# Incidence and Mortality of Acute Lung Injury and the Acute Respiratory Distress Syndrome in Three Australian States

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**To determine the incidence and 28-d mortality rate for acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) using the 1994 American–European Consensus Conference definitions, we prospectively screened every admission to all 21 adult intensive care units in the States of South Australia, Western Australia, and Tasmania (total population older than 15 yr of age estimated as 2,941,137), between October 1 and November 30, 1999. A total of 1,977 admissions were screened of which 168 developed ALI and 148 developed ARDS, which represents a first incidence of 34 and 28 cases per 100,000 per annum, respectively. The respective 28-d mortality rates were 32% and 34%. The most common predisposing factors for ALI were nonpulmonary sepsis (31%) and pneumonia (28%). Although the incidences of ALI and ARDS are higher and the mortality rates are lower than those reported from studies in other countries, multicenter international studies are required to exclude methodological differences as the cause for this finding.**

**Keywords:** acute lung injury; ARDS; incidence; mortality

The incidence and outcome from acute lung injury (ALI) and the acute respiratory distress syndrome (ARDS) are uncertain. Although initial estimates of incidence were ~ 75 per 100,000 population per annum (1), the incidence in the Canary Islands was reported to be as low as 1.5–3.5 per 100,000 per annum (2). Reports of reduced mortality rates (3) seem to be supported by survival rates of 60 to 70% reported by the ARDS Network (4); however, this was a highly selected study population, and Krafft and coworkers (5) reported that mortality rates were unchanged with time following a meta-analysis of 101 ARDS studies. In large part, the variation in these data can be attributed to the lack of a uniform clinical definition of ALI and ARDS.

The 1994 American–European Consensus Conference (AECC) definitions of ALI and ARDS (6) now provide well-accepted clinical definitions that should simplify comparisons of incidence and outcome. Indeed, Luhr and coworkers (7) have recently reported a large epidemiological study using these definitions and reported an incidence of ALI of 17.9 per 100,000 population per annum, with a mortality rate of 41%. In a subgroup of this study, age and acute physiology score over their first 6 d were associated with 90-d mortality (8).

Despite the use of uniform definitions for ALI and ARDS, there may be significant regional variations in incidence and outcome due to a number of factors, including etiology, management, differences in the overall structure of health care, and the structure and implementation of intensive care. To determine the incidence, etiology, and mortality of ALI and ARDS in Australia, using the AECC criteria, we undertook a 2-mo prospective cohort study in three Australian States. To examine factors that were associated with death, physiological variables were collected for the duration of the patients' stay in intensive care, up to 28 d.

## METHODS

Ethics committee approval was required and granted in one institution only. Ethics committee submission was not required at the other sites, as this study did not require data substantially different from that routinely collected. All 21 adult intensive care units (ICU) (253 beds) in South Australia (SA), Western Australia (WA), and Tasmania were identified and participated in the study. Eight units were in large multidisciplinary public teaching hospitals, two were in Veterans Hospitals, and 11 were in private hospitals.

All ICU admissions between October 1 and November 30, 1999 were screened daily during their entire admission for the development of ALI. Dedicated research coordinators or the duty ICU physicians checked unit admission logs, present in every unit, each morning to identify every admission. A unique screening number was issued to every admission. All patients receiving mechanical ventilation (MV), noninvasive ventilation (NIV), or continuous positive airway pressure (CPAP) for greater than 12 h were followed daily for the development of ALI. These patients were included in the study if they fulfilled the AECC criteria (6) for ALI including (i) acute onset of bilateral chest X-ray (CXR) infiltrates and (ii) $Pa_{O_2}$/fraction of inspired oxygen ($FI_{O_2}$) ratio < 300 mm Hg. Patients were excluded if (i) cardiac failure or left atrial hypertension (assessed clinically, echocardiographically, or with invasive monitoring) was the primary cause of respiratory failure, (ii) chronic pulmonary disease was the cause of respiratory failure, (iii) there was a previous admission for ALI during the current hospitalization, or (iv) an extrapulmonary shunt was present.

Data were collected at time of screening, inclusion, and daily until discharge, death, or 28 d following study inclusion (*see* METHODS in the online data suplement). Standard demographic data, admission APACHE II score (9), etiology of ALI, alcohol intake, comorbidities, and the prognostic score of McCabe and Jackson (10) were recorded after inclusion. In addition, ventilator settings, hemodynamic and respiratory variables, lung injury score (11), urine flow, hematological, liver, and renal function tests, the chest radiograph score (number of quadrants with an alveolar or interstitial infiltrate), adjunctive therapies (corticosteroids, inhaled vasodilators, prone positioning), and individual organ and total sequential organ failure score (SOFA score) (12) were recorded each morning between 8 a.m. and 10 a.m. for a maximum of 28 d. Survival status at ICU discharge and 28 d from ALI diagnosis, cause(s) of death (including therapeutic withdrawal), duration of mechanical ventilation (including noninvasive support), continuing need for an artificial airway, and/or ventilatory support at 28 d were recorded.

### Incidence Calculation

The estimated population older than 15 yr, obtained from census data from the Australian Bureau of Statistics (13), was 2,941,137 (1,171,001 in SA, 1,407,497 in WA, and 362,639 in Tasmania). The "first" incidence was calculated for ALI and ARDS. Readmissions and transfers to other hospitals were excluded from incidence calculations.

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### Quality Control

Telephone and e-mail assistance from the coordinating center Flinders Medical Center (FMC) was available 24 h/d. The data were entered onto a database at FMC (Microsoft Access; Microsoft Corporation, Redmond, WA) and then reviewed for inconsistencies and data entry errors. Screening numbers (issued to every patient at enrollment), postcodes, and patient initials were reviewed to detect readmissions and transfers. To identify nonresident cases, we screened patient postcodes (ZIP codes) to determine if they were from a state outside SA, WA, and Tasmania. It was found that only 4 of 168 patients were from a state other than SA, WA, and Tasmania. Additional details regarding the methods can be found in the online data supplement.

### Statistical Analysis

The Pearson's chi-square test was used to compare categorical variables, and continuous variables were compared using the Student's *t* test. Stata Statistical Software release 6.0 (Stata Corporation, College Station, TX) was used.

## RESULTS

### Incidence of ALI and ARDS

A total of 1,977 consecutive patients admitted to all of the 21 adult ICUs in SA, WA, and Tasmania were screened for development of ALI during the 2-mo study period. The AECC criteria for ALI were fulfilled in 168 patients, which represents an incidence of 34 cases per 100,000 per annum (Figure 1). Four patients were transferred to other institutions after diagnosis, and these were not recounted. On the day of diagnosis, 60 patients did not fulfill criteria for ARDS, however, of these, 40 cases (67%) progressed to meet ARDS criteria sometime during their admission. The incidence of ARDS was thus approximately 28 cases per 100,000 per annum. It was possible to calculate the lung injury score (LIS) on Day 1 with three or more score components in 163 patients. Forty patients with ALI by AECC criteria (24%) had a Day 1 LIS $> 2.5$, representing an incidence of 8.2 cases per 100,000 per annum. A further 44 patients with ALI developed a LIS $> 2.5$ at some stage after Day 1, representing an overall incidence of 17 per 100,000 per annum.

### Mortality

The overall 28-d mortality for ALI was 32%, n = 54, with the exact binomial 95% confidence interval (CI) being 25 to 40%. In those who developed ARDS, the mortality was 34%, n = 51 (CI: 27 to 43%), and in those patients with ALI but never fulfilling ARDS criteria (ALI without ARDS), mortality was 15%, n = 3 (CI: 3 to 38%). The overall ICU mortality was 28%, n = 47 (CI: 21 to 35%). The corresponding mortality rate in the ARDS subgroup was 30%, n = 45 (CI: 23 to 38%), and in the ALI without ARDS group, significantly less at 10%, n = 2 (CI: 1 to 31%). No significant differences in mortality rates were seen between the three states. Further details may be found in Figure E1 in the online data supplement.

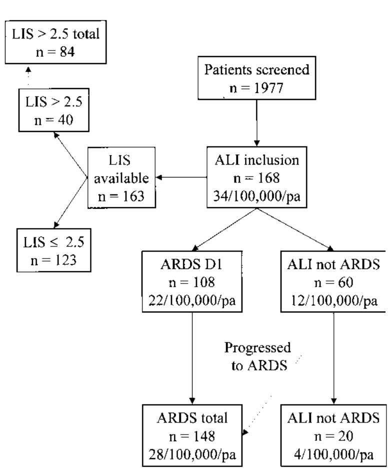


***Figure 1.*** Flow diagram following the course of 1,977 patients screened for acute lung injury (ALI) and acute respiratory distress syndrome (ARDS) using the American–European consensus conference guidelines (6). The lung injury score (LIS) (11) was available in 163 patients. A LIS $> 2.5$ has been defined as severe ARDS (11). The incidence for population older than 15 yr of age is calculated as cases per 100,000 population per annum (pa). Forty patients with ALI subsequently developed ARDS, and 44 patients with a LIS $\leqslant 2.5$ subsequently developed a LIS $> 2.5$.

### Physiological Data

Demographic and physiological data at the time of ALI diagnosis, stratified for severity of respiratory failure and 28-d mortality, are shown in Table 1. Nonsurvivors with ALI were significantly older and had both greater APACHE II scores on the day of ICU admission and total SOFA scores than survivors. The $Pa_{O_2}/FI_{O_2}$ ratio, but not the LIS, was significantly lower for nonsurvivors in the ALI group. The number of chest radiograph quadrants involved was higher in nonsurvivors, but the differences were small. Arterial pH was significantly lower and $Pa_{CO_2}$ was significantly higher in nonsurvivors. There were no significant differences in the frequency of preexisting organ system failure, immunesuppression, or degree of comorbidity between survivors and nonsurvivors.

### Demographic Details

Forty-nine (30%) of the 168 patients with ALI were female (Table 1). The mean age was 62 ± 18 yr, with admission APACHE II score of 20 ± 9 points. The $Pa_{O_2}/FI_{O_2}$ ratio and LIS were 176 ± 76 mm Hg and 2.0 ± 0.7, respectively, and the median number (interquartile range) of involved chest radiograph quadrants at ALI diagnosis was 3 (2–4). Quantification of organ failure at diagnosis using the Day 1 total SOFA score yielded a score of 8.7 ± 3. Preexisting chronic respiratory failure was present in 16 cases, chronic cardiovascular failure in 9, chronic liver disease in 7, hematologic failure in 5, and chronic renal failure in 3. Immunosuppression was present in 20 cases. The McCabe score was recorded in 143 patients. A score of 1 or 2 or 3 was present in 62%, 20%, and 5% of ALI patients, respectively.

Additional data regarding ventilatory parameters and treatment can be found in Table E1 and Figures E2, E3, and E4 in the online data supplement.

**TABLE 1. DEMOGRAPHIC AND PHYSIOLOGICAL VARIABLES OF THE 168 PATIENTS WITH ACUTE LUNG INJURY***

| | Survivors (*n = 114*) | Nonsurvivors (*n = 54*) | p Value |
|---|---|---|---|
| Age, yr | 59 ± 19 | 67 ± 15 | 0.005 |
| Female sex, % | 26 | 35 | 0.28 |
| APACHE II score | 18 ± 8.5 | 24 ± 9 | 0.001 |
| $Pa_{O_2}/FI_{O_2}$ | 186 ± 73 | 153 ± 80 | 0.01 |
| LIS | 2.0 ± 0.7 | 2.2 ± 0.7 | 0.1 |
| CXR score | 2.8 ± 0.9 | 3.2 ± 0.8 | 0.024 |
| Total SOFA | 8 ± 3 | 10 ± 3 | 0.01 |
| Ph | 7.36 ± 0.1 | 7.25 ± 0.1 | 0.001 |
| $Pa_{CO_2}$, mm Hg | 41 ± 9 | 46 ± 14 | 0.02 |
| Chronic comorbidity, % | 21 | 27 | 0.35 |
| McCabe score,† % | | | |
| 1 | 62 | 63 | 0.06 |
| 2 | 21 | 17 | |
| 3 | 0.8 | 7 | |
| Immunosuppression, % | 12 | 11 | 0.8 |

*Definition of abbreviations*: CXR = chest radiographic quadrants involved; $FI_{O_2}$ = fraction of inspired oxygen; LIS = lung injury score; SOFA = total sequential organ failure score at Day 1 of acute lung injury.

* Data presented as mean ± SD.

† McCabe score obtained in 125 cases.

### Etiology

Of the 168 ALI cases, 54 (32%) were postoperative admissions, of which 39 were unplanned. Only 6 patients (3.5%) developed ALI following cardiac surgery, none meeting the severity criteria for ARDS. Direct lung injury was a more common cause for ALI than indirect injury (Table 2), pneumonia being the commonest cause, followed by aspiration and traumatic pulmonary contusion. Nonpulmonary sepsis was the commonest cause of indirect lung injury. No etiological factor was identified for 9 patients. A combination of indirect and direct lung injury was present in 12 patients (7%): six patients with sepsis and pneumonia, five with sepsis and aspiration, and one with lung contusion and multiple trauma. Similar etiological patterns were seen in the ARDS and ALI without developing ARDS subgroups.

No differences in the mortality, $Pa_{O_2}/F_{I_{O_2}}$ ratio, LIS, SOFA score, static respiratory compliance, or positive end-expiratory pressure (PEEP) level were present between patients with direct and indirect lung injury (Table 3). The incidence of barotrauma was significantly increased in the direct lung injury group. Fifteen patients had barotrauma, with nine associated with pulmonary contusion, three with pneumonia, two with aspiration, and one with multiple trauma.

### Time to ALI Diagnosis

The median time to ALI diagnosis from hospital and ICU admission was 2 (1–5) and 1 (0–1) d, respectively. The percentage of patients fulfilling ALI criteria at 24 h, 48 h, 72 h, and 7 d from ICU admission were 78%, 88%, 94%, and 98%, respectively. When time to diagnosis from hospital admission was analyzed, the corresponding percentages were 48%, 62%, 70%, and 83%. No significant differences in age, APACHE II score, SOFA score, $Pa_{O_2}/F_{I_{O_2}}$ ratio, or mortality were seen between those developing ALI within 72 h, ($n = 113$) and those diagnosed $\geqslant$ 72 h ($n = 51$) from hospital admission. Direct lung injury occurred more frequently than indirect lung injury in the < 72 h group (62% versus 45%, $p < 0.05$).

### Cause and Timing of Death

Pulmonary failure contributed to the death of 13 patients (24%) and was the sole cause of death in only five (9%). Nonpulmonary failures alone caused death in 41 cases (76%) and coexisted with a pulmonary cause in eight cases (15%). Multiple organ dysfunction was the commonest single cause, accounting for 27 deaths (50%). Sepsis-related death occurred in 21 cases (40%), and neurological failure in six cases (11%).

Withdrawal of treatment occurred in 13 patients (pulmonary cause three cases, multiple organ dysfunction six cases, and neurological cause four cases). There were no significant differences in the rate of withdrawal between age groups (< 65 versus $\geqslant$ 65 yr), the presence of immunosuppression, or chronic organ system failure. The median time of death from diagnosis of ALI was 7 (3–14) d.

**TABLE 2. ETIOLOGY OF ACUTE LUNG INJURY***

| | ALI† (*n = 168*) | ARDS (*n = 148*) | ALI without ARDS (*n = 20*) |
|---|---|---|---|
| Direct | 96 (57) | 85 (57) | 11 (55) |
| Pneumonia | 48 (28.6) | 44 (30) | 4 (20) |
| Aspiration | 30 (18) | 25 (17) | 5 (25) |
| Contusion | 18 (10.7) | 16 (11) | 2 (10) |
| Other | 2 (1.2) | 2 (1) | 0 |
| Indirect | 75 (45) | 64 (43) | 11 (55) |
| Sepsis | 58 (34.5) | 48 (32) | 10 (50) |
| Trauma | 4 (2.4) | 3 (2) | 1 (5) |
| Multiple transfusion | 5 (3) | 5 (3.3) | 0 |
| Pancreatitis | 3 (1.8) | 3 (2) | 0 |
| Drug overdose | 1 (0.6) | 1 (0.7) | 0 |
| Other | 4 (2.4) | 4 (2.7) | 0 |

*Definition of abbreviations*: ALI = acute lung injury; ARDS = acute respiratory distress syndrome.

* Data presented as number of cases (%). There were no significant differences in the distribution of diagnostic categories among ALI, ARDS, and ALI without ARDS, using the Pearson $\chi^2$ test.

† Direct lung injury only, 84 (50); indirect lung injury only, 63 (38); combination of both direct and indirect lung injury, 12 (7); unknown cause, 9 (5).

**TABLE 3. DIFFERENCES BETWEEN DIRECT VERSUS INDIRECT ALI***

| | Direct Only† (*n = 84*) | Indirect Only (*n = 63*) |
|---|---|---|
| Mortality, % | 22 | 26 |
| Compliance, ml/cm $H_2O$ | 46 ± 24 | 40 ± 12 |
| $Pa_{O_2}/F_{I_{O_2}}$ | 172 ± 80 | 172 ± 72 |
| LIS | 2.1 ± 0.7 | 2.1 ± 0.7 |
| CXR | 2.9 ± 0.9 | 3.0 ± 0.8 |
| PEEP, cm $H_2O$ | 6.3 ± 2.8 | 6.3 ± 2.8 |
| Barotrauma cases, % | 14 (16)‡ | 1 (1.5) |
| ICU length of stay, d | 10.5 ± 2 | 12.2 ± 13 |
| Total SOFA | 8.4 ± 3.2 | 9.4 ± 3.3 |

*Definition of abbreviations*: ALI = acute lung injury; CXR = chest radiographic quadrants involved; $F_{I_{O_2}}$ = fraction of inspired oxygen; LIS = lung injury score; PEEP = positive end-expiratory pressure; SOFA = total sequential organ failure score at admission.

* Data presented as mean ± SD.

† Of the 168 patients with ALI, 12 had a combination of both direct and indirect etiology, 9 had unknown cause, 84 had direct lung injury only, and 63 had indirect lung injury only.

‡ $p = 0.005$ on $\chi^2$ test.

## DISCUSSION

### Incidence

We have found the incidence of ALI to be significantly higher than those reported in other studies (Table 4). In part this can be explained by the variability in definitions used for ALI and by differences in study design. Luhr and coworkers (7) reported the incidence of ALI as 17.9 per 100,000 per annum. Although this is greater than seen in previous studies, it still may be an underestimate, as only those cases that fulfilled ALI criteria within 24 h of developing acute respiratory failure (defined as intubation and ventilation > 24 h) were recorded. In contrast, we screened all patients throughout their entire admission for the development of ALI. To allow direct comparison with the data of Luhr and coworkers, we also report the incidence adjusted to include only those cases of ALI and ARDS developing within 24 h of the onset of acute respiratory failure. Because most of our patients developed ALI within this 24-h window, the rate was still significantly higher (ALI 30 per 100,000 per annum and ARDS 19.6 per 100,000 per annum). The LIS criteria for ARDS were also satisfied in 40 of the 168 cases on Day 1 (8.2 cases per 100,000 per annum). A further 44 cases satisfied the LIS criteria for ARDS after Day 1 (overall incidence, 17 per 100,000 per annum). Although we may have missed patients satisfying LIS criteria but not AECC criteria for ARDS, our rate of ARDS on Day 1 by LIS criteria was still higher than that seen by Luhr and coworkers (7.6 cases per 100,000 per annum), who included all patients with LIS > 2.5. Furthermore, only 71 patients in the study of Luhr and coworkers study satisfied both AECC and LIS criteria on Day 1 (3.9 per 100,000 per annum), which is almost half the comparable incidence seen in our study. Because the requirement for ventilatory support is not included in the current definition of ALI, we adopted a conservative ap-

**TABLE 4. COMPARATIVE INCIDENCE AND MORTALITY DATA***

| Author | ALI | ARDS | LIS > 2.5 | Mortality |
|---|---|---|---|---|
| Current study | $34/10^5$/pa | $22/10^5$/pa | $8.2/10^5$/pa | 32% (ALI)<br>38% (ARDS) |
| Luhr and coworkers (7),† 1999 | $17.9/10^5$/pa | $13.5/10^5$/pa | $7.6/10^5$/pa | 42% (90 d) |
| Valta and coworkers (21), 1999 | | $4.9/10^5$/pa | | 37% (ICU)<br>42% (6 mo) |
| Luce (25), 1998 | | $70/10^5$/pa | $7/10^5$/pa | < 50% |
| Reynolds and coworkers (26), 1998 | | $10–14.2/10^5$/pa | | 36–49% |
| Nolan and coworkers (27), 1997 | | $7.3–9.3/10^5$/pa | | 59% |
| Lewandowski and coworkers (17),† 1995 | | | $3.2/10^5$/pa | 41% (LIS 0–2.5)<br>59% (LIS > 2.5) |
| Thomsen and coworkers (28),‡ 1995 | | $4.8–8.3/10^5$/pa | | |
| Knaus and coworkers (16), 1994 | | | | 24% (ICU)<br>37% (hospital) |
| Sloane and coworkers (20),§ 1992 | | | | 54% |
| Villar and Slutsky (2),‖ 1989 | | $1.5–3.5/10^5$/pa | | 70% |
| Webster and coworkers (29),¶ 1988 | | $4.5/10^5$/pa | | |
| Fowler and coworkers (30), 1983 | | $5.2/10^5$/pa | | 65% |
| NIH (1), 1972 | | $71/10^5$/pa | | 50% |

*Definition of abbreviations*: ALI = acute lung injury; ARDS = acute respiratory distress syndrome; LIS = lung injury score; pa = per annum.
* Multicenter trials or those studying large populations only.
† Patients with acute respiratory failure defined as ventilation > 24 h were studied.
‡ $Pa_{O_2}/PA_{O_2} < 0.2$.
§ $Pa_{O_2}/FI_{O_2} < 250$ mm Hg.
‖ $Pa_{O_2}/FI_{O_2} < 110$ mm Hg.
¶ No diagnostic criteria mentioned.

proach by including only those patients meeting AECC criteria and requiring more than 12 h of ventilatory support. Despite this, we report an increase in incidence of ALI and ARDS of almost 50%. This may be due to a number of factors, including misclassification and hence overreporting, regional or seasonal variation, and chance.

Although the AECC definitions for ALI and ARDS (6) are simple, there is the risk of misclassification. The lack of a readily accessible "gold standard" test to demonstrate the presence of increased alveolar-capillary permeability and diffuse alveolar damage (DAD) increases the chance of this misclassification. Although pathological features are an acceptable gold standard (14), this is rarely practical due to low autopsy rates and low rates of open lung biopsy. We instructed all sites that bilateral alveolar or interstitial infiltrates on chest radiograph were essential for classification of ALI and ARDS, and that this interpretation be performed by a radiologist or an experienced intensivist. However, (i) consensus training was not performed, without which only moderate interobserver agreement is achieved (15), (ii) specific review by a radiologist was not possible at every site, and (iii) there was no audit process. Consequently, misclassification due to chest radiograph misinterpretation is possible, but no more likely than similar studies, and remains an inherent problem when using the current definitions.

Another potential error in classification was the exclusion of hydrostatic pulmonary edema without the requirement for a direct measurement of the left atrial pressure. However, consistent with the AECC definitions these patients were excluded on clinical grounds and through measurement of the pulmonary artery occlusion pressure in some patients.

Finally, although we were unable to find any data documenting seasonal variation in the incidence of ALI and ARDS, this cannot be excluded as the period of data collection was limited. Data collection was conducted over spring and the beginning of summer, usually a representative period, and we were not aware of any reported epidemics during this time.

Despite these caveats, we believe the incidences of ALI and ARDS reported in the current study are likely to be valid because of the following:

1. Intensive care in these three states is centralized to the capital cities. Given the great distances between capital cities in Australia, it is extremely unlikely that transmigration of cases would significantly influence our findings, as might be expected in the United States or Europe.
2. The structure of intensive care in Australia, closed general medical and surgical units with full-time intensivists, lends itself to complete data capture. All 21 ICUs in the three states sampled participated in the study, allowing screening of every ICU admission.
3. The centralized role of critical care in Australia results in nearly all patients with severe and ongoing respiratory failure being transferred to the ICU from other specialty units. Cardiac surgery was performed at 9 of the 21 hospitals with separate postcardiothoracic surgery units in only two hospitals. However, only 6 of 457 patients developed ALI following cardiothoracic surgery in the remaining seven sites, and none of these developed ARDS. It is also possible that some patients were not referred to the ICU and hence were missed, for example, terminally ill ward patients or patients dying in the emergency room or operating theater. Because it was not possible to enroll these sites, the true incidence of ALI and ARDS may be even greater.

### Mortality and Mode of Death

The 28-d mortality for ALI, ARDS, and ALI without ARDS was 32%, 34%, and 15%, respectively, with corresponding ICU mortality rates of 28%, 30%, and 10%. Those patients with ALI, but never fulfilling ARDS criteria, had a significantly lower mortality rate. The figures are generally lower than, but similar to, those reported by Luhr and coworkers (7), Knaus and coworkers (16), and The ARDS Network (4), and are in keeping with the trend of decreasing overall mortality rates over the past 15 yr (3, 17). However, two recent single-center studies involving predominantly medical patients reported mortality rates of 58% and 65% (18, 19). Variations in case mix may account for differences in mortality, highlighting the need for complete population studies to estimate incidence and mortality rates.

Our use of a 28-d mortality rate may have underestimated the true hospital mortality rate, as Sloane and coworkers (20) showed that mortality increased from 44% if measured at 4 wk to 54% without a predetermined time limit. However, because Luhr and coworkers (7) showed no difference in mortality at 7, 14, 21, 30, 60, or 90 d, and Valta and coworkers (21) found no further mortality between hospital discharge and 8-mo follow-up, our mortality rate provides a good estimate.

Finally, death due solely to respiratory failure occurred in five cases (9% of deaths). Consistent with previous studies (21, 22), multiple organ dysfunction and sepsis were the two most common modalities of death and were responsible for 50% and 40% of deaths, respectively.

### Etiology of ALI

Direct lung injury was slightly more prevalent as the initiating mechanism (57% versus 45%). Pneumonia (28%) and aspiration (18%) were the most common direct insults, and sepsis (34%) was by far the most common indirect insult (Table 2). These patterns are in keeping with previous observations (4, 20, 23). There were no statistical differences in mortality, physiological variables, and organ failure scores between direct and indirect lung injury group. We found that barotrauma was more common in the direct group, mainly due to the association with traumatic pulmonary contusion (Table 3).

### Disease Severity and Comorbid Status

Our patients were of age (62 ± 18) and APACHE II score (20 ± 9) similar to those reported by others (7, 18, 23) and had an admission SOFA score of 8.7 ± 3. Our patients had less chronic comorbid illness than seen in others studies and this may partly explain our lower mortality rate. One or more chronic underlying organ system failures were present in only 23% of ALI patients, with immunodeficiency present in 12% of patients, and a McCabe prognostic score of 3 (expected to die from chronic illness within 6 mo) in only 4% of ALI patients. In a study by Monchi and coworkers (19), 30% had a McCabe score of 3 and the overall mortality rate was 65%; however, comparable data from other epidemiological studies are not available.

### Treatment

We can only speculate as to the cause for our relatively low mortality rates. In addition to the suggestion that our patients had less comorbidities, there may have been a treatment effect. It is worth noting that tidal volumes, corrected for predicted body weight, were consistently about 9 ml/kg (*see* Table E1). Although this is higher than that shown to be protective (6 ml/kg) in the ARDS Network study (4), we could not find a statistical relationship between tidal volume and mortality. Further, because relatively low levels of applied PEEP and high $F_{I_{O_2}}$ were administered, it is possible that our mortality rate could be further reduced with minor changes in clinical practice.

### Conclusion

We report an incidence of 34 and 28 cases per 100,000 per annum for ALI and ARDS, respectively, with mortality rates of 32% and 34%, respectively. Although misclassification cannot be completely excluded, this seems unlikely, and the high incidence and low mortality rates appear to be representative of Australian practice. Despite the presence of relatively large tidal volumes, low PEEP levels, and high $F_{I_{O_2}}$ levels, overall mortality was similar to that recently reported by the ARDS Network (4). Consequently, other factors such as the organizational structure of intensive care, which has previously been reported to influence outcome (24), should be examined by international multicenter studies.

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