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Point prevalence study of mobilization practices for acute respiratory failure patients in the United States

SE Jolley, MD, MSc¹, M Moss, MD², DM Needham, MD, PhD³, E Caldwell, MS⁴, PE Morris, MD⁵, RR Miller, MD, MPH⁶, N Ringwood, RN, BSN⁷, M Anders, MD⁸, KK Koo, MD⁹, SE Gundel, RD, CD⁴, SM Parry, PhD¹⁰, CL Hough, MD, MSc⁴, and the ARDS Network Investigators

¹Louisiana State University, Section of Pulmonary and Critical Care Medicine

²University of Colorado, Division of Pulmonary and Critical Care Medicine

³Johns Hopkins University, Division of Pulmonary and Critical Care Medicine and Department of Physical Medicine and Rehabilitation

⁴University of Washington, Division of Pulmonary and Critical Care Medicine

⁵Wake Forest University, Division of Pulmonary and Critical Care Medicine

⁶Intermountain Hospital/University of Utah, Division of Pulmonary and Critical Care Medicine

⁷Massachusetts General Hospital, Division of Pulmonary and Critical Care Medicine

⁸University of Maryland, Department of Anesthesiology

⁹Swedish Medical Center, Seattle, WA

¹⁰Department of Physiotherapy, University of Melbourne

Abstract

Objective—Early mobility in mechanically ventilated patients is safe, feasible, and may improve functional outcomes. We sought to determine the prevalence and character of mobility for intensive care unit (ICU) patients with acute respiratory failure in US ICUs.

Design—Two-day multicenter point prevalence study

Corresponding Author: Sarah Jolley, MD, MSc, Louisiana State University Health Sciences Center, 1901 Perdido Street, Suite 3205, New Orleans, LA 70112.

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Patients—Adult patients (≥ 18 years old) with acute respiratory failure requiring mechanical ventilation in 17 US hospitals and 42 ICUs.

Interventions—We defined therapist-provided mobility as the proportion of patient-days with any physical (PT) or occupational therapy (OT) provided mobility event. Hierarchical regression models were used to identify predictors of out of bed mobility.

Measurements and Main Results—Hospitals contributed 770 patient-days of data. Patients received mechanical ventilation on 73% of the patient-days mostly (n=432, 56%) ventilated via an endotracheal tube. The prevalence of PT/OT-provided mobility was 32% (247/770), with a significantly higher proportion of non-mechanically ventilated patients receiving PT/OT (48% vs. 26%, $p<0.001$). Patients on mechanical ventilation achieved out of bed mobility on 16% (n=90) of the total patient-days. PT/OT involvement in mobility events was strongly associated with progression to out of bed mobility (OR 29.1, CI 15.1 – 56.3, $p=0.001$). Presence of an endotracheal tube and delirium were negatively associated with out of bed mobility.

Conclusions—In a cohort of hospitals caring for acute respiratory failure patients, PT/OT-provided mobility was infrequent. PT/OT involvement in mobility was strongly predictive of achieving greater mobility levels in patients with respiratory failure. Mechanical ventilation via an endotracheal tube and delirium are important predictors of mobility progression.

Keywords

early mobility; ICU acquired weakness; ICU rehabilitation

Introduction

Acute respiratory failure survivors experience long-term morbidity after critical illness [1–3]. Physical functional impairments reduce overall health-related quality of life for survivors increasing healthcare utilization and unemployment [1, 4, 5]. Early physical and occupational therapy (PT/OT) for respiratory failure patients improves functional outcomes at hospital discharge [6–10].

PT/OT utilization in the intensive care unit (ICU) remains low. One-day point prevalence studies in Germany and Australia/New Zealand report most patients on mechanical ventilation do not receive out of bed mobility in the ICU. Across 116 German hospitals, ICU administrators reported only 8% of ventilated patients received out of bed mobility [11] and across 38 Australian/New Zealand ICUs, only 3% achieved sitting at the edge of the bed with none standing, transferring to chair or walking [12].

Across the United States, the prevalence of ICU mobility, as part of routine clinical care, remains unknown. As the literature supporting mobility expands, estimates of current clinical practice are necessary to inform implementation efforts. Our aim was to report the prevalence of PT/OT-provided mobility in respiratory failure patients, define the type and frequency of ICU mobility and identify factors associated with mobility progression.

Methods

We performed a two-day cross-sectional point prevalence study across ARDS Network (ARDSNet) hospitals. Hospitals were invited to participate in the two study dates, three weeks apart (Wednesday, January 15 and Tuesday, February 4, 2014); participation was voluntary. Each ARDSNet site contributed data from at least one hospital. In total, 17 (39%) of 44 hospitals participated, with 2 hospitals completing estimates outside of the pre-specified study dates. Each site obtained IRB approval with waiver of consent for the observational study.

Patient selection

We included adult (≥ 18 years of age) patients diagnosed with acute respiratory failure (requiring > 48 hours of mechanical ventilation) at any point during their ICU stay physically located in the ICU at noon. Mechanical ventilation (MV) was defined as any ventilation via an endotracheal tube (ETT), tracheostomy tube or non-invasive positive pressure ventilation (NIPPV). Since we aimed to capture any patient who would have met criteria for early mobility in earlier trials [9], ongoing mechanical ventilation use was not required for eligibility.

Mobility events

A therapist-provided mobility event was defined as receipt of at least one PT/OT-provided event on a study day. Mobility events not performed by a therapist were also recorded such that we ascertained any mobility event performed on a patient with respiratory failure on either study date. Events were reported by PT/OT and/or nursing using bedside real-time event recording on custom-made case report forms. Events were subsequently confirmed verbally between study coordinators and the bedside nurse and categorized using a published hierarchical ICU mobility scale [13]. Standardized forms allowed for free text of any activities performed outside of the standardized mobility scale. Study coordinators received training on the activity case report forms prior to the study date. Mobility events performed by multiple providers (e.g., PT/OT and bedside nursing) were reported on a single form. Out of bed mobility was defined as sitting at the edge of the bed, standing, standing and moving to chair, marching in place or walking. Adverse outcomes that occurred during a mobility session were coded using international consensus adverse outcome guidelines [14].

Patient demographics/clinical characteristics

Trained abstractors abstracted physiologic data from the medical record with values reported as that closest to 8 AM on the study date. Study coordinators interviewed bedside nurses to obtain reasons mobility did not occur and invasive catheter data. Potential medical exclusions were defined using published ICU mobility safety guidelines [15].

Intensive care unit characteristics

Administrators for participating ICUs were contacted after study completion to participate in a survey regarding ICU characteristics. Medical Directors (n=25) and Nurse Managers (n=15) participated with at least one hospital administrator from each of the 17 hospitals contributing data.

Statistical analysis

The prevalence of therapist-provided mobility was estimated as the proportion of patient-days with any therapist-provided mobility event during the two study days. Patients contributing data to both study dates were included in the prevalence estimates and logistic regression models the large time interval between events. Hierarchical multivariable logistic regression models with random effects for ICU site were used to evaluate predictors of therapist-provided therapy and out of bed mobility. Predictors of interest based on steering committee expert consensus included: mechanical ventilation, vasoactive agent use, coma (Richmond Agitation Sedation Score (RASS) of -4 or -5), agitation (RASS ≥ -2), intravascular catheter location, sedative infusion use, weight, and delirium (Confusion Assessment Method-Intensive Care Unit (CAM-ICU) positive/negative). Missing CAM-ICU status was categorized as CAM-ICU unable to assess and included as a unique category. All statistical analyses were completed using SAS software (Cary, NC).

Results

ICU characteristics

A total of 42 ICUs from 17 hospitals participated. Most ICUs were medical (51%), trauma (12%), or mixed medical/surgical (9%) ICUs. ICUs averaged 23 beds in the unit (SD 7) with 6 ICUs (SD 3) in the hospital. Most hospitals reported physician-initiated mobility (73%) and more than half (53%) reported use of a mobility protocol.

Patient baseline characteristics

A total of 744 unique patients contributed 770 patient-days of data after exclusion of 17 patients (2.1%) who were ineligible due to ICU discharge prior to noon (Figure 1). Twenty-six patients (4%) were in the ICU on both study dates. Patients were mostly middle aged (mean age 56 years, SD (16)), men (60%), and most were ambulatory (80%) and independent with activities of daily living (78%) prior to admission. Most (62%) received care in a medical ICU (Table 1).

Study day characteristics

Patients received mechanical ventilation, via an endotracheal tube [endotracheal tube, $n=432$, (56%), tracheostomy $n=81$, (10%)] or noninvasively [$n=47$, (6%)] on 72% ($n=566$) of the patient-days with a mean FiO_2 of 0.43 (SD 0.14) and PEEP of 7 (SD 3) cmH₂O. On 6% ($n=48$) of the patient-days, patients were receiving $>60\%$ FiO_2 and on 7% ($n=56$) of the patient-days they received >10 cmH₂O of PEEP. Patients received $>60\%$ FiO_2 and >10 PEEP on 3% ($n=21$) of the patient-days. Patients were on an infusion of a vasoactive medications on 21% of the ($n=174$) patient-days and received hemodialysis on 15% ($n=112$) of the patient-days [63 (8% continuous, 49 (7%) intermittent]. Sedative infusions were used on 37% of the patient-days ($n=294$) with most patients receiving propofol infusion [propofol 21% ($n=163$), benzodiazepines 9% ($n=68$), dexmedetomidine 8% ($n=63$)]. The median RASS score was 0 (interquartile range [IQR] $[-2$ to $0]$), with 15% ($n=97$) of patient-days spent in a "coma" (i.e. RASS -4 or -5). Median RASS scores differed significantly between mechanically (median -1 , IQR $[-3$ to $0]$) and non-mechanically ventilated (median 0, IQR

[-1 to 0]) patients ($p<0.001$). Delirium was present on 22% ($n=113$) of the patient-days although 281 patient-days (36%) had no CAM-ICU assessment documented (Table 2). A potential safety exclusion was documented on 15% of the patient-days ($n=112$) and more frequently reported in mechanically ventilated patients (18% mechanically ventilated vs. 6% non-mechanically ventilated, $p<0.001$). The most commonly reported exclusions were medical instability (21%), coma (12%) and weakness (11%) (Figure 2).

Therapist-provided mobility

Patients were treated by PT/OT on 247 patient-days for an overall prevalence of therapist-provided ICU mobility of 32% (247/770). Non-mechanically ventilated patients were significantly more likely to receive PT/OT than mechanically ventilated patients (48% vs. 26%, $p<0.001$).

All mobility events

Patients received mobility events from any provider type on 65% ($n=501$) of the total 770 patient-days. Most events were provided by nursing (68%) with most activity sessions involving one provider (44%). Two care providers were involved in 15% ($n=118$) of sessions, while few sessions ($n=47$, 6%) involved more than two providers. Providers involved in activity sessions included: physical, occupational, respiratory and speech therapists or technicians, nurses, physicians, hospital assistants, advanced care providers and patient family.

Activity delivered in the absence of PT/OT was of lower intensity ($p<0.001$ compared with PT/OT-delivered activity) with 21% ($n=43/247$) of patients achieving out of bed mobility without PT/OT involvement. Most mobility events for patients on mechanical ventilation (208/336, 62%) consisted of passive activities (range of motion or passively moved to chair). Mechanically ventilated patients usually participated in a single session/day (median 1 [IQR 0 to 2]). Non-mechanically ventilated patients received mobility on 80% ($n=168$) of the patient-days, with a median one session per day [IQR 1 to 2]. Significantly more mobility sessions occurred in non-mechanically versus mechanically ventilated patients ($p<0.001$).

Out of bed mobility in patients on mechanical ventilation

Mechanically ventilated patients achieved out of bed mobility on 16% ($n=90$) of the patient-days progressing to sitting at the edge of the bed on 6% ($n=31$), standing on 2% ($n=13$), transferring to chair from standing on 3% ($n=18$), marching in place on 1% ($n=5$) and walking on 4% ($n=23$) of patient-days (Figure 3). Non-mechanically ventilated patients were significantly more likely than mechanically ventilated patients to achieve out of bed mobility (56% vs. 16%, $p<0.001$).

Adverse events

Seven potential safety events occurred in 807 mobility events (0.9%). Potential safety events included new arrhythmias ($n=3$), oxygen desaturations ($<85\%$ for >3 minutes) ($n=2$), hypotension (mean arterial pressure <55 mmHg for >3 minutes, $n=1$) and an endotracheal dislodgement ($n=1$). Six (86%) of these events occurred in patients receiving lower level mobility, with 4 events occurring during range of motion and 2 during passive chair transfer.

The single endotracheal tube dislodgement occurred during an in-bed passive range of motion session.

Predictors of ICU mobility

PT/OT involvement was strongly associated with progression to out of bed mobility (Table 3, adjusted OR 26.1, 95% CI 14.2–47.9, $p < 0.001$). Use of mechanical ventilation via an endotracheal or tracheostomy tube was negatively associated with achieving out of bed mobility [endotracheal tube adjusted OR 0.10, 95% CI 0.05–0.20, tracheostomy tube adjusted OR 0.20, 95% CI 0.09–0.47, $p < 0.001$] as was presence of delirium (adjusted OR 0.41, 95% CI 0.18–0.93, $p = 0.003$). Although weight was significantly associated with out of bed mobility in bivariate analysis (mean weight 78 kg in patients achieving out of bed mobility vs. 92 kg receiving only in-bed mobility, $p = 0.001$), it was not independently associated in the adjusted model (OR 0.99, 95% CI 0.98–1.00).

Among patients receiving mechanical ventilation via an endotracheal tube, PT/OT involvement remained highly associated with out of bed mobility (Table 4, adjusted OR 138.4, 95% CI 29.8–643.5, $p < 0.001$). Presence of delirium or coma remained negatively associated with out of bed mobility (delirium present adjusted OR 0.13, 95% CI 0.02–0.75, coma adjusted OR 0.05, 95% CI 0.01–0.40, $p = 0.02$).

Hospital-level variance

There was significant variation in clinical practice between participating hospitals. PT/OT participation in mobility varied with a minimum participation of 7% ($n = 3/45$) to a maximum of 74% ($n = 31/42$) in some study hospitals ($p = 0.03$). Achievement of out of bed mobility for mechanically ventilated patients varied between 4 ($n = 2/45$) and 67% ($n = 26/39$) between study hospitals ($p = 0.04$). Significant between-hospital differences remained after adjustment for patient demographics with between-hospital differences accounting for 66% (standard error 0.31) of the overall model variance.

Discussion

These data represent the first US estimates of mobility in routine clinical practice for respiratory failure patients. Patients with respiratory failure received therapist-provided mobility on 32% of patient-days. Out of bed mobility was delivered on a minority of patient-days to mechanically ventilated patients (16%), with patients rarely progressing to walking (4% of patient-days). PT/OT involvement was strongly associated with mobility progression, while mechanical ventilation via an endotracheal tube and delirium were negatively associated.

Our prevalence estimates of ICU mobility are similar to prior estimates from Germany and Australia/New Zealand [11, 12]. Unlike the prior studies, we included two prevalence dates on different weekdays to account for daily variation in rehabilitation care to better estimate prevalence. Additionally, we captured actual rather than reported mobility. Despite reducing the chance of misclassification with two separate study dates, our estimates remained low. Our estimates were comparable to those reported in Germany where only 24% of mechanically ventilated patients received mobility with 8% mobilizing out of bed [11] and

Australia/New Zealand where no (0/391) patients on mechanical ventilation sat out of bed, stood or ambulated [12].

The low levels of mobility observed highlight discrepancies between reported and actual delivery in clinical practice. Survey of ICU administrators across Michigan reported ICU mobility use in 39% of their mechanically ventilated patients with 10% achieving ambulatory status upon ICU discharge [16]. Similarly, survey of nurse managers across Washington State reported 47% of mechanically ventilated patients received out of bed mobility [17]. Our results suggest that reported and actual delivery of mobility may differ substantially and further studies are needed to understand reasons for this discordance.

Presence of PT/OT involvement was strongly associated with mobility in our cohort. Quality improvement studies suggest dedicated ICU therapists enhance access to mobility [11, 18–20]. Stepwise progression through a therapy-driven ICU mobility protocol resulted in increased mobility uptake with length of stay and mortality reductions in a cohort of respiratory failure patients [7, 8]. Randomized early involvement of PT/OT for mechanically ventilated patients improved functional independence at discharge [9, 21]. Our findings support earlier evidence suggesting therapist involvement may increase mobility progression.

Although PT/OT involvement was strongly associated with out of bed activity, it was not required. Nursing providers provided most of the activity events in our cohort either alone or in conjunction with PT/OT and patients achieved out of bed mobility in the absence of PT/OT on 21% of patient-days. Nursing staff may represent an expandable workforce for ICU mobility delivery, however, little is known regarding their potential role in optimal mobility delivery. Similarly, it is not known if the most common activities provided by nurses—passive movement in and out of bed—should be considered as part of “ICU mobility” at all. Furthermore, the large PT/OT association may reflect institutional commitment to mobility rather than staffing. If PT/OT involvement is a surrogate marker of institutional mobility commitment, then increasing PT/OT staffing alone may be insufficient to increase mobility intensity. This disconnect between culture and staffing may explain why prevalence across countries remains low [11, 12] despite institution of high-intensity staffing models. Qualitative studies indicate that factors beyond staff including degree of buy-in, perceived workload and rehabilitation training are important for implementation and sustainability of an ICU rehab program [22]. Studies are needed to better understand the influence of these organizational factors in ICU mobility uptake.

Mechanical ventilation via an endotracheal tube and delirium were important negative predictors of out of bed mobility in our study. Our results support prior notions that mechanical ventilation via an endotracheal tube is an important barrier to ICU mobility despite multiple safety studies. Studies report adverse event rates of <1% in respiratory failure patients [6, 14, 23]. Our adverse event rate was 0.9%; most of the events were minor. The single endotracheal tube dislodgment occurred in a patient receiving passive range of motion. Yet, intubation remains a frequently reported reason for mobility avoidance. Data are needed regarding methods for overcoming potential barriers between perceived and actual safety of mobility in intubated patients.

Delirium in critically ill patients represents an increasingly recognized predictor of worse outcomes after critical illness [24]. Despite this, many patients in our cohort received no CAM-ICU delirium screening on our study dates. This lack of routine CAM-ICU administration is not unique to our cohort. Across Michigan ICUs, only 31% of ICUs performed routine delirium assessments for mechanically ventilated patients [16]. Report of delirium assessment as part of standard practice was predictive of report of higher-level activity (OR 15.6 vs. 4.5, $p=0.006$ delirium vs. no delirium assessment) in the Michigan cohort [16]. Similarly, in our cohort, patients who underwent screening were frequently delirious and delirium was predictive of failure to achieve higher mobility levels. While early mobility is associated with reductions in delirium duration [9], there is little data guiding mobilization practices specifically in delirious patients.

Predictably, we found significant between-hospital variation around mobility utilization. Studies identify site as a significant predictor of ICU mobility [23, 25]. Between-hospital variation explained 66% of our overall cohort variance after adjustment for patient factors. Hospitals that provided out of bed mobility often did so in patients with greater severity of illness or organ dysfunction. This suggests that local care practices exert substantial effects on the overall uptake of ICU mobility. A number of studies support the need for broad multidisciplinary, ICU culture change for acceptance of ICU mobility [9, 22, 26, 27]. Utilization of high-performing hospitals as a care model for ICU mobility delivery may serve to increase access broadly while use of ICU mobility quality initiatives may enhance local uptake.

There are several potential limitations to our study. First, mobility assessments were unblinded potentially leading to greater mobility delivery. Efforts were made to limit knowledge of the study and the relatively low observed prevalence makes it unlikely that single day escalation of mobility efforts biased the overall estimates. Second, participation was voluntary and limited to ARDS Network hospitals reflecting sites with larger clinical and research infrastructure and/or targeted interest in mobility potentially limiting the generalizability of our results. Third, restriction of study dates to weekdays rather than weekends may lead to overestimation of ICU activity as activities generally occur less frequently on weekends. Finally, despite our attempts to exclude patients with potential contraindications to mobility, we were unable to reliably exclude them due to inconsistent charting. Contraindications varied throughout the study date, changing mobility eligibility over time, and potential contraindications conflicted across centers depending on institutional mobility comfort level. It is possible that our estimates underestimate the true prevalence of ICU mobility in medically-eligible patients.

Conclusions

In a cohort of hospitals caring for acute respiratory failure patients, PT/OT-provided mobility occurred infrequently. PT/OT involvement in ICU mobility was strongly predictive of out of bed mobility for patients on mechanical ventilation. Mechanical ventilation via an endotracheal tube and presence of delirium were negatively associated with out of bed mobility. There was significant variability around ICU mobility delivery between hospitals.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.

Reasons for no reported mobility. Presence of coma and medical instability were the most commonly reported reasons for lack of ICU mobility.

Figure 2.

Highest level of mobility achieved by patients on the study dates. Patients on mechanical ventilation were significantly less likely to achieve out of bed mobility compared with patients off mechanical ventilation ($p < 0.001$). Reported categories are mutually exclusive.

Table 1

Baseline characteristics

	All (n=770)	Mechanical Ventilation (n=559)*	No Mechanical Ventilation (n=211)*	P-value
Age, mean $\pm$ SD [†]	56 $\pm$ 16	56 $\pm$ 16	57 $\pm$ 16	0.69
Male, n (%)	465 (60)	330 (59)	135 (64)	0.24
ICU Category [‡]				<0.001
Medical	477 (62)	374 (67)	103 (49)	
Surgical	238 (31)	158 (28)	80 (38)	
Neurologic	55 (7)	27 (5)	28 (13)	
Reason for Admission [§]				
ARDS	140 (18)	117 (21)	23 (11)	0.002
COPD exacerbation	33 (4)	23 (4)	10 (5)	0.86
Sepsis from lung source	96 (13)	88 (16)	8 (4)	<0.001
Sepsis from other source	103 (13)	79 (14)	24 (11)	0.38
Hemorrhage	39 (5)	23 (4)	16 (8)	0.08
Trauma	59 (8)	37 (7)	22 (10)	0.11
Malignancy	18 (2)	10 (2)	8 (4)	0.17
ARDS diagnosis during hospitalization	279 (36)	237 (43)	42 (20)	<0.001
Ambulatory at baseline	533 (80)	379 (80)	154 (82)	0.46
Independent with activities of daily living at baseline (ADLs)	505 (78)	359 (78)	146 (80)	0.55
Mode of ventilation , n (%)				
Endotracheal tube	432 (56)	432 (77)	NA	
Tracheostomy tube	81 (11)	81 (15)	NA	
Non-Invasive Positive Pressure Ventilation (NIPPV)	46 (6)	46 (8)	NA	
FiO ₂ , mean $\pm$ SD		0.43 $\pm$ 0.14	NA	
PEEP (cmH ₂ O), mean $\pm$ SD		7 $\pm$ 3	NA	
Vasoactive infusions [§] , n (%)				
Vasopressors	159 (21)	149 (27)	10 (5)	<0.001
Inotropes	15 (2)	12 (2)	3 (1)	0.72
Neither	606 (79)	408 (73)	198 (94)	<0.001
Body mass index, n (%)				0.82
≤ 18.5	32 (5)	22 (5)	10 (6)	

	All (n=770)	Mechanical Ventilation (n=559)*	No Mechanical Ventilation (n=211)*	P-value
18.5–25	156 (25)	113 (25)	43 (25)	
25–30	174 (28)	124 (27)	50 (29)	
>30	264 (42)	197 (43)	67 (39)	
Weight (kg), mean $\pm$ SD	89 $\pm$ 31	90 $\pm$ 33	87 $\pm$ 26	0.10
Hemodialysis, n (%)	112 (15)	96 (18)	16 (8)	0.001
Type of hemodialysis, n (%)				
Continuous	63 (8)	55 (10)	8 (4)	0.003
Intermittent	49 (7)	41 (8)	8 (4)	
RASS, median [IQR]	0 [–2 to 0]	–1 [–3 to 0]	0 [–1 to 0]	<0.001
Agitation (RASS $\geq +2$)*, n (%)	31 (4)	28 (5)	3 (1)	0.06
Delirium, n (%)				<0.001
Coma (RASS –4 or –5)	94 (12)	84 (15)	10 (5)	
Delirium (CAM-ICU positive)	113 (15)	89 (16)	24 (11)	
No Delirium (CAM-ICU negative)	219 (28)	139 (25)	80 (38)	
No category	344 (45)	247 (44)	97 (46)	
Sedative/Analgesia infusions, n (%)				
Benzodiazepines	65 (8)	64 (11)	1 (0.5)	<0.001
Dexmedetomidine	63 (8)	49 (9)	14 (7)	0.42
Propofol	162 (21)	158 (28)	4 (2)	<0.001
Opioids	215 (28)	200 (36)	15 (7)	<0.001
None	430 (56)	251 (45)	179 (85)	<0.001
Sedative/Analgesia boluses, n (%)				
Benzodiazepines	116 (15)	105 (19)	11 (5)	<0.001
Opioids	288 (37)	215 (39)	73 (35)	0.37
None	456 (59)	320 (57)	136 (65)	0.08
CAM-ICU score, n (%)				<0.001
Negative	221 (46)	141 (39)	80 (68)	
Positive	116 (24)	92 (26)	24 (21)	
Unable to perform	140 (29)	127 (35)	13 (11)	
Antipsychotic use, n (%)	119 (16)	94 (17)	25 (12)	0.12
Intravascular catheters, n (%)				
Central venous catheter (CVC)				<0.001
Femoral	32 (4)	28 (5)	4 (2)	
All other sites	451 (60)	349 (65)	102 (49)	
None	263 (35)	162 (30)	101 (49)	

	All (n=770)	Mechanical Ventilation (n=559)*	No Mechanical Ventilation (n=211)*	P-value
Hemodialysis				
Femoral	19 (2)	17 (3)	2 (1)	0.87
All other sites	92 (12)	78 (14)	14 (7)	
None	659 (86)	464 (83)	195 (92)	
Arterial				<0.001
Femoral	36 (5)	31 (6)	5 (2)	
All other sites	267 (35)	214 (39)	53 (26)	
None	451 (60)	302 (55)	149 (72)	
Chest tube	107 (14)	76 (14)	31 (15)	0.81
Intra-aortic balloon pump (IABP)	4 (0.5)	4 (0.7)	0 (0)	0.50
Left ventricular assist device (LVAD)	8 (1)	5 (0.9)	3 (1)	0.82
Foley catheter	606 (80)	470 (86)	136 (66)	<0.001
Rectal tube	134 (18)	111 (20)	23 (11)	0.005
Potential contraindication to mobility ^{††}	112 (15)	99 (18)	13 (6)	<0.001

* Missing data: ARDS diagnosis (n=3 of mechanically ventilated patients, 0.4%), ambulation status (n=24 non-mechanically ventilated, 112 of mechanically ventilated, 18%), ADL (n=29, non-mechanically ventilated, 97 mechanically ventilated, 16%) FiO₂ n=14 (2.5%), PEEP n=31 (5.5%), BMI n=144 (18.7%), weight n=55 (7.1%), hemodialysis n=22 (2.9%), Richmond Agitation-Sedation Scale (RASS) n=130 (16.9%), Confusion Assessment Method-ICU (CAM-ICU) n=293 (38.1%), anti-psychotics n=10 (1.3%), CVC n=24 (3.1%), Arterial line n=16 (2%), chest tube n=19 (2.4%), IABP n=19 (2.4%), LVAD n=19 (2.4%), Foley n=16 (2%), Rectal tube n=16 (2%)

[†] Age >90 coded as 90 for calculation (n=2 mechanically ventilated, 0.3% of total cohort)

[‡] ICU types categorized as medical include: medical n=389 (51%), medical/cardiac n=2 (0.3%), cardiac n=15 (2%), medical/surgical n=71 (9%)
ICU types categorized as surgical: surgical n=69 (9%), cardiac surgery n=29 (4%), burns n=19 (3%), trauma n=91 (12%), cardiothoracic n=28 (4%), pediatric n=2, (0.3%), ICU types categorized as neurologic include: neurologic n=55 (7%),

[§] Categories are not mutually exclusive

// High frequency oscillatory ventilation use, n=1 (0.1%), Extracorporeal membrane oxygenation use, n=8 (1%), NA: not applicable

*** Categorized as RASS ≥+2, RASS < +2, no RASS reported

^{††} Contraindications defined per previously published mobility safety recommendations: Hodgson CL, Stiller K, Needham DM, et al. Expert consensus and recommendations on safety criteria for active mobilization of mechanically ventilated critically ill adults. *Critical care* 2014; 18: 658

Table 2

Predictors of out of bed mobility for patients ventilated via an endotracheal tube

	All (n=432)	Out of Bed Mobility (n=45)	In Bed Mobility (n=387)	P-value
Vasoactive agent (vasopressor and/or inotrope), n (%)	140 (32)	8 (18)	132 (34)	0.04
Benzodiazepine or Propofol infusion, n (%)	191 (44)	15 (33)	176 (46)	0.16
Bolus benzodiazepine use, n (%)	86 (20)	4 (9)	82 (21)	0.08
Opioid infusion, n (%)	173 (40)	17 (38)	156 (40)	0.87
Bolus opioid use, n (%)	176 (41)	15 (33)	161 (42)	0.37
Intravascular catheter (no catheter referent), n (%)				
Internal jugular, femoral, subclavian, or radial catheter	316 (73)	27 (60)	289 (75)	0.04
Unknown	7 (2)	0 (0)	7 (2)	
Delirium assessment (no delirium CAM-ICU [*] negative referent), n (%)				
Delirium (CAM-ICU positive)	73 (17)	7 (16)	66 (17)	0.05
Unable to assess (CAM-unable)	114 (26)	5 (11)	109 (28)	
Delirium status unknown (CAM-missing)	148 (34)	18 (40)	130 (34)	
Agitation assessment (no agitation RASS [†] <2 referent), n (%)				
Agitation (RASS ≥ 2)	21 (5)	0 (0)	21 (5)	0.001
Agitation status unknown (RASS missing)	49 (11)	12 (27)	37 (10)	
Physical or occupational therapy involvement, n (%)	88 (20)	38 (84)	50 (13)	<0.001
ICU type (medical ICU referent), n (%)				
Neurologic ICU	22 (5)	3 (7)	19 (5)	0.57
Surgical ICU	121 (28)	15 (33)	106 (27)	
Ambulatory prior to admission (not ambulatory referent), n (%)				
Ambulatory	310 (72)	35 (78)	275 (71)	0.33
Unknown	60 (14)	3 (7)	57 (15)	
Age (years), mean (SD)	56 (16)	59 (15)	55 (16)	0.11
Weight (kilograms), mean (SD)	90 (31)	78 (24)	92 (32)	0.001

* CAM-ICU: Confusion Assessment Method-Intensive Care Unit,

† RASS: Richmond Agitation-Sedation Scale

Table 3

Hierarchical multivariable logistic regression model of factors associated with out of bed mobility*

	OR	95% CI	p-value
Age (years)	1.02	1.00 – 1.03	0.07
ICU type (medical ICU referent)			
Neurologic ICU	0.45	0.14 – 1.44	0.11
Surgical ICU	1.50	0.72 – 3.09	
Ambulatory prior to admission (not ambulatory referent)			
Ambulatory	1.58	0.75 – 3.34	0.20
Unknown	0.80	0.29 – 2.18	
Route of mechanical ventilation (no MV [†] referent)			
Endotracheal tube	0.10	0.05 – 0.20	<0.001
Tracheostomy tube	0.21	0.08 – 0.52	
NIPPV [‡]	0.56	0.19 – 1.74	
Vasoactive agent (vasopressor and/or inotrope)	0.59	0.23 – 1.49	0.24
Weight (kilograms) [§]	0.99	0.98 – 1.00	0.02
Agitation assessment (no agitation RASS ^{//} <2 referent)			
Agitation (RASS = 2)	0.15	0.01 – 1.87	0.06
Agitation status unknown (RASS missing)	2.13	0.92 – 4.90	
Bolus opioid use	0.84	0.43 – 1.62	0.57
Bolus benzodiazepine use	0.73	0.28 – 1.91	0.49
Delirium assessment (no delirium CAM-ICU ^{**} negative referent)			
Delirium (CAM-ICU positive)	0.37	0.15 – 0.89	0.003
Unable to assess (CAM-unable)	0.15	0.05 – 0.44	
Delirium status unknown (CAM-missing)	0.35	0.17 – 0.74	
Intravascular catheter (no catheter referent)			
Internal jugular, femoral, subclavian, or radial catheter	0.58	0.31 – 1.07	0.07
Unknown	0.17	0.02 – 1.34	
Physical therapy or occupational therapy involvement	29.1	15.1 – 56.3	<0.001

* Out of bed mobility: sitting at the edge of the bed, standing, marching in place, walking

[†] MV: mechanical ventilation[‡] NIPPV: non-invasive positive pressure ventilation[§] Missing weight data (n=55 patients, 715/770 patients included in final model)^{//} RASS: Richmond Agitation-Sedation Scale

**
CAM-ICU: Confusion Assessment Method-Intensive Care Unit

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Table 4

Hierarchical multivariable logistic regression model of factors associated with out of bed mobility restricted to patients on mechanical ventilation via an endotracheal tube *

	OR	95% CI	p-value
Age (years)	1.05	1.01–1.09	0.02
ICU type (medical ICU referent)			0.15
Surgical ICU	3.96	0.90–17.38	
Neurologic ICU	0.74	0.08–6.93	
Ambulatory prior to admission (not ambulatory referent)			0.41
Ambulatory	2.44	0.52–11.68	
Unknown	1.03	0.11–9.62	
Vasoactive agent (vasopressor and/or inotrope)	0.59	0.16–2.19	0.43
Weight (kilograms) †	0.97	0.95–1.00	0.02
Delirium assessment (no delirium CAM-ICU ‡ negative referent)			0.02
Delirium (CAM-ICU positive)	0.13	0.02–0.75	
Unable to assess (CAM-unable)	0.05	0.01–0.40	
Delirium status unknown (CAM-missing)	0.21	0.04–1.09	
Benzodiazepine or Propofol infusion	1.43	0.39–5.25	0.59
Bolus benzodiazepine use	0.40	0.08–1.98	0.26
Opioid infusion	2.01	0.58–7.03	0.27
Bolus opioid use	0.37	0.10–1.39	0.14
Physical therapy or occupational therapy involvement	138.4	29.75–643.49	<0.001

* Out of bed mobility: sitting at the edge of the bed, standing, marching in place, walking

† Missing weight data (n=29 patients, 403/432 patients included in final model)

‡ CAM-ICU: Confusion Assessment Method-Intensive Care Unit