Rheumatic heart disease complicating pregnancy

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RHEUMATIC HEART DISEASE
COMPLICATING PREGNANCY

by

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INTRODUCTION

The late Sir James MacKenzie, (67) the great Scotch Cardiologist and Physician, who was keenly interested in the behavior of the heart during gestation, opened his book with these words: "There are few subjects in medicine of which an accurate knowledge is urgently required than a woman's fitness for childbearing."

The association of rheumatic heart disease and pregnancy is a problem of vital importance when it is estimated that each year in the United States about 1,000 women die from heart disease in pregnancy, labor and the puerperium. (52) Murray (72) states that heart disease in pregnancy forms one of the trinity of causes of extremely high maternal mortality; the other two being toxemia and infection. The immediate and remote prognosis is frequently uncertain; therefore, the course of the cardiac patient, who become pregnant, should be guided by an intelligently planned cooperation not only of the obstetrician but also the internist.

Within the last few years there has developed a closer cooperation between the obstetrician and the cardiologist; and many of the larger obstetrical clinics in the East have established special prenatal clinics to deal specifically with the cardiac patient in pregnancy.
A discussion of this problem is considered very necessary in order that one may show the effect of pregnancy on heart disease. A brief summary of rheumatic fever will be presented as it is the most important etiological cause of heart disease in the child-bearing age. Next, a brief statistical analysis of the incidence of this lesion in pregnancy will be reported. The puzzling problem of diagnosis of heart disease will be presented also. It has been found that a scheme of classification of heart disease is very useful in arriving at a prognosis in pregnancy; therefore, an attempt will be made to review the various methods that have been suggested by several authorities in classifying this condition and to show how it may apply to the prognosis in individual cases falling into certain classifications. Also a review of the complications of heart disease in pregnancy and mortality statistics, as well as opinions of many outstanding writers as to the management of pregnancy, labor and puerperium in these patients.

Even though there has been a tendency for authors to group patients into certain functional or anatomical classifications and thereby determine their possibilities for a successful and fruitful pregnancy or the reverse; nevertheless, most authors are in agreement on the subject that there is a great deal of uncertainty attached to each
case. Therefore, it must be remembered that each case of heart disease in pregnancy must be studied individually, as the person presenting the signs and symptoms of this malady is an individual and no two individuals are exactly alike in every respect.

The subject chosen for this paper is rheumatic heart disease, since the greatest majority of cases of heart disease that are found in the child-bearing period belong to this group. Other types of heart disease as congenital heart, the heart of thyrotoxicosis, syphilitic heart disease have been found, but they are in the minority. In this paper, as well as in the majority of the literature, unless it is otherwise stated "heart disease in pregnancy" refers to the rheumatic form of heart disease.

At this point an attempt will be made to give a short resume of the work a few men who have greatly influenced the development of the subject. Also the historical development of various aspects of the subject will be discussed under the arbitrary headings.

The first outstanding writing on the subject was by Augustus MacDonald (65) of Edinburgh in 1878, who wrote a very gloomy monograph entitled "The Bearings of Chronic Disease of the Heart Upon Pregnancy, Parturition and Childbed" in which he reported in detail the histories of 31 pregnant women with far advanced cardiac disease,
19 of whom died (61%) mortality. For 40 years there was little change in the picture. From 1873 to 1915 almost all of the cases of pregnancy with heart disease, collected from the Boston Lying-In Hospital records and published case reports, entered the hospital in decompensation and 46% of them died.

After MacDonald, there were no outstanding contributions to the subject of the pregnant cardiac patient until Sir James MacKenzie (67) published his work on "Heart Disease and Pregnancy" in 1921, based on 35 years of study. MacKenzie complained that the medical knowledge of the heart was in general poorly understood and taught. The main object of his book was "to direct the attention of obstetrical physicians to newer knowledge." He hoped that this subject would be "taken up and pursued by those who have greater facilities than I possess."

In 1922, Pardee (89) was the individual who first recognized the importance of classifying patients based on functional capacity rather than on anatomical defects, and thereby instituted a standard useful in treatment and prognosis of cardials who are pregnant.

In the last 20 years, much literature has been written on various phases of the subject of heart disease as a complication of pregnancy. The treatment phase of this subject as well as the physiology of the normal pregnant
heart has been receiving special emphasis. I hope to review as much of this vast amount of literature as is possible.
CIRCULATORY CHANGES IN THE NORMAL PREGNANT WOMAN

Today, our knowledge of the behavior of the normal heart during pregnancy is more accurate than formerly, due to methods of diagnosis such as the x-ray and the electrocardiograph. It is believed that considerable changes occur during pregnancy, but owing to the lack of specific knowledge about antenatal conditions, there has been a controversy among writers on this subject.

It is rather important, therefore, before entering upon a study of various cardiac complications of pregnancy that one should learn about various physiological changes which take place in a normal pregnant woman.

In a careful study of 239 perfectly normal pregnant women, Gammeltoft (34) found in 39 or 16.3%, circulatory signs and symptoms to suggest heart disease. Many of these patients, 24 of the 39, complained of dyspnea during the last months of pregnancy. The urine contained albumin in 19 instances. Edema was present in 34 cases. Physical examinations showed enlargement of the pulmonic second sound, and venous pulsations in the neck. The chief complaints of these patients were cardiac pains and distress, headache and shortness of breath. Digitalis or rest in bed had no effect upon either the signs
or symptoms of these women. When they went into labor, it was impossible, even by very careful observation, to demonstrate aggravation of any symptoms of these women during the whole process and, when they were discharged two weeks post partum, all the abnormal findings had disappeared. The murmurs were not audible on the day after delivery.

This study of Gammeltoft's indicates that the handling of heart disease in pregnancy is not merely a management of the 1/2, (52) who have a genuinely damaged heart, but is a more comprehensive undertaking in whom certain gestational changes simulate heart disease. The latter type of case has been called "Functional" or "Gestatory" heart disturbance.

The real problem is to distinguish this from true heart disease. Since these "Gestatory" heart disturbances depend on the physiological alterations which occur in every pregnancy, the most rational approach is, to first consider the normal heart in pregnancy and the changes which it undergoes.

The most important functional change which takes place in the heart during pregnancy is the increase in cardiac output. By cardiac output is meant the amount of blood expelled by the left ventricle into the aorta in a limited amount of time, a quantity which is expressed
in terms of litres per minute. Most methods for determining the cardiac output are based on the principle that the amount of foreign gas absorbed by the blood in the passage through the lungs is determined by the pulmonary blood flow. Hence, by determining the rate of absorption of such a gas, which the subject breathes in and then exhales after a stated interval, one can calculate the amount of blood passing through the lungs in a unit time, and that is the cardiac output.

It is generally assumed that the cardiac output is increased during pregnancy. Two observations support this assumption, namely: (1) women with apparently normal hearts may, during pregnancy, show signs and symptoms of cardiac distress, and (2) cardiac distress from any cause may be promptly relieved by delivery.

It is quite unanimously admitted that pregnancy and labor increase the work of the heart, there is little agreement on the nature of the mechanism involved. (10) (51) (73) A great deal of information is available on the subject but it is rather often contradictory.

Gammeltoft (34) in 1926, studied the cardiac output in five women during a number of months before delivery. He found that the cardiac output rises progressively during pregnancy to a maximum reached at the 34th week, the increases ranging between 40-60% of the pregravid output.
In 1926, Stander, Duncan and Sisson (96) reported studies on the heart output in non-pregnant and pregnant dogs. Their results showed that during pregnancy the minute volume of the heart is markedly increased, being one-third to one-half greater than before; and that following labor, the minute volume gradually falls and regains its non-pregnant value within two to three weeks.

In 1926, Marshall and Grollman (69) introduced the acetylene method for determining cardiac output in man. This method has been used since rather than the nitrous oxide method used by previous workers as Gammeltoft.

Stander and Cadden, (95) using the acetylene method, in 1932 reported determinations of cardiac output at various stages of pregnancy and the puerperium in 13 normal women and in four women with heart disease or nephritis. On the basis of their observations, these authors concluded that the heart output in normal pregnant women steadily increases as pregnancy progresses from the third month to full term. Two and two-tenths litres per square meter per minute was determined as the normal level for heart output. The cardiac output begins to rise above the normal non-pregnant value at the fourth month of pregnancy, gradually increases until at term it is 4.5 litres, as compared with the normal of 2.2 litres per square meter. The heart output falls immediately following labor, and
regains normal level at the end of the third week of puerperium.

It is incident that such a marked increase in minute volume of the heart during gestation must be of utmost importance in patients suffering from cardiac disturbance. The additional work placed on the heart as a result of pregnancy and labor may be more of a strain than the diseased heart can stand, and the outcome often is heart failure resulting in death.

Many factors have been considered in the explanation of how cardiac work is increased during pregnancy. Important among them are the following: (1) general increase in body weight; (2) changes in respiratory volume, especially vital capacity; (3) increase in metabolism; and (4) increase in blood volume.

Conflicting reports appear in the literature as to the effect of pregnancy on vital capacity. MacKenzie (65) in 1904, indicated by actual measurements that what the lungs lose in the vertical, they gain in the lateral excursion.

In 1930, Alward (1) published numerous readings on 60 cases showing a definite tendency for vital capacity to decrease about 20% below the estimated normal just before labor. Immediately after delivery, there was further decrease to 28% below normal. Then the vital capacity
returned to within 5% of the normal.

Some modern authors, as Rowe, Alcot and Mortimer (39) examined a large number of women routinely through pregnancy and found an upward trend of the vital capacity, amounting to 10.6% per week.

Burwell (10) also found the vital capacity does not diminish during pregnancy. He did not explain his reasons for his opinion. He did point out that in patients in whom there is reason for heart failure to develop, a definite decrease in vital capacity may be a warning of approaching decompensation.

Vital capacity studies were made on 31 pregnant women during pregnancy and puerperium at the Boston Lying-In. There was a distinct tendency for the vital capacity to increase during pregnancy and decrease after delivery. The average vital capacity showed a progressive increase from the fifth month value 3,300 cc., and it reached its highest value of 3,445 cc., in the tenth lunar month. After delivery there was a sharp decrease to 3,204 cc., by the second post partum day. (42)

A considerable amount of work has been done on the subject of increase metabolism as a cause of increase in cardiac work. Under certain conditions, notably hyperthyroidism, increase in metabolism is associated with increase in cardiac work. If an increase in metabolism can
be demonstrated in pregnancy, it might similarly be the cause of increase in cardiac work.

In general, writers on the subject have worked in one of two ways; either they have studied a few cases or have contented themselves with relatively few tests on a large number of cases.

During pregnancy, the following changes in metabolism seem to be established. About 10 to 18 weeks after conception there is a decrease in the oxygen requirements. This is followed by an increase, slow at first, but gaining momentum about the 34th week. It reaches a maximum of somewhat less than 20% above the normal shortly after delivery. After delivery it begins to decrease and in 10 to 14 days may reach quite a low level. (90)

Assuming that the rate of metabolism is closely related to thyroid function, the increase in metabolism may be attributed to thyroid hyperfunction during pregnancy. (50)

However, Herring (49) in a carefully conducted experiment on rats failed to find any enlargement of the thyroid during pregnancy; on the contrary, the thyroid gland was on the average 10% lighter during pregnancy, and microscopically no functional changes could be demonstrated.

Plass and Yocken (83) found that following delivery, the basal metabolic rate falls faster than is usual in recovery from hyperthyroidism.
Therefore, in pregnancy there may be an increase in oxygen consumption which may exceed 25% of the BMR while a high metabolic rate of fetus and increased respiratory work are factors in producing this increase. There is much evidence that overfunction of the thyroid gland is an important cause. If so, there may result in an increase in cardiac work similar to thyrotoxicosis.

Studies were made by Cohen and Thomson in 1939 (19) on the total amount of blood in the body and its composition. It was found that there was a progressive increase in plasma volume from early pregnancy through the ninth lunar month, when a maximum of 65% over the average normal non-pregnant value was reached, then a decrease in the tenth lunar month. This decrease continued through the post partum period, so that by the end of the second week the volume had reached the normal level for the non-pregnant woman. The total cell count, measured by the hematocrit, also changed during pregnancy, following total blood volume. The total blood volume increased to a maximum of 45% over the value for normal non-pregnant woman at the height of the increase. The cause of the increase in the plasma is not known, but it is thought that it might be due to endocrine disturbance in pregnancy.

Another aspect of the physiology of circulation was studied by Cohen and Thomson (19) concerning the velocity
of blood flow in the pregnant woman. 143 observations were made on 36 normal pregnant women, which fell within the normal non-pregnant limits of 9 to 21 seconds. The pathway between the antecubital vein and the carotia sinus was used in making these determinations. The average blood flow is normal early in pregnancy, increases about the 17th week of gestation and remains increased until the 36th week and then decreases prior to term. It then increases again immediately post partum and finally returns to normal levels by the seventh post partum week.

Benjamin and Landt (60) found that the arterial pressures showed significant changes during pregnancy. In comparison with pressures observed post partum, the diastolic pressure manifested during pregnancy a greater fall than the systolic, so that the pulse pressure rose.

Observations made by Thomson and Cohen, Reed (49) on venous pressures in 20 normal pregnant women by direct venipuncture method showed that all of the values fell within the normal range of 3 to 12 cms. of water. Venous pressure tended to be slightly elevated in early pregnancy. There was a tendency for the average venous pressure to decrease slightly toward term and rise again in the puerperium. The tendency for venous pressure to decrease in pregnancy concomitant with increasing blood volume seems somewhat paradoxal, but is probably accounted for by
the opening of normal unusual venous channels or the dilatation of already existing ones. The slight post partum increase in venous pressure may be associated with the physiology of lactation.

Many were valuable studies in addition to those mentioned have been made in recent years on the physiology of circulation in the pregnant woman at the Boston Lying-In Hospital.

In summarizing the physiological changes that occur during pregnancy, it is generally assumed that the work of the heart is increased during pregnancy, but the causes have not been exactly determined. Many factors have been considered, especially general increase in body weight, changes in the respiratory volumes, particularly the vital capacity, and increases in blood volume. It has been found that the metabolic rate is increased out of proportion to increase in weight. A consideration of hemodynamic changes accompanying pregnancy can be useful in giving physiological information for the occurrence of many of signs and symptoms of the so called "Gestatory" heart.
EFFECTS OF PREGNANCY ON THE NORMAL HEART

Although it is quite certain that pregnancy increases the work of the heart, it is difficult to ascertain how the organ meets the extra demands placed on it. Individual variations seem to play a great part in determining the degree to which the heart utilizes the various means at its disposal. Consequently the effects of pregnancy on the heart may vary, and cardiac changes found in one patient may not necessarily be found in the next patient.

On routine examinations of hearts of pregnant women, various writers have found changes in auscultatory signs, in x-ray shadows and in electrocardiograms. The interpretation of these findings is extremely difficult, for lack of knowledge of the exact physiological limits in non-pregnant women.

During the last months of pregnancy the growing uterus pushes the diaphragm upwards with the result that the heart is displaced to the left, upward and somewhat in the direction of the anterior chest wall; at the same time a certain degree of rotation of the heart is believed to take place. (30) These changes are inconstant in degree and direction and vary according to the size and position of the child, the
amount of amniotic fluid, the strength of the abdominal muscles, and the constitutional type of thorax.

MacKenzie (67) discovered that about the seventh month of gestation the growing uterus altered the shape of the chest, widening it out so that the circumference gradually increased. Immediately after delivery the circumference diminished, and it did not return to normal until several weeks post partum. MacKenzie also stated that coincident with the change in chest circumference, the heart was frequently displaced until the apex beat was pushed out one inch beyond the left nipple line and upwards to the fourth interspace, but "no evidence of hypertrophy could be perceived."

As early as 1828, Larcher (61) advanced the doctrine that considerable cardiac hypertrophy in a constant concomitant of pregnancy. The question is debated, some authorities believe that a moderate hypertrophy takes place during gestation, others that a slight dilation occurs.

If either hypertrophy or dilatation of the heart, or both, occur in the course of normal pregnancy, the evidence as yet has been inconclusive. Experimental studies on animals do not support this contention. Van Liere and Sleeth (101) determined the heart weight
and body weight ratio in guinea pigs, dogs and cats before and during the later part of pregnancy and corrected for the weight of the uterine contents. They concluded (1) "that pregnancy does not cause cardiac hypertrophy in the cat, dog or guinea pig" (2) "since pregnancy does not cause hypertrophy of the heart in these types of animals, it is unlikely to do so in humans;" (3) "increased cardiac work does not necessarily produce cardiac hypertrophy." In regard to the second conclusion, it is only fair to question the analogy between experimental animals studied and pregnant women on basis of difference in anatomical patterns of placentae and duration of gestation.

A considerable amount of interesting work has been done on the electrocardiographic changes in normal pregnant women. Wilson and Ferrman (103) in 1923, failed to find any significant changes in the Electrocardiogram in pregnancy. It was Smith (93) who first demonstrated left axis deviation in pregnant women. He found a definite increase in the complexes in all leads in pregnancy. McIlroy and Rendel (70) found a right axis deviation in the early months of pregnancy. Pregnant women sometimes have a deep Q-wave
in Lead III. Carr, Hamilton and Palmer (13) found such Q-waves in 14 out of 244 normal pregnant women. They were ascribed entirely to change in position of the heart. With these changes in Lead III, there has been a tendency to inversion of both P-waves and T-waves.

The question of murmurs in the latter months of pregnancy has received a great deal of consideration. During the latter half of pregnancy, systolic murmurs are usually heard loudest over the base of the heart in 10-20% of normal pregnant women. (30) Various theories have been promulgated to account for these "functional" or "accidental" murmurs.

The physiological heart murmurs heard in pregnancy are rarely, if ever, diastolic in time. It is true however that Gammeltoft (34) in his series of 239 pregnant women reported diastolic murmurs in a few instances, but it is to be noted that these were heard over the base of the heart and not over the mitral area.

The incidence of murmurs varies widely, according to the literature. Gammeltoft (34) has called these functions murmurs in pregnancy "gestatory" murmurs. Most of the functional systolic murmurs fall into three
groups; those heard over the mitral area, those heard over all the precordium, and those heard over the pulmonic area.

Among the 106 murmurs heard by Hanley and Anderson, (43) 52 were heard over the mitral area, 38 over the pulmonic, and 16 over both areas.

Lamb (59) found about one half of the functional systolic murmurs heard in pregnant women over the mitral area.

Such signs and symptoms, as have been found by the various authorities concerning the normal heart, should be borne in mind in making a diagnosis of heart disease. The differentiation is also important from the point of therapy. These patients require no special treatment, such as rest or drugs, or any deviation from the usual obstetrical procedures which are followed when there are no cardiac symptoms.

Accentuation of pulmonic second sound has been demonstrated in 30% of normal pregnant women. (30) It is apparently due to slight relation its normal position by the rising diaphragm, the rotation being in such a direction that the pulmonary value is brought nearer to the anterior chest wall than usual and hence its closure is made more readily audible.

Eastman (30) also states that during the latter
months of pregnancy, extra-systoles are of frequent occurrence. Various authors have reported them in 10-50% of their patients they are of no clinical significance except when associated with definite signs of heart disease.

In summarizing the effects of pregnancy on the normal heart, it has been found that the heart is often displace upward and to the left as pregnancy progresses, so that during the last months of gestation, the apex impulse may be in the fourth left interspace and the left border of dullness at or outside of the midclavicular line. In some patients this may be falsely interpreted as cardiac enlargement, particularly when large breasts make palpation and percussion difficult. Auscultation of the heart usually reveals systolic murmurs both apical and pulmonic which are "functional" and vary widely in loudness, pitch, and transmission. Extra systoles and accentuation of the pulmonic second sound have been noted in normal pregnant women.
RHEUMATIC INFECTION AND RHEUMATIC HEART DISEASE

Rheumatic fever in childhood is a public health problem just as much as syphilis and tuberculosis are. Since it is a known fact that rheumatic infection is the etiological basis of about 90% of the heart disease found in pregnancy, the proper approach to this problem in pregnancy would be one of prophylaxis in childhood, as rheumatic fever is usually acquired in childhood.

Data on the epidemiology of rheumatic fever are inadequate at the present time. It is popularly believed that rheumatic fever is prevalent in urban populations of the temperate zone. It is uncommon in the subtropical and tropical regions.

Rheumatic fever is believed to be more common among the less favorable economic groups. Unfavorable environmental conditions, such as crowding, insufficient food and clothing, and frequent respiratory infections, are believed to be factors in the infection among underprivileged children. Nevertheless, rheumatic fever does occur among the more fortunate groups economically. Wilson (104) states that rheumatic fever disease and that hereditary susceptibility determines the familial incidence of rheumatic fever, but not
necessarily the sole condition for the development of the disease.

The desirability of including rheumatic fever among reportable diseases is of unquestionable value in dealing with this problem. A great majority of the pregnant cardiac patients who come into physician's office, have never known prior to this that they have a lesion of the heart which was probably of rheumatic etiology.

The etiology of rheumatic fever is unknown. The view that the rheumatic process is initiated or activated by "streptococcal" respiratory infection has been widely accepted. (104) The evidence which has accumulated in support of this concept originated in the association of tonsillitis and rheumatic fever and the rheumatic sequelae of scarlet fever. (104)

On the basis of the association between tonsillitis and rheumatic fever, Schuman (91) in 1935 has gone so far as to state that tonsillectomy should be a routine procedure in children to prevent possible rheumatic infection.

Rheumatic fever is primarily a disease of childhood, with its usual onset and characteristic manifestations during this age period. It may be fatal within a few weeks after onset, but the usual course is
of any manifestation of the activity of the infection. Rheumatic infection involves all tissues of the heart, the endocardium, myocardium, and the pericardium.

Cecil (15) states that about 85% of persons who have had rheumatic fever in childhood develop chronic deforming valvular disease of the heart. This usually begins in childhood, and is found most commonly in the decades from 15-35 yrs. the period of child bearing in the woman. The most frequently observed chronic valvular lesion is that of mitral stenosis.

Briefly, the pathology of and ins chronic valvular disease consists of a scaring of the cusps and shortening of the chordae tendinae. There is a thickening of the lines of closure of the cusps to one another; and finally a fusion of the whole valve into one fibrous mass which leaves but a narrow funnel-shaped, button hole, or fish-mouth opening in the valve. Hardening even to the point of calcification may occur in long standing conditions of aortic stenosis and mitral stenosis. When the valve is so deformed that it can no longer close completely, regurgitation, or insufficiency, is said to be present; and when the deformity causes obstruction of the normal onward flow of blood, stenosis is said to exist. (15)

Clinical signs of mitral valve lesions are as
follows: an apical diastolic murmur, with or without a thrill, which begins a brief interval after the second sound. There may or may not be a presystolic crescendo murmur at the end of it. This is the only positive sign of mitral valve lesion. There are other signs which indicate the probability of mitral lesion but do not prove it. A very loud blowing or rough systolic murmur masking the first sound, heard best at the apex, and transmitted to the axilla and the back is fair evidence of mitral damage with regurgitation.

Roentgenologic finding of a heart enlarged transversely with prominence of the left upper border is also good evidence of mitral valve disease.

Marked accentuation of the pulmonic second sound is a usual finding in chronic mitral disease.

Bramwell and Longson (8) found mitral stenosis to be the commonest valvular lesion in pregnant women. In their series of 293 cases, it was present alone in 260 cases, and in combination with other valves in 33 cases. Aortic incompetence was found in 31 cases.

Blumenfeld (3) reports the incidence of valvular lesions found at the Bronx Hospital in a series of 50 cases. Single valve lesions were found in five cases, and combined lesions in 45 cases. The most frequent
combination was mitral stenosis, and insufficiency found 42 cases. Mitral insufficiency alone was present in three cases, mitral stenosis in two, pulmonary stenosis in two, and aortic insufficiency in one cases.

Breed and White (9) found on incidence of 68% mitral stenosis, 19% mitral stenosis and aortic insufficiency, 9% mitral insufficiency, 2% mitral stenosis with aortic insufficiency and stenosis, and 2% non-rheumatic at the Massachusetts General Hospital.

Thomson and Hamilton (9) have concluded that "the average young woman with rheumatic heart disease is determined to bear children and fulfill her life despite of her handicap." They found 78 of 150 of their private patients, who were of child-bearing age with rheumatic heart disease, produced 169 living children during a ten year period which they state is a higher fertility rate than has been reported by some groups of college women for ten years after graduation.

Summary:

Rheumatic fever is a disease of childhood. It is more common in colder climates and is rarely seen in the tropics.

The period of life when women become pregnant is the time when rheumatic fever runs its course. Neihaus (74) states that 90% of heart disease complicating
pregnancy is rheumatic. Mitral stenosis is the most common valvular lesion. Therefore in order to reduce morbidity and mortality from this lesion in pregnancy, one must attack the problem of rheumatic fever in childhood which necessitates the cooperation of many specialists as pediatrician, nutritionist, social worker, general practitioner, and cardiologist.
THE PROBLEM OF DIAGNOSIS IN PREGNANCY

Many of the signs and symptoms which are characteristic of heart disease, such as apparent cardiac enlargement, systolic murmurs, accentuation of P2, and shortness of breath, occur in the cause of pregnancy when the heart is normal. These changes may resemble heart disease so that a definite diagnosis is not always possible. All expert authors on the subject have stressed this difficulty. Hamilton (41) recognized its importance to the point where he established a special category of "possible heart disease."

A history of rheumatic infection probably implies a 50% chance that the patient has rheumatic heart disease and the significance of any suggestive findings is markedly enhanced. (31)

Dyspnea in certain circumstances has been mentioned by Jensen, (53) to be a criterion for diagnosis of heart disease. He states also that pregnancy may cause dyspnea on effort and even orthopnea. Increasing dyspnea is not a certain sign of heart disease. If, however, Jensen adds, heart disease is known to be present, it is a sign that the diseased heart is becoming embarrassed. A history of dyspnea on effort before conception is much more valuable, especially if labored breathing
was provoked by less and less effort.

Jensen (53) mentions that "palpitation" is a symptom too indefinite to be of much value, but an observed tachycardia of 100 or more, persisting in spite of rest is suggestive of cardiac embarrassment though not necessarily of organic heart disease. Other causes of tachycardia should be considered also.

Cardiac enlargement - is of little value unless it is definite. Difficulties in palpation and percussion of heart have been created by the increase size of the breast and by cardiac displacement by the diaphragm. These difficulties also apply to x-ray examinations which are often misleading unless the physiological changes in pregnancy are borne in mind. Physiologically, the shadow is both enlarged and displaced, and therefore, a pathologically enlarged heart may be difficult to identify. Therefore all cases of slight or moderate cardiac enlargement during pregnancy require corroboration before a diagnosis of pathological hypertrophy can be made. (30)

Murmurs may be significant. More than 90% of pregnant women with genuinely injured hearts have mitral stenosis. The diagnosis of mitral stenosis is based on the characteristic diastolic or pre-systolic murmur. (30) The other common cardiac lesion
of pregnant women is aortic insufficiency. The diastolic murmur of aortic insufficiency is heard best not over the so-called "aortic area" but to the left or over the body of the sternum. It is a high pitched whiff which replaces or follows the second sound. There is no interval between the second sound and the murmur, as in the case of the diastolic murmur of mitral stenosis.

Eastman (30) has mentioned other established signs of cardiac disease, which are not simulated by gestational changes which may be depended upon to be helpful in the diagnosis of heart disease in pregnant women. These signs may be innumerable as follows: a precordial thrill which is a definite "purr" and not a slight vibration, irregular rhythm persisting after exercise, especially if the rate is 120 per minute or higher, an unmistakable friction rub, an expansile pulsation of the liver which occurs most commonly as a result of relative insufficiency of the tricuspid value, due to dilatation of the right ventricle and concomitant stretching of the tricuspid value.

Arrhythmias have the same significance in pregnancy as at other times. In the child bearing age, auricular fibrillation most often occurs in association with rheumatic heart disease, however, other causes, especially hyperthyrodism may sometimes be effective.
The criterion used by Carr and Thomson (42) at the Boston Lying-In clinic for the diagnosis of heart disease are those of the criteria committee of the New York Heart Association. The criteria for diagnosis are as follows: (1) enlargement (2) a diastolic murmur (3) significant disorders of the beat (4) signs or history of cardiac failure ("anginal" or "congestive" or "paroxysmal dyspnea").

Niehaus (74) mentions several factors which are important in the diagnosis of heart disease in pregnancy. Cardiac enlargement determined by palpation of the apex beat, by percussion, or x-ray is significant. The degree of heart enlargement and the degree of deficiency closely parallel each other. "An enlarged heart is never normal," claims Niehaus. Signs of congestive failure evidenced by breathlessness, cough and rales in the lung bases, an enlarged liver, and edema of the extremities are other factors. A history of auricular fibrillation also has been pointed out by Niehaus, as a definite milestone of the progress of rheumatic heart disease.

In summarizing the various signs and symptoms suggesting heart disease, it can be stated that many of the same ones can be seen when the heart is normal. This has necessitated the use of a preliminary diagnosis of "possible heart disease." Certain points support a
diagnosis of rheumatic heart disease. A history of rheumatic fever is suggestive. Dyspnea and Tachycardia have relative value. They may be produced by pregnancy, but in the presence of heart disease, they indicate that the damaged heart is becoming embarrassed. Cardiac enlargement is of diagnostic value only when definite. A presystolic murmur over the apex, and a diagnostic over the aortic area are more suggestive. Systolic murmurs must be considered in relation to other findings. Arrhythmias are of same diagnostic value in pregnancy as those of the non-pregnant woman.
INCIDENCE OF RHEUMATIC HEART DISEASE

Since rheumatic heart disease is not a notifiable disease, except in the Scandian countries, the incidence among child-bearing women is not absolutely known. The figures which will be quoted are those which come from the recorded experience of various clinics.

After the first isolated disasters of valvular heart disease and pregnancy had been reported, cases were collected into series. In the beginning these contained only the very sick patients and the death rate was very high as in MacDonald's group of cases. MacDonald (65) stated that the death rate from heart disease in pregnancy was over 60%. He failed to say that he based his conclusions on a series of advanced cases and applied them to heart disease in general.

Therefore one must be on guard in analyzing statistics, as they can be interpreted in many ways and may not be a fair sample.

While it is true that statistical results can rarely be applied to individual cases, they express in a brief and pointed manner the accumulated experience of the writers of the various articles, and as such are, a valuable guide to the clinician.
In the determination of the incidence of rheumatic heart disease, certain factors such as geographical distribution must be considered. The disease prevails in Central, Northern and Western Europe, including northern Italy. It is rare in Australia and South America, except amongst the immigrants. (53)

In the U. S. several observations have been made on the prevalence of the disease in various sections. It is quite a well established fact that it prevails in the damp cold areas of the eastern portion of the U. S., while it is much less common in the dry and arid climates of the Southwest. Harrison and Levine (45) found the incidence relatively low in the middle west. Hanley and Anderson (43) found the incidence of rheumatic heart disease very low in Southern California.

Various methods have been employed to learn the incidence of rheumatic heart disease among the white women of child-bearing age such as autopsy statistics, as well as case reports from various clinics.

Davis and Weiss (26) in 1932 found that 9.1% of patients dying in the Boston City Hospital had rheumatic heart disease. Rothchild, Kugel, and Gross (88) found heart disease in 6% of 3,000 autopsies in New York.

These reports are from a certain geographical section of the U. S. where rheumatic infection is
prevalent, and therefore can not be applicable to all climates and regions of the U. S. They do not help, therefore toward a practical estimate of the evidence of valvular heart disease in pregnancy.

Jensen (53) found in 2,200 autopsies performed at the St. Louis City Hospital 41 cases or 1.36% with mitral lesions of rheumatic etiology and 15 cases or 68% with aortic stenosis.

In the case reports recorded by competent observers, figures vary greatly. Fitzgerald (32) of the Cook County Hospital in Chicago reports an incidence of organic heart disease in the prenatal clinic of 0.66%; Fitz-gibbon (33) states the incidence to be 0.16%; while Daly and Strouse (24) also estimate the incidence to be in the lower brackets - 0.25%.

Stander and Kuder, (77) of the New York Lying-In in 1931 report the incidence of organic heart disease in their clinical patients to be 3.97%. In 14,157 patients, 56 were found to have valvular lesions. Lemb (39) found it to be 2.7%; Schurnan (91) mentions the incidence at the Sinai Hospital in Baltimore to be 2.3%.

A majority of the other reports by reliable authors state that the incidence of heart disease in pregnancy ranges between one and two per cent. An incidence of
cardiac disease in pregnancy of 1.6% is quoted by both Pardee (82) and Munro Kerr. (57) Clahr, Klein and Greenstein (16) of the New York City Hospital found their incidence to be 1.8%; and Gorenberg, and McGleary (36) at the Margaret Hague Maternity Hospital of Jersey City and Jensen, Wegner and Keyes (55) of St. Louis City Hospital estimate an incidence of 1.2%. Reis and Frankenthal (86) as well as Watson (102) from the Sloane Hospital report 1.3%. Carr & Hamilton (12) of the Boston Lying-In gives a incidence that of 1.1%, having found 500 cases of heart disease in 45,069 obstetrical deliveries.

An impression of the importance of heart disease in pregnancy may be gained by a study of the rate it plays in maternal mortality. It is one of the most important causes of death in connection child-bearing, possibly the most important cause of death in labor. Eastman (30) believes that only toxemia and sepsis claim more lives during pregnancy and puerperium than does heart disease.

In summarizing the estimate of incidence of heart disease, the available data fall into three groups. The highest incidence of 6-9% is found by anatomical examination. An incidence of 2-3% based on simple physical examination; while the lowest incidence of
about 1% is indicated by statistical analysis.

Probably the statistical analyses, indirect though they may be, come closer to the truth, and the incidence of heart disease among women of the child-bearing age, lies between 0.6 - 1.0%.
THE VALUE OF A FUNCTIONAL CLASSIFICATION IN PROGNOSIS

The correct estimate of prognosis in heart disease and pregnancy is of immense importance, for on it rests the management of the individual case to a large extent. Heart disease is a treacherous complication of pregnancy which the majority of cases go through pregnancy, labor, and puerperium without incident. The problem as to whether a given patient may undertake or continue her pregnancy, is the estimation of her cardiac reserve, and the relative diminution of it which may be expected from pregnancy and labor.

Reddick (84) feels that prognosis resolves itself into balancing the extra burden which pregnancy will impose on the heart, versus the ability of the heart to carry out that work. The consensus of opinion of many writers is that the problem is a very difficult one, because physician is called on before the beginning of pregnancy or during the early months to estimate the capability of the heart to react some months later to a strain, the severity of which no one can fully and adequately predict. It is impossible to state with much accuracy the nature and duration of labor in a given patient. In addition to the medical factors in
a given case, there are other factors such as social and economic which must also be weighed.

One may see women with almost any type of heart lesion, go through pregnancy, labor, and the puerperium with little or no difficulty. (84) Obviously then the structural lesion, is of little or no value as a foundation for prognosis. There is an old belief that mitral stenosis alone is sufficient cause to interrupt pregnancy. (84) And yet there are cases reported in the literature where pregnant women with mitral stenosis, even with combined mitral stenosis and aortic insufficiency, go through pregnancy uneventfully.

The earlier writers based their prognosis of heart disease on the anatomical lesion present. Their results indicate that the anatomical lesion is not a reliable basis for prognosis. There has been much discussion by present day writers as to whether prognosis should be based upon the structural change in the heart or upon its functional capacity. Jensen, (53) McIlroy and Rendel, (70) and Lamb, (59) accept the functional classification as one of the many factors in prognosis. The classification is not a perfect one, however, as sometimes as pregnancy advances, a patient must be transferred to a less favorable class. In these cases the term of pregnancy at the time when the change occurs
and the rate of change may influence the prognosis.

In 1894, Sears (92) suggested a prognostic classification based on the functional ability of heart patients. In 1921, there appeared the important monograph of Sir James MacKenzie (67) on "Heart Disease and Pregnancy," in which he pointed out that the structural lesion alone is not an adequate criterion on which to base prognosis, but rather the functional ability of the heart is the significant factor in prognosis.

In 1922, Pardee, (80) for many years cardiac consultant to the Lying-In Hospital of New York City, advocated the grading of the functional capacity of the heart based on the patient's history of her reaction to the routine of her everyday life. After 1924, Pardee grouped his pregnant cardiac patients according to the functional classification introduced the preceding year by the New York Heart Association. This scheme is now widely used; it has been adopted by the American Heart Association for the grading of patients. (78)

Pardee (80) not only investigated the ability of these patients to carry their usual household tasks, but he allowed the patients to perform certain exercises and then observed their pulse, respirations and general reaction. The exercise consisted in swinging a five to ten pound dumbbell between the legs to straight over
Pardee (80) found that a normal pregnant woman could swing a 10 pound dumb bell without distress 20 times with only slight amount of dyspnea, and acceleration of pulse to 120 per minute and by the end of a minute, respirations should be normal at the end of two minutes. Pardee places all pregnant women in groups 1-4 and by this rates the degree of cardiac impairment. More recently McIlroy and Rendel (70) and MacLenman (68) have carried out similar classification.

Patients belonging to Class I (Pardee's) are able to carry on their usual household activities without difficulty. Even in the latter months of pregnancy, they can climb two flights of stairs without under shortness of breath. They have no subjective reason for suspecting cardiac disease.

Patients in Class I can be expected to go through pregnancy, labor, and the puerperium without untoward event. Among the cases so classed by Pardee, (80) none showed any evidence of cardiac embarassment during or after labor. One patient died, but this was the result of pneumonia and the heart played no role. Among the 58 cases so grouped by McIlroy and Rendel, (70) all had uneventful pregnancies and labors so far as the heart is concerned. MacLenman (68) found that their
cases were very little or at all disturbed by labor and the vast majority of them delivered spontaneously.

Patients in Class 2A are able to carry on usual duties, but in so doing experience some discomfort, particularly shortness of breath. They should be able to complete the climbing of two flights of stairs, but only at the expense of considerable dyspnea and tachycardia. They should be able to swing the dumbbell 20-25 times but the reaction at the end will be rather marked and will persist for three minutes or more. Patients in this group usually go through pregnancy and labor safely. In some instances, evidence of mild cardiac embarrassment may occur during labor and on rare occasions more serious complications develop. Among the patients grouped in this classification by Pardee, (80) McIlroy and Rendel, (70) and MacIennan (68) as a whole did satisfactorily and there were no instances of collapse during labor.

Patients in Class 2B were unable to carry out their more difficult household duties without having to stop on account of fatigue, shortness of breath or palpitation. Such patients would find it necessary to stop for rest while climbing two flights of stairs, and they would be unable to complete 20 swings of the dumb bell because of dyspnea or palpitation. Pregnant women in
this group present a serious problem to the obstetrician, as a substantial portion of them develop congestive heart failure before the puerperal state is ended.

Patients in Class III, may be said to be definitely decompensated. They are unable to do any household task or climb a single flight of stairs. As a rule, the test exercise is superfluous.

Carr (11) in 1938 stated: that this procedure appears successful in Pardee's hands. He and Hamilton are of the opinion that pulse rate and respirations are too variable, even in the normal individual to be accurate guides to heart function.

The American Heart Association Classification is an outgrowth of MacKenzies teaching. In obstetrical cardiology it has received the support of such persons as: Pardee, Eastman, (30) McIlroy, and Rendel, (70) MacLennan (68) and Gilchrist. (35)

The classification is as follows:

"Class I-Patients suffering from organic heart disease, able to carry on ordinary physical activity without discomfort."

"Class II-Patients suffering from organic heart disease, unable to carry on ordinary physical activity without discomfort."

(A) Activity greatly limited.
(B) Activity slightly limited.

"Class III-Patients suffering from organic heart disease showing definite symptoms of heart failure when at rest."

Roughly speaking, cases falling into Classes I and IIA, would have a good prognosis, those falling into Class IIB would have a guarded prognosis, and those in Class III, a poor prognosis.

The classification used by Bramwell (6) and Hamilton (38) differs from the American Heart Associations grouping. Like that of the American Heart, it has three classes but have an entirely different significance—

Class I includes severe cardiac disease, while Class III includes "possible heart disease."

Using the classification of the American Heart Association, Stander (94) of the New York Iying-In, in 1938, reports on a series of 436 women suffering from cardiac disease. In this five year study during the period of 1932-1937, there were 20,957 obstetrical discharges, and the incidence of heart disease was 3.5% of the total number of pregnancy. The distribution of cardiac patients according to functional classification was 50.5% in Class I, 37.3% in Class IIA, 10.4% in Class IIB and 1.8% in Class III.

By totaling the cases reviewed by the following
men (a series of 1,428 cases) as Gilchrist, (35) McIlroy and Rendel, (70) MacLennan, (68) Lamb, (59) Daichman, and Kornfeld, (22) Hanley and Anderson (43) and Naish, (73) the prognostic value of a functional classification is definitely indicated. The total death rate was less than 0.5% in either Group I and IIA, rising to 5.33% in IIIB, while in Group III it rose to 22.61%.

Jensen (53) feels that this method of classification is valuable, but also states that the prognosis heart disease and pregnancy is too complicated to be entirely determined thereby. Further he goes on to mention, the various causes of death should be considered as well as the time thereof in relation to conception and delivery, that one may know what to fear and at what time to fear it. Age, the anatomical lesion, twin pregnancy, and hydramnios all have been thought to effect prognosis.

Branwell (5) believed the most important considerations as regards to prognosis are:

(1) The presence or absence of heart failure and auricular fibrillation, (2) the extent of structural lesions, and (3) the temperament and economic circumstances of the patient and her willingness to adapt her mode of life to the limitations placed on it by a damaged heart.

It has been often said that a patient with mitral
stenosis might have two or three pregnancies, but should not have any more, since each pregnancy takes away something from her cardiac reserve. Hamilton and Thomson (42) have estimated that the death rate for patients in their second and third pregnancies average 4.6% in a group of 750 cardios, after the fourth it averaged 6.7%.

Whatever may be the risk of pregnancy, the risk is repeated in each pregnancy. Hamilton and Thomson (42) do not believe that there is any special number of pregnancies when the risk for another changes. If a cardiac has passed the age of 35 years, her chance of heart failure is higher, and if her heart condition has changed between pregnancies or during a pregnancy from a "favorable" to an unfavorable group, her risk is much higher.

Strayhorn (98) wrote "That a close cooperation between internist and obstetrician, the outlook is not so bad as has been in the past. Neglected, the dangers are just as great, the mortality is just as high."

If the mother is suffering from an active rheumatic infection, it is felt that pregnancy under these circumstances is undesirable. In addition to the ill effects on the mother, the child may be born with rheumatic carditis. Levine (64) has reported instances of acquired intrauterine infection.

The question of whether pregnancy should be undertaken
or not has aroused considerable interest. If there is any evidence of congestive failure, in the past or present, Levine (64) believes no future pregnancy should be undertaken, because there is a great risk of recurrence of this state and life expectancy after such an event is so short.

Strayhorn (98) also supports this opinion of Levine and states that if a patient has ever had cardiac failure, she should be advised against marriage and pregnancy.

Reiss and Frankenthal (86) feel that the clinical course of the cardiac during the period subsequent to her last pregnancy should afford an index of her safety in future pregnancies. It has been pointed out that while a primipara may stand pregnancy and labor uneventfully, she may die some years later as a cardiac failure in a second pregnancy. This fact is of prognostic significance as mitral disease of rheumatic origin is a notoriously progressive disease.

There are differences in the advice which a physician should give when the question whether a patient should undertake a first or subsequent pregnancy. Levine (64) is of the opinion that, even when there is some doubt as to the exact state of the heart, a slight added risk should be hazarded for the joy of having a child in contrast to a childless life. The situation is
different if the patient when the patient has one or more healthy children. Daichman and Kornfeld (22) are of the opinion "that the fact that one pregnancy will do no harm is no proof that another one will not". Danforth (65) feels that the patient with cardiac disease should be advised so that pregnancy will take place during the early years of married life, as it will be borne better at this time.

King (58) is of the opinion that the economic status of the family should influence the physician's judgement, because it is often more work to raise and care for children than to bear them. The hard work during their infancy and childhood may break down the cardiac reserve more so than the actual ordeal of pregnancy.

In summarizing, the prognosis in each individual case should be based on the functional capacity of the heart rather than on the structural type of lesion. The adoption of the American Heart Association Classification has avoided much confusion and has been helpful in aiding the determination of prognosis in cardiac cases. Social and economic status of the patient as well as desires of the patient to have children should be considered. The prognosis, even with the aid of the functional classification, is still very uncertain. If congestive failure has ever been present, it should be a contraindication of pregnancy because of the high incidence of mortality.
AURICULAR FIBRILLATION IN RHEUMATIC HEART DISEASE

Auricular fibrillation is a disorder of rhythm which is a common accompaniment of rheumatic heart disease, and Gilchrist and Murray-Lyon (35) states that it occurs in about one-half of the severer cases of mitral stenosis. It is a definite manifestation of increasing cardiac embarrassment and as the common forerunner of congestive heart failure, auricular fibrillation calls for special consideration in connection with pregnancy.

Since the days of MacKenzie, auricular fibrillation has been almost universally regarded as a serious complication of pregnancy. In the women of the childbearing age group, fibrillation is due to rheumatic heart disease rather than other forms such as thyrotoxicosis.

Jensen (53) is of the opinion that the clinician has assumed a too optimistic attitude in regard to auricular fibrillation in rheumatic heart disease, which he thinks has been inspired by the exceptional cases of auricular fibrillation which survived in fair health for years. De Graff and Lane (27) followed 190 cases of
auricular fibrillation to the end and found only three survived for respectively 10, 11, and 12 years. King (58) states that the duration of life after the onset of fibrillation is not over 2 years. According to De Graff and Hingg, (27) auricular fibrillation does not usually come on until eighteen years after the onset of valvular heart disease, and the average age at death is 38 years. In their experience auricular fibrillation in rheumatic heart disease is a terminal manifestation appearing late among those patients who survive for a long time. This experience seems to apply also to obstetrical cases, for 6 cases out of 18 cases reported by Robinson (87) and 6 out of Carr and Hamilton's (12) 14 patients were 35 years or more.

The high average age of patients at the onset of fibrillation has suggested that it is due to a normal progression of the disease rather than a result of the pregnancies. (35) (12) The general opinion of various authors is that the prognosis is grave. (67) (12) (87) (46) (21)

Jensen (53) states that, "auricular fibrillation has a double significance." It may be evidence of severe damage to the heart muscle for the reason it adds to the seriousness of the prognosis. Second, auricular fibrillation impairs the circulation because of the
inefficient and wasteful action of the heart. Therefore in the management of heart disease in pregnant women, both of these aspects should be considered in the management program.

Cases of auricular fibrillation complicating pregnancy appeared in the literature before the arrhythmia was recognized. It was MacKenzie (66) who in 1904 identified auricular fibrillation as a clinical entity and studied its relation to pregnancy.

The incidence of auricular fibrillation is not very common and the death rate is high. In Naish's (73) 533 cardiac cases, there were 12 with auricular fibrillation. In Bramwell and Longson's (8) series of 350 cases, there were 24 patients who developed auricular fibrillation either prior or within 6 months of delivery, of these seven died. Thus the death rate amongst fibrillators was 29.2% and the total mortality was 6.6%. Thus the mortality in this series was four times as heavy as among the gross death rate. Robinson (87) in 1927 recorded 18 cases of fibrillation of which 13 died. Eight of these cases, however had not been under any antenatal supervision.

In McIlroy and Rendel's (70) series, there were seven fibrillators, only one of whom died.

Hay and Hunt (46) found 5 cases of fibrillation in
a series of 38 cases, with one death which was due to an associated kidney condition. In the remaining four labor was normal. All were suffering from advanced mitral stenosis.

Herrick (48) records four patients with valvular heart disease and auricular fibrillation in a series of 40 patients, with no fatalities. Gilchrist and Murray-Lyon (35) found 54 cases in 109 who were known to fibrillate before death.

In considering the prognosis of patients who have auricular fibrillation along with rheumatic heart disease, certain accessory factors have to be considered. Embolism either cerebral or pulmonary, is a complication, the possibility of which has to be considered in all cases of fibrillation. Bramwell and Longson (8) state that embolism is frequently due to the fact that when the auricles fibrillate, they have become for all purposes paralyzed. Coordinate contraction no longer occurs, dilatation sets in, the blood stagnates and the conditions favor the formation of mural thrombi. So from time to time fragments of thrombi become detached and pass into the ventricle. If the clot is in the right auricle, it is carried to the lung and produces a pulmonary infarct: if it is in the left auricle, it enters the general circulation, and since the middle
cerebral artery is in almost direct alignment with the aorta and internal carotid, it is the site where the embolus is most apt to occur with the resulting hemiplegia.

De Graff and Ling (27) found the incidence of embolism slightly higher among patients with auricular fibrillation than among those with normal rhythm.

The outlook in patients suffering from auricular fibrillation depends on the results of specific treatment. It depends also on the degree to which the fibrillation is distressing and handicapping the heart. If the auricular fibrillation responds to digitalis so that the ventricular rate may be kept in the 70's, and if exertion does not cause marked dyspnea or excessive tachycardia, the outlook is as favorable as it can be under the circumstances.

If a patient with fibrillation presents herself to a doctor and asks if pregnancy should be undertaken, King (58) states, that the answer should always be "no." If the patient is seen in the early weeks of pregnancy, a therapeutic abortion should be performed in most cases. Bremwell (8) is also of the opinion that pregnancy should be terminated in the first trimester. If the desire for a child is great and the parents are fully aware of the risk involved and if the cardiac reserve seems good and
if the ventricular rate can be controlled with digitalis, continual watchfulness may carry the patient through safely.

If the patient is first seen with the pregnancy well advance, one has no alternative but to give the patient the best care with digitalis and rest and carry the patient until viability of the child and terminate by caesarean section.

In summarizing, auricular fibrillation is a late complication of advanced rheumatic heart disease. It has a high mortality rate and doesn't occur commonly; nevertheless it is of very serious prognostic importance.
MORTALITY RATE AND CONGESTIVE

FAILURE IN CARDIACS

Little attention has been given to the future outlook of those patients who survive pregnancy. It would be natural to suppose that frequent, repeated pregnancies in a woman afflicted with organic heart disease would impose a series of successive strains upon the heart as to ultimately decrease permanently its functional ability.

It is difficult to prove this idea that repeated pregnancies in the cardiac patient tend to shorten life. Rheumatic heart disease, as has been discussed previously, is by far the commonest form of organic heart disorder found in the child-bearing period and in approaching this subject it must be borne in mind that rheumatic infection, itself, tends to run a definite downward course as the years pass from the time of the original infection. Jensen (53) is of the opinion that child-bearing does not exacerbate the rheumatic infection or hasten any pathological process in the heart, but that it may be possible that by adding to the load of circulation it may accelerate the onset and development of congestive failure. Gilchrist and Murray-Lyon (35) are of the opinion that congestive
failure and early death are natural consequences of rheumatic infection, but that it isn't an easy task to show that pregnancy accelerates the process.

The first recorded statistics on death rate of cardiac patients was that of Angus MacDonald's (65) in which he reports a very high death rate of 64.4% in pregnant cardiac patients which were advanced heart cases. There has been a steady decline in death rate in the last 60 years.

Various figures have been given by different authors on the death rate. Meares (71) finds the mortality rate to be 6%; in another series published by Bramwell (8) it was 9% among primipara and 2.6% among multipara. Stander and Kuder (97) found the maternal death rate in the cardiac group twice as high as the total clinic patients, mortality rates being 7.1 per thousand in the former while 2.8 per thousand in the latter. Nelson and Eades (75) report a gross mortality of 6%.

Several authors give figures on death rate to be much higher than those mentioned previously. At Sinai Hospital in Baltimore, Schuman (91) found it to be 16%, 3 of the obstetrical deaths, being due to heart disease. Reid (85) and Greenhill (37) also give high percentages 15.8% and 16% respectively. Hamilton and Kellog (41) found nearly 20% of maternal deaths at Boston-Lying-In to be due to heart disease.
Jensen (53) has tabulated a large group of cases and gives the gross death rate in cardiaics as 4.3%. He noted that this ratio varied according to the source of information, and that there seems a tendency for the rate to fall to from an original 8-10% to 2-3%, which is at the present an irreducible minimum.

No comparable death rate is available for non-pregnant cardiaics. but from De Graff and Lingg's (27) material it is near 7%.

It is possible that these larger figures are subject to errors since there is room for greater accuracy in determining death rates from heart disease. However, it can be seen quite readily that with the improved methods of treatment the death rate has fallen, and that many disasters have been avoided by proper prenatal management.

Congestive failure is by far the most important cause of death in pregnancy and heart disease. The occurrence of decompensation is regarded of grave significance by Robinson. (87) The incidence was found to be between 16-33% of the cardiaics in four clinics. (59) (23) (12) (94).

According to De Graff and Lingg (27) and King, (58) that in rheumatic heart disease, congestive failure is
the cause of death from 45-70% of the cases. The exact incidence is difficult to determine, because congestive failure is frequently complicated by pulmonary edema, pneumonia, embolism, and sepsis.

It has been found that most of the cases of congestive failure in connection with childbirth develop during pregnancy. McIlroy, and Rendel, (70) Levine, (64) Carr and Hamilton (12) and King (58) have found that congestive failure occurs most often during pregnancy. Comparatively few cases become decompensated during labor, and decompensation appearing in the puerperium is rare.

King (58) points out that congestive failure is manifested during the sixth, seventh, and eighth months of gestation and rarely does it begin in the last few weeks of pregnancy or during labor if it was manifest before. Off hand it would seem reasonable to believe that the load on the heart would be felt more late in pregnancy. Some authors as McIlroy and Rendel (70) state that the incidence of failure increases after the seventh month.

Granted then that congestive failure appears in a certain percentage of heart patients in pregnancy, the question arises why do they develop it? A further study of the subject indicates two causes to be of
primary importance overwork and infection. A fatiguing shopping trip, moving into a new apartment, entertaining or any sort of activity which causes undue fatigue have been found to precipitate congestive failure in pregnant cardiac patients.

Intercurrent infections have been stressed by Jensen (53), Oppel (70) and Hamilton and Thomson (42) and King (58) as provoking factors in heart failure in pregnancy. Any infection with fever and elevated metabolism imposes a burden on the circulation.

Obesity and anemia and oral sepsis have also been mentioned by Hamilton and Thomson (42) to cause additional burdens on the heart.

Because of its importance to both mother and child, congestive failure should be discovered as early as possible in the pregnant woman. To await until marked signs appear, this would be dangerous.

Certain signs and symptoms as increasing fatigue, persistent cough, or insomnia, dyspnea, palpitation, and edema are manifestations of cardiac distress. (52)

Rales at lung bases are the "earliest reliable sign of heart failure in pregnancy." (67) Hemoptysis, fullness of neck veins, engorgement of liver, dependent edema are additional signs of congestive failure.

In the literature there is considerable confusion
regarding the relative danger of the various phases of gestation in patients with congestive failure. McIlroy and Rendel, (70) emphasize the special danger of the period immediately following delivery. Jensen (53) analyzed 462 fatal cases in order to determine the phase of pregnancy during which death occurred. Many of these patients died following premature delivery. Of the 462 patients, 15.77% died during pregnancy, 9.41% died during labor, and 74.82% died after delivery. During the first months of gestation he found the death rate was so low that it did not exceed what might be expected without the presence of pregnancy, however about the seventh month it began to increase.

(12)

In 1933 Carr and Hamilton reported that the incidence of heart failure increased progressively from the third to ninth lunar month of pregnancy, after which it decreased progressively. In 1939 Cohen and Thomson (19) working also in the Boston Lying-In, have shown that those circulatory factors associated with increased cardiac burden of pregnancy follow a curve which parallels that formed by the figures of Carr and Hamilton. (12) Contrary to these reports, Jensen (53) who analyzed a much larger series of cases, was unable to find any particular time in pregnancy when heart failure was most apt to occur. Oppel (79) finds that
there is no time in pregnancy after the second month when heart failure does not occur.

About 10% of the patients were found by Jensen to die during labor. During the first 24 hours following delivery 17.46% died, of these respectively 5.10% and 3.33% (of the 462) during each of the first two hours. Then the hourly incidence fell rapidly.

So it seems that the danger of death increases throughout pregnancy, reaches a maximum during labor and the few hours and days following delivery and then it rapidly and progressively falls.

In summarizing, the death rate from rheumatic heart disease places it as an important cause of death in pregnancy. It is declining because of better management. Until recently it was responsible for a mortality of 8-10%, now being reduced to about 2-3%. Heart disease is among the first four or five important cause of maternal deaths. By far the largest number of these mothers are from congestive failure. It is the cause of death in approximately 70.1% of fatal cases. Over-exertion and fatigue are the precipitating causes of congestive failure.

In patients who have had heart failure before term, and in those who have not, acute and severe decompensation is not unknown within the 1st 24 hours after
delivery.

Most deaths from congestive failure occur during pregnancy, but also many of these patients deliver prematurely. Congestive failure is manifested during sixth, seventh and eighth months and rarely begins in last few weeks of pregnancy and labor if it wasn't present before.
MANAGEMENT AND OBSTETRICAL DELIVERY

Prenatal Management

The treatment and management of the pregnant cardiac includes both medical treatment as well as the obstetrical conduct of the case. Each case presents and individual problem in which the severity of the heart disease is the essential problem. In the prenatal care, the most important concern of the attending physician is to improve the patient's cardiac condition by suitable medical procedures, and only a small part of this care is to prevent the numerous obstetrical complications which are possible to develop in all pregnant women.

The object of management is to prevent further damage and subsequent failure. Management of the pregnant patient suffering from heart disease can be discussed under the headings of management during the prenatal period, during labor, and during the puerperium.

Prenatal care is a comparatively new concept in obstetrics, and its application to cardiac patients should receive more attention than it has. Yet, by reading the published accounts of fetal and maternal death rates in the last few years, there has been a striking reduction due to the education of the lay
public, and the awakening of physicians to the problem created by a combination of pregnancy and the impaired heart.

The first step in antepartum care of a woman with cardiac findings is an accurate diagnosis. When the diagnosis of rheumatic disease has been made, the further management depends on prognosis. The most important single factor here is the functional capacity of the heart. Though subject to change during pregnancy and the puerperium, it has helped as guide in prognosis.

During the antenatal period, the consensus of opinion is that rest is of undoubttable value. (73) Also a primary requisite of good antenatal management is frequent observation. Hamilton (39) insists on weekly visits; Jensen (53) requests one visit every three weeks, while Clahr, Klein and Greenstein (16) advise one per two weeks. The value of such prenatal examinations is particularly well emphasized by Lamb, (59) who reports a 2.2% mortality where adequate antenatal care was carried out, compared with mortality of 20% in patients who did not receive prenatal observation. Special advice should be given in regard to hours of rest and limitation of exercise as well as control of weight by restrictions in diet. (47) Opinions differ as to the
amount of exercise which should be undertaken by pregnant cardiac patients. Exercise within the limits of her capacity are beneficial to any pregnant woman. MacKenzie's (67) rule is still very practical for a guide to advising exercise. He advises a pregnant woman with heart disease may undertake as much as she can do without getting short of breath. As pregnancy advances the burden becomes heavier, and more frequent rest periods should be observed, both during morning and afternoon.

If patient is obese, efforts should be made to reduce her weight and prevent gain. Also of importance is the avoidance of intercurrent infections, and when slight colds occur, the patient should remain in bed.

Opinions also differ on the use of digitalis in cardias. Since digitalis is a powerful, poisonous drug, its routine use over long periods of time may probably result in some disastrous effects. Claehr, Klein and Greenstein, (16) administer digitalis routinely to all patients entering the hospital except Class I (American Heart Classification). Their purpose is to prevent decompensation during the strain of labor. The drug is administered slowly and the amount of drug is determined by weight of patient, one cat unit per 10 pounds of body weight at beginning of gestation, and it is given for four days. After this the patient is kept
on a maintenance dose of one or two cat units per day.

In general the program of antenatal care that should be followed when the heart is efficient is as follows: maintain general health, avoid fatigue and excessive muscular exertion, adequate rests and avoid mental worries, and prevent infections.

The management of the pregnant cardiac patient when the heart is inefficient should be regarded as a medical rather than an obstetrical problem. Newman (76) emphatically states that on no account should any active interference with pregnancy be taken until heart failure has been adequately treated, for mortality of labor when there is heart failure is very high. Corwin and Herrick (21) estimating about 50%.

It is generally believed that congestive failure advances very rapidly in the pregnant patient, and therefore treatment should be administered at the first signs of failure. Leamon (62) states that the early recognition of congestive is not easy, but is possible if careful examinations are carried out. Symptoms of dyspnea and palpitation together with the signs of tachycardia and edema, must all be evaluated in the light of the physical state. On the other hand, congested neck veins, orthopnea, gallop rhythm, pulmonary edema, pulsus alternans are all advanced signs of failure.
Hamilton (39) emphasizes the importance of persistent rales at the pulmonary bases as a constant and reliable sign.

The treatment of congestive failure used by Hamilton and Thomson (42) at the Boston Lying-In Hospital is a very efficient one. The important points of treatment will be stated briefly. The patient should be put to bed at once. All appropriate aids to rest should be given: special nursing, sedatives, and oxygen. Food, fluids and bowels should be managed carefully. In some cases direct removal of fluid, venesection should be considered. Digitalis and diuretics are given as usual.

They control then the diet and fluids by beginning treatment with the Karell diet, twenty-eight ounces mild (four feedings of seven ounces each) and no other foods or fluids for 24 hours. This is usually continued for two days and then cooked cereal is added, and later orange juice. When failure has cleared up meat, fish, small potato are added to the diet.

Venesection is attempted after conservative means as nursing care, oxygen, and sedatives have failed to relieve the dyspnea and cough in congestive failure. They usually remove about eight to sixteen ounces of blood and have received prompt improvement following this.
Thomson and Hamilton (42) give digitalis to cardiac patients for the control of auricular fibrillation, for rapid rates, and for congestive failure with normal or abnormal rhythm. Once given to a cardiac in pregnancy, they feel it is seldom wise to discontinue it until after the puerperium. They do not routinely digitalize cardiaics who have normal heart rate and rhythms, who have never failed, in anticipation of possible failure.

Jensen (53) recommends an effective dose of digitalis when given, 0.3 gram of powdered leaf three times daily for the first day. The later dosage should be determined by the progress of the case. Bramwell (8) and Longson recommend 20 minims of tincture or 2 grains of powdered leaf, twice daily if the symptoms are not urgent in auricular fibrillation. With this dosage, they don't expect to get full digitilization for five to six days.

Premature Interruption

If the patient is not seen until congestive failure is far advanced, energetic medication for this condition should be tried, and then premature interruption pregnancy is considered. There has been a great deal written on this subject. The first case of interruption of pregnancy for heart disease was reported by and Englishman, Robert Lee (63) in 1845. Unfortunately it was done too late to save the patient's life.
MacDonald (65) was opposed to premature interruption of pregnancy for heart disease. His views dominated the British school for many years.

There followed a too free use of the procedure during the first part of the 20th century so that in 1917, Kellog (56) emphatically made the statement: "That there never was a case of valvular disease of the heart and pregnancy whose circulatory efficiency was not improved by rest and medical treatment, unless moribund. But there comes a time in the treatment of every case of decompensated heart disease when her circulatory efficiency has been raised to a point where she is either fit to continue her pregnancy or where she must be forthwith delivered, because she is now at her high point as an operative risk."

Hamilton, (38) Pardee, (80) and Herrick, (48) have followed Kellogg's ideas on premature interruption of pregnancy. Herrick (48) in 1922 wrote that medical measures should first be tried on a decompensated cardiac patient. If compensation can not be restored, a grave situation is present, "without delivery, the patient may die; without forcible delivery, she will certainly perish and it is usually better to trust nature."

At the present time the indications of premature interruption are well established. They were expressed
best by Pardee (81) at the meeting of the American
Medical Association in Cincinnati in 1934.

At the present time the trend is toward restricting its use to fewer cases. Strayhorn (98) reported 217 pregnancies observed in 93 cardiac patients. Only three were interrupted, Hanley and Anderson (43) did not recommend it for the interruption of any of 65 pregnancies in cardiac patients. Stander and Kuder (97) reported on 386 pregnancies; abortion was induced in 12, premature labor in one. Among the 598 pregnancies in cardiaics reported by Teel, (99) there were 67 induced abortions. Among the 533 pregnancies, reported by Naish, (73) 28 or (5.25%) were interrupted before viability. Jensen (53) reports that there has been no pregnancy that has been interrupted at the St. Louis Maternity Hospital since 1930, until the child was viable.

There is only one indication for the interruption of pregnancy in a patient with rheumatic heart disease whose heart failure will not respond to medical treatment. Medical treatment should be used, because there maybe improvement to such an extent which will make interruption unnecessary. In some cases where McIlroy and Rendel (70) had decided to interrupt the patients responded to medical treatment and later went on to term.

Auricular fibrillation has been considered as an
absolute bar to continued pregnancy by Hamilton and Kellog (41) and Bramwell; (6) but women with auricular fibrillation have successfully bore living children. Auricular fibrillation responds to digitalis, and if effort does not cause excessive tachycardia, the arrhythmia need not preclude successful pregnancy, though it does render the prognosis less favorable.

Certain social factors also enter into the picture in addition to the medical indications for interrupting the pregnancy prematurely. Donovan (28) mentions the parity of the patient, occupation and necessity for hard work. If the pregnant patient is an elderly primipara, other factors being equal, there is, more justification in allowing some risk to be undertaken in hope of at least one live child. If, or the otherhand, there are one or more living children, one can expect an easier labor, and there is more justification for allowing the pregnancy to progress. Social conditions affect the treatment in doubtful cases to the extent that it is of serious importance to a woman, who is a wage earner herself or has to perform household tasks, that her heart be as competent as possible, than it is to a woman who can afford to have nursing or maid service.

The term of gestation is usually the method of determining the procedure to be used in interrupting the
pregnancy. Donovan (28) as well as many other writers believe that up to two months the emptying of the uterus is a relatively easy and safe procedure, and it can be performed in one stage with few risks of hemorrhage. After three months, the one stage operation carries risks of hemorrhage and patients bear the loss of blood badly. The operation is performed after some previous dilatation by guaze, tents or bougies. After the fourth month, the question of hysterotomy may arise, and this has the advantage that it can be combined with sterilization. The nearer the patient is to term, the greater the justification for allowing the pregnancy to proceed to viability when caesarean section can be performed.

Conduct of Labor.

Labor in the cardiac patient has often been said to be of shorter duration than in the non cardiac, but the literature does not indicate that there is any change in the duration of labor in the cardiaics. Turino and Antony (100) report that the average length of hours in primiparae was 13 hours and 15 minutes, and in multiparae was 10 hours and 26 minutes. In marked contrast to figures was that of Deichman an Kornfeld's (22) estimation that the average duration of labor in 82 primiparae with heart disease to be 20 and one half hours. Blumenfeld (3) quotes
17 hours as the average duration of labor. Nelson and Eades (75) found in 333 cases of labor in cardiac women (91 primiparae and 241 multiparae) that the average duration of labor very nearly corresponded with the standards of the normal women.

Much has been written on the conduct of labor during pregnancy. A great deal of which is based on theory. My plan is to mention briefly only a few of the more important principles in the management of labor. Since one is unable to predict what the disease heart will do, it is very necessary to have these cardiac patients delivered in the hospital. Eastman (30) recommends a week or two of preliminary rest in the hospital as a preparation for parturition.

For patients of Class I (American Heart Association) in whom everything has been going well, a delivery at term with low forceps will give good results according to King. (58)

Under ideal conditions, the cardiac patient Class I, in a vast majority of cases, begins her labor with cardiac compensation and with the proper amount of cardiac reserve. This can be maintained throughout the first stage of labor by adequate amount of morphine, sedatives, and various analgesics. Reis and Frankenthal (86) state the use of morphine still furnishes the best means of insuring rest
during labor, and therefore feels that a liberal use of morphine is doubly indicated for the cardiac patient. As long as there is no evidence of cardiac distress, labor should be allowed to proceed routinely.

A definite amount of muscular effort is required to complete the second stage of labor spontaneously. It is generally considered that the repeated effort of bearing down is too great a strain on the already diseased heart, hence in almost every discussion in the literature, the trend is to eliminate the second stage of labor. (86) (58) (30)

If evidence of mild cardiac embarrassment appears, labor may be slowed down to let the patient rest. Eastman (30) recommends morphine and digitalis in these cases where the cervix is partially dilated. Under morphine, labor pains may cease for three to four hours, and the patient is allowed to rest; signs of embarrassment will disappear and when pains recur, the patient may be allowed to continue in labor until full dilatation is reached, and then apply forceps. If this treatment is not effective, and signs of cardiac embarrassment persist, labor must be quickly terminated; if early in labor by the abdominal route; after full dilatation, by forceps. (53)

Eastman (30) recommends the semirecumbent position
for delivery of dyspneic cardiac patients, as well as the use of sandbags to be applied as a weight on the abdomen after delivery. Its use is based on a hypothetical basis that it might prevent a sudden muscular relaxation in the abdomen with a consequent cardiovascular collapse.

More drastic methods of terminating labor are used in those cases which are found in Class IIB or III of the American Heart Association Classification. It is in these groups that the entire mortality is found. (4) Women whose heart condition has ever justified this classification of IIB, should have been advised against pregnancy or if they were in a better rating, failed to follow instructions. Patients seen in the first trimester, who have previously decompensated, and enter pregnancy in this state should not be permitted to carry on. Therapeutic abortion should be advised before the fourth month, after the decompensation has been treated in the proper manner. (75) If the patient is seen late in the pregnancy, caesarean section is justified.

Patients belonging to Class III and who are seen after the third month, should likewise be treated. Delivery of this class of patients by any known means carries more than 50% mortality. (30) (47) If these
heart disease who have had as many children as they can manage, and in whom contraceptive advice is usually ineffective. Before sterilization, however, one should be fairly reasonable that this patient will never be able to, or desire to have more children.

Pulmonary edema is a most drastic event in heart disease and pregnancy. Jensen (53) states that it should be treated by two measures: venesection and morphine. If labor is advanced, it should be quickly terminated, but all drastic measures involving great shock and strain are exceedingly dangerous. He also states that the use of amyl nitrite may be beneficial.

The choice of anesthesia is a subject in which there is considerable disagreement. In the hands of some writers, chloroform has been successful, while other authors favor ether. Pardee, (81) Carr and Hamilton, (12) and Stander and Kuder (97) are favorably disposed to ether. Carr and Hamilton (12) consider ether unsuitable when the fetus is premature. The indications for gas and oxygen is also the subject of much controversy. Stander and Kuder (97) maintain that they can't get satisfactory anesthesia with it, without producing a certain amount of anoxemia; therefore do not use it. Spinal anesthesia has only had limited use in
this country. Jensen (53) feels that it reduces cardiac output and is especially dangerous in the Trendelenburg position, because it reaches the respiratory center and reduces the lethal dose to one-half.

In the end, the choice of anesthetic to be used depends on individual preference and choice as well as skill of the person administering the drug.

Post Partum

Care of the cardiac patient doesn't end with the delivery, but should be carried into the puerperium. Clahr and Greenstein (16) report that there were five women who delivered without difficulty and showed signs and symptoms of cardiac decompensation within 10 days post-partum.

Henderson (47) advises that the cardiac patient requires a close observation during the puerperium, as there frequently occurs two to three days after delivery, a period of exhaustion and the patient feels more ill than at any time during the pregnancy. The average patient, he finds, requires three weeks in bed and the more severe ones a longer time.

Carr and Hamilton (12) in reporting their observations on 500 cardials, showed that a great majority of complications that occurred before deliver with the exception of respiratory infections were dependent on heart disease,

In general the facts seem to be that there is no great mystery about babies born of cardiac mothers. If they are born after the 35th week, their chance for
child.

Teel (99) observed that delivery of cardiascs by low forceps yielded a lower fetal death rate than spontaneous delivery is of great interest.

In terms of maternal and fetal deaths, babies born of cardiac mothers are extremely costly. The question is frequently asked if there is any danger of a child born of a cardiac mother to be born with a heart defect or later develop heart disease. Thomson and Hamilton (42) state that there is no reason to think that there is such a tendency. A cardiac who has a child with congenital heart defect is a coincidence, rare enough so that it does not warrant concern in any individual case.

Rheumatic fever, however, is known to have a tendency to recur in families.

There is no reason why the patient, unless she is to exhausted, why she cannot nurse the baby.

Summary

Adequate prenatal care should be given early in pregnancy with a thorough examination of the heart and a diagnosis of heart disease determined at first visit. The careful observation given to cardiac patients during pregnancy has greatly reduced the death rate from heart disease and pregnancy. Bed rest should be indicated to
preserve heart tone. Decompensation should be treated early and thoroughly, and not until treatment has failed, should pregnancy be interrupted. The indication for interruption of pregnancy is heart failure that does not respond to treatment. Cardiac symptoms arising during labor, require prompt use of digitalis along with sedatives. If these distressing symptoms persist early in labor, caesarean section is indicated. Pulmonary edema in pregnancy is treated with morphine, and venesection. Sterilization is frequently used with caesarean section in patients who have damaged hearts and have had as many children as they can handle. The choice of anesthetic depends a great deal on individual preference. There is a high infant mortality rate among cardiacs delivered by caesarean section. Low forceps gave a lower fetal mortality than spontaneous delivery. Lactation should only be avoided when heart failure threatens, and all means must be employed to preserve cardiac strength.
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