Background: In the context that special weaning units have been advocated as effective alternatives to the ICU for weaning selected patients, we initiated a Respiratory Special Care Unit (ReSCU) at the Cleveland Clinic Hospital in August 1993. The goals of the ReSCU were the following: (1) to wean ventilator-dependent patients when possible; and (2) when weaning was not possible, to optimize patient and family instruction for patients going home with ventilatory support. This study presents our 4-year experience with 212 patients managed in the ReSCU and analyzes clinical features associated with favorable clinical outcomes.

Methods: The features of the ReSCU include six private beds in a pulmonary inpatient ward staffed by nurses with special pulmonary expertise; 24-h respiratory therapy supervision; bedside and central noninvasive monitoring (ie, continuous pulse oximetry, end tidal capnometry, and ventilator alarms); and a multidisciplinary approach involving dietitians, physical therapists, occupational therapists, social workers, and speech pathologists. All ReSCU patients were cared for primarily by a pulmonary/critical care attending physician and fellow, with consultative input solicited as deemed necessary. The criteria for admission to the ReSCU included hemodynamic stability; absence of an arrhythmia requiring telemetry; and in the attending physician’s judgment, the ability to benefit from the ReSCU.

Results: Between August 23, 1993, and August 31, 1997, 212 patients were admitted to the ReSCU. The median age was 68 years old; 55% were women; 86% were white; and 55% were transferred from the medical ICU. Underlying reasons for ventilator dependence were ARDS from a nonsurgical cause (33%), ARDS following surgery (18%), status post-cardiothoracic surgery (13%), status post-thoracic surgery (12%), and COPD (12%). The median length of ReSCU stay was 17 days (interquartile range, 10 to 29 days). Eighteen percent (n = 38) died during the hospitalization. Among the 174 survivors, complete ventilator independence was achieved in 127 patients (60% of the 212 patient cohort), 28 patients were ventilator dependent (13% of 212 patients), and the remaining 19 patients (9%) required partial ventilatory support. Univariate analysis regarding the association of baseline characteristics with death identified lower albumin and transferrin levels, increasing age, and the physician’s estimate of lower weaning likelihood as significant correlates of death. In contrast, achieving complete ventilator independence was associated with a higher serum albumin level, a nonmedical ICU referral source, a cause of respiratory failure other than COPD, and a physician’s estimate of higher weaning likelihood. To analyze the financial impact of the ReSCU, we assumed that ReSCU patients would have otherwise stayed in the medical ICU and compared the charges (ICU vs ReSCU) with, for a subset of patients, the true costs of ReSCU vs ICU care. Analyses of both charges and cost differences showed similar savings associated with ReSCU care ($13,339 per patient [charges] and $10,694 per patient [costs]).

Conclusions: We conclude the following: (1) the rate of achieving complete ventilator independence in the ReSCU was high; and (2) based on our achieving clinical outcomes, which are comparable to the most favorable rates reported in other series from ventilator units, we conclude that the ReSCU can be an effective and cost-saving alternative to the ICU for carefully selected patients.

Key words: long-term ventilation; weaning; weaning predictors

Abbreviations: CI = confidence interval; IQR = interquartile range; ReSCU = Respiratory Special Care Unit
In the era of increasing attention to the risks of intensive care, the knowledge that some long-term ventilator-dependent patients can benefit from weaning management in alternate care settings has led to the proposal that weaning units be used as effective alternatives to traditional ICUs. Following promising reports from an initiative by the Health Care Financing Administration to establish several weaning units and to examine their costs and efficacy, the Respiratory Special Care Unit (ReSCU) was organized at the Cleveland Clinic Hospital in August 1993 as a special ward in which to promote weaning from mechanical ventilation for eligible patients. This report presents our 4-year experience with 212 consecutive patients managed in the ReSCU. Specifically, we describe the operational features of the unit, the eligibility criteria for admission, and the clinical features of all ReSCU patients and of those successfully liberated from mechanical ventilation. Furthermore, we examine the following several questions regarding weaning outcomes in such patients: (1) What features are associated with enhanced weaning success? (2) What features are associated with an increased mortality risk in ReSCU patients? (3) Does the rate of successful weaning change by year, suggesting a weaning “learning curve?” (4) Is there a duration of ReSCU stay beyond which weaning success becomes increasingly unlikely? and (5) Can physicians predict weaning success at the patient’s ReSCU entry?

**Materials and Methods**

The ReSCU was opened on August 22, 1993 as a designated section in the pulmonary specialty ward of the Cleveland Clinic Hospital. The six-bed ReSCU is staffed by nurses with special pulmonary and rehabilitation expertise (staffing ratio, 1:2 to 1:3 [nurses:patients]), and it features 24-h respiratory therapy supervision (ratio, 1:6); noninvasive monitoring (CO₂ SMO model 7100; Novametrix Medical Systems; Wallingford, CT), and ventilator alarms) with signal outputs at each bedside; and a central monitoring station (Patient Care Monitoring System; Spacelabs Medical; Redmond, WA). Patients were cared for by a multidisciplinary team supervised by an attending pulmonary and critical care physician and fellow, with consultative input from dietitians, physical and occupational therapists, speech pathologists, social workers, relevant subspecialists, and from referring physicians for longitudinal care continuity. During the patient’s ReSCU stay, primary care was assumed by the pulmonary/critical care attending physician; medical house officers did not participate in ReSCU patients’ daily care, but received nightly sign-outs on ReSCU patients to allow emergency intervention if needed.

Eligibility criteria for ReSCU admission included hemodynamic stability, the lack of need for invasive or continuous ECG monitoring, the presence of a mature tracheostomy, and in the attending pulmonary/critical care physician’s judgment, the ability to benefit from the ReSCU. Hemodialytic support could be provided in the ReSCU. The patients already deemed to be ventilator-dependent could be admitted to facilitate the transition to an appropriate alternate-care setting, to optimize the patient’s and caregivers’ education regarding management of tracheostomy and both invasive and noninvasive ventilators, or to acutely decompress the ICU.

In order to analyze weaning success and predictive clinical features, this study considered patients who developed respiratory failure on the same hospitalization as the ReSCU stay and patients whose ReSCU admission had the intention of weaning. Patients who were unweanable before ReSCU admission or patients who were deemed ventilator-dependent prior to initial hospital admission were excluded from the analysis.

For all patients admitted to the ReSCU, the following data elements were prospectively recorded: their demographic features; the type of ICU from which the patient was admitted; their condition leading to ventilator dependence; the duration of their hospital stay preceding the ReSCU admission; the duration of their total ReSCU stay; the number of days they required mechanical ventilation; their first day of freedom from mechanical ventilation (defined as the first day after which spontaneous breathing was maintained for ≥ 48 h); their need for readmission to an ICU; their admission and discharge body weight; measurements of their nutritional status on ReSCU admission and discharge (including serum albumin and transferrin level); their vital status on hospital discharge; and their discharge destination. At the time of ReSCU admission, the attending pulmonary/critical care physician and/or the fellow physician was asked to predict the likelihood that a patient would wean completely, using a 7-point ordinal rating scale (where 1 signified impossible, and 7 meant definitely successful).

The causes of respiratory failure leading to ReSCU admission were classified into nine categories as follows: (1) COPD; (2) ARDS with or without multiple organ failure in a nonsurgical patient; (3) ARDS with multiple organ failure in a surgical patient; (4) postcardiovascular surgery (without ARDS); (5) post-thoracic surgery (without ARDS); (6) after any other surgery; (7) neuromuscular disease; (8) underlying lung disease other than COPD, eg, idiopathic pulmonary fibrosis; and (9) miscellaneous. In instances when more than one of the nine categories applied, the patient was categorized according to the proximate cause of the respiratory failure leading to ReSCU admission. For example, a patient who developed ARDS after coronary artery bypass surgery would be categorized as having ARDS of surgical cause rather than as having post-cardiovascular surgery.

Ventilatory outcomes were classified as follows: (1) complete ventilator independence; (2) nocturnal ventilation only (with tracheostomy); (3) noninvasive nocturnal ventilation support (bilevel pressure ventilation or another noninvasive method); (4) partial daily (and full nocturnal) mechanical ventilation; and (5) full (24 h/day) mechanical ventilation. The onset of complete ventilator independence was defined as the first day followed by ≥ 48 h of spontaneous breathing.

The primary outcome measures in this study were the rates of hospital mortality and ventilator independence at the end of the hospital stay. Time-to-event survival models were used to assess associations between these outcomes and baseline factors. Spe-
specifically, Cox proportional hazards survival models were used to assess the associations among each outcome and the patient’s age, gender, race, source of referral to ReSCU, admission, albumin, transferrin, weight, ICU length of stay before ReSCU admission, cause of respiratory failure, and physician’s initial wean estimate. Multivariable Cox models were attempted for each outcome. The likelihood ratio test p value is reported for each association, along with a risk ratio and 95% confidence interval (CI). The risk ratio gives the risk of either dying or becoming ventilator independent at a given point in time for a patient in the risk category compared to a patient in the reference category. Kaplan-Meier survival curves are also shown for several associations.

Costs were calculated using computer software (TSI; Transition Systems, Inc; Boston, MA), a decision support system that assesses direct and indirect costs for all clinical services. Calculations included all costs of care (eg, nursing, other allied health-care providers, laboratory tests, medications, etc) other than those for physician services.

**Results**

Between the opening of the ReSCU on August 23, 1993, and August 31, 1997, 239 patients were admitted to the ReSCU, of whom 212 patients were eligible for this study and 27 patients were excluded (Fig 1). Multiple ReSCU admissions during the same hospitalization occurred in 33 patients, accounting for a total of 262 separate ReSCU episodes. The median age of eligible patients was 68 (interquartile range [IQR], 59.5 to 73); 55% were female (n = 117); 86% were white; and 55% were transferred to the ReSCU from the medical ICU.

Of the 212 eligible patients, 18% (n = 38) died, and 82% (n = 174) survived and were discharged from the hospital (Fig 2). Complete ventilator independence was achieved in 60% of the patients (n = 127/212), whereas 22% of the patients (n = 47) were discharged with either partial or continuous ventilatory support. Of the 38 patients who died, 20 died in the ReSCU, and the remaining 18 died between ReSCU and hospital discharge. Withdrawal of life support in respect of patient (when competent) and family wishes was observed in 13 patients (6%). For 11 patients, the withdrawal occurred during the ReSCU stay, and in 2 others, the withdrawal took place in another ward. Among the 174 hospital survivors, 73% (n = 127) were weaned completely, and 28% (n = 48) were discharged directly to home.

An examination of the disposition site by the patient’s ventilator status at hospital discharge (Fig 3) showed that, although more ventilator-independent patients (34%) returned home following their hospitalization than did partially or fully ventilator-dependent patients (21% and 4%, respectively), the majority of patients in all groups were discharged to other facilities for posthospital rehabilitation or long-term care.

A comparison of hospital survival and weaning success rates by year of ReSCU operation (Table 1) shows relatively consistent outcome rates. For example, after an initial rise from 50% in 1993 to 68% in 1994, the rates of achieving ventilator independence remained
stable at 57 to 59%. The length of stay in the ReSCU also remained stable over the study interval, despite a 37% reduction in the total hospital length of stay (median days decreased from 80 in 1993 to 50 in 1997) and a 27% reduction in the total ICU length of stay (median days decreased from 33 in 1993 to 24 in 1997) before initial ReSCU admission. These length-of-stay trends suggest accelerated ICU discharge and utilization of the ReSCU earlier in the patient’s hospitalization, which may indicate the perceived value of the ReSCU to the referring physicians.

The most common underlying cause of respiratory failure at ReSCU admission (Table 2) was nonsurgical ARDS (33%; n = 70). Other causes included surgical ARDS in 18% (n = 38); post-cardiovascular surgery in 13% (n = 28); post-thoracic surgery in 12% (n = 26); COPD in 12% (n = 26); neuromuscular disease in 4% (n = 9); after any other surgery in 3% (n = 6); underlying chronic lung disease (other than COPD) in 1% (n = 2); and miscellaneous causes in 4% (n = 7) of the patients (eg, anoxic encephalopathy following cardiac arrest [3 patients], cerebral vasculitis [1 patient], metabolic encephalopathy due to hypoglycemia [2 patients], and central hypoventilation following stroke [1 patient]).

Weaning outcomes stratified by cause of respiratory failure are presented in Table 2. Patients with COPD (35%) were least likely to become ventilator
independent, and patients with respiratory failure following thoracic surgery (85%) were most likely to become ventilator independent.

Table 3 presents univariate analyses regarding the association between baseline variables and both mortality and weaning outcomes. Of the variables examined on ReSCU admission, those associated with a higher rate of hospital mortality were lower levels of serum albumin ($p = 0.001$) and transferrin ($p < 0.05$), increasing age ($p = 0.04$), and physician’s estimate of lower weaning likelihood ($p = 0.03$). Although multivariable Cox models were attempted for both weaning and mortality outcomes, for neither outcome did more than one variable simultaneously achieve statistical significance at a level of $p \leq 0.05$.

Specifically, although the rate of survival decreased with increasing age in this series, the rate of survival was high in patients $\geq 80$ years old (63%). Similarly, features associated with ventilator independence included a higher serum albumin level ($p = 0.02$), a nonmedical ICU referral source ($p = 0.02$), a cause of respiratory failure at ReSCU admission other than COPD ($p = 0.04$), and an admitting physician’s estimate of higher weaning likelihood ($p < 0.001$).

To assess the time course of weaning success in the ReSCU, Figure 4 depicts a Kaplan-Meier analysis of days to ventilator independence. The median time to achieving ventilator independence was 10 days. For the 212 eligible ReSCU patients, weaning success tended to plateau at about day 33, at 67% (95% CI, 60 to 73), so that few patients remaining in the ReSCU thereafter weaned successfully. By the time patients had spent 63 days in the ReSCU, the estimated percent who achieved ventilator independence increased only slightly to 71%. In interpreting these data, it must be remembered that this study is observational and that the curves reflect “out-migration” of patients whose poor weaning prospects and performance may have triggered their transfer to extramural extended care facilities.

In further examining features affecting weaning outcomes, we evaluated the impact of transfer back to the ICU because of a clinical deterioration during the course of the ReSCU stay. Figure 5 shows the Kaplan-Meier estimated time to wean and the percent of single ReSCU admissions (n = 179) vs the percent of multiple ReSCU admissions (n = 33) achieving ventilator independence. It also shows that

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</thead>
<tbody>
<tr>
<td>Total hospital length of stay, d*</td>
<td>80 (33–130)</td>
<td>68 (52–90)</td>
<td>53 (39–73)</td>
<td>48 (32–68)</td>
<td>50 (34–74)</td>
<td>54 (39–77)</td>
</tr>
<tr>
<td>Total ICU length of stay before ReSCU, d*</td>
<td>33 (15–45)</td>
<td>32 (20–45)</td>
<td>25 (16–36)</td>
<td>23 (13–32)</td>
<td>24 (17–32)</td>
<td>25 (17–37)</td>
</tr>
<tr>
<td>Total ReSCU length of stay, d*,†</td>
<td>14 (11–32)</td>
<td>22 (12–35)</td>
<td>17 (12–31)</td>
<td>14 (8–26)</td>
<td>16 (9–24)</td>
<td>17 (10–29)</td>
</tr>
<tr>
<td>Total days on mechanical ventilation in ReSCU*</td>
<td>12 (6–22)</td>
<td>16 (6–30)</td>
<td>12 (5–18)</td>
<td>12 (6–23)</td>
<td>14 (5–20)</td>
<td>13 (15–23)</td>
</tr>
<tr>
<td>Hospital survival, %</td>
<td>71</td>
<td>91</td>
<td>80</td>
<td>83</td>
<td>78</td>
<td>82</td>
</tr>
<tr>
<td>% Ventilator independent at hospital discharge</td>
<td>50</td>
<td>68</td>
<td>59</td>
<td>59</td>
<td>57</td>
<td>60</td>
</tr>
</tbody>
</table>

*Indicates median (IQR, 25%–75%).
†Does not include ICU days separating two ReSCU admissions during same hospitalization.
‡From August 23, 1993.
§To August 31, 1997.
||Denominator is all patients including nonsurvivors.
readmission to the ICU was associated with slower weaning in the ReSCU (median time, 83 days vs 14 days) and that there was a lower percent of ventilator independence at 7 weeks (45% [95% CI, 26 to 64] vs 77% [95% CI, 68 to 86]; p = 0.001).

In view of reports that older patients experience poor weaning outcomes, we examined rates of achieving ventilator independence in patients ≥70 years old. Although increasing age was associated with higher mortality in this series (Table 3), weaning success rates were nearly as high in older survivors (eg, age ≥70 years old) as they were in younger patients (p = 0.13). Specifically, as shown in Figure 6, the rate of weaning success for patients ≥70 years old was 56% (95% CI, 45 to 67) compared with 68% (95% CI, 59 to 77) for patients <70 years old.

Finally, to examine the financial impact of the ReSCU, we analyzed both charges and costs of caring for patients in the ReSCU vs those for patients in the ICU (in which they would likely otherwise have been managed). Regarding charges, the difference in daily bed charges between the ICU and the ReSCU was $585 per day. Assuming that in the absence of the ReSCU, the patients would have remained in the ICU for the entire duration of the ReSCU stay, the total savings achieved by the ReSCU for these 212 patients was $585 multiplied by the total number of ReSCU days (4,834), or $2,827,890 ($13,339 per patient).

Because the introduction of software in our institution that is used to calculate the true costs of care postdated the opening of the ReSCU, cost calcula-

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**Table 3—Univariate Analysis of Relationship of Outcomes to Baseline Characteristics at ReSCU Admission**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ventilator Independence</th>
<th>Mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Risk Ratio (95% CI)</td>
<td>p Value†</td>
</tr>
<tr>
<td>Age, per 10 yr</td>
<td>0.92 (0.81–1.1)</td>
<td>0.22</td>
</tr>
<tr>
<td>Female gender</td>
<td>0.99 (0.70–1.4)</td>
<td>0.95</td>
</tr>
<tr>
<td>Black race</td>
<td>0.64 (0.41–1.0)</td>
<td>0.06</td>
</tr>
<tr>
<td>Referral source, non-MICU</td>
<td>0.66 (0.47–0.9)</td>
<td>0.02†</td>
</tr>
<tr>
<td>Admission albumin, per 1 U</td>
<td>1.4 (1.05–1.9)</td>
<td>&lt; 0.001†</td>
</tr>
<tr>
<td>Admission transferrin,* per 10 U</td>
<td>1.0 (0.98–1.1)</td>
<td>0.33</td>
</tr>
<tr>
<td>Admission weight, per 10 kg</td>
<td>1.0 (0.93–1.1)</td>
<td>0.93</td>
</tr>
<tr>
<td>Pre ReSCU, ICU length of stay, per 5 d</td>
<td>1.0 (0.96–1.1)</td>
<td>0.91</td>
</tr>
<tr>
<td>Cause of respiratory failure in COPD patients</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARDS (nonsurgery)</td>
<td>2.0 (0.96–4.0)</td>
<td></td>
</tr>
<tr>
<td>ARDS/MOF (surgery)</td>
<td>1.8 (0.81–3.8)</td>
<td></td>
</tr>
<tr>
<td>Post-cardiovascular surgery</td>
<td>2.1 (0.95–4.7)</td>
<td></td>
</tr>
<tr>
<td>Post-thoracic surgery</td>
<td>3.2 (1.5–6.9)</td>
<td></td>
</tr>
<tr>
<td>Physician’s initial wean estimate, per category</td>
<td>1.6 (1.3–1.9)</td>
<td>&lt; 0.001†</td>
</tr>
</tbody>
</table>

*MOF = multiple organ failure; MICU = medical ICU.
†Cox proportional hazards model.
‡Statistically significant (p < 0.05).

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**Figure 4.** Kaplan-Meier estimates of days to ventilator independence for all ReSCU patients.

**Figure 5.** Kaplan-Meier estimates of days to ventilator independence adjusted for number of ReSCU visits (single vs multiple admission) in the same hospitalization.
tions were restricted to a convenience sample of 11 ReSCU patients. For these patients, the difference in the mean daily cost of their first 3 full ReSCU days (including costs of all allied health-care services, eg, physical therapy or other kinds of therapy) and the mean daily cost incurred during their last 3 full ICU days was $469. Extrapolated to the 4,834 ReSCU days occupied by the 212 patients in this series, this $469 difference equals a savings of $2,267,146 associated with the ReSCU ($10,694 per patient).

**Discussion**

In this description of our first 4 years’ experience with the ReSCU, our main findings are the following:

1. Using the selection criteria that were applied, the rates of hospital survival and of achieving ventilator independence were high in this series and similar to the most favorable rates described in other reports1-4-9 (only two of which present larger patient cohorts; see Table 4).

2. After initial improvement in the second year of ReSCU operation, the rates of weaning success and of hospital survival remained stable over the latter 3-year interval examined, even as patients were admitted to the ReSCU sooner in their hospitalization and as total hospital length of stay was reduced by 37% for these patients. Indeed, these outcomes are especially noteworthy in the context that these patients had among the fewest ventilator days before ReSCU admission (Table 4) and fewest days on mechanical ventilation while in the ReSCU among the available series.

3. In contrast to published experience that advanced age was associated with lower rates of ventilator independence, survivors ≥ 70 years old in this series achieved a similar rate of ventilator independence as younger patients did (Fig 6).

4. Features on ReSCU admission that were associated with a higher rate of hospital mortality include lower serum levels of albumin and transferrin, increasing age, and the physician’s estimate of lower weaning likelihood. Features associated with a greater likelihood of ventilator independence include higher serum albumin level, referral from an ICU other than the medical ICU, a cause of respiratory failure other than COPD, and the physician’s estimate of a higher weaning likelihood.

Under the assumption that ReSCU patients would have otherwise remained in the ICU had the ReSCU been not available, our calculations show that the availability of the ReSCU was associated with substantial per-patient savings ($10,694 to $13,339), whether they were calculated as actual costs of care or charges, respectively.

Our experience with the ReSCU has caused it to be favorably received at the Cleveland Clinic Hospital based on several features shown in this study: (1) availability of the ReSCU has allowed the ICUs to be decompressed by providing a setting in which

![Figure 6. Kaplan-Meier estimates of days to ventilator independence adjusted for age strata (< 70 years old vs ≥ 70 years old).](image)

**Table 4—Comparison of Outcomes in Available Series of Units for Long-term Ventilation**

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Elpern et al1</th>
<th>Indihar4</th>
<th>Scheinhorn et al5</th>
<th>Gracey et al6</th>
<th>Latriano et al7</th>
<th>Gracey et al8†</th>
<th>CCF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total patients</td>
<td>95</td>
<td>171</td>
<td>421</td>
<td>129</td>
<td>224</td>
<td>206</td>
<td>212</td>
</tr>
<tr>
<td>% Hospital mortality</td>
<td>67</td>
<td>33</td>
<td>28</td>
<td>10</td>
<td>50</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>% Ventilator dependent</td>
<td>1</td>
<td>33</td>
<td>21</td>
<td>12</td>
<td>3</td>
<td>18</td>
<td>22</td>
</tr>
<tr>
<td>% Ventilator independent</td>
<td>32</td>
<td>34</td>
<td>50</td>
<td>76</td>
<td>47</td>
<td>74</td>
<td>60</td>
</tr>
<tr>
<td>% Surgical patients in weaning cohort</td>
<td>67</td>
<td>23.5</td>
<td>63</td>
<td>28</td>
<td>60</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Ventilator days before respiratory unit admission</td>
<td>NS</td>
<td>25</td>
<td>49†</td>
<td>46</td>
<td>23†</td>
<td>44</td>
<td>25</td>
</tr>
<tr>
<td>Days on ventilator in respiratory unit</td>
<td>NS</td>
<td>45</td>
<td>57</td>
<td>16</td>
<td>49†</td>
<td>—</td>
<td>13</td>
</tr>
<tr>
<td>% COPD</td>
<td>NS</td>
<td>67</td>
<td>24</td>
<td>13</td>
<td>—</td>
<td>—</td>
<td>12</td>
</tr>
</tbody>
</table>

*All values are median unless otherwise indicated. NS = not specified; CCF = Cleveland Clinic Foundation.
†Includes patients in earlier series.
‡Values are mean.
appropriately selected patients can be managed safely; (2) ReSCU care has been associated with a high rate of ventilator independence; and (3) ReSCU care has incurred lower costs than the ICU. Though patient satisfaction was not examined in this study, most clinicians regard the ReSCU atmosphere of private rooms and health-care providers that are attuned to rehabilitation rather than to resuscitation as preferable for appropriate candidates.

Other results of our analyses have also provided important clinical lessons for our practice that we suspect will have general value. First, in contrast to some reports, our findings suggest that advanced age should not preclude aggressive support and weaning attempts in selected individuals. Also, the analysis of time to achieve ventilator independence (Fig 4) has helped to define important, clinically sensible temporal milestones for our practice in weaning. Recognizing that the results of our time-to-event analyses may certainly reflect local practice, we commend this type of analysis to others so that decisions about the need for long-term ventilator support can be based on observed outcomes.

As presented in Table 4, outcomes for ReSCU patients in this series were similar to the most favorable rates of hospital survival and weaning independence in reports from other ventilator units. At the same time, the comparison of these rates among available series suggests substantial variations across units, with rates of hospital mortality ranging from as low as 8% to as high as 67%, and rates of ventilator independence ranging from as low as 32% to as high as 76%. In addition to possibly reflecting operational differences between units, it is likely that other sources of this variation include differences in patient characteristics (eg, medical vs surgical referral source, cause of respiratory failure, prevalence of COPD, etc) and selection criteria for admission to the various units. Indeed, a comparison of the performance of units like that performed for 13 ICUs by Knaus et al is hampered by a lack of standard severity-of-illness measuring scores across available series. Also, in interpreting the reported rates of weaning success, it is important to note whether the denominator used includes all patients considered or hospital survivors only (ie, excluding nonsurvivors). As an example of the impact of this difference in denominators, the 93.8% rate of weaning success among survivors reported by Latriano et al is reduced to 47% when the denominator of all patients (rather than only survivors) is used.

In order not to inflate the rates of weaning success reported in our series, our overall reported rate of 60% weaning success considers all 212 patients in this series (of whom 18% died). On the other hand, our inclusion in this series of only patients admitted to the ReSCU with the intention of weaning, even if the likelihood was deemed low, would be expected to enhance the weaning outcomes in this series, especially in view of our finding that the physician’s estimate of greater weaning likelihood on ReSCU admission was associated with higher rates of achieving ventilator independence. Though not all of them have, some of the other studies have applied similar admission criteria to those used in our ReSCU.

Our high rate of survival among patients aged ≥ 80 years old (63%) is almost identical to the rate (62%) reported by Scheinhorn et al but is in variance with several other reports. For example, in the series by Elpern et al, only 33% of 95 patients aged 60 to 90 years old who were on mechanical ventilation > 3 days survived to hospital discharge, and only 16% remained alive 1 year later. In making this comparison, it must be recognized that the cohort analyzed by Elpern et al considered all Medicare patients rather than those deemed weanable. Similarly, in a retrospective review of 282 patients aged > 80 years old, Swinburne et al reported a 31% hospital survival and an only 9% survival for such patients remaining on mechanical ventilation for > 15 days. Finally, Cohen et al reported a 9% hospital survival among 22 patients > 80 years old and observed that outcomes were especially unfavorable in patients for whom the sum of “age plus duration of mechanical ventilation” was a value > 100. Though it is likely that these outcome differences reflect different selection criteria for ventilator unit admission, a better understanding of causes for these differences will require longitudinal tracking of outcomes among a complete inception cohort of mechanically ventilated patients, as well as a severity-of-illness adjustment.

In the context of prior reports that show that measures of nutritional status are significantly associated with survival, our finding that lower levels of serum transferrin and albumin on ReSCU admission were significantly associated with death and that a higher serum albumin level was associated with enhanced weaning are not surprising. On the other hand, our analysis of the change in the levels of serum albumin and transferrin over the course of ReSCU stay fails to show that improved nutritional measures were associated with improved outcomes (data not shown).

Several shortcomings of the current study warrant discussion. First, the lack of information about long-term survival in our series precludes comparison to rates of survival between 1 and 4 years, as reported by Gracey et al or to 1-year survival rates, as reported by Latriano et al. Indeed, to address this need, examination of long-term survival by telephone inquiry and by analysis of survival databases
(eg, the National Death Index and Equifax) is planned. Similarly, as with many other series, we lack standard measures of severity of illness that are needed to permit adjustment in comparing outcomes with other series. We elected not to include APACHE (acute physiology and chronic health evaluation) III scores in our analysis of outcome predictors because these scores characterize patients at the time of initial ICU admission. In the context that patients were admitted to the ReSCU a median of 25 days after initial ICU admission, it is reasonable to think that their clinical status had changed by the time of ReSCU admission.

Another shortcoming is that, although transfer to the ReSCU was arranged for most patients for whom requests were made, we neither tallied the number of requests for ReSCU transfer nor the number of ventilated patients in our hospital for whom the idea of ReSCU transfer might have been entertained. As such, we cannot calculate the rates of ReSCU admission.

Also, although our finding that a health-care provider’s prediction of weaning likelihood is strongly associated with weaning success and agrees with findings by others, it could be argued that initial pessimism by the admitting physician may have caused a slackening of efforts to wean such patients. Because estimates from physicians uninvolved in the patient’s subsequent management might be less susceptible to such bias, the fact that physicians rotated biweekly into the ReSCU means that patients were often managed by physicians other than those rendering the initial weaning prediction. Also, weaning in the ReSCU is facilitated by applying protocols by the supervising respiratory therapists, thereby lessening the risk that physician bias would affect weaning rates.

Finally, although our economic analysis is based on true cost measures and suggests that ReSCU care is less expensive than ongoing care in a traditional ICU, the comparison is based on several assumptions. First, because software for analyzing costs had become available at our institution only after the ReSCU opened, our assessment of costs is based on a small sample of patients and compares the mean costs of the initial 3 days in the ReSCU with mean costs of the final 3 days in the ICU (before ReSCU transfer) for this sample. Although the staffing ratio in the ReSCU and the avoidance of invasive monitoring and attendant testing (eg, frequently drawn arterial blood gases through an indwelling arterial line) virtually ensure lower ReSCU costs, our analysis assumes similar clinical outcomes of care, whether provided in the ReSCU or continued ICU stay. Although our observations suggest high rates of survival and weaning in caring for this group of ReSCU patients, analysis of costs and outcomes in a randomized trial (eg, ICU vs ReSCU care) would more clearly elucidate the relative clinical and cost benefits of the alternative clinical settings. Until such a trial is undertaken, we believe that results such as ours will provide an important clinical and cost endorsement for units like the ReSCU for appropriately selected patients.

In summary, our experience in caring for 212 patients over the first 4 years of ReSCU operation suggests that high rates of survival and of ventilator independence can be achieved and that the ReSCU is a clinically effective, cost-saving alternative to traditional ICU care for selected patients.

REFERENCES