CHEST

Original Research

CRITICAL CARE MEDICINE

# Acute Lung Injury Outside of the ICU*

## Incidence in Respiratory Isolation on a General Ward

*Andrew A. Quartin, MD, MPH; Michael A. Campos, MD; Diego A. Maldonado, MD; David Ashkin, MD; Cynthia M. Cely, MD; and Roland M. H. Schein, MD*

***Background:*** **Epidemiologic investigations of acute lung injury (ALI) and ARDS have focused on mechanically ventilated patients in ICUs, and have reported high mortality rates. We sought to determine the incidence and lethality of these syndromes in the respiratory isolation areas of general wards, a non-ICU setting that often serves patients with acute lung processes.**
***Methods:*** **We prospectively studied all patients who were admitted to respiratory isolation rooms on the general wards of a large tertiary care hospital over a 1-year period. Patients were classified as having ALI or ARDS if they met consensus definitions for the syndromes. Characteristics and outcomes were compared to those of other patients who had been admitted to a respiratory isolation room with infiltrating lung disease but lacking bilateral infiltrates, hypoxemia, or both.**
***Results:*** **Of 715 patients admitted to respiratory isolation rooms on general wards, 474 (66%) had acute infiltrates. ALI criteria were met by 9% of patients (62 of 715 patients), with 2% of patients (15 of 715) satisfying the criteria for ARDS. Respiratory distress was present in 71% of ALI patients (44 of 62 patients) and 32% of patients (130 of 412 patients) with acute infiltrates who did not have ALI ($p < 0.001$). However, the 90-day survival rates (ALI patients, 88%; patients with acute infiltrates who did not have ALI, 90%) was similar between the two groups ($p > 0.50$).**
***Conclusions:*** **ALI and ARDS may be frequent among patients who are admitted to respiratory isolation beds outside of ICUs. Mortality rates are substantially lower than those typically reported from surveys of ventilated ICU patients with ALI and ARDS.**

***(CHEST 2009; 135:261–268)***

**Key words:** adult; blood gas analysis; patient isolation; pneumonia; respiratory distress syndrome

**Abbreviations:** ABG = arterial blood gas; ALI = acute lung injury; ANOVA = analysis of variance; $H^-B^-$ = unilateral infiltrates without documented hypoxemia; $H^-B^+$ = bilateral infiltrates without documented hypoxemia; $H^+B^-$ = hypoxemia but no bilateral infiltrates; IQR = interquartile range; LDH = lactate dehydrogenase; PCP = *Pneumocystis carinii* pneumonia; P/F = $Pao_2$/fraction of inspired oxygen; PSI = pneumonia severity index; $Spo_2$ = pulse oximetric saturation

The first case series reporting the ARDS, published > 40 years ago, described a disorder characterized by dyspnea, tachypnea, hypoxemia, poor lung compliance, and diffuse alveolar infiltrates in 12 patients.[1] All received mechanical ventilatory support in ICUs.

Subsequent ARDS studies employed a variety of case definitions, contributing to the substantial variability in the reported incidences of and outcomes from ARDS. Recognizing the need to standardize nomenclature, an international consensus conference was convened in 1992. The resultant definitions for acute lung injury (ALI) and ARDS,[2] requiring acute onset of hypoxemia ($Pao_2$/fraction of inspired oxygen [P/F] ratio, ≤ 300 and 200 mm Hg, respectively) and bilateral infiltrates without left atrial

**For editorial comment see page 251**

*From the Division of Pulmonary and Critical Care Medicine, University of Miami Miller School of Medicine, Miami, FL.
No external funding was received for this study.
The authors have reported to the ACCP that no significant conflicts of interest exist with any companies/organizations whose products or services may be discussed in this article.
Manuscript received January 30, 2008; revision accepted June 26, 2008.

*Correspondence to: Andrew Quartin, MD, MPH, Critical Care Medicine (111), Miami VAMC, 1201 NW Sixteenth St, Miami, FL 33125; e-mail: aquartin@med.miami.edu*
**DOI: 10.1378/chest.08-0280**

hypertension, have since become widely accepted and used. The importance of distinguishing between the ALI population and its ARDS subpopulation is unsettled, with many interventional trials[3–11] including both, and investigators divided over whether their prognoses differ appreciably.[12–18]

ALI has been viewed as a syndrome of critically ill patients, with epidemiologic studies[12–15,19,20] almost entirely restricted to ICUs. However, the consensus definition of ALI explicitly omits a requirement for mechanical ventilation and does not specify or imply ICU admission. We have previously conjectured that there may be populations of ALI patients found outside intensive care areas.[21] Respiratory isolation wards care for patients with suspected infectious respiratory diseases who are, therefore, at risk for ALI.

We prospectively studied patients who had been admitted directly to non-ICU respiratory isolation wards in a large city hospital to ascertain the ALI burden, and to identify the characteristics of and outcomes for these patients. We compared these ALI patients to other patients with lung infiltrates who had been admitted to respiratory isolation rooms.

## Materials and Methods

### *Population*

During 2003, all adult patients who were admitted directly to non-ICU respiratory isolation at Jackson Memorial Medical Center, a university-affiliated city hospital in Miami, FL, were evaluated for the study. Study exclusion criteria were the absence of lung infiltrates, or infiltrates considered to be chronic or secondary to elevated left atrial pressure (based on either the treating physicians' dictated summary or the impression of the study team after a review of the medical record). Patients with multiple admissions to respiratory isolation in 2003 were only eligible for the study during their first admission. The Institutional Review Board of the University of Miami School of Medicine approved the study and waived the need for consent.

### *Data Collection*

The data collected included age, sex, respiratory symptoms, HIV serostatus, laboratory test results, and echocardiography reports. Arterial samples were assumed to have been drawn while breathing room air unless otherwise specified. Survival was confirmed through follow-up visits to the medical center, and deaths were identified using hospital records and a Web-based engine (the Social Security Death Index). Chest radiograph readings from attending radiologists on the hospital staff were used for classifying lung infiltrates. Severity of illness was assessed using the pneumonia severity index (PSI).[22]

While isolated, patients were visited once by study team members, and were assessed for respiratory distress and cognitive capacity. Compliance with ordered supplemental oxygen therapy at the time investigators entered patients' rooms was noted, and pulse oximetry was performed with the patient breathing room air and prescribed oxygen.

### *Patient Classification*

Patients were classified as having ALI if they had bilateral infiltrates visible on a chest radiograph and a P/F ratio of $\leq 300$ mm Hg from an arterial sample by the first calendar day after hospital admission, without an intervening radiograph or arterial sample not meeting these criteria. Patients without ALI were categorized as having bilateral infiltrates, hypoxemia (P/F ratio, $\leq 300$ mm Hg), or neither.

ALI patients were classified as having ARDS if, within 7 days of hospital admission and before the resolution of bilateral infiltrates, they had an arterial sample with a P/F ratio of $\leq 200$ mm Hg. A P/F ratio of $< 100$ mm Hg, implying a minimum lung injury score of 3.0 for unintubated patients,[23] indicated severe ARDS.

### *Statistical Analysis*

As data distributions were generally not normal, comparisons of continuous values between two groups were made using the Wilcoxon rank-sum test. Comparisons across the different types of pulmonary presentation (*eg*, ALI, hypoxemia alone, bilateral infiltrates alone, or neither) were made using analysis of variance (ANOVA), with variables transformed to improve the fit with distributional assumptions when appropriate. Further comparisons using the Wilcoxon test were made between the ALI group and each of the other groups for parameters where ANOVA indicated significant differences.

Categorical variables were compared using the Fisher exact test for $2 \times 2$ comparisons, and the $\chi^2$ test otherwise. As with continuous variables, comparisons were made across the different types of pulmonary presentation, with comparisons then made between the ALI group and each of the other groups if the overall $\chi^2$ test result was significant. Survival time comparisons were performed using the log rank test.

To assess the relationships among ALI, HIV infection, and *Pneumocystis carinii* pneumonia (PCP), patients were classified as being in one of the following three groups (HIV/PCP grouping): HIV-infected patients with PCP; other HIV-infected patients; and patients without known HIV infection. Comparisons of parameters of interest were then made using this classification and ALI status as grouping variables in a $3 \times 2$ ANOVA. Differences were considered to be significant at $p < 0.05$. Statistics were analyzed using a statistical software package (NCSS 2004; NCSS; Kaysville, UT).

## Results

### *Isolation Population*

Of the 715 patients who were admitted to respiratory isolation rooms on the general wards during 2003, 474 patients met the study entry criteria (Fig 1). The patients included in the study were predominantly men and infected with HIV, and usually were isolated because of suspected tuberculosis infection (Table 1).

Patients were visited by a member of the study team within a median time of 1 day (interquartile range [IQR], 1 to 2 days) of hospital admission. While 91 of the 215 patients who had supplemental oxygen therapy ordered for them were not receiving it at the time of the study visit, significant hypoxemia was rare, with a pulse oximetric saturation ($Spo_2$) of $< 90\%$ in only 35 patients (7%).