Effect of Pregnancy on the Course of Heart Disease

Re-evaluation of 106 Cardiac Patients Three to Five Years after Pregnancy

By Mary M. Miller, M.D. and James Metcalfe, M.D.

One hundred and six patients have been restudied three and one-half to 5 years (average 4.1 years) after they were observed with pregnancy and heart disease at the Boston Lying-in Hospital.

This re-evaluation indicated that the altered circulatory dynamics of pregnancy may temporarily decrease functional capacity. However, no permanent change in degree of heart disease could be directly attributed to the pregnancy for which these patients were followed in 1950 and 1951.

The woman with heart disease who has entered or is planning pregnancy will ask a series of questions involving her immediate and remote prognosis. One of the questions involves her chance of surviving pregnancy. Many studies have been reported evaluating the mortality during pregnancy and the puerperium in women with heart disease. This mortality varies from less than 1 per cent to more than 3 per cent in patients under careful medical management throughout their pregnancies. As pointed out by Hamilton in his recent summary of cardiovascular problems in pregnancy, the immediate maternal mortality will be influenced by the severity of the heart disease at the time of pregnancy judged by a careful review of the patient’s history, with particular regard to

the previous occurrence of episodes of heart failure, the maternal age, the availability of good medical and obstetrical advice and the cooperation of the patient in accepting this advice. It will also be affected by the policy of the patient’s physicians toward the interruption of pregnancy, since if pregnancy is interrupted early in all patients with severe heart disease, the immediate maternal mortality might decline, possibly at the cost of an increased fetal mortality.

A second question to be expected from the woman with heart disease entering pregnancy is what chance she has of producing a living infant. The infant mortality when the mother has heart disease has been studied in several large clinics. Bunin and Appel reported an infant mortality rate of 6 per cent in women with compensated heart disease and one of 15 per cent for infants of mothers in congestive heart failure, excluding the fetuses lost through therapeutic interruption. If to this is added the fetal mortality due to therapeutic interruption of pregnancy, the total fetal mortality may be as high as 35 per cent in women with congestive failure during pregnancy. Litzenberg in a recent review of

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This work was done by Dr. Metcalfe during the tenure of an Established Investigatorship of the American Heart Association.
the literature states that the mortality of infants born to patients classified functionally in class I and II by the American Heart Association Classification will be the same as in patients with no heart disease, while those born of mothers in class III and IV, under the same classification, will have a 30 per cent mortality.

Thus, these two questions can be answered in fairly definite terms. The woman with well compensated heart disease, who is class I or class II by the functional classification of the American Heart Association, has better than a 97 per cent chance of surviving pregnancy and about as good a chance of producing a living baby as the woman without heart disease.

A third question that the pregnant woman with heart disease logically may be expected to ask is in regard to her prognosis for life and health, once the immediate dangers of pregnancy are past. Few data are available to answer that question. For this reason a follow-up study of those women with heart disease who were seen during pregnancy in the Boston Lying-in Hospital is being made. This is the first report on that study.

**Material**

In July 1950 Dr. C. Sidney Burwell and his associates assumed responsibility for the medical clinic at the Boston Lying-in Hospital. In the ensuing 18 months, 91 cardiac patients were delivered, and an additional 15 patients, delivered shortly before July 1950, were seen and evaluated at a postpartum visit to the medical clinic. This total of 106 patients included 92 with rheumatic heart disease, 8 with congenital heart disease, 1 with hypertensive cardiovascular disease, 1 with combined hypertensive and rheumatic heart disease, and 4 with "potential" rheumatic heart disease. The patients, at the time of pregnancy,* were classified according to functional capacity (American Heart Association Classification) as follows:

- No heart disease† ................. 4
- Class I cardiac disease ............ 64
- Class II cardiac disease .......... 19
- Class III cardiac disease ......... 14
- Class IV cardiac disease .......... 5

In the group there were 16 interruptions of pregnancy because of heart disease, 2 interruptions for noncardiac reasons, and 4 spontaneous abortions. Eighty-four patients continued through pregnancy (81 of these had a living baby).

**There were no maternal deaths during pregnancy or in the postpartum period in this group of 106 patients.**

These 106 patients were recalled in order to study the evolution of the mothers' heart disease, and thereby to clarify the course of cardiac patients following pregnancy. The re-evaluation was accomplished in a 6-month period between January and June, 1955. The planned work-up included history, physical examination, vital capacity, electrocardiogram, fluoroscopy with barium swallow, and routine chest film. Such a study was completed in 85 patients who came to the clinic, while a history was procured by telephone or letter in the remaining 21 patients who could not report for more specific study.

This group of 106 was selected only in so far as it comprised all the patients followed within a specified time interval in a metropolitan obstetrical hospital and referred to the hospital's medical clinic because of heart disease. The follow-up period of 3 to 5 years was selected because the changes since pregnancy could be evaluated by the same group of physicians that had supervised the therapeutic regimen during pregnancy. While the follow-up period is short, re-evaluation after even this time serves to indicate certain trends in cardiac patient behavior. Reports of all examinations made were sent to family doctors or to local clinics. The patients were

* Patients were classified as to functional status at the eighth month of pregnancy or at the time of interruption. Ideally their pre-pregnant classification should have been used but we did not see them until they were pregnant.

† Patients with symptoms or signs referable to the heart but in whom a diagnosis of cardiac disease is uncertain. At the time of pregnancy heart disease could not be excluded in these patients.
again classified as to functional capacity (American Heart Association Classification) as follows:

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>No heart disease</td>
<td>8</td>
</tr>
<tr>
<td>Class I cardiac disease</td>
<td>67</td>
</tr>
<tr>
<td>Class II cardiac disease</td>
<td>21</td>
</tr>
<tr>
<td>Class III cardiac disease</td>
<td>7</td>
</tr>
<tr>
<td>Class IV cardiac disease</td>
<td>0</td>
</tr>
<tr>
<td>Dead</td>
<td>3</td>
</tr>
</tbody>
</table>

The changes in classification between the original examination (July 1950–December 1951) and the present examination (January 1955–June 1955) are shown in table 1.

As shown in table 1, the 4 patients who were classified during pregnancy as “no heart disease, undiagnosed manifestation” were, on re-examination, found to have no heart disease, but only a predisposing etiologic factor, rheumatic fever. The total group now classified as having no heart disease also includes 4 patients originally placed in class I. The other 60 patients who had been in class I are classified at the present time as follows: 50 in class I, 8 in class II, 2 in class III. Of the 19 patients originally in class II, there are at present 9 in class I, 8 in class II, 1 in class III and 1 dead. The 14 patients who were in class III are now classified as follows: 5 in class I (improvement in 1 after valvuloplasty), 5 in class II (improvement in 1 after valvuloplasty), 3 in class III, and 1 dead. Of the 5 patients who were class IV during pregnancy, 3 had a valvuloplasty performed after delivery and are now in class I; 2 did not have valvuloplasty, and of these, 1 is now in class III and 1 is dead.

Thus re-evaluation revealed an unchanged functional classification in 65 patients and an improvement in classification in 27 (5 with valvuloplasty). There was worsening of heart disease in terms of functional classification in 14 patients. These data are summarized below:

<table>
<thead>
<tr>
<th>Class</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>106</td>
</tr>
<tr>
<td>After 4.1 years</td>
<td></td>
</tr>
<tr>
<td>Dead</td>
<td>3</td>
</tr>
<tr>
<td>Worse</td>
<td>11</td>
</tr>
<tr>
<td>Unchanged</td>
<td>65</td>
</tr>
<tr>
<td>Better</td>
<td>27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 1.—Comparison of Functional Classification during Pregnancy with Functional Capacity at Re-evaluation Three to Five Years after Pregnancy in 106 Women with Heart Disease</th>
</tr>
</thead>
<tbody>
<tr>
<td>Original Class</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>---------------------------------</td>
</tr>
<tr>
<td>No heart disease</td>
</tr>
<tr>
<td>I–64</td>
</tr>
<tr>
<td>II–10</td>
</tr>
<tr>
<td>III–14</td>
</tr>
<tr>
<td>IV–5</td>
</tr>
</tbody>
</table>

The number of patients in each functional class during pregnancy is indicated at the left hand column of the table. The number of women in each class at re-evaluation is indicated at the top of the table. The origin of each of the present groups can be determined by locating them horizontally in the table so that their original classification is seen at the left. The heavily outlined squares contain the numbers of patients whose classification has remained the same. To the left of these squares are seen the number in each of the original classes whose present classification is improved. To the right of the darkly lined squares are seen those whose present status is functionally worse than when evaluated during pregnancy.

In 6 of the 27 patients who showed an improvement in functional classification, the change was attributed to an operative procedure performed since pregnancy. One patient with a coarctation of the aorta was much improved following excision of this lesion.* Five valvuloplasties were performed after pregnancy for relief of mitral stenosis, with definite improvement in each case. In some of the other patients in whom functional classification improved, the improvement may have been more apparent than real; the altered dynamics of pregnancy may well have temporarily diminished functional capacity. In other instances there may have been spontaneous

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* A second patient with a coarctation of the aorta was not operated upon because of an associated papillary cystadenocarcinoma of the ovaries; a third patient has done so well that excision has not been advised.
EFFECT OF PREGNANCY ON HEART DISEASE:

healing of inflammatory valvular lesions in
the interval between the 2 examinations. 4

In the group of 14 patients who showed
worsening of heart disease, there were three
deaths. These are discussed later. The re-
maining 11 patients may be compared with
those who showed improvement or no change
in functional classification. The group that
showed progression had an average age of
31.5 years, which did not differ significantly
from the average age of 33.1 for the improved
group, or 31.7 for the unchanged group. The
average number of pregnancies in the patients
who progressed was 2.6 per patient, which
does not differ from the average of 2.5 for
the improved group,† or 3.1 for the unchanged
group. The patients who are now pregnant
include 3 of the 11 who progressed, 2 of the
27 who improved and 4 of the 65 who re-
mained unchanged.

Of the 11 patients who showed progression,
the three who are now pregnant note increased
symptoms during their present pregnancies.
The progression of heart disease in the other
eight patients of this group does not appear
to be directly related to past pregnancies.
It seems rather to be a result of the evolution
of rheumatic heart disease.

The three deaths in the total group of 106
patients were all confirmed by official copies
of Certificates of Death. These three patients
are of such interest and significance that their
histories will be outlined.

The first patient had a diagnosis of both
hypertensive cardiovascular disease and rheu-
matic heart disease with mitral stenosis.
She was first seen at the age of 27 with a past
history of recurrent rheumatic fever and of
hypertension of nine years' duration. There
had been a miscarriage at 20 weeks' gestation
at the age of 26. The only symptom during
the pregnancy for which she was seen was
persistent headache. Physical examination
revealed elevated blood pressure (190/110–
210/120), grade II eyeground changes, and an
enlarged heart with signs of mitral stenosis
and mitral insufficiency. There was electro-
cardiographic and x-ray evidence of left
ventricular hypertrophy. Her functional clas-
sification was class II. The pregnancy was
interrupted at five months gestation, and the
patient was sterilized. She died three years
later of a cerebral vascular accident.

The second patient was seen first at the
age of 25 with a clear history of multiple
attacks of rheumatic fever and with physical
findings of mitral stenosis, mitral insufficiency,
aortic stenosis and aortic insufficiency, as
well as atrial fibrillation. She had a history of a
normal full-term delivery at 21, and a spon-
taneous abortion at three months at the age
of 22. This patient had congestive heart
failure early in the pregnancy for which she
was seen at the Boston Lying-in Hospital.
Her functional classification was class III.
Electrocardiographic and x-ray abnormali-
ties were present. The pregnancy was inter-
ruped in the third month and the patient
was sterilized. She died four years later, and
autopsy showed evidence of acute rheumatic
fever, as well as multiple valve lesions.

The third patient, 40 years old when first
seen, had rheumatic heart disease with both
aortic and mitral valvular disease. There was
a past history of a single attack of rheumatic
fever. She had taken digitalis irregularly for a
period of 13 years. She had delivered a still-
born child at 23; two subsequent pregnan-
cies were complicated by toxemia, but viable
babies were delivered by cesarean section.
History and physical examination during the
fourth pregnancy revealed early cardiac failure.
Her functional classification was class IV.
Electrocardiogram showed left bundle branch
block; chest x-ray films revealed cardiac en-
largement and increased vascular markings.
The patient was admitted for interruption,
but had a spontaneous abortion at three and
one half months. Her failure cleared and she
returned to work. She died six months later in
another attack of cardiac failure.

Therefore, three patients, in a total of 106,
died during the 3 to 5 year follow-up period.
They were all severely ill cardiac patients and
evidence indicates that the pregnancies for
which they were seen did not contribute

†This calculated average excludes one patient
who had 16 viable babies; inclusion of this unusual
patient would give an average for the improved group
of three pregnancies.
directly to their deaths. Indeed, none of these three patients underwent the full circulatory burden of pregnancy. It is a striking fact that none of the women who were allowed to complete pregnancy died in the follow-up period. That the three patients who died were among those with severe heart disease is indicated by the fact that their pregnancies were interrupted.

A re-evaluation, such as was accomplished in this study, offered a unique opportunity to gather data concerning rheumatic heart disease in women of childbearing age. History, physical examination, and laboratory data all contributed interesting information.

A history of multiple attacks of rheumatic fever was found in 28 patients (13 class I, 7 class II, 7 class III, 1 class IV). In this group of 28, there were 10 interruptions of pregnancy and 12 sterilizations, while in the total group of 106 there were only 16 interruptions. Three of the five patients who had atrial fibrillation in 1950 and 1951 are in this group. These observations indicate that patients with a history of repeated attacks of rheumatic fever tend to develop more severe heart disease and warrant special observation during pregnancy.

The most frequently observed valve lesions, single or combined, found in the patients with rheumatic heart disease, were as follows:

Mitral stenosis and mitral insufficiency .................... 28
Mitral stenosis alone .................................. 16
Mitral stenosis, mitral insufficiency, aortic stenosis, and aortic insufficiency ............ 14
Mitral insufficiency .................................. 8

Mitral stenosis was the predominant lesion in over 50 per cent of the rheumatic patients.

Of the 71 patients with rheumatic heart disease who reported to the clinic for a complete examination, 16 were noted to have gained or lost murmurs in the past 3 to 5 years. The murmur of mitral stenosis was lost in 4 and gained in 2 cases; that of mitral insufficiency was lost in 2 and gained in 1 case; those of mitral stenosis and mitral insufficiency were lost in one case; that of aortic stenosis was gained in five cases; and murmurs indicating a combination of mitral insufficiency and aortic stenosis were gained in one case. The disappearance of murmurs following delivery may be due to the altered circulatory dynamics of the pregnant state. The murmur that most frequently appeared was that of aortic stenosis, as might be expected in an older group. One of the two patients in whom the murmur of mitral stenosis appeared was in the sixth month of a third pregnancy at the time of the re-examination; the other patient was a 23 year old girl in whom the progression of rheumatic heart disease was apparent in that she showed a concomitant decrease in functional capacity.

Two of the 16 patients who in 1950 to 1951 had signs of, or a past history of, cardiac failure were dead at the time of the re-evaluation. Of the remaining 14 patients with previous failure none has shown progression of heart disease in terms of functional classification. However, only 3 have not been sterilized and only 1 has had a subsequent pregnancy.* Five valvuloplasties were performed on patients who had evidence of cardiac failure in 1950 to 1951; all these were improved but only 2 of the 5 had not been previously sterilized; these patients have not had a subsequent pregnancy. There was no clear evidence of cardiac failure in any of the patients who were re-examined although enlarged, tender livers were palpable in 2 patients.

Atrial fibrillation persisted in all patients who had this rhythm in 1950; of these, 4 are living and 1 is dead. Two patients have developed atrial fibrillation since their previous examinations. Of these 2, 1 had intermittent episodes of atrial fibrillation in 1950, and the other had an undiagnosed arrhythmia during pregnancy.

Not all of the 85 patients who were re-examined had electrocardiograms and full size x-ray films of the chest made during pregnancy. In cases where old tracings and films were available for comparison, there

* This patient was pregnant at the time of examination and was found to have an enlarged tender liver without other clear evidence of cardiac failure or of active rheumatic fever.
was evidence of a change in the electrocardiogram in 10 cases, 3 showing improvement and 7 showing increased electrocardiographic abnormality. Comparison of available x-ray films showed a smaller heart or decreased vascular markings in 9 patients, and a larger heart in 5 patients. There was no apparent relationship between the x-ray and electrocardiographic changes and the changes in functional capacity except in patients who had had valvuloplasty. Here, there was definite correlation.

In the eight patients with congenital heart disease, cardiac catheterization was not performed to assess the nature of the lesions. Probable diagnoses based on available work-up were as follows: interatrial septal defect, 1 patient; subaortic stenosis, 2 patients; pulmonic stenosis, 2 patients; coarctation of the aorta, 3 patients.

Discussion

The course of the 106 cardiac patients who were observed during this study was surprisingly good in regard to both survival and well-being. There were no maternal deaths during pregnancy or in the postpartum period in this group of 106 patients. Three to 5 years after their pregnancies only 3 of the 106 patients were dead. Sixty-five patients (61 per cent) were functionally unchanged according to the American Heart Association Classification, and 27 patients (26 per cent) showed an improvement in their cardiac functional ability. In 5 of these this improvement could be attributed to valvuloplasty and in another to resection for coarctation of the aorta. Only 14 patients (12 per cent) showed progression of heart disease in terms of functional classification.

Because of the small number of patients with congenital heart disease in this study, no conclusions can be drawn as to the effect of pregnancy on congenital heart disease, and the following comments apply to the 92 patients with rheumatic heart disease.

Several explanations may be invoked to explain the relatively benign course of the patients in this study. As has been known since Grant’s classic work, the adult patient with valvular heart disease may maintain well-being for many years before the intervention of congestive heart failure. Furthermore, all our patients had already survived to the childbearing age and thus had passed the period of greatest mortality in the natural history of rheumatic fever. According to Wilson, two thirds of the total mortality in children with rheumatic fever occurs before puberty and of those who survive to age 15, over 70 per cent can be expected to survive to age 40. In the study of Bland and Jones of 1,000 patients who survived their first attack of rheumatic fever at an average age of 8 years, 202 were dead at the end of 10 years, and only an additional 99 died in the second 10 years following their initial attack of rheumatic fever. Twenty years after the acute attack, 699 of the original group were alive (380 with rheumatic heart disease) and of these, 3 out of 4 had little or no limitation. Thus, in a real sense, our patients had been selected by the natural history of rheumatic fever as a group with a relatively good prognosis. In addition, in 5 of the patients with severe rheumatic heart disease and in 1 with congenital heart disease (coarctation of the aorta) the natural history of the disease was altered by surgery.

The patients were further selected by the fact that they were well enough to become pregnant and to complete it, except for the 16 who had therapeutic abortion.

In the past, the influence of pregnancy on the natural course of rheumatic heart disease has been studied largely by reviewing the childbearing record in known cardiac patients. Boyer and Nadas, in a careful review of the age at death in nulliparous women in comparison to those who had survived pregnancy, came to the conclusion that women who have borne children do not die sooner than either nulliparous women or males with rheumatic heart disease. Furthermore, according to their studies, even multiple pregnancies could not be held accountable for any reduction in the average age at death. This study wisely excluded patients who had not survived to the end of the reproductive period (age 40) be-
cause some nulliparae died too early to have a chance at pregnancy.

Little follow-up work comparable with that presented here has come to our attention. In the discussion of a paper presented by Carr and Hamilton, Dr. B. P. Watson reported that of 223 patients with heart disease who survived pregnancy, 9 died within 1 year after delivery, 6 died in the second year after delivery and 31 were dead within 10 years of delivery. Naish's attempt to study the remote effects of pregnancy in cardiac patients is largely invalidated by the fact that she was able to report on only 95 of a total of 426 pregnant cardiac patients. Of this group of 95, seen an average of 5 years after pregnancy, 3 were dead and 37 per cent were worse than before pregnancy.

Haig and Gilchrist conducted a follow-up study of 295 women observed during pregnancy from 1 to 10 years previously. The average duration of follow-up is not given. Forty-one women had died since pregnancy, the major death occurring in those women who were classified as class IV during pregnancy. They felt that the burden of pregnancy was capable of causing congestive heart failure in a woman roughly 5 to 7 years before it would appear in the normal course of events.

The careful studies of Gorenberg and Chesley lead to a more optimistic conclusion. They state "There is nothing to suggest that the heart is damaged by childbearing or that the course of the rheumatic process is thereby accelerated." They examined 260 women 9 to 14 years after delivery. The groups are therefore to some extent not comparable, and this may explain their observation of a higher annual death rate (26.6 per 1000 per year) than was observed in the relatively short follow-up period of the present series (8.0 per 1000 per year). Cardiac surgery, by altering the natural course of rheumatic heart disease, has probably also played a part in lowering the annual mortality in our group.

Valvuloplasty performed since pregnancy has produced impressive results in the five patients in whom it was performed; all had functional improvement. The greatest improvement in the total group of 106 patients was found in three of the patients who had valvuloplasty. This symptomatic improvement was directly correlated in the 2 patients who reported to the clinic with improved x-ray findings, i.e., smaller heart size and decreased pulmonary vascular markings, and a decreased notching of the P waves in the electrocardiogram. These results make it necessary to discard a therapeutic concept prevalent in 1950 and 1951, i.e., that interruption of pregnancy for cardiac indications should automatically be followed by sterilization. Since the functional capacity of cardiac patients may be changed from class IV to class I by operation, this concept is no longer valid. With increasing knowledge and improving methods of therapy the indications for interruption of pregnancy are becoming more limited.

It should be emphasized again that the improvement in functional ability of some of the patients seen in this study may have been due in large part to the fact that their first classification was made during pregnancy, while in the great majority their follow-up evaluation was while nonpregnant. However, nine of the patients re-evaluated were pregnant at the time of the present study. Despite the circulatory burdens of pregnancy the indications for functional classification during the period of their present pregnancy.

With regard to management as a factor affecting prognosis the following points may be made. A significant fraction of the patients in the medical clinic of the Boston Lying-in Hospital, between one third and one half, are not aware that they have heart disease until the diagnosis is made during the pregnancy. This is partly because they have not been to physicians and partly because the increased cardiac work of pregnancy tends to increase the evidence of valvular heart disease and to make the diagnosis less difficult. There seems to be no doubt, then, that through the Lying-in Hospital a considerable number of women come under systematic medical supervision who otherwise would not have it. We take
great pains in the medical clinic at the Boston Lying-in Hospital to try to arrange for a continuing follow-up for all of our patients with heart disease. They are referred with complete information to a private physician of their own choice or to one of the many competent medical or cardiac clinics in the community. We are impressed with the probability that the education of these patients during the months of pregnancy appears in many to be followed by a more responsible attitude on their part toward their cardiac disease.

SUMMARY
One hundred and six patients have been restudied three and one half to five years (average 4.1 years) after they were observed with pregnancy and heart disease at the Boston Lying-in Hospital. No patient died during pregnancy or the puerperium. Only three have died since; 92 patients have shown either no change or an improvement in functional classification.

This re-evaluation indicated that the altered circulatory dynamics of pregnancy may temporarily decrease functional capacity. However, no permanent change in degree of heart disease could be directly attributed to the pregnancy for which these patients were followed in 1950 to 1951.

SUMMARIO IN INTERLINGUA
Cento sex patientes esseva restudiate a periodos de inter 3½ e 5 annos (periodo median: 4,1 annos) post que illas habeva essite observate con graviditate e morbo cardiac al Maternitate Boston. Nulle paciente morive durante graviditate o puerperio. Solmente tres ha morite al tempore del presente studio; 92 ha monstrate un melioration del classification functional o nulle alteration.

Iste re-evaluation indica que le alterate dynamica circulatori del graviditate pote temporarimente reducer le capacitale functional. Tamen, nulle alteration permanente del grado de morbo cardiac poteva esser attribuite directemente al graviditate pro que le patientes esseva sub observation in le annos 1950 a 1951.

REFERENCES
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