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Is There a Best Way to Set Tidal Volume for Mechanical Ventilatory Support? **225**
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Tidal breaths are an important component of mechanical ventilation. However, an inappropriate tidal volume setting can overstretch and injure the lung. Maximal stretch, tidal stretch, frequency of stretch, and rate of stretch are all implicated in such injury. Clinical trials have shown that limiting maximal and tidal stretch improves outcomes, even if gas exchange is partially compromised. Thus, current strategies should focus on limiting tidal and maximal stretch as much as possible.

Is There a Best Way to Set Positive Expiratory-End Pressure for Mechanical Ventilatory Support in Acute Lung Injury? **233**
Neil R. MacIntyre

Airspace collapse is a hallmark of parenchymal lung injury. Strategies to reopen and maintain patency of these regions offer three advantages: improved gas exchange, less lung injury, and improved lung compliance. Elevations in intrathoracic pressure to achieve these goals, however, may overdistend healthier lung regions and compromise cardiac function. Positive expiratory-end pressure is a widely used technique to maintain alveolar patency, but its beneficial effects must be balanced against its harmful effects.

Protocol-Driven Ventilator Weaning: Reviewing the Evidence **241**
Timothy D. Girard and E. Wesley Ely

Though seminal clinical trials have identified efficacious methods of liberating patients from mechanical ventilation (ie, weaning), this knowledge is not applied often by physicians in routine practice. Weaning protocols are a strategies by which research results can be translated effectively and efficiently into clinical practice, but results of clinical trials evaluating weaning protocols have not been uniform, and controversy continues to surround this important area in critical care medicine. This article reviews the rationale for and against the routine use of weaning protocols and highlights informative details of many clinical trials that have evaluated such protocols.

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Christopher King and Lisa K. Moores

With the large and increasing population of mechanically ventilated patients, critical care physicians frequently face the dilemma of whether to perform tracheotomy. The decision is a complex one, requiring a detailed understanding of the risks and benefits of both tracheotomy and prolonged translaryngeal intubation (TLI). It also must be individualized, taking into consideration the patient's preferences and expected clinical course. This article reviews the medical literature regarding the benefits and risks of tracheotomy as compared with TLI. The authors then discuss current data regarding the optimal timing for the procedure and propose an algorithm that may aid intensivists in clinical decision making.

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Chuin Siau and Thomas E. Stewart

Lung protective ventilatory strategies using conventional ventilators have resulted in decreased mortality in adult patients who have acute lung injury and acute respiratory distress syndrome. Conceptually, high frequency oscillatory ventilation and airway pressure release ventilation appear not only able to fulfill the goals of lung protection, but also to offer some additional advantages over conventional ventilation. Although early data for each of these modes in adults have been encouraging, their widespread use—particularly outside of a rescue situation—cannot be recommended without further evidence.

How Best to Deliver Aerosol Medications to Mechanically Ventilated Patients **277**
Rajiv Dhand and Vamsi P. Guntur

Pressurized metered-dose inhalers (pMDIs) and nebulizers are employed routinely for aerosol delivery to ventilator-supported patients, but the ventilator circuit and artificial airway previously were thought to be major barriers to effective delivery of aerosols to patients receiving mechanical ventilation. In the past two decades, several investigators have shown that careful attention to many factors, such as the position of the patient, the type of aerosol generator and its configuration in the ventilator circuit, aerosol particle size, artificial airway, conditions in the ventilator circuit, and ventilatory parameters, is necessary to optimize aerosol delivery during mechanical ventilation. The best techniques for aerosol delivery during noninvasive positive-pressure ventilation are not well established as yet, and the efficiency of aerosol delivery in this setting is lower than that during invasive mechanical ventilation. The most efficient methods of using the newer hydrofluoroalkane-pMDIs and vibrating mesh nebulizers in ventilator-supported patients also require further evaluation. When optimal techniques of administration are employed, the efficiency of aerosolized drug delivery in mechanically ventilated patients is comparable to that achieved in ambulatory patients.

Do Newer Monitors of Exhaled Gases, Mechanics, and Esophageal Pressure Add Value? **297**
Robert L. Owens, William S. Stigler, and Dean R. Hess

The current understanding of lung mechanics and ventilator-induced lung injury suggests that patients who have acute respiratory distress syndrome should be

ventilated in such a way as to minimize alveolar over-distension and repeated alveolar collapse. Clinical trials have used such lung protective strategies and shown a reduction in mortality; however, there is data that these "one-size fits all" strategies do not work equally well in all patients. This article reviews other methods that may prove useful in monitoring for potential lung injury: exhaled breath condensate, pressure-volume curves, and esophageal manometry. The authors explore the concepts, benefits, difficulties, and relevant clinical trials of each.

Effects of Respiratory-Therapist Driven Protocols on House-Staff Knowledge and Education of Mechanical Ventilation **313**
Jessica Y. Chia and Alison S. Clay

High practice variability in critical care medicine contributes to medical errors and the high cost of ICU care. Clinical guidelines and protocol-based strategies can reduce the variation and cost of ICU medicine, increase adherence to evidence-based interventions, and reduce error, thereby improving the morbidity and mortality of critically ill patients. There are various barriers to guideline adherence, and protocols often are more successful when implemented by nonphysicians. However, this has potential consequences for house-staff knowledge and education. This article discusses the implications of mechanical ventilation protocols on patient care and medical education, and this article offers suggestions for synchronizing the processes for improving patient care to improve medical education.

Mechanical Ventilation in an Airborne Epidemic **323**
Ghee-Chee Phua and Joseph Govert

With the increasing threat of pandemic influenza and catastrophic bioterrorism, it is important for intensive care providers to be prepared to meet the challenge of large-scale airborne epidemics causing mass casualty respiratory failure. The severe acute respiratory syndrome outbreak exposed the vulnerability of health care workers and highlighted the importance of establishing stringent infection control and crisis management protocols. Patients who have acute lung injury and acute respiratory distress syndrome who require mechanical ventilation should receive a lung protective, low tidal volume strategy. Controversy remains regarding the use of high-frequency oscillatory ventilation and noninvasive positive pressure ventilation. Standard, contact, and airborne precautions should be instituted in intensive care units, with special care taken when aerosol-generating procedures are performed.

Proportional Assist Ventilation and Neurally Adjusted Ventilatory Assist—Better Approaches to Patient Ventilator Synchrony? **329**
Christer Sinderby and Jennifer Beck

Understanding the regulation of breathing in the critical care patient is multifaceted, especially in ventilator-dependent patients who must interact with artificial respiration. Mechanical ventilation originally consisted of simple, manually-driven pump devices, but it has developed into advanced positive pressure ventilators for continuous support of patients in respiratory failure. This evolution has resulted in mechanical ventilators that deliver assist intermittently, attempting to mimic natural breathing. Recently, modes of mechanical ventilation that synchronize not only the timing, but also the level of assist to the patient's own effort, have been introduced. This article describes the concepts related to proportional assist ventilation and neurally adjusted ventilatory assist, and how they relate to conventional modes in terms of patient-ventilator synchrony.

Does Closed Loop Control of Assist Control Ventilation Reduce Ventilator-Induced Lung Injury? **343**
Richard D. Branson and Kenneth Davis, Jr

The standard of care for mechanical ventilation of the patient who has acute lung injury remains volume control ventilation at 6 mL/kg. Despite this fact, clinicians often employ pressure control ventilation and adaptive pressure control ventilation in an attempt to improve synchrony and limit the possibility for overdistension. Adaptive pressure control uses pressure control breaths to guarantee a minimum delivered tidal volume. Other techniques (such as adaptive support ventilation) use pressure-limited breaths, switching between time and flow cycling based on patient effort. Neither of these techniques has been compared with volume control in a randomized setting. Understanding operation of these techniques is essential for determining any impact on outcome or ventilator induced lung injury.

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