Anesthetic Management of the Adult Patient with Concomitant Cardiac and Pulmonary Disease

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KEYWORDS

• Anesthesia • Obstructive lung disease • COPD • Asthma • Restrictive lung disease • Pulmonary hypertension • Systolic heart failure • Diastolic heart failure

KEY POINTS

- Balancing the demands of concurrent heart and lung disease during the administration of anesthesia can be challenging, but understanding the physiology behind each disease process allows for thoughtful management of each and minimizes the adverse effects resulting from such coexisting conditions.
- Management of left heart failure and valvular lesions in the setting of lung disease focuses on reducing forces that contribute to increased pulmonary venous pressure and possible resultant pulmonary congestion or edema.
- Right ventricular (RV) failure is intimately tied to the status of the pulmonary system, and management efforts are best directed at reducing or avoiding excessive RV afterload imposed by the pulmonary vasculature and thoracic pressures.
- Management of patients with pulmonary disease resulting in cor pulmonale similarly includes efforts to, where possible, reduce pulmonary vascular resistance (PVR), including avoiding hypoxia, hypercarbia, high positive end-expiratory pressure (PEEP), high intrathoracic pressure, pain, hypothermia, and N_2O.
- Many factors interact to affect the clinical picture of patients with concomitant heart and lung disease. It follows that anesthetic management requires careful attention to multiple interacting forces to optimize intraoperative care.

INTRODUCTION

Anesthesiologists are increasingly faced with complex patients suffering from multiple comorbidities and often of advanced age. As the population ages, many disease processes develop or progress. Many of these aging individuals seek medical care,

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including procedures requiring anesthetic care. In some cases, the appropriate management or natural course of one disease has important consequences for a concomitant condition and, subsequently, optimal management. These interactions make the delivery of anesthesia challenging for providers. Such competing priorities may be seen in patients with concomitant heart and lung disease, and this review describes interactions of the heart and lung in disease and outlines key points in management of specific scenarios.

CARDIOVASCULAR DISEASE AND EFFECTS ON THE PULMONARY SYSTEM

Heart Failure

Left heart systolic dysfunction

The etiology of left ventricular (LV) failure or dysfunction is commonly due to ischemia or infarction related to coronary artery disease (CAD) but may also be secondary to toxins, radiation, infections, congenital diseases, chronic valvular disease, or idiopathic in nature.

The basic abnormality in left heart failure is a reduction in cardiac output (CO) that leads to an imbalance between systemic oxygen delivery and metabolic needs of the body. Extensive compensatory mechanisms characterize heart failure and have important implications in disease management. Increased sympathetic outflow, activation of the renin-angiotensin-aldosterone system, and antidiuretic hormone secretion represent the efforts of the body to maintain CO in the setting of reduced systolic function. Chronic management focuses on reducing the maladaptive effects of these compensatory mechanisms (LV remodeling, elevated systemic vascular resistance [SVR], and fluid retention).

Fluid retention can become maladaptive and result in reduced pulmonary vascular compliance secondary to vascular congestion or pulmonary edema associated with elevated filling pressures, which are transmitted to the pulmonary venous system. Concomitant lung disease, such as chronic obstructive pulmonary disease (COPD), reduces pulmonary reserve in these patients. Even modest degrees of pulmonary edema or reductions in vital capacity related to low pulmonary vascular compliance and vascular congestion may lead to respiratory distress or failure.

Anesthetic management of patients with LV systolic dysfunction takes into consideration the compensatory mechanisms in place, which may be currently maintaining a patient's hemodynamics. Induction of anesthesia may reduce the sympathetic outflow on which these patients rely and precipitate decompensation, emphasizing the importance of careful titration of induction agents.

Maintenance of anesthesia should include avoiding LV volume overload by judicious fluid management. Fluid management may be challenging and relies on clinical judgment and context. Titrating fluid administration to balance ongoing losses and fluid shifts related to capillary leak is ideally guided by trending filling pressures or other measures of intravascular volume, if available. Miscalculation of fluid management may lead to pulmonary edema and/or progressive systolic dysfunction. Excessive reductions in myocardial contractility are limited by reducing doses of volatile agents and maintaining coronary perfusion pressure (CPP). Measures to reduce afterload (without compromising CPP) and avoidance of sudden and significant increases in SVR have a favorable impact on myocardial work. Although the afterload reduction related to volatile agents and intravenous anesthetics is favorable to the failing left heart, it should be considered that intravenous fluids administered in the setting of anesthetic-induced vasodilation may not be tolerated as preoperative SVR returns when anesthetic agents are discontinued. With a return to baseline SVR, a relative