ozs.
263	40	4	74	69	4.0 "	3.5 "	0.92	0.98	Pos.	+	Normal	Normal	7 " 8 "
264	39	3	83	78	4.5 "	4.0 "	0.92	0.97	-	-	Normal	Normal	7 " 4 "
265	27	1	81	77	4.0 "	3.8 "	1.01	1.01	-	-	Normal	Normal	9 " 0 "
266	26	4	78	73	4.2 "	3.9 "	0.92	0.93	-	-	Normal	Normal	9 " 4 "
267	23	2	92	80	5.5 "	4.4 "	0.83	0.90	Neg.	-	Normal	Normal	7 " 0 "
268	24	2	82	76	4.1 "	4.0 "	1.00	0.95	-	-	Normal	Normal	8 " 0 "
x269	32	3	49	44	3.0 "	3.1 "	0.81	0.71	POS. Anisocytosis Poikilocytosis Microcytosis	+	Normal	Normal	6 " 6 "
270	24	1	83	75	3.9 "	3.6 "	1.06	1.04	-	-	Normal	Normal	7 " 0 "
271	21	1	82	84	4.5 "	4.1 "	0.91	1.02	-	-	Forceps	Normal	9 " 4 "
272	23	2	83	71	4.0 "	3.5 "	1.03	1.01	-	-	Normal	Normal	5 " 11 "
273	31	7	79	72	4.7 "	4.1 "	0.84	0.87	Pos.	+	Normal	Normal	8 " 0 "
274	23	1	88	80	4.9 "	4.3 "	0.89	0.93	Neg.	-	Normal	Normal	6 " 12 "
275	22	1	84	81	5.4 "	4.9 "	0.77	0.82	Pos.	+	Normal	Normal	7 " 8 "
276	25	1	70	66	3.7 "	3.5 "	0.94	0.94	Neg.	-	Post Partum Haem.	Normal	6 " 0 "
277	27	3	76	71	3.8 "	3.5 "	1.00	1.01	-	-	Normal	Normal	7 " 0 "
278	37	7	85	68	4.6 "	4.1 "	0.92	0.97	Pos.	-	Normal	Normal	8 " 0 "
279	34	7	59	61	4.0 "	3.7 "	0.73	0.82	Pos.	-	Normal	Normal	8 " 8 "
280	23	2	77	71	3.8 "	3.6 "	1.01	0.98	-	-	Normal	Premature	5 " 5 "
281	33	3	87	80	4.9 "	4.5 "	0.88	0.88	Pos.	+	Forceps. Puerperal Pyrexia	Normal	7 " 7 "
282	32	3	95	89	5.2 "	4.6 "	0.91	0.96	-	-	Normal	Normal	7 " 8 "
283	40	3	89	84	4.3 "	4.2 "	1.03	1.00	-	-	Normal	Normal	6 " 8 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth.
284	30	1	104	90	5.6 mills.	5.0 mills.	0.92	0.90	-	-	Normal	Normal	8 lbs. 6 ozs
285	18	1	78	68	4.8 "	4.0 "	0.81	0.85	Pos.	+	Forceps	Normal (Twins)	6 " 3 " 5 " 13 "
286	31	2	92	83	5.0 "	4.3 "	0.92	0.96	-	-	Normal	Normal	6 " 8 "
287	34	2	95	84	5.1 "	4.5 "	0.93	0.93	-	-	Normal	Normal	8 " 0 "
288	38	6	92	87	4.4 "	4.2 "	1.04	1.03	-	-	Normal	Normal	8 " 12 "
289	20	1	89	86	5.4 "	4.8 "	0.82	0.89	Neg.	+	Forceps	Still Born	12 " 0 "
290	37	5	81	64	3.8 "	3.3 "	1.06	0.96	Neg.	-	Normal	Normal	7 " 0 "
291	24	1	93	80	4.6 "	4.0 "	1.01	1.00	-	-	Normal	Normal	6 " 9 "
292	30	4	89	82	4.5 "	4.1 "	0.98	1.00	-	-	Normal	Normal	5 " 12 "
293	28	3	89	78	4.4 "	4.3 "	1.01	0.90	-	-	Normal	Normal	10 " 0 "
294	35	2	86	84	4.5 "	4.6 "	0.95	0.91	-	-	Normal	Normal	6 " 0 "
295	37	2	71	56	3.7 "	3.6 "	0.95	0.77	Pos.	+	Normal	Normal	6 " 14 "
296	19	1	89	78	4.6 "	4.3 "	0.96	0.90	-	-	Normal	Normal	9 " 4 "
x 297	30	4	67	59	3.9 "	3.5 "	0.85	0.84	POS.Microcytosis	+	Normal	Normal	7 " 8 "
298	25	3	87	80	4.2 "	4.0 "	1.03	1.00	-	-	Normal	Normal	7 " 14 "
299	24	1	76	69	4.2 "	3.7 "	0.90	0.93	Neg.	-	Normal	Normal	8 " 5 "
300	24	4	80	83	4.2 "	4.2 "	0.95	0.98	-	-	Normal	Normal	8 " 0 "

x Films showed other evidence of iron-deficiency anaemia besides hypochromasia.
ǂ Case lost sight of after initial examination.

I R O N   T R E A T E D   G R O U P

IRON TREATED GROUP

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth.	Weight of Child at Birth.
1	30	1	88	90	4.3 mills.	4.5 mills.	1.02	1.00	-	-	Post Partum Haem. Puerperal Pyrexia	Normal	9 lbs. 0 ozs.
2	24	1	85	88	4.2 "	4.2 "	1.01	1.04	-	-	Normal	Normal	9 " 4 "
3	23	1	82	85	4.3 "	4.3 "	0.95	0.96	-	-	Normal	Normal	8 " 0 "
4	22	2	81	83	3.9 "	4.3 "	1.03	0.96	-	-	Puerperal Pyrexia	Normal	9 " 0 "
5	36	1	76	72	3.8 "	4.3 "	1.00	0.83	Pos.	+	Normal	Normal	6 " 0 "
6	21	1	89	82	4.9 "	4.1 "	0.90	1.00	-	-	Normal	Normal	6 " 13 "
7	21	1	82	84	4.0 "	4.5 "	1.02	0.93	-	-	Normal	Normal	6 " 8 "
8	30	2	74	74	3.9 "	4.5 "	0.94	0.82	Pos.	+	Normal	Normal	7 " 8 "
9	34	5	75	75	3.6 "	3.7 "	1.04	1.01	Pos.	+	Normal	Normal	6 " 0 "
10	25	1	84	84	4.1 "	4.2 "	1.02	1.00	-	-	Post Partum Haem.	Still Birth	
11	31	7	79	79	3.8 "	3.7 "	1.03	1.06	Neg.	+	Normal	Normal	6 " 8 "
12	39	4	80	68	3.5 "	3.3 "	1.14	1.03	Neg.	-	Normal	Normal	9 " 0 "
13	22	1	77	77	3.8 "	4.1 "	1.01	0.93	-	-	Normal	Normal	7 " 0 "
x14	29	5	65	73	3.5 "	4.5 "	0.92	0.81	POS. Microcytosis	+	Normal	Normal	8 " 8 "
15	22	1	66	66	3.2 "	3.2 "	1.03	1.03	Neg.	-	Forceps. Post Partum Haem. Puerperal Pyrexia	Normal	7 " 8 "
16	32	2	70	83	4.0 "	4.5 "	0.87	0.92	Neg.	+	Normal	Normal	7 " 0 "
17	33	2	89	94	5.2 "	4.8 "	0.85	0.97	Neg.	+	Normal	Normal	8 " 0 "
18	21	1	96	87	5.5 "	5.0 "	0.87	0.87	Neg.	+	Post Partum Haem.	Normal	9 " 0 "
19	22	1	87	87	4.0 "	4.6 "	1.08	0.94	-	-	Normal	Normal	7 " 8 "
20	30	3	92	84	4.3 "	4.0 "	1.06	1.05	-	-	Normal	Normal	7 " 0 "
21	20	1	88	78	4.5 "	3.8 "	0.97	1.02	-	-	Normal	Normal	8 " 4 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
22	24	1	80	83	4.2 mills.	4.6 mills.	0.95	0.90	-	-	Normal	Normal	6 lbs. 0 ozs
23	42	3	89	89	4.7 "	4.6 "	0.94	0.96	-	-	Normal	Normal	9 " 0 "
24	28	2	71	71	4.8 "	4.4 "	0.73	0.80	Pos.	+	Normal	Normal	5 " 15 "
25	23	1	74	67	3.6 "	3.9 "	1.02	0.85	Neg.	-	Forceps	Normal	7 " 15 "
26	41	5	82	76	4.5 "	3.8 "	0.91	1.00	-	-	Normal	Normal	9 " 0 "
27	20	1	85	85	4.2 "	4.6 "	1.01	0.92	-	-	Caes. Section	Normal	7 " 0 "
28	35	2	78	78	4.0 "	4.5 "	0.97	0.86	Neg.	+	Normal	Normal	7 " 5 "
29	29	1	90	80	4.9 "	3.8 "	0.91	1.05	-	-	Normal	Normal	8 " 0 "
30	34	3	99	99	4.7 "	4.9 "	1.05	1.01	-	-	Normal	Normal	9 " 8 "
31	24	1	89	90	4.1 "	4.5 "	1.08	1.00	-	-	Normal	Normal	6 " 10 "
32	27	2	87	73	4.9 "	4.5 "	0.88	0.81	Neg.	-	Normal	Normal	8 " 0 "
33	22	1	76	75	3.5 "	3.7 "	1.08	1.01	-	-	Normal	Normal	7 " 0 "
34	22	1	83	85	3.9 "	4.1 "	1.06	1.03	-	-	Normal	Premature	4 " 8 "
35	34	3	74	78	4.5 "	4.0 "	0.82	0.97	Neg.	-	Normal	Normal	9 " 0 "
x36	21	1	70	59	4.5 "	3.8 "	0.77	0.77	Pos. Anisocytosis Poikilocytosis Microcytosis	+	Normal	Premature	4 " 12 "
37	22	1	87	87	4.0 "	4.1 "	1.08	1.06	-	-	Normal	Normal	7 " 12 "
38	36	4	74	64	4.2 "	3.5 "	0.88	0.91	Neg.	-	Normal	Normal	6 " 8 "
39	31	2	94	80	4.5 "	4.0 "	1.04	1.00	-	-	Normal	Normal	7 " 15 "
40	27	3	79	81	4.5 "	4.0 "	0.87	1.01	Neg.	-	Normal	Normal	7 " 8 "
41	34	2	80	76	3.9 "	3.7 "	1.02	1.02	-	-	Normal	Normal	7 " 0 "
42	23	1	79	68	3.7 "	4.1 "	1.06	0.82	Neg.	-	Normal	Normal	7 " 13 "
43	37	2	80	77	4.8 "	4.4 "	0.83	0.89	Neg.	+	Normal	Normal	7 " 8 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
44	33	3	58	52	3.2 mills.	3.2 mills.	0.90	0.81	Pos.	+	Normal	Normal	7 lbs. 3 ozs
45	19	1	96	88	4.7 "	4.6 "	1.02	0.95	-	-	Normal	Normal	7 " 8 "
46	20	1	77	86	4.2 "	4.2 "	0.91	1.02	-	-	Normal	Normal	9 " 12 "
47	26	2	77	64	4.1 "	3.2 "	0.93	1.00	Neg.	+	Normal	Normal	8 " 4 "
48	41	5	69	70	3.5 "	3.8 "	0.98	0.92	Neg.	-	Normal	Normal	7 " 8 "
49	25	2	86	85	4.6 "	4.7 "	0.93	0.90	-	-	Normal	Normal	7 " 8 "
50	21	1	85	85	5.0 "	4.5 "	0.85	0.94	Neg.	-	Normal	Normal	5 " 12 "
51	22	1	87	89	4.2 "	4.8 "	1.03	0.92	-	-	Normal	Normal	6 " 4 "
52	27	2	82	75	3.8 "	3.7 "	1.07	1.01	-	-	Puerperal Pyrexia	Normal	7 " 8 "
53	34	3	73	72	3.8 "	3.6 "	0.96	1.00	-	-	Normal	Normal	7 " 8 "
54	20	1	89	81	4.9 "	4.4 "	0.90	0.92	-	-	Normal	Normal	7 " 0 "
55	35	3	77	53	5.5 "	4.5 "	0.70	0.58	Pos.	+	Normal	Normal	5 " 14 "
56	33	2	81	69	5.4 "	4.5 "	0.75	0.76	Pos.	-	Post Partum Haem.	Normal	8 " 8 "
57	24	1	76	79	4.1 "	4.1 "	0.92	0.96	-	-	Normal	Normal	7 " 8 "
58	27	2	87	72	4.0 "	3.8 "	1.08	0.94	-	-	Normal	Normal	8 " 0 "
59	20	1	84	84	3.9 "	3.8 "	1.07	1.10	Neg.	-	Normal	Normal	7 " 12 "
60	37	7	89	88	5.5 "	4.8 "	0.80	0.91	Neg.	+	Normal	Normal	6 " 0 "
61	27	2	87	93	4.7 "	4.8 "	0.92	0.96	-	-	Normal	Normal	8 " 8 "
62	37	3	83	85	4.5 "	4.0 "	0.92	1.06	-	-	Normal	Normal	8 " 12 "
63	23	1	94	79	4.8 "	3.8 "	0.97	1.03	-	-	Normal	Normal	6 " 0 "
64	30	6	91	89	5.6 "	4.3 "	0.81	1.03	Pos.	+	Normal	Normal	8 " 0 "
65	24	1	79	83	4.4 "	4.8 "	0.89	0.86	Neg.	-	Forceps	Normal	6 " 8 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th. Month	Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
66	30	2	90	74	5.0 mills.	4.0 mills.	0.90	0.92	-	-	Normal	Normal	9 lbs. 0 ozs
67	35	1	86	90	4.0 "	4.5 "	1.07	1.00	-	-	Normal	Normal	7 " 3 "
68	35	2	79	90	3.9 "	4.5 "	1.01	1.00	-	-	Normal	Normal	8 " 12 "
69	23	1	95	95	5.2 "	5.2 "	0.91	0.91	-	-	Normal	Normal	8 " 4 "
70	32	2	87	89	4.0 "	4.3 "	1.08	1.03	-	-	Normal	Normal	7 " 8 "
71	29	4	58	58	4.5 "	4.1 "	0.64	0.70	Pos.	+	Normal	Premature	5 " 1 "
72	20	1	75	84	4.5 "	4.4 "	0.83	0.95	Neg.	-	Normal	Normal	7 " 0 "
73	32	3	69	76	3.6 "	3.9 "	0.95	0.97	Pos.	+	Normal	Normal	7 " 0 "
74	38	4	84	84	5.0 "	4.4 "	0.84	0.95	Neg.	-	Normal	Normal	9 " 8 "
75	34	3	82	87	4.0 "	4.7 "	1.02	0.92	-	-	Normal	Normal	8 " 12 "
76	24	1	79	71	3.7 "	3.9 "	1.06	0.91	-	-	Normal	Normal	8 " 0 "
77	22	1	79	79	4.3 "	4.3 "	0.91	0.91	-	-	Normal	Normal	6 " 12 "
78	21	3	87	87	4.0 "	4.3 "	1.08	1.01	-	-	Normal	Normal	7 " 14 "
79	21	1	81	91	3.9 "	4.5 "	1.03	1.01	-	-	Normal	Normal	6 " 12 "
80	25	1	90	94	4.9 "	5.2 "	0.91	0.90	-	-	Normal	Normal	8 " 0 "
81	28	3	94	94	4.7 "	4.7 "	1.00	1.00	-	-	Normal	Normal	9 " 0 "
82	26	5	76	80	5.4 "	5.4 "	0.70	0.74	Pos.	+	Normal	Normal	6 " 8 "
83	38	3	85	85	4.5 "	4.2 "	0.94	1.01	-	-	Normal	Normal	8 " 0 "
84	22	2	100	85	5.2 "	4.2 "	0.96	1.01	-	-	Normal	Normal	5 " 14 "
85	32	3	87	72	4.2 "	4.3 "	1.03	0.83	Pos.	+	Normal	Normal	7 " 0 "
86	32	3	94	94	5.0 "	4.8 "	0.94	0.97	-	-	Normal	Normal	7 " 0 "
87	20	2	80	90	4.5 "	4.6 "	0.88	0.97	Neg.	-	Normal	Normal	8 " 0 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
88	33	2	83	91	4.5 mills.	4.7 mills.	0.92	0.96	-	-	Normal	Normal	6 lbs. 4 ozs
89	31	2	95	81	5.3 "	4.6 "	0.89	0.88	Neg.	-	Normal	Normal	7 " 2 "
90	20	1	75	81	4.3 "	4.0 "	0.87	1.01	Neg.	+	Normal	Normal	6 " 8 "
91	28	1	77	79	3.6 "	3.7 "	1.06	1.06	-	-	Forceps	Normal	9 " 8 "
92	22	2	75	75	4.1 "	4.0 "	0.91	0.93	-	-	Normal	Normal	9 " 12 "
93	23	1	94	99	4.6 "	5.0 "	1.00	0.99	-	-	Normal	Normal	8 " 0 "
94	28	2	84	75	4.4 "	3.6 "	0.95	1.04	-	-	Normal	Normal	6 " 8 "
95	20	1	79	84	4.7 "	4.4 "	0.84	0.95	Neg.	+	Normal	Normal	7 " 12 "
x96	36	3	89	70	5.4 "	4.3 "	0.82	0.81	EOS.Microcytosis	+	Normal	Normal	7 " 0 "
97	26	4	87	89	4.0 "	4.1 "	1.08	1.08	-	-	Normal	Normal	8 " 0 "
98	25	1	75	77	4.0 "	3.8 "	0.93	1.01	-	-	Normal	Normal	7 " 0 "
99	34	2	80	80	4.4 "	4.4 "	0.90	0.90	-	-	Normal	Normal	8 " 4 "
100	23	2	81	84	4.2 "	4.2 "	0.96	1.00	-	-	Normal	Normal	8 " 2 "
101	31	2	85	88	4.4 "	4.4 "	0.96	1.00	-	-	Normal	Normal	7 " 4 "
102	39	1	72	79	3.9 "	3.9 "	0.92	1.01	-	-	Forceps	Normal	7 " 0 "
103	32	2	73	85	3.8 "	4.5 "	0.96	0.94	-	-	Normal	Premature	5 " 0 "
104	28	4	77	86	4.2 "	4.3 "	0.91	1.00	-	-	Normal	Still Birth. Hydrocephaly	
105	40	5	70	80	3.5 "	4.2 "	1.00	0.95	-	-	Normal	Normal	8 " 0 "
106	24	1	91	84	5.1 "	4.4 "	0.89	0.95	Neg.	-	Normal	Normal	8 " 4 "
107	28	2	91	93	5.0 "	4.8 "	0.91	0.96	-	-	Normal	Normal	8 " 0 "
108	26	2	82	82	3.9 "	4.0 "	1.05	1.02	-	-	Normal	Normal	7 " 12 "
109	37	6	91	91	4.8 "	4.7 "	0.94	0.96	-	-	Normal	Normal	7 " 4 "

No.	Age	Para.	Hoemoglobin % Beginning of 4th. Month	Hoemoglobin % End of 8th. Month	Red Blood Cells per c.m.m. Beginning of 4th. Month	Red Blood Cells per c.m.m. End of 8th. Month	Colour Index Beginning of 4th. Month	Colour Index End of 8th Month.	Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
110	38	3	80	80	4.0 mills.	3.7 mills.	1.00	1.02	-	-	Normal	Normal	8 lbs. 0 oz
111	28	2	83	84	4.1 "	4.2 "	1.01	1.00	-	-	Normal	Normal	7 " 0 "
112	23	1	83	86	4.9 "	4.2 "	0.84	1.02	Neg.	+	Post Partum Haem.	Normal	8 " 4 "
113	24	1	86	88	4.3. "	4.2 "	1.00	1.04	-	-	Normal	Normal	7 " 0 "
114	26	2	78	74	4.2 "	4.2 "	0.92	0.88	Pos.	+	Normal	Normal	7 " 12 "
115	25	3	81	82	4.2 "	4.5 "	0.96	0.91	-	-	Normal	Normal	7 " 4 "
116	19	1	71	81	4.4 "	4.1 "	0.80	0.98	Neg.	+			
117	27	1	85	90	4.2 "	4.6 "	1.01	0.97	-	-	Normal	Normal	9 " 0 "
x118	38	4	45	45	3.8 "	4.1 "	0.59	0.54	Pos. Anisocytosis Poikilocytosis Microcytosis	+	Normal	Normal	9 " 4 "
119	24	1	83	83	4.0 "	4.1 "	1.03	1.01	-	-	Normal	Normal	8 " 12 "
120	31	5	89	87	4.4 "	4.2 "	1.01	1.03	-	-	Post partum Haem.	Normal	6 " 8 "
121	28	1	87	92	4.8 "	4.7 "	0.90	0.97	-	-	Normal	Normal	6 " 14 "
122	29	1	84	87	4.5 "	4.5 "	0.93	0.96	-	-	Normal	Normal	6 " 14 "
123	32	3	82	89	4.0 "	4.2 "	1.02	1.05	-	-	Normal	Normal	9 " 0 "
124	32	3	75	81	4.0 "	3.9 "	0.93	1.03	-	-	Normal	Normal	7 " 8 "
125	31	5	77	69	4.6 "	4.0 "	0.83	0.86	Pos.	+	Normal	Normal	6 " 13 "
126	20	1	93	93	4.3 "	4.3 "	1.08	1.08	-	-	Normal	Normal	7 " 0 "
127	34	3	91	94	4.5 "	4.7 "	1.01	1.00	-	-	Normal	Normal	6 " 8 "
128	39	9	84	87	4.1 "	4.2 "	1.02	1.03	-	-	Normal	Normal	7 " 8 "
129	25	3	74	74	4.1 "	3.9 "	0.90	0.94	-	-	Normal	Normal	7 " 0 "
130	32	2	69	73	5.3 "	4.5 "	0.65	0.80	Pos.	-	Normal	Normal	8 " 0 "

No.	Age	Para.	Hoemoglobin %		Red Blood Cells per c.m.m.		Colour Index		Blood Film	Clinical Evidence of Anaemia	Labour and Puerperium	Condition of Child at Birth	Weight of Child at Birth
			Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month	Beginning of 4th. Month	End of 8th. Month					
131	32	1	72	64	3.6 mills.	3.2 mills.	1.00	1.00	Pos.	-	Forceps	Normal	7 lbs. 14 ozs.
132	26	3	84	87	4.5 "	4.4 "	0.93	0.99	-	-	Normal	Normal	7 " 8 "
133	22	1	77	87	4.0 "	4.3 "	0.96	1.01	Neg.	+	Normal	Normal	7 " 8 "
134	39	5	79	81	4.2 "	3.9 "	0.94	1.03	-	-			
135	29	3	75	80	4.1 "	4.0 "	0.91	1.00	-	-	Normal	Normal	7 " 0 "
136	41	4	81	77	4.3 "	4.2 "	0.94	0.91	Pos.	+	Normal	Normal	7 " 0 "
137	24	1	80	84	4.4 "	4.4 "	0.90	0.95	-	-	Normal	Normal	5 " 15 "
138	27	1	74	74	3.6 "	4.0 "	1.02	0.92	-	-	Normal	Normal	8 " 14 "
139	22	1	72	73	4.0 "	3.9 "	0.90	0.93	-	-	Normal	Puerperal Pyrexia	7 " 0 "
140	30	2	73	84	3.8 "	4.1 "	0.96	1.02	-	-	Normal	Normal	7 " 10 "
141	23	1	74	65	3.8 "	3.5 "	0.97	0.92	Pos.	-	Normal	Normal	8 " 8 "
142	26	4	74	79	3.7 "	4.1 "	1.00	0.96	Neg.	+	Normal	Normal	7 " 0 "
143	32	2	81	87	4.2 "	4.2 "	0.96	1.03	-	-	Normal	Normal	9 " 3 "
144	42	6	73	84	3.9 "	4.3 "	0.93	0.97	-	-	Normal	Normal	7 " 4 "
145	23	1	80	85	4.3 "	4.5 "	0.93	0.94	-	-	Normal	Normal	6 " 4 "
146	25	1	78	81	4.2 "	4.2 "	0.92	0.96	-	-	Normal	Normal	6 " 14 "
147	25	2	94	88	5.0 "	4.5 "	0.94	0.97	-	-	Normal	Normal	9 " 4 "
148	26	2	75	83	4.1 "	4.3 "	0.91	0.96	-	-	Normal	Normal	7 " 0 "
149	29	3	71	75	3.4 "	3.9 "	1.04	0.96	-	-	Normal	Normal	9 " 0 "
150	44	2	85	85	4.3 "	4.3 "	0.98	0.98	-	-			

x Films showed other evidence of iron-deficiency anaemia besides hypochromasia