Ventilator-Dependent Survivors of Catastrophic Illness Transferred to 23 Long-term Care Hospitals for Weaning From Prolonged Mechanical Ventilation*

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Study objectives: **This multicenter study was undertaken to characterize the population of ventilator-dependent patients admitted to long-term care hospitals (LTCHs) for weaning from mechanical ventilation.**

Design: **Observational study with concurrent data collection. Characteristics of the LTCHs were also surveyed.**

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 the patients was 71.8 years old (range, 18 to 97.7 years), with an equal gender distribution. The premorbid domicile was home or assisted living in 86.5%; "good" premorbid functional status (Zubrod score 0–2) was assessed in 77%. There was a history of smoking in 59% (mean, 57 ± 42 pack-years [± SD]); premorbid diagnoses averaged 2.6 per patient. Patients came to the LTCH after mean of 33.8 ± 29 days at the transferring hospital; mean time to tracheotomy was 15.0 ± 10 days. A medical illness led to ventilator dependency in 60.8% of patients; a surgical procedure led to ventilatory dependency in 39.2%. On admission to the LTCH, the median acute physiology score of APACHE (acute physiology and chronic health evaluation) III was 35 (range, 4 to 115); > 90% of patients had at least three penetrating indwelling tubes/catheters; 42% of patients had stage 2 or higher pressure ulceration.**

Conclusions: **This is the first multicenter study to characterize ventilator-dependent survivors of catastrophic illness admitted to the post-ICU venue of LTCHs for weaning from prolonged mechanical ventilation (PMV). Overall, our findings suggest that ventilator-dependent patients admitted to LTCHs for weaning will continue to require considerable medical interventions and treatments, owing to the burden of acute-on-chronic diseases resulting in PMV.**

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

Abbreviations: APACHE = acute physiology and chronic health evaluation; APS = acute physiology score; CCI = chronic critical illness; DCC = data coordinating center; IRB = institutional review board; LOS = length of stay; LTAC = long-term acute care; LTCH = long-term care hospital; NALTH = National Association of Long Term Hospitals; PMV = prolonged mechanical ventilation; RCP = respiratory care practitioner; RN = registered nurse; SSAH = short-stay acute hospital

Advances in acute critical care in supporting and treating ICU patients have resulted in the emergence of "chronic critical illness" (CCI), prolonged ventilator-dependent respiratory failure. This has engendered a specialized area of critical care medicine: the management of patients requiring prolonged mechanical ventilation (PMV). For > 2 decades, these patients have increasingly been

transferred to the post-ICU setting of long-term care hospitals (LTCHs) for continued treatment and weaning attempts.

Thirty-three to forty percent of patients who enter an ICU in North America require mechanical ventilatory support to treat respiratory failure[1,2]; only 5 to 20% require PMV.[3,4] The transfer out of the ICU of tracheotomized patients receiving mechanical ventilation is driven in part by the high cost of treatment: > 100,000 patients annually at a cost estimated in the tens of billions of dollars.[5] Bed scarcity, risk of complications, lack of a multidisciplinary rehabilitative approach to weaning that benefits them most,[6] and the goal of improving patients' experience[7,8] also play roles in these transfer decisions.

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In 2001 the National Association of Long Term Hospitals (NALTH) commissioned the first large multicenter study of patients entering those LTCHs that offered weaning from mechanical ventilation. The NALTH advocates on behalf of its membership for government policy and payment, education, and outcomes research. The purpose of the study was to characterize the post-ICU weaning population, the LTCH hospitalization, and the outcomes of treatment. Herein, we report population characteristics of ventilator-dependent patients transferred to NALTH-member LTCHs for weaning from PMV, including patient demographics, premorbid diagnoses, etiology of ventilator dependency, and status on admission to the LTCHs. Characteristics of the LTCHs are also reported.

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Materials and Methods

A series of surveys of the 95 NALTH-member hospitals yielded 23 sites for study participation. An eight-member expert panel was recruited from the participating facilities for study design and protocol development. The resultant Ventilation Outcomes Study design was an observational, quality assurance study, with concurrent data collection. The primary research site and data-coordinating center (DCC) was Barlow Respiratory Hospital and Barlow Respiratory Research Center. The DCC produced data collection forms and the operations manual. Each facility designated a physician coinvestigator and a study coordinator. A 2-day training session was held to teach data collection and Web-based submission processes.

Consecutive adult patients receiving invasive mechanical ventilation admitted to the 23 sites 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; patients receiving 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. Before data collection, the institutional review boards (IRBs) of nine participating facilities approved the protocol. Fourteen facilities accepted the review services of the central IRB at Barlow Respiratory Hospital. The central IRB found the study to be exempt from informed consent requirements.

Study coordinators consulted with physician coinvestigators for data point collection assistance (patient comorbidities, diagnoses, complications); coinvestigators also served to validate individual site data. The DCC retrieved, processed, and stored de-identified protected health information. Data cleaning activities, to maximize the overall quality of the final database, were realized via e-mail and telephone contact between the DCC and study coordinators. Data editing functions were performed only by the DCC. As questions and/or concerns were presented to the DCC from individual sites, these questions and subsequent answers were shared with the entire group, to ensure most complete uniformity of communication and data collection.

Data Collection and Submission

All patient health information was de-identified, and submitted to the DCC via a secure Web site: www.pmvoutcomes.org. 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 admission. The following information was collected on each patient as available: age; gender; smoking history; onset of mechanical ventilation; date of tracheotomy; premorbid domicile and functional status; premorbid diagnoses; medical and surgical diagnoses from the transferring hospital; pressure ulceration and indwelling lines present on admission to the LTCH; and clinical data to calculate the acute physiology score (APS) of APACHE (acute physiology and chronic health evaluation) III.

Patient functionality was ascertained with the Zubrod score: 0 = fully active; 1 = restricted in strenuous activity; 2 = ambulatory, capable of self-care but not work; 3 = bedridden ≥ 50% of the time, limited self care; 4 = totally bedridden and disabled, no self care; and 5 = dead.[9] This scoring system was chosen because it is easily understood, concise, and has been used in other studies of pulmonary/critical care outcomes.[10] Zubrod scores of 0–2 were determined to be good functional status; scores of 3 and 4 were poor functional status. Duration of mechanical ventilation prior to LTCH admission was defined as the number of days from initiation of ventilatory support until discharge from the transferring facility. New categories of se-

lected data were established from free-text entries when the number of entries exceeded 5% of submitted data sets, or the category was determined to be of particular interest. A facility profile survey was employed to characterize each LTCH.

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 Excel spreadsheets (Microsoft; Redmond, WA). The spreadsheets were the 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.

Results

Between March 1, 2002, and February 28, 2003, 23 LTCHs with weaning programs admitted 1,587 ventilator-dependent patients, enrolling 1,419 patients after 168 exclusions. Patients were excluded for the following reasons: 80 patients (48%) for prior inclusion in the study; 43 patients (25%) were receiving long-term ventilation, not admitted for weaning; 18 patients (11%) were not weaning candidates as documented by physician on hospital admission; 16 patients (10%) were admitted for home ventilator training; 7 patients (4%) were admitted for end-of-life care; and 4 patients (2%) patients were excluded for other reasons. Characteristics of enrolled patients are shown in Table 1. In very few patients, intubation occurred in the emergency department of a short-stay acute hospital (SSAH), with transfer of the patient to the LTCH within the host hospital. This atypical "direct admission" to the LTCH resulted in transferring hospital length of stay (LOS) and duration of mechanical ventilation of zero days. Similarly, a small number of patients were tracheotomized the same day as initiation of mechanical ventilation. Days ventilated prior to admission to the LTCH exceeded transferring hospital LOS for the few patients receiving long-term ventilation admitted to acute hospitals, and then transferred to LTCHs for renewed weaning attempts.

Eleven hospitals were freestanding facilities, and 12 hospital were "hospitals within hospitals"; 20 of the facilities had a not-for-profit designation. Facility profile surveys were submitted by 19 of the 23 participating sites. Median number of beds per hospital was 50 (range, 15 to 311 beds); patient enrollment by hospital ranged in number from 6 to 283. There was no correlation between the number of facility beds and the number of ventilator-dependent patients admitted for weaning. Although 8 of the 19 facilities offered multiple levels of care (long-term acute, acute rehabilitation, subacute, and skilled nursing), all conducted weaning activities at the long-term acute care (LTAC) level of care. Five LTCHs had ICU beds. Registered nurse (RN) staffing was 1:5 (3 to 10 patients), and for all nurses 1:4 (3 to 6 patients). Staffing of respiratory care practitioners (RCPs) was 1:7 (2 to 20 patients). Aggregate facility profile data are detailed in Table 2. Ventilator-dependent patients comprised 10.4% of the total number of patients admitted to all inpatient programs of these 19 facilities during the study period. The number of patients admitted to the individual hospitals for weaning as the percentage of admissions to all inpatient programs ranged from 1.1 to 50.3%.

Premorbid diagnoses reported are noted in Table 3. Cardiovascular and respiratory diseases lead the list, and nearly one fourth of patients had comorbid diabetes mellitus. At the transferring facilities, medical illnesses alone led to mechanical ventilation in

Table 1—*Demographics and Characteristics in 1,419 Patients Admitted to 23 LTCHs for Weaning From Mechanical Ventilation

Characteristics	Data
Age, yr	
Median	71.8
Range	18–97.7
Female/male gender, %	49.9/50.1
History of smoking	
%	59
Pack-years	57 ± 42
Living at home or assisted living facility	1,226 (86.5)
Premorbid functional status, "good" (Zubrod score of 0–2)	1,098 (77.4)
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)
Chronic tracheostomy	26 (1.8)
Location prior to LTCH admission	
Acute care hospital	
ICU	1,331 (93.9)
Step-down or monitored unit	60 (4.2)
Regular ward or nonmonitored respiratory care unit	5 (0.4)
Transitional care or rehabilitation unit	3 (0.2)
Unknown	4 (0.3)
Other	16 (1.0)
Transferring hospital length of stay, d	
Mean ± SD	33.8 ± 29
Median (range)	27 (0–563)
Mechanical ventilation duration, d	
Mean ± SD	33.9 ± 45
Median (range)	25 (0–1,154)
Time to tracheotomy, d	
Mean ± SD	15.0 ± 10
Median (range)	14 (0–102)

*Data are presented as No. (%) unless otherwise indicated.

Table 2—*Characteristics of 19 LTCHs: Aggregate Facility Survey Data

Variables	Data
Location	
Urban	12
Rural	6
Affiliation†	
University medical center	9
Community hospital	10
Private health-care system	1
Bed designation	
No. of beds	50 (15–311)
Designated weaning unit	12
No. of beds for weaning	23 (11–83)
No. of facilities with an ICU	5
No. of ICU beds	6 (3–12)
Admissions during study period	
Total admissions all inpatient programs	14,404
Total admissions for ventilator patients	1,492
Other programs offered	
Wound care	19
Medically complex care	17
Pulmonary rehabilitation	16
Stroke rehabilitation	14
Spinal cord injury	4
Levels of care	
LTAC	19
Acute rehabilitation	5
Subacute care	3
Skilled nursing/extended care	3
Care level of weaning activity	
LTAC	19
Laboratory support in LTCH	
Clinical chemistry laboratory	15
Microbiology laboratory	13
Blood bank	9
Staffing (day shift)	
Patients per RN	5 (3–10)
Patients per all types of bedside nurses	4 (3–6)
Patients per RCP	7 (2–20)
Weaning protocols	
Use/no use of a protocol	9/10
RCP implemented	7
Physician implemented	2
Care structure	
Almost all rehabilitation disciplines	19
Case managers are RNs	16
Staff enterostomal therapist	14
Staff clinical psychologist	8
Medical staff members	150 (20–388)
Almost all internal medicine specialties on medical staff	15
Patient care conferences/team rounds	
Convened once per wk	17
Convened twice per wk	2
Team members/conference attendees	
Conference leader is case/nurse manager	11
Physical therapy/occupational therapy	19
Dietitian	18
Physician, speech therapy, social services	17
Patients' bedside RCP	14
Respiratory care supervisor	10

*Data are presented as No. or median (range). The answers to some questions on individual surveys were omitted, so dichotomous answers do not always add up to 19.
†Hospitals had more than one affiliation.

60.8% of patients; a surgical procedure contributed to respiratory failure in 39.2%. The most common medical diagnoses, often multiple ones per patient, and the surgical procedures that initiated PMV are shown in Tables 4, 5, respectively. The average number of medical diagnoses was 2.5 per patient, with bacterial pneumonia (36.5%) and COPD exacerbation (21.3%) of greatest frequency. There were 628 surgical procedures in 556 patients with resultant PMV; 72 patients had two surgical procedures. In addition to their surgical procedures, these patients also registered 1,100 medical diagnoses, approximately 2 per patient, during their stay in the ICU.

Treatment interventions already in effect on admission to the LTCH, and some descriptive characteristics, are tabulated in Table 6. The majority of patients underwent tracheotomy prior to LTCH admission, and nearly all had at least three indwelling tubes or catheters. Pressure ulceration with broken skin was present in 41.6%. The median APACHE III APS, available for 561 patients, was 35 (range, 4 to 115). The median of 25 days prior time ventilated at the transferring hospital approximated the transferring hospital LOS, indicating that respiratory failure occurred on admission to the SSAH, or soon thereafter, for the majority of patients.

Discussion

A wide range of acute illnesses, usually superimposed on chronic diseases, result in prolonged ventilator dependency. Selected data describing these patients have been captured by retrospective analyses of medical records of patients transferred from ICUs to LTAC hospitals and noninvasive respiratory care units.[11,12] Ours is the first multicenter study to characterize the CCI patient population admitted to LTCHs for weaning from PMV, looking back "upstream" to include data from the ICU experience, and premorbid status.

The 23 hospitals admitted a total of 1,587 ventilator-dependent patients during the 12-month study period, with 89% enrollment (1,419 of 1,587 patients). Of the 168 patients excluded, nearly half were excluded because of prior inclusion in the study. This is best explained in that this population is selected for advanced lung disease, prone to multiple episodes of respiratory failure in a 1-year period. As well, patients transferred to SSAH for intercurrent medical problems or procedures not available at the LTCH were scored as discharged if they did not return within 24 h, per the reimbursement policy in place during the study period. Therefore, any subsequent readmissions of these patients to the LTCH, albeit clearly for the same episode of critical illness, were excluded per the study protocol.

Table 3—*Premorbid Diagnoses in 1,419 Patients Admitted to LTCHs for Weaning From Mechanical Ventilation

Diagnoses	No. (% of Patients)
Cardiovascular	
Hypertension	671 (47.3)
Coronary artery disease with prior myocardial infarction or revascularization	374 (26.4)
Congestive heart failure (left ventricular failure)	301 (21.2)
Right ventricular failure (cor pulmonale)	56 (3.9)
Other (coronary artery disease, atrial fibrillation, peripheral vascular disease, mitral/atrial valve disease/replacement)	193 (NA)
Respiratory	
COPD	599 (42.2)
Interstitial lung disease, pulmonary fibrosis	39 (2.7)
Prior lung resection	36 (2.5)
Pulmonary vascular disease	30 (2.1)
Bronchiectasis	18 (1.3)
Severe kyphoscoliosis or other chest wall restriction	16 (1.1)
Respiratory neoplasm including larynx/trachea	12 (0.8)
Other	177 (NA)
GI	
Cirrhosis, ascites	16 (1.1)
Hepatic failure	12 (0.8)
Neurologic	
Prior cerebrovascular accident with neurologic deficit	176 (12.4)
Depression	69 (4.9)
Neuromuscular disease: amyotrophic lateral sclerosis	12 (0.8)
Other (Alzheimer disease, seizure disorder, Guillain Barré, cerebral vascular disease, transient ischemic attack, mental retardation, Down syndrome, quadriplegia, paraplegia, vegetative state)	121 (NA)
Diabetes mellitus	330 (23.3)
Obstructive sleep apnea, Pickwickian syndrome, apnea, obesity	116 (8.2)
Neoplastic: active cancer localized or metastatic	111 (7.8)
Renal insufficiency/failure	102 (7.2)
Hypothyroidism	68 (4.8)
Total	3,655

*NA = not applicable.

Facilities

Unlike ICUs, whose structure, staffing, and capabilities are generally recognized, practitioners may not be as familiar with those elements of the LTCH. PMV patients are cared for in a wide variety of settings, which reflect local institutional culture, practice style, bed availability, reimbursement environment, and legal constraints.[13] The 19 facilities completing the facility profile survey in our study are characterized in Table 2. The awareness that weaning shifts a patient to a status that requires enhanced management and monitoring is reflected by all of the hospitals carrying out their weaning activity at the higher-staffed LTAC level, regardless of some facilities having multiple levels of care. As a group, though, it is of interest that weaning from PMV was not the main activity of the LTCHs, as evidenced by the relatively low percentage of ventilator-weaning patients admitted compared to the total inpatient admissions of all service lines.

A rehabilitative multidisciplinary approach to weaning was universal, with care teams structured to include physicians, nursing, respiratory care, rehabilitation disciplines, nutritional care, and social services. Team members participated in weekly patient care conferences, most often led by the case manager. Conferences served as the communication forum for patient progress, family and staff concerns, and discharge planning decisions. Nurse staffing was congruent among facilities, and consistent with expected acute care staffing. In contrast, the wide range of RCP staffing is worth noting. Reasons for this disparity may include size of the weaning unit and volume of ventilator patients served by the facility, reflecting RCP responsibility for patients on other service lines, who may require less monitoring and fewer interventions. Facilities may also have areas of professional overlap in the partnership between nursing and respiratory care, *eg*, suctioning and medication administration, affecting staffing ratios.

In this era of protocol use, it is surprising that only half of the facilities used a weaning protocol, which has been shown to have a major impact on time to

Table 4—*Medical Diagnoses That Resulted in Ventilator Dependency in 863 Patients**

Medical Diagnoses	No. (% of Patients)
Respiratory	
Pneumonia (nonaspiration)	315 (36.5)
Exacerbation of COPD (without pneumonia)	184 (21.3)
Aspiration pneumonia	138 (16.0)
ARDS	65 (7.5)
Mucus plugging or atelectasis	67 (7.8)
Pneumothorax	36 (4.2)
Pulmonary embolism	18 (2.1)
Status asthmaticus	6 (0.7)
Other	104 (NA)
Cardiovascular	
Decompensation or new-onset congestive heart failure	129 (15.0)
Cardiopulmonary resuscitation	74 (8.6)
Myocardial infarction or unstable angina	48 (5.6)
Others	65 (NA)
Neurologic	
New cerebrovascular accident or intracranial hemorrhage	77 (8.9)
New onset or progression of neuromuscular diseases	24 (2.8)
Guillain-Barré syndrome	17 (2.0)
West Nile virus	9 (1.0)
Neurologic infection	6 (0.7)
Others	66 (NA)
Sepsis with shock	105 (12.2)
Sepsis without shock	78 (9.0)
Head trauma with or without multiple trauma	89 (6.3)
Acute renal failure, renal insufficiency, hemodialysis	65 (4.6)
GI hemorrhage	47 (5.4)
Chest trauma with flail chest, contusion, or hemothorax	33 (3.8)
Metabolic coma	9 (1.0)
Diabetic ketoacidosis	5 (0.6)
All other medical diagnoses	250 (NA)
Total	2,129

*See Table 3 for expansion of abbreviation.

Table 5—*Surgical Procedures That Resulted In Ventilator Dependency in 556 Patients**

Procedures	No. (% of Patients)
Cardiovascular	
Coronary artery bypass graft	167 (30.0)
Heart valve replacement	76 (13.7)
Abdominal aortic aneurysm repair	27 (4.9)
Dissecting/ruptured aorta	18 (3.2)
Peripheral artery bypass graft	11 (2.0)
Respiratory	
Lung resection, for neoplasm	21 (3.8)
Lung resection, not for neoplasm	7 (1.3)
GI	
GI surgery, not for neoplasm	88 (15.9)
GI surgery for neoplasm	25 (4.5)
Hepatobiliary surgery, not for neoplasm	13 (2.3)
Hepatobiliary surgery for neoplasm	2 (0.4)
Neurological	
Craniotomy, not for neoplasm	33 (5.9)
Craniotomy for neoplasm	4 (0.7)
Orthopedic	
Orthopedic surgery other than hip replacement	25 (4.5)
Orthopedic surgery for hip replacement	9 (1.6)
All others	102 (NA)
Total	628

*See Table 3 for expansion of abbreviation.

wean in the post-ICU setting.[14] The need for consultants to bring expertise to bear on the comorbidities and complications results in large medical staffs, with internal medicine specialists particularly well represented. Other medical specialties—physiatry, psychiatry, anesthesia, dentistry, and oral surgery—were listed by a small number of sites.

Patient Population

Important new information in this patient population regarding premorbid location and functional status can be summarized as follows: the great majority resided at home, where they were largely independent and able to perform daily activities and self-care, before their ICU stay. Table 1 characterizes the study population at the time of respiratory failure treated with mechanical ventilation in the ICU, including demographics and ICU LOS. Patient demographics were consistent with those from single-site and other reports.[12,15–19] The patients were elderly, there was no gender preponderance, and

Table 6—*Status of 1,419 Ventilator-Dependent Patients on Admission to 23 LTCHs**

Selected Variables	Data
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)
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

*Values are presented as No. (%), mean ± SD, or median (range) unless otherwise indicated.

nearly 60% were smokers with a heavy smoking history. A prior episode of mechanical ventilation for respiratory failure is evidence of severe lung disease in most instances. Chronic tracheostomy tube use was occasioned by numerous diagnoses resulting in altered sensorium, neuromuscular weakness with attendant pulmonary secretion clearance problems, or upper airway obstruction.

Premorbid Diagnoses and Those Initiating PMV

The most common premorbid diagnoses (before the catastrophic illness requiring ICU care) are shown in Table 3. In an elderly population, the nature and number of comorbidities are not unexpected. There is considerable overlap in the percentages, as each patient typically had more than one diagnosis. Although not usually the inciting diagnoses of this episode of respiratory failure, these comorbid conditions may have contributed to PMV. The not-unexpected predominance of COPD, cardiovascular disease, and stroke probably reflects the effects of cigarette smoking on the vascular as well as the respiratory systems.

An acute insult, either medical or surgical, added to the burden of chronic disease carried by this population, generated additional medical problems and led to an episode of catastrophic illness and subsequent ventilator dependency. There were often multiple medical diagnoses per patient, which initiated PMV, as found by Carson et al.[16] Medical diagnoses may complicate a surgical procedure, contributing to ventilator dependency. It is not surprising that in 2002 to 2003, coronary artery bypass grafting leads the list of procedures resulting in PMV, in a population with heavy smoking history. Major chest surgery, heart or resectional lung surgery, and upper abdominal surgery all have a direct effect on the musculoskeletal respiratory pump. All are implicated in short-term problems in weaning from mechanical ventilation, but in this population with underlying pathology as well they may have led to PMV. The effects of neurosurgical and orthopedic procedures are, in the majority of cases, indirect. Infectious illnesses (pneumonia, bacterial infection with sepsis) were among the most common medical diagnoses that precipitated PMV. New or worsening congestive heart failure, exacerbations of COPD, and new neurologic events follow in frequency.

On Admission to the LTCH

Although patients are now no longer in the ICU, it is evident that staffing must be provided at levels appropriate for the following: (1) the heavy burden of disability on admission, (2) adequate monitoring of patient safety during weaning activities, and (3) rehabilitation for restoration of functionality. Not unexpectedly, this largely elderly population of PMV patients had very poor functional status at LTCH admission; nearly all were totally bedridden, a result of the effects of prolonged critical illness. The prevalence and number of penetrating or indwelling catheters, each breaching host defenses against infection, are striking. Another area of infection risk and need for increased nursing care is generated by pressure ulceration of the skin.

The etiology of hypoalbuminemia on LTCH admission is most likely multifactorial, with the catabolic effects of the inflammatory response, difficulties with provision of nutrition in the ICU, and fluid balance (overload) playing roles in most patients. Anemia, as evidenced by low mean hematocrit, is a common comorbid condition in the ICU, and is found in virtually all critically ill patients.[20] Sustained severe illness, abnormal gastric emptying, as well as debility and altered sensorium, account for the high rate of percutaneous feeding. Note the relatively low percentage of patients receiving the two life support modalities: mechanical ventilation and hemodialysis. While the selection factor of decreased ICU survival in that cohort plays a role, administrative controls that restrict admission to individual LTCHs of renal replacement therapy patients are another factor to consider. Such patients are known to have less success weaning from PMV, as well as high mortality[21–23]; if weaning is unsuccessful at the LTCH, options for transfer to lower levels of care are limited owing to their high resource utilization.

Selected measures of patient acuity included a significantly elevated mean alveolar-arterial oxygen gradient of 127 mm Hg, representing still resolving acute-on-chronic lung diseases in an elderly population. The median APACHE III APS, a measure of "physiologic instability and risk of death," was 35 in this study population. For comparison, the median APACHE III APS was 41 on admission to ICUs in a large urban series,[24] showing that PMV patients are almost as ill on admission to the LTCH as patients entering ICUs. Despite these findings, the Glasgow coma score shows that 70% are interactive with the care team (able to follow commands) on LTCH admission. The prevalence and severity of pressure ulceration on admission to the LTCH is consistent with a prior single site report,[15] and can be used as evidence of overall debility, inability to turn patients in the ICU,[25] or as evidence of breakdown of the integument as another organ failure caused by critical illness. The CCI population is almost universally at high risk for pressure ulcers, as typically they are of advanced age, and have multiple comorbid illnesses in addition to ventilator dependency and immobility.[26]

Given the comorbidities that accompany PMV, and the fact that weaning attempts will continue beyond the ICU, the intensity of treatment and monitoring essential for the continued care of this population may preclude transfer to facilities without some level of ICU or acute care capabilities. As plans for post-ICU care often begin when tracheotomy is first considered, physicians, working with discharge planners/case managers, have from 1 to 2 weeks to select a transfer destination, guided by the services and interventions each patient requires.[8] We found this to be the case in the current study, with patients transferred to the LTCH, on average, approximately 2 weeks after tracheotomy.

Our study has 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.

Conclusions

This is the first multicenter study to characterize ventilator-dependent survivors of catastrophic illness admitted to PMV-focused patient care venues. The limited information on CCI patients admitted to the continuum of LTCHs for weaning from mechanical ventilation is now extended, with new evidence of premorbid functional status, premorbid diagnoses, etiology of ventilator dependency, and status on discharge from the transferring ICU. Overall, our findings suggest that ventilator-dependent patients admitted to LTCHs for weaning will continue to require considerable medical interventions and treatments, owing to the burden of acute-on-chronic diseases resulting in PMV. We look forward to reporting our findings on: treatments and interventions, complications, and weaning outcomes from patients admitted to the 23 LTCHs in this study, along with discharge disposition and survival.

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