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Factors Associated with Receipt of Physical Therapy Consultation in Patients Requiring Prolonged Mechanical Ventilation

Sarah E. Jolley, MD,

Division of Pulmonary and Critical Care Medicine, University of Washington

Ellen Caldwell, MSc, and

Division of Pulmonary and Critical Care Medicine, University of Washington

Catherine L. Hough, MD, MSc

Division of Pulmonary and Critical Care Medicine, University of Washington

Abstract

Background/Introduction—Mobilization of critically ill patients in the intensive care unit (ICU) is associated with improved function at hospital discharge and reduced duration of mechanical ventilation (MV). Few studies, however, focus on physical therapy (PT) in patients on prolonged mechanical ventilation (PMV) despite their high risk of immobility and poor outcomes.

Objective/Aims—To identify factors associated with the receipt of PT consultation among patients requiring PMV. We hypothesized that key factors including age, severity of illness and presence of a tracheostomy are associated with PT consultation.

Methods—Retrospective cohort study of adults on MV for ≥ 14 days for acute respiratory failure at an academic medical center. Primary outcome was PT consultation by day 14 of MV. We examined associations between the following key predictors, chosen a priori, and PT consultation: age, tracheostomy, illness severity, oxygenation status, shock, hemodialysis and medical service using multivariable logistic regression. Wilcoxon rank sum testing was used to test relationship between sedation and PT.

Results—We identified 175 patients requiring PMV at our institution. Most were middle-aged (mean 49.7, SD 18.5) men (65%) with high illness severity (mean APACHE III 86, SD 40). Less than half of all patients requiring PMV (78/175, 45%) received PT consultation in the ICU and most failed to progress with therapy beyond range of motion exercises (86%). Failure to progress was associated with level of sedation (med Ramsay score 4.5 [IQR 3–6] v 3.5 [IQR 3–5], $p=0.01$).

Corresponding Author Address: Harborview Medical Center, 325 Ninth Avenue Box 359762, Seattle, Washington 98104, Telephone: 206-369-4381, sjolley2@u.washington.edu *Dimensions in Critical Care Group*: General ICU management.

Study performed at Harborview Medical Center, Seattle, WA

Authors Contributions:

SJ conceived of the study with CH and participated in its design, performed chart abstraction and drafted the manuscript. CH conceived of the study design, performed duplicate chart abstraction for a subset of patients to ensure internal validity and helped draft the manuscript. EC performed the statistical analysis and helped draft the manuscript. All authors read and approved the final manuscript.

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Presence of a tracheostomy and pre-hospital non-ambulatory status were associated with receipt of PT by day 14 of MV (OR 6.94 and 3.42 respectively, $p=0.05$).

Conclusions—In our study, we found that PT for PMV patients occurs infrequently and is generally of low intensity. Level of sedation, presence of a tracheostomy and pre-hospital non-ambulatory status were associated with receipt of PT consultation by day 14 of MV.

Keywords

prolonged mechanical ventilation; physical therapy; early mobilization; critical care

Background/Introduction

Patients requiring prolonged mechanical ventilation (PMV), currently defined as greater than 14 days of mechanical ventilation, constitute 3–7% of all intensive care unit (ICU) patients yet consume a disproportionate amount of health care resources. Estimated one-year survival cost reach over \$300,000 with costs upwards of 3.5 million to achieve functional independence [1–6]. These patients often undergo a tracheostomy and experience prolonged ICU stays and experience mortality rates approaching 50% in the year after hospitalization [1, 3, 7]. Their prolonged hospitalizations often necessitate skilled care after hospital discharge and they experience four transitions in care, on average, within the year after their acute illness resulting in further disability. As a result of this disability, survivors of PMV report significant reductions in health related quality of life [1–5, 7, 8].

Patients on prolonged mechanical ventilation experience long periods of bed rest. This prolonged bed rest leads to reductions in muscle mass, decreased muscle efficiency and overall reductions in strength occurring over days to weeks [9–12]. Simultaneously, patients on PMV are at high risk of developing ICU acquired weakness given the underlying conditions necessitating longer durations of mechanical ventilation including ARDS, sepsis and traumatic injuries [4, 9–13]. This prolonged bed rest and ICU acquired weakness contributes to the impaired physical function reported by survivors of PMV. Physical therapy was reported early on as a means of reducing the skeletal muscle changes associated with inactivity. Studies of patients with acute respiratory failure in respiratory intensive care units reported improvements in ambulation and six minute walk testing with initiation of an early stepwise exercise program. These early studies were limited by patient heterogeneity and a lack of data supporting the feasibility and safety of PT as a routine intervention in critically ill patients [14–18]. Additionally, the role of the physiotherapist varied greatly making uniform study design difficult.

More recently, a number of studies have evaluated use of physical therapy as a targeted intervention using defined stepwise mobility protocols [19–24]. Studies using these protocols in patients undergoing weaning protocols from MV in respiratory care units showed that early PT was safe and feasible in this patient population [19–24]. An increasing number of studies, including one randomized control trial, have suggested that physical therapy (PT) in critically ill patients may confer potential long term benefits including increased independence at time of hospital discharge [25–27]. Few studies, however, have focused on patients requiring prolonged mechanical ventilation and few have reported

access to therapy outside of controlled trials or targeted quality improvement projects [16, 20, 21, 28–33].

Objective/aims

In this study, we aim to identify factors associated with the receipt of physical therapy among patients requiring prolonged mechanical ventilation (PMV). We hypothesized that key factors including age, severity of illness and presence of a tracheostomy would be associated with physical therapy consultation.

Methods

We performed a retrospective cohort study utilizing data collected from Harborview Medical Center, Seattle, during the ProVent study [34, 35] (a multicenter study aimed at developing a prediction tool for PMV). This particular study institution is an urban, academic hospital in Seattle, WA with a level 1 trauma center containing 80 ICU beds with a major teaching affiliation. The institution averages 100,000 acute care days annually with an average of 24,000 days annually of intensive care unit care. The study included all patients in 2005 who were at least 18 years old who and received 14 days of mechanical ventilation for acute respiratory failure without interruption of more than 48 hours.

Our primary outcome was defined as the presence of a physical therapy consultation note by day 14 of mechanical ventilation. We then assessed for presence of a consultation within 2 days of ICU discharge and hospital discharge. The level of therapy performed at these time points was recorded according to the following categories (passive or active range of motion, transferring to a chair, standing or walking).

The remainder of our potential predictors of interest, chosen *a priori* based on prior studies of ICU mobility [36, 37], included: sex, ongoing hemodialysis use at day 14, ongoing shock at day 14 (use of vasopressors), oxygenation status on day 14 (PaO₂:FiO₂), ambulation status prior to hospitalization (ambulatory vs. non-ambulatory) and medical service of record were obtained from chart abstraction. We opted to include day 14 variables for our physiologic parameters (vasopressor use, hemodialysis, oxygenation status) given prior mobility studies suggesting that feasibility of therapy is dependent on barriers present at time of therapy and less dependent on earlier time points [13–16]. Level of sedation was defined by highest Ramsay score in the 24 hour period (12 am–12 am) surrounding the consultation date.

Statistical Analysis

All patients with available data were included in the analysis. Baseline characteristics were reported as means for continuous variables and proportions for binary variables. A multivariable logistic regression model was developed using all potential predictors of interest and PT consultation in order to identify potentially important factors associated with receipt of physical therapy consultation for PMV patients. . We assumed that missing data was missing at random regarding sedation level and physical therapy consultation, thus we opted to analyze only patients with available data in our multivariable analysis. We

performed a secondary analysis using a separate multivariable logistic regression model to investigate the association between ambulation status at time of hospitalization and receipt of PT using only patients with available ambulatory status data prior to admission. Wilcoxon ranksum testing was performed to investigate the association between degree of sedation and progression to higher levels of physical therapy.

Results of the logistic regression model were reported as odds ratios with two-sided p-values <0.05 considered statistically significant. The analysis for this paper was generated using SAS/STAT software, Version 9.3 of the SAS System for Windows (copyright © 2010 SAS Institute Inc. SAS and all other SAS Institute Inc. product or service names are registered trademarks or trademarks of SAS Institute Inc., Cary, NC, USA), MedCalc for Windows, version 12.4.0.0 (MedCalc Software, Mariakerke, Belgium) and Stata 10.x (StataCorp. 2007. Stata Statistical Software: Release 10. College Station, TX: StataCorp LP).

The study was approved by the University of Washington Institutional Review Board with waiver of consent given its retrospective nature utilizing de-identified patient data.

Results

We identified 175 patients (Table 1) who required prolonged mechanical ventilation (14 days) at our institution in 2005 with a median duration of mechanical ventilation of 25.4 days [IQR 17.1–28.6]. Most patients were cared for by a trauma or surgery service (46%, n=80), just over one-third cared for by a medical service (35%, n=61) and the remainder cared for by a neurology service (19%, n=34). Most were middle-aged (mean 49.7, SD 18.5) men (65%) who were ambulating independently (67%) and independent with activities of daily living (69%) prior to hospitalization. Most were severely ill on admission with an average APACHE III score of 86.1 (SD 30.9).

Seven-percent (n=13) of patients (Table 2) had ongoing shock requiring vasopressor therapy and 3% required hemodialysis at day 14 (n=5). Twenty-five patients (14.0%) underwent a tracheostomy prior to day 14. Patients cared for by a neurology service were significantly more likely to undergo a tracheostomy (9% vs. 6%) than non-neurology patients (p-value <0.001). Eighteen percent of patients died prior to hospital discharge. Twenty-nine percent of patients who survived were discharged on mechanical ventilation with survivors spending a median of 24.3 days in the ICU [IQR 20–33 days] with a median of 34 days in the hospital [IQR 28–45]. Most survivors were discharged to skilled care facilities (n=59, 34%) or inpatient rehabilitation (n=31, 18%). Most patients survived to hospital discharge and one year post-hospitalization.

Physical therapy was consulted on 78 patients and worked with 65% of patients with consultation (Figure 1) by day 14 of MV (n=51). PT was consulted most frequently by surgical services (29% vs. 22% for medical services vs. 15% for neurologic services), but this difference was not statistically significant (p-value 0.07). Despite having PT consultations, most patients did not have documentation of therapy performed by PT in the ICU (n=124, 71% missing activity at day 14). More patients had documentation of therapy sessions documented in the medical chart prior to ICU discharge (n=110, 63%). Of those

with documented therapy sessions in the ICU, most did not progress beyond range of motion (n=93, 52%) prior to transfer out of the ICU. Only 10% of patients transferred to a chair and none stood or ambulated while in the ICU. Only 18% of patients requiring prolonged mechanical ventilation were walking prior to hospital discharge with only 11 (6%) standing with assistance.

Over one-third of patients who had PT consultation did not have a sedation assessment performed on day of consultation (n=54, 35%). Of patients who did have a Ramsay assessment, only 37 patients (24%) had a sedation score of 2 to 3 suggesting ability to cooperate with therapy (score of 2—cooperative, alert and score of 3—responding to commands). Thirty-seven percent of patients were comatose with scores between 3 and 6 (n=57). Patients who did not progress beyond range of motion in the ICU had deeper levels of sedation at the time of PT consultation (median Ramsay score 4.5, IQR 3–6) compared to those who achieved higher intensity therapy (median 3.5, IQR 3–5, p=0.01).

Presence of a tracheostomy (Table 3) was associated with receipt of PT consultation by day 14 of mechanical ventilation (OR 5.07, 95% CI 1.61–15.97, p-value 0.006) after addition of service of record, age, severity of illness (APACHEIII score), comorbidities, ongoing shock, hemodialysis and oxygenation status (PaO₂:FiO₂). In models including pre-hospital ambulation status, pre-hospital non-ambulatory status was independently associated with receipt of physical therapy by day 14 of mechanical ventilation (OR 3.42, 95% CI 1.02–11.41 p-value 0.05) and tracheostomy remained associated with consultation (OR 6.94, 95% CI 1.72–27.97, p-value 0.007). There was no statistically significant difference in death or duration of mechanical ventilation for patients undergoing a tracheostomy compared to no tracheostomy.

Discussion

In this large cohort of patients on prolonged mechanical ventilation majority of whom were functionally independent prior to hospitalization, we found that use of physical therapy was infrequent and of low intensity. Only 45% (n=78) of patients received physical therapy by hospital day fourteen in the ICU with only 63% (n=110) receiving documentation of physical therapy prior to ICU discharge. Presence of a tracheostomy and history of not ambulating prior to hospital admission were associated with receipt of PT consultation (OR 6.94 and 3.42, respectively).

In our cohort, most patients did not have documentation of receipt of physical therapy in the ICU. When there was documentation of a therapy session occurring, it was often of low intensity with most patients failed to progress with therapy prior to discharge from the ICU. Our study focused on patients with chronic critical illness late in the course of illness. These patients have the longest hospital durations and increased risk of impaired muscle strength associated with prolonged immobility. In addition to infrequent consultation, we found that when consultation did occur, patients frequently did not have documentation of any therapy occurring. Our study suggests that there should be additional research around ways to enhance documentation of physical therapy in the ICU and reasons for failure of ICU physical therapy documentation need to be explored.

In our study, 86% (n=96) of patients who had documentation of a therapy session (n=110) failed to progress beyond range of motion in the ICU with 38% (n=104) not progressing beyond range of motion prior to hospital discharge despite average hospitalizations of 34 days. Some of the failure to progress in our study is likely attributable to the high proportion of trauma or neurology patients who were potentially unable to progress due to neurologic or traumatic injuries. However, this failure to progress with therapy parallels reported levels of therapy achieved in larger quality improvement and prevalence studies of physical therapy use in the ICU suggesting that degree of physical therapy use in clinical practice may be lower than suspected [16, 31–33].

Deeper level of sedation was significantly associated with failure to progress beyond passive range of motion in our cohort. Interestingly, the median Ramsay score in our cohort at day 14 was 4.5 suggesting most of our patients were still heavily sedated two weeks into their hospital course. While we anticipate that this degree of sedation is less frequent currently in ICUs, data used for this study was collected after the introduction of a standardized sedation protocol with daily awakenings. Interestingly, although these protocols were in place, many patients failed to have assessment of daily sedation level on the day of therapy consultation further limiting our inference. High levels of sedation are reported as a barrier to progression of therapy in studies evaluating use of mobility in the ICU and likely contributed to the low use of therapy in this cohort [19, 22, 25, 26, 33, 38, 39]. Quality improvement trials targeting reduction in sedation have demonstrated greater access to physical therapy and further progression through functional activities. Further studies should explore sedation utilization particularly in chronic critical illness to better understand its role later in the course of illness and ways to lighten sedation to allow for greater access to therapy.

Few factors were associated with receipt of PT consultation in our study. Our ability to evaluate these associations were limited by the infrequent use of therapy overall in the cohort. There was evidence of an association between receipt of physical therapy consultation and presence of a tracheostomy. The stability of this association is uncertain given the relatively small numbers of patients who underwent a tracheostomy in our cohort (14%) and warrants further investigation given the negative associations reported in prior studies [23]. Patients undergoing tracheostomy in our cohort were on neurology services where use of physical therapy in the rehabilitative process may be more standard, but patient injuries limit progression through therapy. Providers, however, may feel a greater sense of safety for participation in physical therapy for patients with a tracheostomy. Alternatively, the decision to undergo a tracheostomy may represent a transition point from acute care towards longer-term care and survivorship. This shift in focus may be associated with increased utilization of physical therapy.

We did not identify associations between physiologic parameters (oxygenation status, acute physiology score) or interventions such as hemodialysis and vasopressor use and receipt of physical therapy. We utilized day fourteen data for hemodialysis and vasopressor use in order to better understand if these factors represent barriers to physical therapy consultation as suggested from prior studies [36, 37]. As such, the numbers of individuals receiving these interventions were small possibly limiting our ability to detect associations. Additionally, it is possible that earlier use of these interventions prior to day 14 may bias providers away

from consultation and this would not be reflected in our risk estimates. Regardless, our results support earlier studies suggesting that early physiologic states captured by *APACHEIII* may lose their utility for prediction when applied to chronically critically ill patients. Studies are needed to understand the late barriers to physical therapy in the ICU and to better understand predictors of care in the chronically critically ill.

Finally, we identified a paradoxical association between the likelihood of receiving therapy and patients reported to have a non-ambulatory status prior to admission. This finding is interesting, but not entirely surprising as it suggests that provider prediction for patients at risk for chronic critical illness may not reflect the true population at risk for long term dependence [2, 4, 8, 14, 15]. Additionally, this reinforces prior literature suggesting a need for further studies investigating the benefit of physical therapy in patients with baseline mobility impairment [40]. Further understanding of chronic critical illness as a clinical entity may better inform providers and help identify previously un-identified at risk patients. Studies are needed to confirm this association in a cohort with fully available pre-hospital data and to better understand the impact of pre-hospital functional status on development and outcomes associated with chronic critical illness. Our study adds to building literature that patients with chronic critical illness represent a patient population that is distinctly different from acutely critically ill patients. They represent a heterogeneous group with different care needs often not assessed in the acute care setting. Further studies targeting chronically critically ill patients are needed to better identify the correct risk population and the correct study outcomes or best practices.

Our study has a number of important limitations. First, our study focused on mobility that was delivered by physical therapist consultation and was reliant on physical therapy documentation. It is possible that greater levels of therapy were achieved than demonstrated in our estimates if additional therapy was performed by bedside nurses rather than physical therapists. Nurses in the intensive care unit recognize the overall importance of mobility in the recovery process and are trained to deliver bedside mobility in many institutions. It is possible that by making our primary outcome, PT consultation, we biased our results by omitting patients who were able to progress to independence with nursing assistance only. This selection bias would bias our cohort towards a population at lower likelihood of progressing overall. Further study is needed to understand the respective roles of nursing and rehabilitative therapy (physical and occupational therapy) in delivering mobility in the intensive care unit. These studies should aim to explain differences in outcomes by nursing or physical therapy delivered mobility and better define guidelines for timing and appropriateness of physical therapy consultation.

Additionally, our study reported practice at a single institution potentially limiting its generalizability. We utilized data from 2005 given the difficulty with obtaining a large cohort of patients requiring prolonged mechanical ventilation. While we recognize that this coincides with much of the early data supporting early mobility, this study, focuses on late rather than early therapy specifically with patients on prolonged mechanical ventilation. Studies have suggested physical therapy is important for recovery after a course of PMV for decades⁷⁻¹². It is possible, however, that practice patterns regarding sedation and mobilization have changed in the interim not reflected in this analysis.

Conclusions

In this single-institution study, most patients on PMV received no physical therapy in the first two weeks of the hospitalization. When physical therapy did occur, it was initiated late in the ICU course and was of low intensity. Greater use of physical therapy in PMV patients may reduce the need for post-hospitalization skilled care and potentially improve health related quality of life by preserving physical function. Modifiable factors such as level of sedation and physician education regarding the burden of chronically critically illness may represent important opportunities to increase access to this intervention in PMV patients. Further studies are needed to understand the predictors of PT practice variation in the chronically critically ill and to investigate the impact of pre-hospital functional status on development of chronic critical illness as to better identify patient subgroups whose long-term outcomes may benefit most from therapy. Additionally, studies are needed to better understand the role of PT consultation in delivery of early ICU mobility and to identify processes of care factors and staffing models that result in increased delivery of this beneficial intervention.

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Figure 1.

PT consultation patterns for patients requiring prolonged mechanical ventilation

Table 1**Baseline Characteristics of Patients Requiring Prolonged Mechanical Ventilation**

Sex, n (%)	
Male	115 (64.6)
Age, mean $\pm$ SD	49.7 $\pm$ 18.5
Ambulation status prior to hospitalization ⁱ n, (%)	
Ambulatory	130 (95.6)
Non-ambulatory	6 (3.4)
Service of record, n (%)	
General surgery/trauma	80 (45.5)
Medicine	62 (35.2)
Neurology/neurosurgery	34 (19.3)
APACHE III score, mean $\pm$ SD	85.9 $\pm$ 31.0

ⁱ Percentages represent percent of non-missing data

Table 2**Hospital Characteristics for Patients Requiring Prolonged Mechanical Ventilation**

Ongoing shock at day 14, n (%)	13 (7.4)
Hemodialysis on day 14, n (%)	4 (2.3)
Highest RAMSAY on PT consultation date ⁱ , n (%)	
1	6 (6.2)
2	14 (14.4)
3	22 (22.7)
4	20 (20.6)
5	16 (16.5)
6	19 (19.6)
Tracheostomy by day 14, n (%)	25 (14.2)
Tracheostomy by service, n (%)	
Surgery	5 (20.0)
Neurology/neurosurgery	15 (60.0)
Medicine	5 (20.0)
Duration of mechanical ventilation, med [IQR] days	22 [17–29]
ICU length of stay, med [IQR] days	24 [20–33]
Hospital length of stay, med [IQR] days	34 [28–45]
Died in hospital, n (%)	31 (17.6)

ⁱ Percentages represent percent of non-missing data

Table 3

Factors Associated with Receipt of Physical Therapy Consultation by Day 14 of Mechanical Ventilation for Patients Requiring Prolonged Mechanical Ventilation

	Excluding Baseline Ambulation Status (n=170)			Including Baseline Ambulation Status (n=132)		
	OR	95% CI	p-value	OR	95% CI	p-value
Ongoing shock	0.63	0.16–2.40	0.50	0.25	0.04–1.45	0.12
APACHE III score	1.02	1.00–1.03	0.01	1.01	1.00–1.03	0.07
Hemodialysis	2.80	0.41–19.22	0.29	4.85	0.44–53.82	0.20
PaO2:FIO2	1.00	1.00–1.01	0.20	1.00	0.99–1.00	0.89
Tracheostomy	5.07	1.61–15.97	0.006	6.94	1.72–27.97	0.007
Baseline non-ambulatory	--	--	--	3.42	1.02–11.41	0.05