CHEST

Original Research

CHRONIC CRITICAL ILLNESS

Post-ICU Mechanical Ventilation at 23 Long-term Care Hospitals*

A Multicenter Outcomes Study

David J. Scheinhorn, MD, FCCP; Meg Stearn Hassenpflug, MS, RD; John J. Votto, DO, FCCP; David C. Chao, MD, FCCP; Scott K. Epstein, MD, FCCP; Gordon S. Doig, PhD; E. Bert Knight, MD, FCCP; and Richard A. Petrak, MD; for the Ventilation Outcomes Study Group†

Study objectives: **This multicenter study was undertaken to characterize the population of ventilator-dependent patients admitted to long-term care hospitals (LTCHs) with weaning programs, and to report treatments, complications, weaning outcome, discharge disposition, and survival in these patients.**

Design: **Observational study with concurrent data collection.**

Setting: **Twenty-three LTCHs in the United States.**

Patients: **Consecutive ventilator-dependent patients admitted over a 1-year period: March 1, 2002, to February 28, 2003.**

Results: **A total of 1,419 patients were enrolled in the Ventilation Outcomes Study. Median age of patients was 71.8 years (range, 18 to 97.7 years). Patients averaged 6.9 procedures and treatments during the LTCH hospitalization; median length of stay was 40 days (range, 1 to 365 days). Seven of the 10 most frequent complications treated at the LTCH were infections; congestive heart failure and diabetes mellitus were the most common comorbidities requiring treatment. Outcomes of weaning attempts, scored at LTCH discharge, were 54.1% weaned, 20.9% ventilator dependent, and 25.0% deceased. Median time to wean (n = 766) was 15 days (range, 7 to 30 days). Discharge disposition included 28.8% to home, 49.2% to rehabilitation and extended-care facilities, and 19.5% to short-stay acute hospitals. Nearly one third of patients were known to be alive 12 months after admission to the LTCH.**

Conclusions: **Patients admitted to LTCHs for weaning attempts were elderly, with acute-on-chronic diseases, and continued to require considerable medical interventions and treatments. The frequency and type of complications were not surprising following prolonged and aggressive ICU interventions. In the continuum of critical care medicine, more than half of ventilator-dependent survivors of catastrophic illness transferred from the ICU were successfully weaned from prolonged mechanical ventilation in the setting of an LTCH.**

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Key words: chronic critical illness; functional status; long-term care hospital; multicenter study; outcomes; post-ICU; prolonged mechanical ventilation; survival; ventilator dependent

Abbreviations: CCI = chronic critical illness; IRB = institutional review board; LTCH = long-term care hospital; NALTH = National Association of Long Term Hospitals; NIV = noninvasive ventilation; PMV = prolonged mechanical ventilation; SSAH = short-stay acute hospital

It is now recognized that mechanical ventilation is the major critical care treatment modality that goes beyond the confines of the ICU, establishing a critical care continuum in step-down units, noninvasive respiratory care units, and long-term care hospitals (LTCHs). Admitted to these post-ICU venues for continued care and weaning are ventilator-dependent survivors of catastrophic illness. These patients with "chronic critical illness" (CCI) are distinguished by a syndrome of significant, characteristic derangements of metabolism, and of neuroendocrine, neuropsychiatric, and immunologic function.[1]

Along with profound debilitation and continued dysfunction of multiple organ systems, these abnormalities frustrate the weaning process and contribute to prolonged mechanical ventilation (PMV).

Outcomes research studies of post-ICU weaning at single centers, but with various definitions of weaning success, have reported divergent results, *eg*, weaning success 55% and in-hospital mortality 28%,[2] vs 38% weaned and 50% mortality.[3] In 2001 the National Association of Long Term Hospitals (NALTH) commissioned a multicenter study of patients entering those LTCHs that accepted patients for weaning from mechanical ventilation. The purpose of this study was to characterize the post-ICU weaning population, the LTCH hospitalization, and the outcomes of treatment. We have previously reported population characteristics of ventilator-dependent patients transferred to 23 NALTH-member LTCHs for weaning from PMV, including patient demographics, premorbid diagnoses, etiology of ventilator dependency, and status on admission to the LTCH.[4] Characteristics of the LTCHs were also described. Herein we report treatments, procedures, complications, weaning outcomes, discharge dispositions, survival, and functional status of ventilator-dependent patients transferred to those 23 NALTH-member LTCHs for weaning from PMV. Available costs of care estimates are also reported.

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Materials and Methods

A detailed description of the Ventilation Outcomes Study regarding facility recruitment, investigator training, institutional review board (IRB) approval, and data collection and submission processes has been published.[4] Briefly, a series of surveys of NALTH-member hospitals yielded 23 sites for study participation. The study design was an observational, quality assurance study, with concurrent data collection. Consecutive adult patients receiving invasive mechanical ventilation admitted to the 23 sites for weaning attempts from March 1, 2002, to February 28, 2003 were enrolled in the study, with the following exclusions: patients admitted specifically for end-of-life care or terminal weaning, or for home ventilator training; long-term ventilation admitted for treatment of an intercurrent medical problem; not a weaning candidate as documented by the physician on admission; prior inclusion in the study; and age < 18 years.

Data Collection and Submission

The admission data set information was collected from transfer documents, LTCH history and physical, and multidisciplinary assessments, with clinical data collected from the first 72 h of hospital admission. Discharge data sets were collected from discharge summaries, physician and multidisciplinary progress notes, and International Classification of Diseases, Ninth Revision coding, and submitted as soon as all required data became available. The following information was collected on each patient for the discharge data set: selected procedures and services received at the LTCH, complications and comorbidities treated, wean date, survival to discharge, ventilator and airway status at discharge, and discharge functional status and disposition. Criteria for determination of a diagnosis of infection were facility specific due to the observational study design. Weaning outcomes (weaned, ventilator dependent, deceased) were scored at LTCH discharge. For patients who were weaned, weaning duration (time to wean) was calculated by subtracting the number of consecutive ventilator-free days prior to discharge from the LTCH length of stay.

Twelve-month postadmission follow-up was performed via telephone survey. Given the long lengths of stay in this patient population, survival data were collected at 12 months after hospital admission, as opposed to after discharge, to give the study a fixed end point. The Social Security Death Index was employed for dates of death when unknown.

Cost-to-charge ratios, a federally mandated filing for Medicare patients at all hospitals, and gross charges were obtained by study coordinators from facility financial services departments. These were multiplied to estimate cost of care. If hospitals had already calculated cost of care per discharge using a cost-accounting system, those submitted costs were used.

Statistical Analysis

Data submitted via the secure Web site were initially in FLATTEXT 7.0a format (FLATTEXT Database Scripts; Boardman, OH). Data were then transferred to spreadsheets (Excel; Redmond, WA). The spreadsheets were converted to data sets (SAS version 6.12; SAS Institute; Cary, NC). All results are reported using appropriate descriptive statistics. Binary and categorical variables were summarized using frequency counts and percentages. Continuous variables are presented as mean if normally distributed, and median if skewed. Lengths of stay > 1 year were right censored at 365 days.

Results

Between March 1, 2002, and February 28, 2003, 23 LTCHs with weaning programs admitted 1,587

*From Barlow Respiratory Hospital and Research Center (Dr. Scheinhorn and Ms. Hassenpflug), Los Angeles, CA; Hospital for Special Care (Dr. Votto), New Britain, CT; Oak Bend Medical Center (Dr. Chao), Richmond, TX; Tufts University School of Medicine (Dr. Epstein), Boston, MA; Institute for International Health (Dr. Doig), University of Sydney, Sydney, Australia; Spartanburg Hospital for Restorative Care (Dr. Knight), Spartanburg, SC; and RML Specialty Hospital (Dr. Petrak), Hinsdale, IL.
†For the Ventilation Outcomes Study Group. A list of participants is given in the Appendix.
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Correspondence to: Meg Stearn Hassenpflug, MS, RD, Barlow Respiratory Hospital and Research Center, 2000 Stadium Way, Los Angeles, CA 90026; e-mail: megstearn@aol.com
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ventilator-dependent patients, enrolling 1,419 patients after 168 exclusions. Characteristics and status of enrolled patients on LTCH admission are shown in Table 1.

Discharge data sets were submitted for 1,414 of 1,419 patients (99.6%) enrolled. The frequency of selected procedures, services, and treatments received by patients during the LTCH stay are listed in Table 2. All patients received multiple procedures and services, averaging 6.9 per patient. The majority of procedures and services were supplied at the LTCH; same-day transfer to another facility (< 24 h) was reported for 262 procedures and services. The most frequent service provided outside of the LTCH was CT imaging, with 66 of 347 patients (19%) receiving this procedure; 16 of 40 MRIs also required transfer to another facility. Thirty of 145 gastrostomy tube insertions were performed as a same-day transfer procedure, as were 23 of 53 jejunostomy or gastrojejunostomy tube insertions. The number of patients receiving ICU care at the LTCH was driven primarily by two sites, which admitted all patients directly to an ICU bed for initial assessment and evaluation. "Site-specific" services and treatments were those largely unique to an individual facility.

Complications and comorbidities are tabulated in Tables 3, 4, respectively. The numbers of infections included those in patients whose treatments were initiated prior to LTCH admission, and continued, as well as nosocomial infections acquired at the LTCH. Median length of stay and time to wean were significantly prolonged in patients with urinary tract infection, lower respiratory tract infection, and *Clos-*

Table 1—*Characteristics of 1,419 Patients on Admission to 23 LTCHs for Weaning From Mechanical Ventilation**

Characteristics	Data
Age, yr	71.8 (18–97.7)
Female/male gender, %	49.9/50.1
Premorbid diagnoses per patient, No.	2.6
Diagnosis resulting in mechanical ventilation	
Medical	863 (60.8)
Surgical	556 (39.2)
Prior episode of mechanical ventilation	220 (15.5)
Transferring hospital length of stay, d	
Mean	33.8 ± 29
Median	27 (0–563)
Mechanical ventilation duration, d	
Mean	33.9 ± 45
Median	25 (0–1,154)
Time to tracheotomy, d	
Mean	15.0 ± 10
Median	14 (0–102)
Alveolar-arterial oxygen pressure gradient, mm Hg	127 ± 77
Serum albumin, g/dL	2.44 ± 0.58
Hematocrit, %	30.9 ± 4.4
APACHE III APS (n = 561)	35 (4–115)
Functional status, 'poor' (Zubrod score 3–4), %	98.7
Able to follow commands (per Glasgow coma score), %	70.0
Tracheostomy tube	1,344 (94.7)
Indwelling urinary catheter	1,342 (94.5)
Enteral (tube) feeding: all	1,313 (92.5)
Percutaneous gastric or jejunostomy tube	914 (64.4)
Nasogastric tube	399 (28.1)
Pressure ulceration ≥ stage 2	591 (41.6)
Multiple pressure ulcerations	375 (26.4)
Total parenteral nutrition	90 (6.3)
Renal replacement therapy (hemodialysis)	80 (5.6)

*Values are presented as median (range), mean ± SD, or No. (%) unless otherwise indicated. APACHE = acute physiology and chronic health evaluation; APS = acute physiology score.

Table 2—*Selected Procedures, Services, and Treatments Provided During the LTCH Admission**

Procedure or Service	No. (% of Patients)
Mechanical ventilation	1,414 (100.0)
Physical therapy	1,199 (84.8)
Occupational therapy	1,152 (81.5)
Speech therapy	1,127 (79.7)
Cardiac monitoring, telemetry	700 (49.5)
Blood transfusion	480 (34.0)
CT scan	347 (24.5)
Central venous catheter insertion	298 (21.1)
Ultrasound	291 (20.1)
Echocardiogram	253 (17.9)
Wound debridement	216 (15.3)
Bronchoscopy	206 (14.6)
Psychiatry/psychology†	206 (14.6)
ICU care	179 (12.7)
Ventilation/perfusion scan or perfusion scan only	158 (11.2)
Gastrostomy tube insertion	145 (10.3)
EEG†	124 (8.8)
Upper endoscopy	116 (8.2)
Medically complex rehabilitation†	109 (7.7)
Renal replacement therapy (hemodialysis)	103 (7.3)
Cardiopulmonary resuscitation	81 (5.7)
Lower endoscopy	71 (5.0)
Tracheotomy	61 (4.3)
Jejunostomy or gastrojejunostomy tube insertion	53 (3.7)
Phrenic nerve study†	44 (3.1)
Modified barium swallow or fiberoptic endoscopic evaluation of swallowing	40 (2.8)
MRI	40 (2.8)
Chest tube insertion	32 (2.3)
Peripherally inserted central catheter insertion	27 (1.9)
Therapeutic recreation†	26 (1.8)
Thoracentesis	24 (1.7)
Sleep study	19 (1.3)
Pacemaker insertion	12 (0.8)
Pulmonary artery catheter insertion	4 (0.3)
Other	328 (NA)
Total	9,685

*NA = not applicable.
†Site specific.

Table 3—*Complications Treated in 1,414 Patients at LTCHs**

Complications	No. (% of Patients)
Urinary tract infection	488 (34.5)
Pneumonia or tracheobronchitis	439 (31.0)
Clostridium difficile colitis	298 (21.1)
Sepsis without shock	193 (13.6)
Indwelling line-associated sepsis	165 (11.7)
Aspiration pneumonia	143 (10.1)
Renal failure, acute renal insufficiency	142 (10.0)
Sepsis with shock	124 (8.8)
GI hemorrhage	109 (7.7)
Deep vein thrombosis	70 (5.0)
Ileus or gastroparesis	69 (4.9)
Infections, other	67 (4.7)
ARDS	43 (3.0)
Acute myocardial infarction or unstable angina	32 (2.3)
Pleural effusion	32 (2.3)
Pneumothorax	17 (1.2)
New stroke or intracranial hemorrhage	12 (0.8)
Acute pulmonary embolism	5 (0.4)
Other	280 (NA)
Total	2,678

*NA = not applicable.

tridium difficile colitis ($p < 0.001$). Weaning outcome was negatively impacted in patients with lower respiratory tract infection (48.5% vs 56.7%, $p = 0.022$). The need for patient isolation for particularly resistant bacterial isolates was frequent: methicillin-resistant *Staphylococcus aureus* in 453 patients (31.9%), vancomycin-resistant Enterococcus in 85 patients (6.0%), and 55 patients (3.0%) with both organisms. Isolation for other infections was noted in 827 patients (58.2%).

Outcomes of weaning attempts at the LTCHs, and airway status at discharge, are reported in Table 5. Patients discharged on part-time and noninvasive ventilation (NIV) were scored as ventilator dependent, as they retained increased equipment and monitoring needs. Weaning outcomes by site are reported in Table 6. LTCH median length of stay was 40 days (range, 1 to 365 days); time ventilated was 21 days (range, 1 to 365 days). Total days of hospitalization (transferring facility plus LTCH) were 83 ± 50 days (mean ± SD). Although liberated from mechanical ventilation, 50.7% (388 of 766 patients) required supplemental oxygen at time of discharge.

Table 4—*Comorbidities Treated in 1,414 Patients at LTCHs**

Comorbidities	No. (% of Patients)
Decompensated or new-onset congestive heart failure	503 (35.6)
Diabetes mellitus	465 (32.9)
Atrial fibrillation	370 (26.2)
Hypothyroidism	175 (12.4)
Cancer	78 (5.5)
Encephalopathy (unspecified etiology)	72 (5.1)
Chronic renal failure (receiving hemodialysis prior to PMV)	61 (4.3)
Other	424 (NA)
Total	2,148

*NA = not applicable.

Table 5—*Weaning Outcome and Airway Status at Discharge from LTCHs**

Outcome	Data
Weaned	766 (54.1)
No ventilator, decannulated	449
No ventilator, tracheostomy retained	317
Ventilator dependent	295 (20.9)
Full-time mechanical ventilation with tracheostomy	232
Part-time or nocturnal mechanical ventilation, with tracheostomy	53
Noninvasive positive pressure ventilation or bilevel positive airway pressure (decannulated)	10
Died	353 (25.0)
Total	1,414 (100.0)

*Data are presented as No. (%) or No.

Table 7 shows discharge destinations of all patients discharged alive. Nearly 20% were discharged to a short-stay acute hospital (SSAH) for surgery, a procedure, or treatment of an intercurrent illness; 65% of those were ventilator dependent at the time of discharge. The majority, 144 of 207 patients (69.6%), were transferred for intercurrent medical problems unable to be treated at the LTCH. Medical conditions included but were not limited to the following: acute GI bleeding, tracheal bleeding, abdominal distension, acute myocardial infarction, sepsis, seizures, cardiac arrest, and hypotension. Forty-seven of the 207 patients (22.7%) were transferred to SSAH for surgery or a procedure. Surgeries and procedures included but were not limited to the following: pacemaker insertion, amputation, hemicolectomy, colonoscopy, laparotomy, placement of hemodialysis catheter, CT scan, thoracotomy, and coronary artery bypass graft. Six patients were discharged back to SSAH at the request of the patient and/or family; 10 patients were discharged to SSAH for other or unknown reasons. The mean estimated cost of care for the hospital stay of patients at 14 LTCHs reporting financial data was $63,672 (median, $47,217; range $949 to $553,485).

Figure 1 shows the flow diagram of 12-month postadmission survival. Four sites did not participate in follow-up activities owing to IRB restrictions.

Table 6—*Weaning Outcomes by Site*

Site	Patients, No.	Weaned, No. (%)	Ventilator Dependent, No. (%)	Died, No. (%)	Time to Wean, d*
A	6	5 (83.3)	1 (16.7)	0 (0.0)	24 (18.5–29.0)
B	16	13 (81.3)	0 (0.0)	3 (18.7)	20 (8.5–32.5)
C	7	5 (71.4)	1 (14.3)	1 (14.3)	10 (5.2–46.0)
D	105	74 (70.5)	10 (9.5)	21 (20.0)	21 (14.0–37.0)
E	35	24 (68.6)	7 (20.0)	4 (11.4)	9 (5.0–14.8)†
F	48	31 (64.6)	11 (22.9)	6 (12.5)	16 (8.0–25.8)
G	42	27 (64.3)	5 (11.9)	10 (23.8)	13 (6.0–26.5)
H	36	23 (63.9)	2 (5.5)	11 (30.6)	11 (4.0–17.0)
I	11	7 (63.6)	4 (36.4)	0 (0.0)	17 (5.0–22.0)
J	95	58 (61.0)	26 (27.4)	11 (11.6)	10 (5.0–27.5)
K	60	36 (60.0)	5 (8.3)	19 (31.7)	13 (6.0–24.0)†
L	86	50 (58.1)	30 (34.9)	6 (7.0)	17 (11.0–42.0)
M	21	12 (57.1)	1 (4.8)	8 (38.1)	10 (7.2–28.8)†
N	22	12 (54.6)	5 (22.7)	5 (22.7)	20 (9.8–35.8)
O	41	21 (51.2)	14 (34.2)	6 (14.6)	10 (6.0–21.0)†
P	186	92 (49.5)	40 (21.5)	54 (29.0)	17 (9.5–28.5)†
Q	25	12 (48.0)	7 (28.0)	6 (24.0)	22 (13.8–45.8)†
R	48	23 (47.9)	3 (6.3)	22 (45.8)	30 (14.0–46.0)†
S	283	134 (47.4)	72 (25.4)	77 (27.2)	9 (5.0–22.5)†
T	34	16 (47.1)	2 (5.9)	16 (47.0)	21 (6.8–34.2)
U	135	60 (44.5)	33 (24.4)	42 (31.1)	20 (7.0–46.0)
V	41	18 (43.9)	4 (9.8)	19 (46.3)	13 (4.8–21.0)†
W	31	13 (41.9)	12 (38.7)	6 (19.4)	20 (13.5–24.5)
Total	1,414	766 (54.1)	295 (20.9)	353 (25.0)	15 (7.0–30.0)

*Values are given as the median (interquartile range).
†Sites with weaning protocols.

Functional status at selected time points are shown in Table 8. Among the 179 patients reporting good functional status 12 months after admission, 177 were discharged ventilator free from the LTCH.

Discussion

Ours is the first multicenter study to report weaning outcomes of ventilator-dependent survivors of catastrophic illness transferred to the post-ICU setting of LTCHs. In this continuum of critical care medicine, more than half of the patients were discharged weaned from mechanical ventilation. Strengths of the current study are that consecutive patients receiving mechanical ventilation were enrolled from 23 different LTCHs, employing uniform definitions of weaning outcomes. More than 30 published studies have reported outcomes of weaning from PMV in long-term acute care hospitals, noninvasive respiratory care units, and step-down units, but comparisons are difficult mainly due to various definitions of weaning success, ranging from 48 h to 1 year without ventilatory support. A recent consensus conference report[5] recommended that complete liberation from mechanical ventilation (or a requirement for only nocturnal NIV) for 7 consecutive days should denote successful weaning. We selected to score weaning outcome at discharge for the current study, as that largely determines the next step in the continuum of care. Seven ventilator-free hospital days, followed by reinstitution of ventilatory support, or death, arguably does not truly reflect weaning success.

Table 7—*Disposition in 1,061 Patients Discharged Alive from LTCH*

Type of Facility	No. (% of Patients)
Home or assisted living	306 (28.8)
Acute rehabilitation	126 (11.9)
Extended-care facilities	
Skilled nursing	247 (23.3)
Subacute (high-level nursing)	90 (8.5)
Custodial/nursing home	58 (5.5)
LTAC	18 (1.7)
SSAH	207 (19.5)
Unknown	9 (0.8)
Total	1,061 (100.0)

Table 1 characterizes the study population at the time of their respiratory failure treated with mechanical ventilation in the ICU, including demographics and ICU length of stay. The patients were elderly, there was no gender preponderance, and nearly 60% were smokers with a heavy smoking history.

All patients received multiple procedures and services during the LTCH admission. The very high

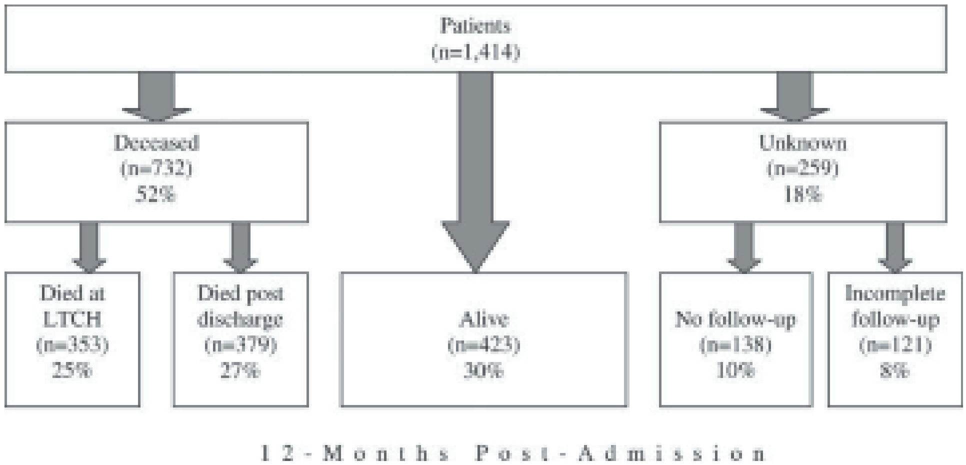

FIGURE 1. Twelve-month postadmission survival. IRB restrictions precluded follow-up at four sites (n = 138). An additional 121 patients were unavailable for follow-up due to incomplete data capture.

frequency of physical, occupational, and speech therapy reflects use of the rehabilitative model of care adopted by many post-ICU weaning programs, noted above to be important in restoration of functionality. Acuity of illness dictates the broad and multisystem nature of interventions; fully one third of the patients received a blood transfusion. The total number of procedures and services does not include those services provided as standards of practice/standards of care at the LTCH. These services included nursing care (including wound care), respiratory care, social services, nutritional care, and pharmacy services. When these are considered together with the services listed in Table 2, the intensity of treatment required by this CCI population is evident.

Infectious and cardiovascular complications led the list of problems; 10% of patients had documented renal insufficiency or failure, a known obstacle to weaning from PMV.[6–8] The complications are not surprising following prolonged and aggressive ICU interventions, particularly when exposure to highly resistant bacteria is considered. Special note should be made that the 5 most frequent complications, and 7 of the 10 most frequent complications at the LTCH, were infections; over half of the patients were treated for this complication. Note that these include infections present on admission, for which antibiotic treatment is continued from the transferring hospital, as well as recurrent and nosocomial infections. These patients have a host of risk factors that may make them particularly susceptible to infections, including diabetes mellitus; advanced age; multiple organ dysfunction; ICU exposure to broad-spectrum antibiotics with resultant antibiotic resistance[9]; impaired mental status; incontinence; indwelling lines (venous catheters, Foley catheters, enteral feeding tubes); aspiration; and ventilation per tracheostomy. The relationships of selected infectious complications in this population to outcomes are clinically relevant, with time to wean, length of stay, and weaning outcome all negatively impacted. Additional threats of infection risk are lapses in host immune responses born from the cumulative effects

Table 8—*Comparison of Zubrod Functional Status Scores**

Zubrod Score	Premorbid (n = 1,393)	Admission (n = 1,418)	Discharge (n = 831)	12 Months After Admission (n = 299)
0, fully active	29.9	0	1.3	19.1
1, restricted in strenuous activity	19.7	< 1	6.1	15.0
2, ambulatory, self-care, no work	29.4	< 1	23.6	25.8
3, bedridden > 50% of time, limited self care	13.1	11.8	37.8	21.7
4, bedridden, no self-care	8.0	86.9	31.2	18.4
Good functional status (Zubrod 0–2)	78.9	1.0	31.0	59.9
Poor functional status (Zubrod 3–4)	21.1	98.7	69.0	40.1

*Data are presented as %. Discharge scoring was not performed for patients who died at the LTCHs, or those transferred to SSAH; accordingly, 12-month postadmission scoring was not performed for patients transferred to SSAH.

of recent critical illness and premorbid diagnoses. Kalb and Lorin[10] coined the term *immune exhaustion* to describe "the potentially disabling effects of depleted, dysfunctional, or inhibited immune resources that may impair defense against pathogens."

Despite advanced age and numerous comorbidities and complications, more than half of all patients enrolled in our study were weaned from PMV. To put these findings in broad perspective, comparison is made to a summation of data selected from nine units and facilities, the largest published reports of weaning success and other outcomes selected from among 30 studies.[11] Therein, the overall number of patients with PMV was > 3,000, with 52% weaning success. Survival to discharge was 67%. That three fourths of patients in our study, in comparison, survived to discharge is an end point measure of safety in weaning in a population with exceptional medical challenges. Two studies[12,13] have suggested beneficial use of NIV in facilitating weaning of tracheotomized patients from PMV, and one third continued with long-term NIV after discharge. Very few patients in our study were discharged receiving NIV, possibly owing to advanced age, multifactorial etiologies of ventilator dependency, and practice patterns.

Caution must be used in interpreting Table 6, as the percentages of PMV patients with weaning success are ordered highest to lowest, with obviously great variation in number of PMV patients admitted to each facility during the year of the study. The considerable range in weaning success is striking, again with "denominators" of PMV patients admitted the most important factor. Comparison of weaning outcomes between sites was not the intent of this study, as there was no attempt to control for differences in: size or type of facility, admission criteria, patient mix, severity of illness, activity, staffing, and practice styles. The availability of ICU beds in the LTCH, and the rate of discharge to SSAH, both possibly altering the locus of death, must also be considered. Nevertheless, liberation from mechanical ventilation was achieved in > 40% of patients at each of these 23 LTCHs, worth noting for patients previously unable to be weaned in the acute care ICU setting.

When patients are transferred to the LTCH for continued weaning efforts, the objective is to "peel off" the layers of support modalities initiated in the ICU. The capability of LTCHs to provide care if the patient becomes paradoxically more critically ill, is facility specific and limited. Of patients discharged alive, almost 20% were discharged to SSAHs; 65% of those were ventilator dependent at the time of discharge. This cohort of patients may not have had the same opportunity for weaning attempts, as evidenced by the percentage of ventilator dependency at discharge. The transfer of patients to SSAHs for treatments not provided at the LTCH may affect outcomes in two ways: (1) increase in ventilator-dependent discharges, and (2) decrease in death as an outcome at the LTCH. Of interest is that having designated ICU beds in the LTCH did not correlate with a lower percentage of patients discharged to SSAH.

Discharge destinations are impacted by a variety of selection factors. Patients with adequate functional status and/or family and caregiver support can return to a home environment. Nearly 30% of all patients discharged alive in our study returned directly home or to assisted living, but this percentage was not comparable to their status prior to their catastrophic illness. In general, few ventilator-dependent patients are discharged home, as there is a need for demonstrated expertise in using mechanical devices safely, and availability of 24-h care. Suctioning is essential for those with tracheostomy, and overall debility may be such that paid or family caregivers at home are needed even for weaned patients. These factors all influence the decision-making process that often results in sending patients to rehabilitation or chronic care facilities rather than home, at least initially.

Twelve-Month Postadmission Follow-up: Survival and Functional Status

Long-term survival and functional status serve as realistic end points to complete the experience of the PMV population. At 12 months after admission to the LTCHs, one half of the patients enrolled in our study were known to have died; 353 died at the LTCHs, while an additional 379 were known to have died after discharge during the follow-up period. In a population of elderly ICU survivors with multiple comorbidities, this was not an unexpected finding. There are several series[2,3,12,14–16] with wide variations in 1-year survival for patients discharged from post-ICU weaning venues. Carson et al[3] reported only 23% of 133 patients were alive 1 year after long-term acute care hospital admission, compared to the experience of Gracey et al,[16] in which 76% of 132 patients discharged from the Mayo ventilator dependent unit realized 1-year survival.

Forty percent of patients discharged alive (423 of 1,061 patients) in the current study were known to have survived 12 months after hospital admission. Functional status information at this time point was obtained for 71% (299 of 423 patients), adding to the limited available experience in the PMV population. The series of Zubrod scores in Table 8 show the following: (1) patients were largely independent before their catastrophic illnesses and PMV; (2) functional status falls to expected lows in an elderly population with PMV following a catastrophic illness; (3) functional status at discharge in the surviving patients was less than premorbid but improved from that at transfer to the LTCH; and (4) continued gains were evident at 12 months after hospital admission, as improved functional status was reported by 49% of patients; 42% reported no change, and only 9% reported decline. Ventilator-free status at discharge from the LTCH correlated with the observed improvement in functionality at 12 months after hospital admission.

Cost-of-Care Estimates

While a prospective payment system for LTCHs[17] was instituted shortly after the completion of this study, which changed reimbursement for care, cost-of-care estimates are still of interest. Fourteen LTCHs submitted proprietary cost data or data sufficient to estimate cost per discharge (*ie*, gross patient charges and cost-to-charge ratios). In this study, with various payer data submitted on 978 patients, the primary payer for 64% of patients was Medicare, and for 6%, Medicaid or state equivalent. The mean cost-to-charge ratio for the 8 of 14 hospitals reporting them was 0.449 ± 0.077. The mean cost of care for patients at all LTCHs reporting financial data was $63,672 (median, $47,217; range, $949 to $553,485). In comparison was the similar mean cost of $56,825 (in 1994 dollars) in PMV patients discharged from 26 LTACs in a large for-profit health-care system.[18]

Dasta and colleagues[19] recently published mean costs of mechanical ventilation in a very large cohort of patients admitted to > 250 ICUs of different types. They found the mean cost of ICU treatment of a patient receiving mechanical ventilation to be $3,968 per day for day 3 and following, with the cost of mechanical ventilation alone $1,522 per day, adjusting for patient and hospital characteristics. One could posit, if the mean ICU cost per day is multiplied by mean days in the LTCH, an estimate of cost per discharge can be calculated that assumes, *ceteris paribus*, that the patient continued to be treated in the ICU. LTCH length of stay, if in the ICU, would cost $210,304 per patient; ventilated time $150,784; and time to wean $99,200. The considerable difference between these costs and the mean LTCH cost would be even greater when considering that the cohort of patients receiving mechanical ventilation studied by Dasta et al[19] was drawn not only from medical ICUs, but from trauma and surgical ICUs. Therein were younger patients, expected to have many fewer comorbidities and complications requiring treatment than the LTCH population if in the ICU.

Our study has several limitations. The number (n = 23) and geographic distribution of the participating facilities in relation to the study budget did not allow for individual site visits for independent data validation. Because of the observational study design, the data collected were dependent on the amount and quality of the available documents from the hundreds of transferring facilities, and on the documentation generated at the LTCHs. Finally, not all sites participated in follow-up activities, affecting long-term survival and functional status analysis and conclusions for the entire cohort.

This is the first multicenter study of weaning outcomes from PMV-focused patient care venues. The limited available experience of CCI patients transferred to the continuum of LTCHs is now extended, with new evidence of the intensity of treatment required for patients weaning after the ICU. The CCI patient population is complicated, labor intensive, and costly, owing to the burden of acute-on-chronic diseases resulting in PMV. Overall, our findings suggest that LTCHs with weaning programs are associated with favorable short-term survival and ventilatory goals. Long-term survival rates could be viewed as disappointing, though not truly unexpected, in patients with advanced age, numerous comorbid conditions, and discharge to extended care as opposed to home.

We hope these results will stimulate further investigation and analysis of predictors of PMV, weaning outcomes, survival, and risk factors for complications in CCI. Some complications occurring at the LTCH may be avoidable, which presents the opportunity to seek unifying processes of care, "best practices," which apply to all PMV patients and may improve their outcomes. Addressing these in a meaningful way would be an undertaking for future investigation. Assessing and interpreting functional status and quality of life in these patients is a particularly important challenge. With an elderly population nearing the end of the natural history of their diseases, there is clear need and opportunities for palliative care programs, with emphasis on symptom management, as well as end-of-life care. Efforts to establish uniform definitions, and to benchmark to determine best practices, and compare performance, clearly warrant consideration in this population.

Appendix: Members of the Ventilation Outcomes Study Group

Expert Panel

David C. Chao, MD, Oak Bend Medical Center, Richmond, TX; Gordon S. Doig, PhD, Institute for International Health, University of Sydney, Sydney, Australia; Scott K. Epstein, MD, Department of Medicine, Tufts University School of Medicine, Boston, MA; E. Bert Knight, MD, Spartanburg Hospital for Restorative Care, Spartanburg, SC; Richard A. Petrak, MD, RML Specialty Hospital, Hinsdale, IL; Ellen A. Pitt, MD; David J. Scheinhorn, MD, Barlow Respiratory Hospital and Research Center, Los Angeles, CA; and John J. Votto, DO, Hospital for Special Care, New Britain, CT.

Coinvestigators and Study Coordinators

Emmel Golden, MD, and Debby Spray, RRT, Baptist Restorative Care Hospital, Memphis, TN; David R. Nelson, MD, and Meg Stearn Hassenpflug, MS, RD, Barlow Respiratory Hospital, Los Angeles, CA; Frank Brancaccio, MD, and Tretha Hewett, CRT, RCP, Baylor Specialty Hospital, Dallas, TX; Brain Amdahl, MD, and Scott Sapp, RCP, CRT, Bethesda Rehabilitation Hospital, St. Paul, MN; Karen Bauer, MD, and Toni Harris, RRT, Drake Center, Inc., Cincinnati, OH; Bruce W. Barton, MD, Kayla Stokes, CRT, and James E. Tiblier, BS, RRT, Dubuis Hospital of Alexandria, Alexandria, LA; Andrew Aldrich, MD, and Cindy Lena, RN, BSN, Dubuis Hospital of Beaumont, Beaumont, TX; Arsenio Martin, MD, and Jackie Reynolds, RRT, RCP, Dubuis Hospital of Beaumont at Port Arthur, Port Arthur, TX; Robert C. Holladay, MD, and Patrice Cook, BS, RRT, Dubuis Hospital of Shreveport, Shreveport, LA; J. David Johnson, MD, and Peggy Matthews Hembree, RN, CRRN, CCM, East Texas Medical Center Specialty Hospital, Tyler, TX; Robert Lambert, MD, and Jerry Amato, BS, RRT, HealthSouth Hospital at Tenaya, Las Vegas, NV; Paul J. Scalise, MD, and Laurie Tambellini, RRT, Hospital for Special Care, New Britain, CT; David Miller, MD, Raymond Acebo, MD, Ruben Garza, RRT, and Richard Gonzales, THI Hospital at Corpus Christi, Corpus Christi, TX; Brian Bloom, MD, Ellen A. Pitt, MD, and Lisa Shannon, RRT, RN, New England Sinai Hospital, Stoughton, MA; Nelson Fernandez, MD, Kathy Hudson, RN, CPHQ, Linda McCombs, and Michael Leger, RN, Plaza Specialty Hospital, Houston, TX; Richard A. Petrak, MD, and Lisa Mikolajewski, BA, BS, RML Specialty Hospital, Hinsdale, IL; Neil S. Shore, MD, and Sandra M. Pigulski, RRT, Shaughnessy-Kaplan Rehabilitation Hospital, Salem, MA; Bert Knight, MD, Lisa Runciman, RRT, and Michael Smith, RRT, Spartanburg Hospital for Restorative Care, Spartanburg, SC; Ronald I. Reisman, MD, Nancy Fitzgerald, RN, and Diane Newton, RRT, St. Elizabeth Ann Seton Hospital of Central Indiana, Carmel, IN; Thomas Gullatt, MD, and Kris Robinson, RRT, St. Francis Specialty Hospital, Monroe, LA; Fredrick Duggan, MD, and Lora Jenkins-Lonidier, RNC, MSN, CCRN, CNS, The Specialty Hospital of Meridian, Meridian, MS; Mark Dinga, MD, William D. Henry, BS, RRT, and Hollie Hart, RRT, UHHS Heather Hill Hospital, Chardon, OH; and Marc Gottlieb, MD, and Cindy Carrigan, RN, BSN, USA Knollwood Park Hospital Long Term Care, Mobile, AL.

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