Postoperative respiratory care

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After a completed operation, we receive patients on whom controlled ventilation has usually been performed for several hours during cardiac surgery. Hence, immediately postoperatively we must assess a respirator patient. The first question that I pose postoperatively is not, "Can the patient be extubated?" but rather the questions in the following order: (1) Can the patient be weaned? (2) Was the weaning attempt successful? and (3) Can the patient be extubated?

Immediate postoperative artificial respiration through the endotracheal tube following cardiac surgery with extracorporeal circulation seems purposeful for many reasons.

Preoperative pulmonary alterations

Respiratory insufficiency following cardiac surgery is modified in that pulmonary changes have been already present preoperatively. These preoperative pulmonary conditions can be divided into the following groups: (1) chronic pulmonary congestion, (2) increased pulmonary blood perfusion with pulmonary hypertension, and (3) decreased pulmonary blood perfusion.

Extrapulmonary factors influencing pulmonary function

Postoperative respiratory insufficiency may be caused by extrapulmonary factors. These include depression of the respiratory center as a result of the aftereffect of anesthetic drugs or the residual effect of muscle relaxants. Cerebral complications as well as neuropsychological disorders following extracorporeal circulation may be severe enough to necessitate immobilization of the patient by means of artificial respiration.

Respiratory insufficiency as a secondary result of cardiac insufficiency

Primary heart failure often severely disturbs the gaseous interchange in the lungs leading secondarily to breakdown of pulmonary function.

Basically, we differentiate two types of effects of left ventricular failure on pulmonary function: either the increase in left atrial pressure leads to the development of acute pulmonary edema or redistribution of pulmonary perfusion is produced, whereby the pulmonary edema remains in the background, the bronchospasm being the leading symptom.

Critical increase in metabolic demand

Operative trauma and extracorporeal circulation produce a situation that increases metabolic demands postoperatively. The demand may be increased by shivering caused by cold. An increase in respiratory workload may cause a significant increase in metabolic demand. Furthermore, catecholamines that are used postoperatively cause an increase in current demand.

The indication for weaning from the respirator exists if, following a checklist (*Table*), there are no findings that necessitate continuation of controlled ventilation.

Checklist 1 includes a thorough medical history, the patient's basic disorder, and the resulting secondary pulmonary changes. Furthermore, the intraoperative course of the operation is discussed with the checklist at hand.

Checklist 2 evaluates the patient's current condition. If weaning has been started on the basis of evaluation of these two checklists, the success of the weaning process must then be evaluated. Whether or not extubation is indicated is again determined with the aid of a third checklist.

Which type of ventilation should be used postoperatively for patients who have undergone cardiac surgery? Given an extrapulmonary indication for artificial respiration, for example, a central respiratory depression, a pressure-controlled device may be used for temporary postoperative artificial respiration.

A volume-controlled device is preferable for controlled ventilation in cases of pulmonary or cardiogenic respiratory insufficiency.

Positive end-expiratory pressure

Postoperative ventilation is routinely performed with an FIO_2 of 0.5 with positive end-expiratory pressure (PEEP) of 5 to 10 cm H_2O. Should a minimum level of 80 to 90 mm Hg for arterial oxygen tension not be reached with this form of ventilation, PEEP is first increased to 15 cm H_2O and then the inspiratory oxygen concentration is increased according to need. If the arterial oxygen tension has been improved, the attempt is first made to increase PEEP to 5 to 10 cm H_2O; the inspiratory oxygen concentration is then reduced accordingly.

Table. Checklists for weaning from respirator

Checklist 1. Medical history
1. Preoperative, basic disorder—secondary pulmonary changes
2. Intraoperative, quality of the correction, duration of bypass, departure from bypass, intraaortic balloon pump complications
Checklist 2. Current conditions
1. Cerebral findings, temperature, LAP, metabolic condition, renal function
2. What can be expected? Bleeding, arrhythmia, decompensation, renal complications
Checklist 3.
1. Satisfactory radiological findings
2. Satisfactory blood gas analysis following 1 to 2 hours of spontaneous respiration (PEEP, CPAP) (PaO_2 about 70 at 4 L/min oxygen supplement through the endotracheal tube; $PaCo_2$ no higher than 50 mm Hg and no less than 30 mm Hg)
3. Absence of metabolic acidosis or pronounced alkalosis
4. Body temperature no lower than 30 C and no higher than 38 C
5. Stable circulation
6. No abnormal blood loss from thoracic drainage
7. Consciousness and reflex condition normal
8. Urine output not less than 50 ml/hr
9. Intraaortic balloon pump not required
10. Catecholamine infusions in larger doses not required

LAP = left atrial pressure, PEEP = positive end-expiratory pressure, CPAP = continuous positive airway pressure.

Inversed ratio ventilation

If there is a pronounced effect of the primary cardiac disorder on pulmonary function, ventilation with PEEP may lead to a more extensive disturbance in the distribution of ventilation. The hyperinflation of relatively good "bronchiole-alveolar units" and the hypoventilation of poor units lead to a pronounced increase in dead space ventilation.

In this situation, the use of inversed ratio ventilation with an I:E ratio of 3:1 or 4:1, hemodynamics being carefully monitored, can be advantageous. Inversed ratio ventilation enables (1) pulmonary ventilation with lower alveolar pressure, (2) insurance of uniform distribution of alveolar ventilation, and (3) through the long inspiratory period, a long contact period of gas with the blood phase in the lungs.

High frequency jet ventilation, forced diffusion ventilation

The main advantage of ventilation of this type with respiratory frequencies above 200/min is that the intraalveolar pressure can be kept at a low level. Hence, the hemodynamic strain from this type of ventilation may be considered as being particularly slight. Following improvement of the method, this form of ventilation, which was first used particularly successfully on patients with bronchopleural fistulas, should be of interest in artificial respiration of cardiac surgical patients. However, only further extensive experimental and clinical studies will show the extent to which this specialized form of mechanical ventilation can ensure favorable effects not only on hemodynamics, but also on the mechanics of breathing.