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## Outcomes, Cost, and Caregiver Burden in the Acute Respiratory Distress Syndrome (ARDS)

BY MARGARET S. HERRIDGE, MS, MD, MPH, AND JILL CAMERON, PHD

Patients who survive critical illness are at risk for permanent physical, functional, emotional, and neurocognitive deficits, some or all of which may contribute to a decreased health-related quality of life (HRQL). The reasons for this late morbidity after intensive care unit (ICU) care are multifactorial and include, but are not limited to, the following:

- the nature of and treatment for the inciting critical illness
- multiple organ dysfunction syndrome and hypoxemia
- physiologic and emotional stress in the ICU related to the illness itself, sleep fragmentation, psychoactive medications, and impaired drug metabolism due to simultaneous administration of multiple medications
- prolonged immobility and long ICU stay.

Patients with the acute respiratory distress syndrome (ARDS) represent some of the most complex, high acuity, and long stay ICU patients. Because of the significant potential for morbidity, ARDS patients have been the main focus of long-term outcome studies in survivors of critical illness. ARDS survivor data are some of the most complete long-term outcome data available and represent the current state-of-the-art in the critical care outcomes literature. As such, they will form the primary basis for this issue of *Critical Care Rounds*.

### Long-term outcome measures in survivors of ARDS

#### *Pulmonary function abnormalities*

Many ARDS survivors have persistent pulmonary function impairments that are typically mild to moderate restrictive changes and an associated reduction in diffusion capacity.<sup>1-3</sup> Orme and colleagues reported that ARDS survivors had abnormal pulmonary function associated with decreased HRQL one year following hospital discharge<sup>4</sup> and Schelling recently reported no additional improvement in pulmonary function after the first year following ARDS.<sup>5</sup> In a recent publication, Neff and colleagues reviewed 30 studies that evaluated pulmonary function in ARDS survivors.<sup>6</sup> They reported significant variability in the proportion of patients with obstructive (0%-33%) and restrictive (0%-50%) defects, as well as compromised diffusion capacity (33%-82%). This spectrum of pulmonary dysfunction may relate to population heterogeneity with respect to evolving definitions or severity of ARDS, severity of lung injury, ICU ventilatory strategy, prior history of lung disease or smoking, and the presence of other pulmonary processes that fulfill the ARDS definition but that have a very different natural history (eg, cryptogenic organizing pneumonia).

Most outcome studies found ARDS survivors are frequently unable to resume their prior lifestyle, but the degree of pulmonary dysfunction does not fully explain their functional limitation. This observation has led investigators to explore other possible contributors to physical disability.



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## Limitation in physical functioning

The Toronto ARDS Outcomes group evaluated exercise capacity (distance walked in 6 minutes with continuous oximetry), pulmonary function, and conducted an interview, physical examination, and HRQL measure in 109 ARDS survivors at 3, 6, and 12 months after ICU discharge.<sup>7</sup> Similar to other pulmonary function studies, the ARDS patients had mild restrictive disease and reduced diffusion capacity at 3 months following ICU discharge. By 6 and 12 months, they had normal to near-normal lung volumes and spirometric measures with a persistent mild reduction in carbon dioxide diffusion capacity-lung impairment similar to that noted by others. The ARDS survivors had profound muscle weakness and wasting and were only able to achieve 66% of their predicted exercise capacity 1-year post-ICU discharge. This functional disability was reflected in the HRQL assessment, in which patients reported a profound reduction in the physical functioning and role-physical domains of the SF-36. Impaired exercise capacity was related to burden of comorbid disease, exposure to systemic corticosteroid treatment during the ICU period, and the rate of resolution of lung injury, and multiple organ dysfunction during the ICU stay. The causes for the observed muscle wasting and weakness were not clear. Potential causes for weakness and functional limitation are listed in Table 1.

In our cohort study, patients continued to have functional limitation from 2 to 5 years after ICU discharge.<sup>8</sup> At 5 years, the median distance walked in 6 minutes was 427 meters for ARDS survivors, not significantly improved from the 422 meters walked at 1 year. The proportion of patients returning to work did not increase beyond 2 years after ICU discharge. The majority of patients returned to their original work.<sup>9</sup>

## Emotional outcomes – Emotional function after ARDS

The prevalence and severity of mood disorders, including symptoms of depression, anxiety, and post-traumatic stress disorder (PTSD) in survivors of critical illness are quite variable among patients following ICU care. Rincon et al<sup>10</sup> noted symptoms of depression and anxiety in 14% and 24%, respectively, in survivors of critical illness. Similar prevalence rates of anxiety and depression have been reported by Scragg<sup>11</sup> and Orme and co-workers.<sup>4</sup> In contrast, Weinert and colleagues found that 43% of patients with acute lung injury reported symptoms of depression<sup>12</sup> and Angus and co-workers reported a 50% prevalence of depression and anxiety at 1 year in ARDS patients.<sup>13</sup> The Toronto ARDS outcomes group found that 58% of ARDS survivors reported depressive symptoms almost 2 years after ICU discharge.<sup>14</sup> More severe symptoms of

**Table 1: Causes of weakness and functional limitation in ICU survivors.**

### Critical illness polyneuropathy

- Axonal degeneration of motor and sensory fibers.
- Reported in up to 70% of ICU patients<sup>32-36</sup>

### ICU-acquired myopathy

- May occur in the presence or absence of corticosteroids or neuromuscular blockade.
- May occur in up to 25% of ICU survivors ventilated for >7 days<sup>37-38</sup>

### Entrapment neuropathy

- A 6% prevalence of peroneal and ulnar nerve palsies has been observed<sup>1</sup>

### Heterotopic ossification

- Decreased risk of pneumonia as compared with ETMV
- Decreased risk of mechanical complications (eg, vocal cord damage, tracheal stenosis)

ETMV = endotracheal mechanical ventilation

depression were reported by younger ARDS survivors and these symptoms were associated with a decreased ability to return to work.

In contrast, Hopkins and her group found that ARDS patients reported minimal symptoms of depression or anxiety.<sup>15</sup> The observed depression and anxiety post-ICU treatment are likely multifactorial and further study is needed to better understand patient predisposition, illness, and the treatment-specific determinants of affective morbidity.

Posttraumatic stress disorder (PTSD) is characterized by the development of symptoms that are triggered by a serious personal threat experienced with helplessness and intense fear.<sup>16,17</sup> The diagnostic criteria include a history of traumatic event(s), accompanied by symptoms from each of 3 symptom clusters: hyperarousal symptoms, intrusive recollections, and avoidant/numbing symptoms. Schelling and colleagues first reported PTSD in a cohort of 80 ARDS survivors 4 years following discharge from the ICU. They found that almost one-third of ARDS survivors reported impaired memory, bad dreams, anxiety, and sleeping difficulties after ICU discharge. PTSD was related to the number of adverse ICU-related memories recalled by patients. Memory for nightmares or delusions while in the ICU, as well as a complete absence of any ICU memories, have also been perceived as traumatic events.<sup>18</sup> PTSD has also been associated with a decrease in HRQL and may represent yet another important contributor to subsequent disability and loss of employment.<sup>19</sup>

## Cognitive outcomes – Cognitive impairment in ARDS survivors

Hopkins and colleagues published the seminal long-term cognitive outcome study in ARDS survivors in 1999.<sup>15</sup> In this natural history cohort, they found that

100% of ARDS survivors had cognitive impairments, including memory, attention, concentration, and decreased intellectual function at the time of hospital discharge. At 1-year follow-up, 30% of the survivors had decreased intellectual function and 78% had impaired memory, attention, concentration, and/or mental processing speed. ARDS survivors had significantly lower IQ than their estimated premorbid IQ ( $p \leq 0.05$ ) and their measured IQ 1 year later. In this cohort, the degree of hypoxia significantly correlated with neurocognitive sequelae ( $r^2 = 0.25$  to  $0.45$ , all  $p < 0.01$ ).<sup>15</sup>

Other groups have confirmed these findings. In a retrospective study of 33 ARDS survivors, Marquis and co-workers reported impaired attention, visual processing, psychomotor speed, and cognitive flexibility compared to critically-ill control subjects.<sup>20</sup> Rothenhäusler retrospectively evaluated 46 ARDS survivors and found that 24% had cognitive impairments and 41% were disabled and could not return to work.<sup>19</sup> A study of self-reported memory problems in the Toronto ARDS cohort found that 20% of ARDS survivors rated their memory as “poor” 18 months following their ICU discharge.<sup>14</sup> Forty percent of survivors fell below 1 standard deviation of an age-adjusted sample mean on the ability and frequency scale of the Memory Self-rating Scale.

Cognitive impairments may persist to 2 years after hospital discharge. In their recent prospective, 2-year, follow-up study, Hopkins and colleagues assessed cognitive outcome in 71 consecutive ARDS survivors treated with higher and lower tidal volume strategies. Fifty-nine percent and 43% of patients had evidence of cognitive dysfunction ( $>1.5$  SD below the mean) in at least 2 cognitive domains at 1- and 2-year follow-up, respectively. There were no significant differences between 1- and 2-year cognitive outcomes except improvement in performance IQ. Cognitive impairments at 1- and 2- years correlated with duration of hypoxemia.<sup>21</sup> Hopkins has also shown that ARDS survivors have brain atrophy, significantly enlarged ventricles, and an increased ventricle-to-brain ratio (another measure of generalized atrophy and an indirect index of white matter integrity) compared to matched controls and this was associated with cognitive dysfunction.<sup>22</sup>

### Health-related quality-of-life

In 1994, McHugh and colleagues prospectively evaluated pulmonary function and quality of life to assess the relationship between pulmonary dysfunction and functional disability.<sup>23</sup> These authors found that the Sickness Impact Profile (generic quality of life measure of the subject's self-perceived physical and psychological condition) scores were very low at extubation, rose substantially in the first 3 months, and then exhibited only slight improvement to 1 year. When quality of life

was assessed using a lung-related Sickness Impact Profile score, only a modest proportion of the patients' overall dysfunction was attributed to residual pulmonary problems. Weinert and co-workers<sup>12</sup> identified functional impairment in a cohort of acute lung injury survivors. They administered the Medical Outcomes Study 36-item short-form health survey (SF-36), a tool that has 8 domains, including, physical and social functioning, role limitations because of emotional or physical problems, mental health, vitality, bodily pain, and general health perceptions.<sup>24</sup> While all domains of the SF-36 were reduced, the largest decrements were in role-physical and physical functioning. While some decreased quality of life was attributed to pulmonary dysfunction, many more patients attributed this to global and generalized disability.

Schelling et al<sup>5</sup> made similar observations about impaired physical functioning and inferred that disability was due to pulmonary dysfunction; however, they did not assess this in their study. Davidson and colleagues<sup>25</sup> designed a study to determine if there were differences in HRQL in ARDS survivors and comparably ill controls. They used the SF-36 and a pulmonary disease-specific measure (the St. Georges Respiratory Questionnaire [SGRQ]) to determine the degree to which perceived physical disability in ARDS survivors was related to pulmonary dysfunction. Similar to previous reports, all domains of the SF-36 were reduced and the largest decrement was in the role-physical domain. ARDS survivors had significantly worse scores on the SGRQ compared to critically-ill controls. There appeared to be an ARDS-specific degree of physical disability, but it was not clear whether this was solely related to pulmonary dysfunction or whether there were other important extrapulmonary contributors.

Angus and colleagues<sup>13</sup> used the quality of well-being score (QWB) in a prospective cohort of ARDS survivors to measure quality-adjusted survival in the first year after hospital discharge. The mean QWB scores for the ARDS cohort at 6 and 12 months were significantly lower than for a control population of patients with cystic fibrosis. When QWB was disaggregated into its component subscores, post hoc analyses showed that the symptom component scores of the QWB accounted for 70% of the decrement in perfect health at 6 and 12 months. Although respiratory symptoms were reported in almost half of the patients, the most common complaints were musculoskeletal and constitutional.

In a prospective cohort study of 78 survivors of ARDS, Orme and others<sup>5</sup> evaluated HRQL and pulmonary function outcomes in patients treated with higher tidal volume versus lower tidal volume ventilation strategies. Both groups (higher and lower tidal volumes) reported decreased HRQL in physical func-

tioning, physical ability to maintain their roles (role-physical), bodily pain, general health, and vitality (energy) on the SF-36. The pulmonary function abnormalities correlated with decreased HRQL for domains reflecting physical function.

Not only is the observation of impaired physical functioning robust across studies and investigators, it also appears to persist for long periods of time following ICU or hospital discharge. The Davidson paper<sup>25</sup> discussed the above reported outcomes at 23 months after discharge. We have also reported persistent physical dysfunction at 2 years after ICU discharge.<sup>8</sup> In the Toronto ARDS Outcomes Group cohort, HRQL improved each year after discharge from the ICU, but continued to be lower than an age- and sex-matched normal population at 5 years.<sup>9</sup> The improvement in quality of life is discordant with the lack of ongoing improvement in functional status measured as distance walked in 6 minutes. This is consistent with irreversible functional morbidity to which ARDS survivors accommodate over time.

Hopkins and colleagues were the first to rigorously evaluate cognitive dysfunction in ARDS survivors and report the significant impact this had on reported HRQL outcomes.<sup>15</sup> Fifty-five consecutive ARDS survivors completed detailed neuropsychological testing and questionnaires relating to health status, cognitive and psychological function at hospital discharge and at 1 year after ARDS onset. In this study, decreased HRQL was related to cognitive dysfunction and, in a subsequent report, the cognitive changes persisted to 2 years after hospital discharge.<sup>21</sup> Impaired long-term cognitive function following ARDS has also been reported by others.<sup>26</sup>

HRQL in ARDS survivors is influenced by physical limitation, cognitive impairment, and emotional dysfunction. The HRQL data has had an enormous impact on the critical care community and has helped focus attention on long-term morbidity after critical illness. However, these data provide limited insights into the specific determinants of morbidity. Natural history cohort data – evaluating both functional and cognitive long-term outcomes – has helped us begin to understand the heterogeneous nature of reported morbidity and the complexity of interaction among physical, emotional, and cognitive domains in individual patients.

### Caregiver and family burden in critical illness

The effect of caring for ICU patients after discharge from hospital may cause significant stress for family members. This stress is intensified if one considers that, in most cases, the family members

are the same individuals who have just completed a protracted bedside vigil in the ICU. They may be physically and emotionally exhausted and experiencing financial stress due to the cost of medical care and time spent at the hospital and away from their workplace. They are likely to have very little reserve and will now be responsible for all aspects of the patient's recovery.

Challenges for the caregiver begin during the ICU stay where they may experience overwhelming stress and distress. Post-traumatic stress symptoms consistent with a moderate to major risk of PTSD were found in 33% of ICU family members.<sup>27</sup> Pouchard and co-workers,<sup>28</sup> in a prospective evaluation of anxiety and depression in 836 family members of critically-ill patients, reported that the prevalence of symptoms of anxiety and depression was 70% and 35%, respectively. The long-term impact of these symptoms on the care of the patient and the ability of the family to recover from this catastrophic event is an area of our group's interest.

Chayboyer and colleagues<sup>29</sup> indicate that a very high degree of caregiver burden is related to patient neuropsychological dysfunction as compared with severe physical disability. Importantly, Cameron et al reported that informal caregivers experience negative health outcomes that persist for almost 2 years after the episode of ARDS and caregiver depressive symptoms are closely linked to neuropsychological dysfunction in the ARDS patient.<sup>30</sup> Caregiver stress may also be related to lack of education about the demands of the caregiver role and the responsibility of managing complex medical treatments and technology in the home.

### Impact of acute lung injury on the public health system

Acute lung injury and ARDS have recently been shown to be important public health concerns, with mortality rates comparable to those from human immunodeficiency virus disease and breast cancer.<sup>31</sup> In our cohort, the mean healthcare costs for an ARDS survivor from ICU admission to 2 years was \$160,590 (95% CI, \$135,050 to \$184,460). The most significant cost burden was the initial hospital stay (mean \$127,028), with ICU costs (mean \$97,050) accounting for 75% of total costs. Nursing costs dominated the total ICU costs (mean \$74,280). Once discharged from hospital, ARDS survivors have a low hospital re-admission rate. Use of outpatient health services, including homecare, diagnostic tests, drugs, and consultation with healthcare professionals only accounts for a

small fraction (mean \$5,000) of the total healthcare costs for these patients. Our data show that ARDS survivors are not aggressive health care consumers following discharge from hospital, and these results parallel their favourable clinical outcomes. At 2 years after ICU discharge, functional status remains compromised at ~70% of predicted for an age- and sex-matched control population. However, HRQL continues to improve and more patients return to the workplace (62%).<sup>8</sup>

Several studies have shown that ARDS survivors have generalized weakness, pulmonary dysfunction, cognitive disability, depression, PTSD, and reduced quality of life. As well, there is emerging evidence of the importance of caregiver burden and its impact on long-term outcomes for patients and families. To date, there is no standardized approach to the care of these fragile patients and no systematic follow-up is offered to family members or loved ones. Future work will need to focus on the design and evaluation of a multi-disciplinary intervention to optimize outcomes for patients and loved ones as part of family-centred post-ICU care.

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#### References

- Lakshminarayan S, Hudson LD. Pulmonary function following the adult respiratory distress syndrome. *Chest* 1978;74:489.
- Elliott CG, Morris AH, Cengiz M. Pulmonary function and exercise gas exchange in survivors of adult respiratory distress syndrome. *Am Rev Respir Dis* 1981;123:492.
- Elliott CG, Rasmussen BY, Crapo RO, et al. Prediction of pulmonary function abnormalities after adult respiratory distress syndrome (ARDS). *Am Rev Respir Dis* 1987;135:634.
- Schelling G, Stoll C, Vogelmeier C, et al. Pulmonary function and health-related quality of life in a sample of long-term survivors of the acute respiratory distress syndrome. *Intens Care Med* 2000;26:1304.
- Orme J, Romney JS, Hopkins RO, et al. Pulmonary function and Health-related quality of life in survivors of acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2003;167:690.
- Neff TA, Stocker R, Frey H-R, et al. Long-term assessment of lung function in survivors of severe ARDS. *Chest* 2003;23:845.
- Herridge MS, Cheung AM, Tansey CM, et al. One-year outcomes in survivors of the acute respiratory distress syndrome. *N Engl J Med* 2003; 34:683.
- Cheung AM, Tansey C, Tomlinson G, et al for the Canadian Critical Care Trials Group. Two-year outcomes, costs and health care utilization in survivors of ARDS. *Am J Respir Crit Care Med* 2006;174:538-44.
- Herridge MS, Tansey CM, Matte AL, et al. Five-year pulmonary, functional, and QOL outcomes in ARDS survivors. *Proc Am Thorac Soc* 2006;3:A831.
- Rincon HG, et al. Prevalence, detection and treatment of anxiety, depression, and delirium in the adult critical care unit. *Psychosomatics* 2001;42(5): 391.
- Scragg P, Jones A, Fauvel N. Psychological problems following ICU treatment. *Anaesthesia* 2001;56:9.
- Weinert CR, Gross CR, Kangas JR, Bury CL, Marinelli WA. Health-related quality of life after acute lung injury. *Am J Respir Crit Care Med* 1997;156:1120.
- Angus DC, Musthafa AA, Clermont G et al. Quality-adjusted survival in the first year after the Acute Respiratory Distress Syndrome. *Am J Respir Crit Care Med* 2001;163:1389.
- Al-Saidi F, Cheung AM, Tansey CM, et al. Neuropsychological sequelae in ARDS survivors. *Am J Respir Crit Care Med* 2003; 167(7):A737.
- Hopkins RO, Weaver LK, Pope D, et al. Neuropsychological Sequelae and impaired health status in survivors of severe acute respiratory syndrome. *Am J Respir Crit Care Med* 1999;160:50.
- Horowitz MJ: Stress-response syndromes. A review of post-traumatic stress and adjustment disorders. In: Wilson JP, Raphael B (eds). *International Handbook of Traumatic Stress Syndromes*. New York:Plenum Press;1993:49-60.
- Gersons BPR. Post-traumatic stress disorder: The history of a recent concept. *Br J Psychiatry* 1992;161:742.
- Schelling G, Stoll C, Haller M, et al. Health-related quality of life and posttraumatic stress disorder in survivors of the acute respiratory distress syndrome. *Crit Care Med* 1998;26:651.
- Rothenhausler H-B, Ehrentraut S, Stoll C, et al. The relationship between cognitive performance and employment and health status in long-term survivors of the acute respiratory distress syndrome: results of an exploratory study. *Gen Hosp Psych* 2001; 23:90.
- Marquis K, et al. Neuropsychological sequelae in survivors of ARDS compared with critically ill control patients. *Am J Respir Crit Care Med* 2000;161:A383.
- Hopkins RO, Weaver LK, Collingridge D, Parkinson RB, Chan KJ, Orme JF, Jr. Two-year cognitive, emotional, and quality-of-life outcomes in acute respiratory distress syndrome. *Am J Respir Crit Care Med* 2005;171(4):340-7.
- Hopkins R, et al. Ventricular enlargement in patients with acute respiratory distress syndrome. *J Int Neuropsychol Soc* 2000;6:229.
- McHugh LG, Milberg JA, Whitcomb ME, Schoene RB, Maunder RJ, Hudson LD. Recovery of function in survivors of the acute respiratory distress syndrome. *Am J Respir Crit Care Med* 1994;150: 90-94.
- Ware JE, Sherbourne CD. The MOS 36-item short form health survey (SF-36). I. Conceptual framework and item selection. *Med Care* 1992;39:473.
- Davidson TA, Caldwell ES, Curtis JR, et al. Reduced quality of life in survivors of acute respiratory distress syndrome compared with critically ill control patients. *JAMA* 1999;281:354.
- Perrins J, Keing N, Collings J. Assessment of long-term psychological well-being following intensive care. *Intensive Crit Care Nurs* 1998; 14:108.
- Azoulay E, Pochard F, Kentish-Barnes N, et al. Risk of Post-traumatic stress symptoms in family members of Intensive care unit patients. *Am J Respir Crit Care Med* 2005;171:987.
- Pouchard F, Azoulay E, Chevret S, et al. Symptoms of anxiety and depression in family members of intensive care unit patients: Ethical hypothesis regarding decision-making capacity. *Crit Care Med* 2001;29: 1893.
- John P, Chaboyer W, Foster M, et al. Caregivers of ICU patients discharged home: What burden do they face? *Intensive Crit Care Nurs* 2001;17:219.
- Cameron JL, Herridge MS, Tansey CM, et al. Well-being in informal caregivers of survivors of acute respiratory distress syndrome. *Crit Care Med* 2006;34:81.
- Rubinfeld GD, Caldwell E, Peabody E, et al. Incidence and outcomes of acute lung injury. *N Engl J Med* 2005;353(16):1685.
- Bolton CF, Gilbert JJ, Hagan AF, et al. Polyneuropathy in critically ill patients. *J Neurol Neurosurg Psychiatry* 1984;47:1223.
- Bolton CF, Laverty DA, Brown JD, et al. Critically ill polyneuropathy: Electrophysiological studies and differentiation from Guillain-Barre syndrome. *J Neurol Neurosurg Psychiatry* 1986; 49:563.
- Zochodne DW, Bolton CF, Wells GA, et al. Critical illness polyneuropathy: a complication of sepsis and multiple organ failure. *Brain* 1987;110:819.

35. Fletcher SN, Kennedy DD, Ghosh IR, et al. Persistent neuromuscular and neurophysiologic abnormalities in long-term survivors of prolonged critical illness. *Crit Care Med* 2003;31:1012.
36. DeJonghe B, et al. Paresis acquired in the Intensive Care Unit. A Prospective Multicenter Study. *JAMA* 2002;288:2859.
37. McFarlane IA, Rosenthal FD. Severe myopathy after status asthmaticus. *Lancet* 1977;2:615.
38. Deconinck N, Van Parijs V, Beckers-Bleux G, et al. Critical illness myopathy unrelated to corticosteroids or neuromuscular blocking agents. *Neuromuscul Disord* 1998;8:186.
39. Clements NC, Camilli AE. Heterotopic ossification complicating critical illness. *Chest* 1993;104:1526.
40. Jacobs JW, DeSonnville PB, Hulsmans HM, et al. Polyarticular heterotopic ossification complicating critical illness. *Rheumatology* 1999; 38:1145.

## Abstracts of Interest

### Two-year outcomes, health care use, and costs of survivors of acute respiratory distress syndrome

CHEUNG AM, TANSEY CM, TOMLINSON G, DIAZ-GRANADOS N, MATTE A, BARR A, MEHTA S, MAZER CD, GUEST CB, STEWART TE, AL-SAIDI F, COOPER AB, COOK D, SLUTSKY AS, HERRIDGE MS. TORONTO, ON, CANADA

**RATIONALE:** Little is known about the long-term outcomes and costs of survivors of acute respiratory distress syndrome (ARDS).

**OBJECTIVES:** To describe functional and quality of life outcomes, health care use, and costs of survivors of ARDS 2 yr after intensive care unit (ICU) discharge.

**METHODS:** We recruited a cohort of ARDS survivors from four academic tertiary care ICUs in Toronto, Canada, and prospectively monitored them from ICU admission to 2 yr after ICU discharge.

**MEASUREMENTS:** Clinical and functional outcomes, health care use, and direct medical costs.

**RESULTS:** Eighty-five percent of patients with ARDS discharged from the ICU survived to 2 yr; overall 2-yr mortality was 49%. At 2 yr, survivors continued to have exercise limitation although 65% had returned to work. There was no statistically significant improvement in health-related quality of life as measured by Short-Form General Health Survey between 1 and 2 yr, although there was a trend toward better physical role at 2 yr ( $p = 0.0586$ ). Apart from emotional role and mental health, all other domains remained below that of the normal population. From ICU admission to 2 yr after ICU discharge, the largest portion of health care costs for a survivor of ARDS was the initial hospital stay, with ICU costs accounting for 76% of these costs. After the initial hospital stay, health care costs were related to hospital readmissions and inpatient rehabilitation.

**CONCLUSIONS:** Survivors of ARDS continued to have functional impairment and compromised health-related quality of life 2 yr after discharge from the ICU. Health care use and costs after the initial hospitalization were driven by hospital readmissions and inpatient rehabilitation.

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### Neuropsychological sequelae and impaired health status in survivors of severe acute respiratory distress syndrome

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Acute respiratory distress syndrome (ARDS) is a disease of acute respiratory failure manifested by severe hypoxemia with a high mortality rate. Previous outcome studies of ARDS have assessed survival and/or pulmonary function as the primary outcome variables. Cognitive or psychological outcomes following ARDS have not been described, despite the possibility that ARDS patients are at risk for brain injury through hypoxemia or other mechanisms. In the current study 55 consecutive ARDS survivors completed a battery of neuropsychological tests and questionnaires regarding health status, cognitive and psychological outcomes at the time of hospital discharge and 1 yr after onset of ARDS. At hospital discharge, 100% (55 of 55) of survivors exhibited cognitive and affective impairments, as well as problems with health status, which affected their quality of life. At 1 yr after ARDS, 17 of 55 (30%) patients still exhibited generalized cognitive decline. Forty-three of 55 (78%) patients had all or at least one of the following: impaired memory, attention, concentration, and/or decreased mental processing speed. One year after ARDS a substantial portion of ARDS survivors exhibit impaired health status and cognitive sequelae, which may be due to hypoxemia, emboli, inflammation, drug toxicity, and/or other etiologies.

*Am J Respir Crit Care Med* 1999;160(1):50-6.

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*Drs. Herridge and Cameron declare that they have no conflicts of interest associated with the contents of this issue.*

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