Prolonged mechanical ventilation after open heart surgery

Alan Gilston, M.D.
London, England

The mortality of patients who require prolonged mechanical ventilation for respiratory distress after open heart surgery is high. It is still very difficult to predict accurately who will require this treatment and who will survive. Moreover, the reasons why postoperative respiratory distress develops are not always clear. This paper is concerned with a series of such patients. The results with particular reference to the patients' cardiac status and to the mode of death are discussed.

Patients

Twenty-five consecutive patients who required prolonged mechanical ventilation after open heart surgery for congenital or acquired heart disease and who met two criteria were included in this retrospective study. The first criterion was that to justify the term "prolonged mechanical ventilation" the patient required not less than 3 days of ventilator therapy. The second criterion was that in each case there was obvious clinical evidence of the need for it. Many critically ill patients are ventilated for some days after cardiac surgery without any attempt at spontaneous breathing. Such patients were included in this series only if they also showed clear evidence of respiratory distress when mechanical ventilation was interrupted. The criterion used in

this center for initiating mechanical ventilation for respiratory distress after cardiac surgery, for deciding when to attempt its discontinuance and for the weaning procedure has been described,[1-3] and was used in these cases. Basically, this approach relies heavily on clinical signs and pays little or no attention to the blood-gas state, which is commonly not analyzed until ventilator therapy is established, and is largely ignored during weaning. Other measurements of lung function and mechanics are not used.

The *Table* summarizes the nature of the study and the results. Of the 25 patients, 13 (52%) had mitral valve disease. Nine of these patients had additional valve disease or a history of mitral valve surgery. Seven patients (28%) had ischemic heart disease, and five patients (20%) had complex congenital heart disease.

Table. Patients and results

25 patients	
	Men:
	14 (4 survivors)
	Women:
	11 (9 survivors)
Age	
All patients: 7 to 65 yr (median, 46 yr)	
Survivors: 7 to 62 yr (median, 46 yr)	
Deaths: 9 to 65 yr (median, 48 yr)	
Lesions	
Mitral valve disease	
13 patients (8 survivors)	
8 women (8 survivors)*	
5 men (5 died)	
Ischemic heart disease	
7 patients (4 survivors)	
6 men (4 survivors)	
1 woman (1 died)	
Congenital heart disease	
5 patients (1 survivor)	
Start of mechanical ventilation	
Within 24 hr of surgery: 14 patients (9 survivors)	
2 to 21 days after surgery (mean, 5.7 days): 11 patients (4 survivors)	
Duration of mechanical ventilation	
All patients: 4 to 48 days (mean, 14 days)	
Survivors: 4 to 43 days (mean, 14 days)	

* Highly significant: $p < 0.001$.

All of the "mitral" group of patients showed one or more of the following signs before surgery: dyspnea at rest, a cool periphery, cachexia, hepatomegaly, and obvious cardiac enlargement on the chest roentgenogram (cardiothoracic ratio ≥ 0.6). Nine also had cardiac catheterizations and of these, seven had pulmonary hypertension ($PA_p \geq 40$ mm Hg). Four of the seven patients with ischemic heart disease required mechanical circulatory assistance (counterpulsation) for severe heart failure for several days after surgery. Two of the five patients with congenital heart disease had Fontan's operation, and hence a nonfunctioning right ventricle.

Results

Thirteen of the 25 patients survived and left the hospital, including eight of the 13 mitral patients, four of the seven patients with ischemic heart disease, including one of those four who required mechanical circulatory assistance, and one of the five patients with congenital heart disease. There was no significant difference in the duration of mechanical ventilation between those who survived and those who died, the mean period in each instance being 14 days (*Table*). The survival rate for those who required continuance of mechanical ventilation immediately after or within 24 hours of cardiac surgery was twice that of those who required it later, 69% survival compared with 31% survival. But this finding is less significant than it first appears, since the survival rate of the mitral patients was the same in each group, and the remaining patients are too few for meaningful analysis.

There were 13 patients with mitral, or mitral with other valve disease. All

eight of the women survived, but none of the five men. This is highly significant ($p < 0.001$). No other significant relationships could be established from the data shown in the *Table.*

Only four patients (16%) had widespread haziness and mottling on the chest roentgenogram at the time of decision about mechanical ventilation or shortly afterwards. Eleven (44%) had abnormalities at one or both bases, in particular, haziness or small effusions or both. Ten patients (40%) had clear lung fields. There was no significant relationship between these roentgenographic findings and the survival rate.

The PaO_2 shortly before death exceeded 100 mm Hg in 10 of the 12 fatal cases, though the F102 at this time varied from 0.4 to 1.0. Most of these patients died from multiple organ failure, in particular, heart failure and secondary renal failure, with sepsis as an aggravating or even dominating factor in half of them. Only three patients had a tracheostomy and two of these survived, one of them after 43 days of mechanical ventilation.

Discussion

The picture of respiratory distress after cardiac surgery is similar to that seen in the classic adult respiratory distress syndrome after other insults in terms of clinical signs, blood-gas derangement, problems of management, and mortality. The chief difference is in the roentgenographic picture of the lungs, which may be relatively normal, the typical "white-out" appearance of adult respiratory distress syndrome being uncommon and appearing in less than one in five patients in this series.

The approach used in this center to the questions of initiating and terminating mechanical ventilation for respiratory distress after cardiac surgery postulates that the clinical signs, the threat to the patient's life, and the chief benefits of ventilator therapy are related far more closely to excessive respiratory work and pulmonary hypertension, both well-established abnormalities in adult respiratory distress syndrome, and to their ill effects on the heart than to deterioration in the blood-gas state. In other words, in this view, derangement of lung anatomy and mechanics is of much greater practical importance than deterioration of pulmonary gas-exchange in the context of ventilator therapy and survival. If this view is correct then the signs of respiratory distress, in particular circulatory deterioration, should appear at an earlier stage of the pulmonary lesion if there is preexisting cardiac failure, pulmonary hypertension, or lung stiffness. This may explain why the roentgenographic picture was generally less florid in these cases than in other types of adult respiratory distress syndrome, since less pulmonary damage was required to produce obvious respiratory distress. All the mitral patients had at least one sign of cardiac or respiratory inadequacy or both before surgery, half had pulmonary hypertension, and two thirds had a long history of cardiac trouble. The need for mechanical circulatory assistance in patients with ischemic heart disease demonstrated the severity of myocardial inadequacy.

Heart failure is a well-recognized postoperative complication in complex cyanotic congenital heart disease, and two of the four patients had no right ventricle. It is also possible that in patients with respiratory distress after open heart surgery, they may not have a variant of "classical" adult respiratory distress syndrome, but several completely different conditions. For example, perhaps some patients with mitral valve disease, chronic heart failure, and pulmonary hypertension are precipitated

into overt respiratory failure by what would be normally minor and temporary intraoperative and postoperative pulmonary abnormalities and myocardial dysfunction. The crux of the matter is the nature of the pulmonary lesion, whether it is the severe alveolar-capillary damage of adult respiratory distress syndrome or simply atelectasis and hydrostatic pulmonary edema, for example. Again, respiratory distress in patients with severe left ventricular failure may simply be due to hydrostatic edema from left atrial hypertension, though this would hardly explain the frequently normal roentgenographic picture. It is also unclear why in some patients respiratory distress developed in the early postoperative period, and in others much later, or why there is a highly significant difference in survival rate between men and women with mitral valve disease in this series.

Autopsy was not performed in the fatal cases, though the pathologic appearance of the lungs in similar cases after cardiac surgery is generally the same as in adult respiratory distress syndrome associated with other conditions. It is noteworthy that these patients died not from hypoxemia, but from heart failure, though clearly this, too, greatly impairs oxygen transport.

Sepsis is a well-recognized aggravating feature in the development and mortality of adult respiratory distress syndrome,[4-6] and it was present in half the fatal cases. Although late-onset adult respiratory distress syndrome has a higher mortality than adult respiratory distress syndrome that develops soon after injury,[5] this difference could not be established in this series.

The information provided by this small group of patients also does not answer the question of why respiratory distress sufficient to warrant mechanical ventilation appears in only a fraction of patients of this type. Clearly, more data are necessary in this context. The answer may lie in precise evaluation of such variables as the nature of the lesion, the state of the heart and lungs before surgery, the amount and nature of damage to these organs from the surgery itself and their degree of recovery, and the benefits of the operation.

Summary

This is a report on a retrospective study of 25 patients who required prolonged mechanical ventilation for respiratory distress following open heart surgery for congenital and acquired heart disease. Thirteen survived, including all the women with mitral valve disease but none of the men. It is postulated that preexisting cardiac disease and severe postoperative cardiac failure enhance the likelihood of this complication, though its genesis is not always clear.

References

1. Gilston A. Techniques and complications in cardiac surgery. In: Hewer CL, Atkinson RS, eds. Recent Advances in Anaesthesia and Analgesia. 13th ed. Edinburgh, London, New York: Churchill Livingstone, 1979: 57.
2. Gilston A. Facial signs of respiratory distress after cardiac surgery. Anaesthesia 1976; **31:** 385–97.
3. Gilston A. A clinical scoring system for adult respiratory distress; preliminary report of its use in heart disease. Anaesthesia 1976; **31:** 448–54.
4. Collins JA. The acute respiratory distress syndrome. Adv Surg 1977; **11:** 171–225.
5. Walker L, Eisemann B. The changing pattern of posttraumatic respiratory distress syndrome. Ann Surg 1975; **181:** 693–7.
6. Wilson RF, Sibbald WJ. Acute respiratory failure. Crit Care Med 1976; **4:** 79–89.