302 Mechanical Ventilatory Support

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Mechanical ventilation refers to devices that deliver positive-pressure gas, of varying oxygen content, to patients with acute or chronic respiratory failure. Hypoxemic respiratory failure refractory to supplemental oxygen and requiring mechanical ventilation is most often due to ventilation-perfusion mismatch or shunt caused by processes such as pneumonia, pulmonary edema, alveolar hemorrhage, acute respiratory distress syndrome (ARDS), and sequelae of trauma or surgery. Hypercapnic respiratory failure is most frequently caused by severe exacerbations of obstructive lung disease, including asthma and chronic obstructive pulmonary disease (COPD); loss of central respiratory drive from acute neurologic events, such as stroke, intracranial hemorrhage, or drug overdose; and respiratory muscle weakness from diseases such as Guillain-Barré syndrome. Mechanical ventilation may also be necessary if patients have an artificial airway placed (an endotracheal tube) due to poor airway protection, such as in coma or in the context of a large upper gastrointestinal hemorrhage and vomiting, or due to processes leading to large airway obstruction, such as laryngeal edema. Finally, since mechanical ventilation can lower the work of breathing compared to spontaneous ventilation, it is a useful adjunct therapy for shock and multiorgan system failure.

PRINCIPLES OF MECHANICAL VENTILATION

Although contemporary mechanical ventilators use positive pressure to inflate the lungs, a patient's response to pressure applied across the lung (transpulmonary pressure) depends on the elastic properties of their lungs and chest wall; the amount of pressure needed to inflate a lung is the same, therefore, whether applied positively via mechanical ventilation or negatively using the diaphragm and chest wall muscles. In ARDS, for example, lungs are