Congestive Phenomena Occurring in Pregnant Women with Heart Disease

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Pregnant women with heart disease may exhibit the signs of either pulmonary or peripheral congestion. Evidences of venous congestion in the lower extremities, including the development of pitting edema, are not unusual during pregnancy in normal women and should not be taken as evidence of danger, even in the cardiac patient, without supporting data. In pregnant women with heart disease significant congestive phenomena occur most often in association with mitral stenosis. In this situation they are due to the obstruction at the mitral valve that leads to congestion and edema of the lungs. In a smaller number of pregnant women with heart disease congestive phenomena are due to myocardial failure, and in this case the congestion may affect either the pulmonary or the peripheral circulation according to whether left or right ventricular failure is present. Since, in well over half our pregnant cardiac patients, the major hemodynamic problem is mitral stenosis, significant congestive phenomena during pregnancy are observed most frequently in the lungs.

The left ventricular failure that rarely occurs in pregnant women with heart disease is most often associated with aortic valve disease and only rarely with hypertension. Ventricular failure may also occur in association with specific disease of the cardiac muscle. The most common cause is acute rheumatic myocarditis. It has also been observed in other varieties of myocardial disease including myocardial infarction.

Whatever the predominant cardiac lesion in congestive failure may be, such failure is intensified or indeed precipitated by a long list of extracardiac factors, including certain specific physiologic changes of pregnancy.

Physiology of the Maternal Circulation During Pregnancy

The changes in the maternal cardiovascular system during pregnancy are complex and incompletely understood, but 3 of them, the increases in heart rate, cardiac output, and blood volume lead directly to vascular congestion. These 3 changes are closely related, at least in time; all reach their highest level, not at term, but from 6 to 10 weeks before delivery, and then decline significantly until labor ensues. At their peak values, the resting pulse rate averages 10 beats per minute above the nonpregnant value, the resting cardiac output is increased by about 40 per cent, and the blood volume is elevated by about 30 per cent of control values. It should be remembered, however, that this statement of general performance indicates only the average behavior of a large number of pregnant women with and without heart disease; in the individual patient variations in the intensity and in the time of maximal change undoubtedly occur. The mechanism by which these changes may lead to disability and occasionally to death in pregnant women with heart disease is best understood if mitral stenosis is taken as an example.

Physiology of Mitral Stenosis

The basic defect hemodynamically in mitral stenosis is an obstruction to the flow of blood from left atrium to left ventricle. The maintenance of a normal volume of blood flow
through the narrow valve orifice requires an increase of pressure in the left atrium, and a pressure rise of similar magnitude in the pulmonary veins and pulmonary capillaries. An increase in cardiac output in such circumstances necessitates a further rise in left atrial, pulmonary venous, and pulmonary capillary pressures. Effective blood flow through the mitral valve occurs only during diastole; the increase in heart rate that accompanies pregnancy cuts down the diastolic time for flow through the mitral valve, so that a further increase in left atrial, pulmonary venous, and pulmonary capillary pressure is necessary to maintain cardiac output. The increase in total blood volume that accompanies pregnancy is apparently shared between the pulmonary and peripheral vascular circuits. This increase in pulmonary blood volume distends the pulmonary vascular system and, in patients with significant mitral stenosis, leads to still greater increases in pressure in the capillaries. When the pressure in these vessels exceeds approximately 30 mm. of mercury, it leads to transudation of fluid; if pulmonary capillary hypertension persists, the transudation causes pulmonary edema. The woman with mitral stenosis, then, is in increased danger of developing pulmonary edema during pregnancy. Such pulmonary edema is due to mechanical obstruction to blood flow and is different in mechanism from the pulmonary congestion secondary to left ventricular myocardial failure. The distinction between these 2 varieties of pulmonary congestion should be kept in mind in planning the therapeutic approach in a given patient.

**Prevention of Venous Congestion**

The principle of managing mitral stenosis during pregnancy is to adopt ways and means that limit or restrict the cardiac output, the total blood volume, and the cardiac rate. The total cardiac burden of the pregnant woman includes not only pregnancy but a great variety of other burdens. The physician must be concerned with the algebraic sum of these factors that influence the output of the heart, the rate of the heart, or the volume of blood in the vascular tree. He must think constantly of the total cardiac load resulting from the patient’s total situation, including pregnancy.

In most pregnant women with heart disease, congestive phenomena can be prevented by a program of management that applies these principles to the individual patient. The objective of management is not necessarily to keep the total cardiac load at a minimum. What is needed is to keep the total load safely within the tolerance of the individual patient.

In constructing such a program of management we must consider factors that have 3 essential characteristics. First, they are not necessary to the continuation or success of the pregnancy; second, they impose a cardiac burden; third, they can be limited or eliminated. Important individual factors in patients’ lives that lead to an increase in heart rate, in cardiac output, or in blood volume include the following: (1) physical activity, (2) emotional stress, (3) ectopic rhythms with tachycardia, (4) anemia, (5) obesity, (6) infections, (7) hyperthyroidism, (8) factors that influence the blood volume, such as infusions, transfusions, and increased intake of sodium. Some of these factors are more frequently operative during pregnancy than in the non-pregnant woman. For instance, iron deficiency may manifest itself for the first time as anemia during pregnancy. Infections of the upper respiratory tract or the genitourinary tract are common in pregnant women. The hypertensive toxemias of pregnancy sometimes add to the total burden in women with heart disease; control of the hypertensive disorders of pregnancy by sodium restriction has been an important factor in lowering the maternal mortality in women with heart disease. So has the virtual elimination of puerperal sepsis.

Attention must also be given to prevention of 2 specific diseases, acute rheumatic fever and subacute bacterial endocarditis. In our opinion prophylaxis against rheumatic fever is advisable in all patients with rheumatic heart disease during and for an indefinite period after pregnancy. The customary pro-
Management of Venous Congestion

"In a rare patient from the prenatal medical clinic and an occasional patient first seen late in pregnancy, symptoms and signs of venous congestion have developed. Peripheral edema, while disturbing in its prognostic implications, is seldom dangerous. Pulmonary congestion and pulmonary edema carry danger of immediate death and therefore demand prompt and organized treatment."

Hospitalization and Rest

"Every patient with pulmonary congestion observed in the clinic is admitted to the hospital with the objective of immediate rest. We believe this is achieved by allowing the patient to pick her own best resting position until pulmonary edema has cleared. This is often in an easy chair. A bed is made more comfortable by placing its 'head' legs on four-to eight-inch blocks, so that the entire frame is tilted. Elevation of the head of the bed and flexion of the patient's knees allow comfortable maintenance of the sitting position. Elastic stockings are applied above the knee to combat thrombo-embolic disease. The use of a bedpan is usually more tiring than the use of a bedside commode or travel to the toilet by wheelchair."

Sedation

"Increased mental and physical rest is the aim of sedative therapy. In our experience morphine in small, repeated doses has no equal for this purpose. An initial dose of 10 mgm. is given intramuscularly, followed at four-hour intervals by equal or smaller doses, as indicated."

Sodium Restriction and Diuresis

"The increased blood volume of pregnancy is one of the identifiable factors in distention of the pulmonary vascular tree. If pulmonary congestion appears, sodium restriction to about 200 mgm. daily is usually effective even if a similar program at home has not prevented the development of pulmonary congestion. In such a diet, salt-free milk and bread are used. Dialyzed low-sodium milk is now available. It is palatable and relatively inexpensive."

In patients who accept and follow rigid sodium restriction, diuretic agents are seldom necessary in our experience. In patients exhibiting important venous congestion despite sodium restriction, diuretic agents are employed. Before entering upon a program of forceful or prolonged diuretic attempts, the physician must evaluate the importance of venous congestion in his patient. Edema of the legs, unaccompanied by other evidence of venous hypertension, is less dangerous and disabling than strenuous diuretic medication. When a program of diuresis is decided upon, our current practice is to begin with 500 mg of chlorothiazide twice daily for 3 days of each week, judging our success by changes in fasting body weight measured daily, and evaluating the serum electrolytes each week before diuretic therapy is reinstated. When such a program does not result in satisfactory improvement and weight loss, intramuscular mercurial diuretics are tried. The possibility of electrolyte depletion by these measures should be kept constantly in mind.

Methods of Decreasing Venous Return to the Heart

"The venous return can also be diminished, at least transiently, by the application of tourniquets to the extremities or by phlebotomy. These measures are frequently helpful in the acute emergency of pulmonary edema. The level of blood hemoglobin should be checked before phlebotomy, but we have resorted to this measure in emergency situations in anemic patients knowing, in some cases, that transfusion would subsequently be necessary."

When tourniquets are used to obstruct venous return they may initially be placed on all four extremities if they are not so tightly applied that arterial obstruction results. At half-hour intervals one is removed and re-

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*Some of the following paragraphs are extracted in toto from the book, Heart Disease and Pregnancy, Physiology and Management, by the authors.* These extractions are indicated by quotation marks.
placed after one half-hour, at which time another is removed, rotating the obstruction in an orderly serial fashion. Sudden removal of several tourniquets would result in a sudden large increase in venous return which might be dangerous.''

Methods of Slowing the Heart Rate

"In patients with mitral stenosis, tachycardia is dangerous since it decreases the time available for diastolic flow through the mitral valve. When atrial fibrillation or paroxysmal atrial tachycardia is present, digitalis is the drug of choice in controlling heart rate. In the presence of normal sinus rhythm this drug is frequently disappointing in producing a decrease in heart rate. Indeed, no adequate method of decreasing the heart rate in sinus tachycardia exists. Serpasil is currently being tried for this purpose in our patients. If the tachycardia is accentuated by anemia, thyrotoxicosis, or blood-loss, measures designed to combat these are indicated.''

Digitalis

"Pulmonary congestion is not always due to myocardial failure. Indeed, myocardial failure is an unusual cause of pulmonary congestion in our patients; the common cause is an obstruction to blood flow through a stenotic mitral valve with pulmonary vascular hypertension secondary to the mechanical impediment. In such a situation the chief therapeutic result of digitalis is to slow the heart rate.

"When pulmonary congestion or edema develops in patients with aortic valve disease, then digitalis is indicated. We have, in general, sought to anticipate ventricular failure in such patients, using oral doses of digitalis folia (0.1 Gm. three times daily for five days, then 0.1 Gm. daily) at the earliest suspicion of myocardial failure.

"In the presence of pulmonary edema, rapid digitalization is employed, even in patients we judge to have predominant mitral stenosis. We have used digoxin for this purpose, beginning with 0.5 mgm. intramuscularly, repeating this dose at four-hour intervals for a total initial dose of 1.5 mgm. over a 12-hour period. We do not use this glycoside for maintenance therapy but shift to digitalis leaf.''

Oxygen

"The use of oxygen in the treatment of pulmonary edema has many advocates. It certainly appears to be indicated if it causes symptomatic relief, and is probably indicated when it can be tolerated without apprehension. Unfortunately it frequently does cause apprehension and restlessness, and in such situations its continuance must be decided upon in the light of the individual case. In general, an oxygen 'tent' is tolerated more readily than oxygen administered through a nasal tube, while the face mask is badly received by most patients.''

Other Measures

"The administration of aminophylline in the management of pulmonary edema is indicated for several reasons. It is a bronchodilator, and many believe that bronchoconstriction frequently occurs in conjunction with pulmonary edema. It has the additional advantage of its properties as a xanthine diuretic, and Goodman and Gilman" ascribe direct myocardial stimulation to the xanthines. Usually 0.25 Gm. is given slowly intravenously.''

Prevention of Recurrences

"Following recovery from an acute episode of pulmonary edema, the patient's activity, sodium intake, sleeping position and total program of living must be rescheduled, to avoid recurrences. In pregnant patients strict modification may be necessary only for the duration of pregnancy, but plans for future medical care, including consideration of mitral valvotomy, should be carefully laid for patients who have experienced pulmonary edema.

"The importance of sodium restriction has already been emphasized. Our experience indicates that the diet actually consumed often differs from that recommended. Therefore patients on restricted sodium intake should be seen weekly.

"In our clinic all patients are encouraged
to report at once if symptoms develop or increase. When a cardiac patient misses an appointment we have learned to be concerned. Such patients may fail to turn up because they are in need of additional medical help."

**Cardiac Surgery During Pregnancy**

Despite rigid limitation of the total burden on the patient's heart, an occasional woman is unable to tolerate the cardiac expenditures of pregnancy. If this is judged to be the case in a given patient and if surgical measures are applicable, these should be employed before pregnancy is undertaken. Emergency cardiac surgery during pregnancy has not been found necessary in our experience to date, but we may sometime see a patient, early in pregnancy, in whom evidence of pulmonary congestion persists, despite rigid restrictions accurately followed. In such a patient we would prefer interruption of pregnancy rather than cardiac surgery as the first step toward cardiac rehabilitation. This is sometimes unacceptable for social or religious reasons, and therefore cardiac surgery may rarely be indicated even during pregnancy. It is imperative to make the necessary judgments before persistent congestive failure forces the hand of the surgeon.

The cardiac burdens of pregnancy exhibit certain known variations. The cardiac output, the total blood volume, and the heart rate all reach a maximum 6 to 10 weeks before term. Many patients experience an improvement in symptoms as the point of maximum load is passed and they come into the period of less severe load which precedes delivery. Hamilton and Thomson showed that the incidence of congestive phenomena in pregnant women with heart disease was highest from the thirtieth to the thirty-fourth week, which corresponds to the time of the maximum hemodynamic load of pregnancy.

**Labor and Postpartum Period**

Most patients who have gone through pregnancy without exhibiting congestive phenomena or whose congestive symptoms have been controlled by appropriate therapy are able to go through labor and delivery without intensification of congestive failure. It may be pointed out that the work of labor is discontinuous and that periods of increased work and increased oxygen need are separated by periods of relative rest. It should be emphasized again that the work of the heart in terms of cardiac output is significantly smaller at term than it was 6 to 10 weeks previously, and therefore at the time of delivery a pregnant woman with heart disease has an amount of cardiac reserve which she did not have a month before. It has been found by experience to be important that women with heart disease come up to the time of delivery and labor in optimum condition. Skillfully organized and executed delivery is a vital matter and here, while continued close cooperation is essential, the obstetrician plays the decisive role. The presence of heart disease is not an indication for cesarean section but if a good obstetrical indication for abdominal delivery exists, there is no experience that would warrant the denial of such a procedure to a woman with heart disease.

Congestive phenomena are occasionally intensified or may even develop for the first time during the postpartum period. During this period an intricate series of profound readjustments is being made in the maternal physiology. Some of these adjustments are the reestablishment of normal water and electrolyte balance, a new equilibrium among the hormones and the tissues that produce them, and appropriate changes in the blood volume and in the total capacity of the vascular system. Too little is known about the physiology of the postpartum period to make a didactic or arbitrary application to the management of heart disease. It must be remembered that heart failure can get worse or develop during this period and that the heart disease which has required management during pregnancy still requires management after delivery. Moreover, the patient herself is in a more complex situation and has additional family responsibilities. These matters should all be taken into account in planning.
the postpartum program of a cardiac patient. If congestive phenomena occur during this period, they should be managed by the accepted methods.

In larger scope, pregnancy is an episode in the life of the patient with heart disease—an important episode accompanied by increased danger, but self-limited in duration and generally successfully tolerated. As our understanding of the physiology of pregnancy and the physiology of heart disease has increased the safety of pregnancy in the cardiac patient, other aspects of pregnancy have become increasingly important. One aspect which should concern us here is the importance of pregnancy in bringing women under medical supervision. About 50 per cent of our patients with heart disease were unaware of its existence before pregnancy. Even under our high standards of living and patient care, a surprising number of women have their first contact (since their own birth) with a physician when they consult him for obstetrical help. This has 2 important implications. First, the obstetrician must have a high level of suspicion with regard to heart disease and should develop an effective working relationship with an internist for final diagnosis and help in effective management. Second, the obstetrician and his medical consultant should accept as part of their responsibility the orientation of the patient, not only through the hazards of pregnancy, but through the years that follow. In this sense, pregnancy represents an opportunity for the physician to develop a long-term plan for these young women that will postpone, and sometimes prevent, the development of congestive phenomena in the years ahead.

Keep thy heart with all diligence; for out of it are the issues of life.4

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