life support should be initiated by the physician or left to surrogate decision-makers alone is not clear. One study reported that slightly more than half of surrogate decision-makers preferred to receive such a recommendation, whereas the rest did not. Critical care providers should meet regularly with patients and/or surrogates to discuss prognosis when the withholding or withdrawal of care is being considered. After a consensus among caregivers has been reached, this information should be relayed to the patient and/or surrogate decision-maker. If a decision to withhold or withdraw life-sustaining care for a patient has been made, aggressive attention to analgesia and anxiolysis is needed.

322 Acute Respiratory Distress Syndrome

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Acute respiratory distress syndrome (ARDS) is a clinical syndrome of severe dyspnea of rapid onset, hypoxemia, and diffuse pulmonary infiltrates leading to respiratory failure. ARDS is caused by diffuse lung injury from many underlying medical and surgical disorders. The lung injury may be direct, as occurs in toxic inhalation, or indirect, as occurs in sepsis (Table 322-1). The clinical features of ARDS are listed in Table 322-2. By expert consensus, ARDS is defined by three categories based on the degrees of hypoxemia (Table 322-2). These stages of mild, moderate, and severe ARDS are associated with mortality risk and with the duration of mechanical ventilation in survivors.

The annual incidence of ARDS is estimated to be as high as 60 cases/100,000 population. Approximately 10% of all intensive care unit (ICU) admissions involve patients with acute respiratory failure; ~20% of these patients meet the criteria for ARDS.

ETIOLOGY

While many medical and surgical illnesses have been associated with the development of ARDS, most cases (>80%) are caused by a relatively small number of clinical disorders: severe sepsis syndrome and/or bacterial pneumonia (~40–50%), trauma, multiple transfusions, aspiration of gastric contents, and drug overdose. Among patients with trauma, the most frequently reported surgical conditions in ARDS are pulmonary contusion, multiple bone fractures, and chest wall trauma/flail chest, whereas head trauma, near-drowning, toxic inhalation, and burns are rare causes. The risks of developing ARDS are increased in patients with more than one predisposing medical or surgical condition.

Several other clinical variables have been associated with the development of ARDS. These include older age, chronic alcohol abuse, metabolic acidosis, and severity of critical illness. Trauma patients with an Acute Physiology and Chronic Health Evaluation (APACHE) II score ≥16 (Chap. 321) have a 2.5-fold increased risk of developing ARDS, and those with a score >20 have an incidence of ARDS that is more than threefold greater than the incidence among those with APACHE II scores ≤9.

TABLE 322-1 CLINICAL DISORDERS COMMONLY ASSOCIATED WITH ARDS

Direct Lung Injury	Indirect Lung Injury
Pneumonia	Sepsis
Aspiration of gastric contents	Severe trauma
Pulmonary contusion	Multiple bone fractures
Near-drowning	Flail chest
Toxic inhalation injury	Head trauma
	Burns
	Multiple transfusions
	Drug overdose
	Pancreatitis
	Postcardiopulmonary bypass

TABLE 322-2 DIAGNOSTIC CRITERIA FOR ARDS

Severity: Oxygenation	Onset	Chest Radiograph	Absence of Left Atrial Hypertension
Mild: 200 mmHg < Pao_2/Fio_2 ≤ 300 mmHg *Moderate:* 100 mmHg < Pao_2/Fio_2 ≤ 200 mmHg *Severe:* Pao_2/Fio_2 ≤ 100 mmHg	Acute	Bilateral alveolar or interstitial infiltrates	PCWP ≤18 mmHg *or* no clinical evidence of increased left atrial pressure

Abbreviations: ARDS, acute respiratory distress syndrome; Fio_2, inspired O_2 percentage; Pao_2, arterial partial pressure of O_2; PCWP, pulmonary capillary wedge pressure.

CLINICAL COURSE AND PATHOPHYSIOLOGY

The natural history of ARDS is marked by three phases—exudative, proliferative, and fibrotic—that each have characteristic clinical and pathologic features (Fig. 322-1).

Exudative Phase In this phase (Fig. 322-2), alveolar capillary endothelial cells and type I pneumocytes (alveolar epithelial cells) are injured, with consequent loss of the normally tight alveolar barrier to fluid and macromolecules. Edema fluid that is rich in protein accumulates in the interstitial and alveolar spaces. Significant concentrations of cytokines (e.g., interleukin 1, interleukin 8, and tumor necrosis factor α) and lipid mediators (e.g., leukotriene B_4) are present in the lung in this acute phase. In response to proinflammatory mediators, leukocytes (especially neutrophils) traffic into the pulmonary interstitium and alveoli. In addition, condensed plasma proteins aggregate in the air spaces with cellular debris and dysfunctional pulmonary surfactant to form hyaline membrane whorls. Pulmonary vascular injury also occurs early in ARDS, with vascular obliteration by microthrombi and fibrocellular proliferation (Fig. 322-3).

Alveolar edema predominantly involves *dependent* portions of the lung, with diminished aeration and atelectasis. Collapse of large sections of dependent lung markedly decreases lung compliance. Consequently, intrapulmonary shunting and hypoxemia develop and the work of breathing increases, leading to dyspnea. The pathophysiologic alterations in alveolar spaces are exacerbated by microvascular occlusion that results in reductions in pulmonary arterial blood flow to ventilated portions of the lung (and thus in increased dead space) and in pulmonary hypertension. Thus, in addition to severe hypoxemia, hypercapnia secondary to an increase in pulmonary dead space is prominent in early ARDS.

The exudative phase encompasses the first 7 days of illness after exposure to a precipitating ARDS risk factor, with the patient experiencing the onset of respiratory symptoms. Although usually presenting within 12–36 h after the initial insult, symptoms can be delayed by 5–7 days. Dyspnea develops, with a sensation of rapid shallow breathing

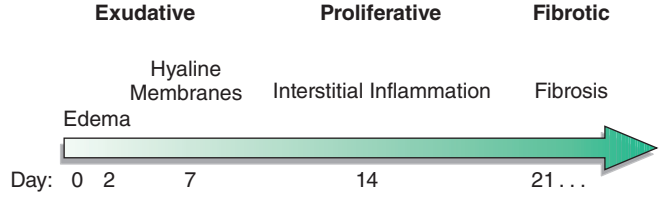

FIGURE 322-1 Diagram illustrating the time course for the development and resolution of ARDS. The exudative phase is notable for early alveolar edema and neutrophil-rich leukocytic infiltration of the lungs, with subsequent formation of hyaline membranes from diffuse alveolar damage. Within 7 days, a proliferative phase ensues with prominent interstitial inflammation and early fibrotic changes. Approximately 3 weeks after the initial pulmonary injury, most patients recover. However, some patients enter the fibrotic phase, with substantial fibrosis and bullae formation.