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Long-term prognosis of older adults who survive emergency mechanical ventilation

Kei Ouchi, MD, MPH^{1,2,3,*}, Josephine Lo Bello, BA^{4,*}, Edward Moseley, BS⁵, Charlotta Lindvall, MD, PhD^{5,6}

¹Department of Emergency Medicine, Brigham and Women's Hospital, Boston, Massachusetts, USA

²Department of Emergency Medicine, Harvard Medical School, Boston, Massachusetts, USA

³Serious Illness Care Program, Ariadne Labs, Boston, Massachusetts, USA

⁴University of North Carolina at Chapel Hill School of Medicine, Chapel Hill, North Carolina, USA

⁵Department of Psychosocial Oncology and Palliative Care, Dana-Farber Cancer Institute, Boston USA

⁶Division of Palliative Medicine, Department of Medicine, Brigham and Women's Hospital, Boston USA

Abstract

Context: Emergent mechanical ventilation represents an important inflection point in seriously ill older adults' illness trajectories. Data is lacking on the long-term prognosis after surviving mechanical ventilation to inform shared decision-making in serious illness conversations.

Objective: Describe the long-term prognosis of older adults who survive emergency mechanical ventilation to inform shared decision-making.

Methods: This is a retrospective cohort study from a single-center, intensive care unit (ICU) in an academic, urban, tertiary care medical center. We included adults aged ≥ 75 years consecutively admitted with mechanical ventilation between 2008 and 2012 in the Multi-Parameter Intelligent Monitoring of Intensive Care III database. We excluded patients who were electively admitted. Our primary outcome was the long-term prognosis after leaving the hospital stratified by discharge location. Our secondary outcome was the frequency of documented serious illness conversations within 48 hours of hospitalization recommended by the National Quality Forum.

Corresponding Author: Kei Ouchi, MD, MPH, Department of Emergency Medicine, Brigham and Women's Hospital, 75 Francis St, Neville 200, Boston, MA 02125, Phone 617-732-5640, Fax 617-264-6848 kouchi@partners.org.

* denotes co-first authorship

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Results: We identified 415 patients (454 hospital admissions) consecutively admitted to the ICU. The median age was 82.6 years, 54% were female, 78.2% were white, non-Hispanic, and in-hospital mortality rate was 36.6%. Among the survivors, the median survival after hospital discharge was 163.5 days (IQR 37.5–476.8). Only 49.1% of patients had documented serious illness conversations within 48 hours of hospitalization. 63% of patients (59 out of 93) who were discharged to LTACH died by six months.

Conclusion: This study demonstrated the long-term prognosis of older adults who underwent emergent mechanical ventilation. This data could be used to inform shared decision-making in serious illness conversations.

Keywords

long-term prognosis; mechanical ventilation; documentation of care preferences

Introduction

The incidence of emergency mechanical ventilation of older adults is doubling between 2001 and 2020.^{1,2} Especially for older adults with serious illness (i.e., an incurable disease with less than one-year prognosis), emergent mechanical ventilation represents an important inflection point in patients' illness trajectories— all too often, this becomes a point of no return. Among critically ill older adults in the intensive care unit (ICU), those who are mechanically ventilated have 3.3 times higher 30-day mortality compared to those who are not.³ As many as 55% of such patients died in the hospital, and as many as 56% may not be weaned off the ventilator.⁴ Those who are mechanically ventilated greater than 48 hours are at five times greater risk of developing delirium than other ICU patients.⁵ In addition, mechanically ventilated patients often cannot communicate well, making it difficult to express their wishes; most of these patients report feeling afraid.^{6,7} Yet, there is significant heterogeneity in the goals of care of seriously ill older adults, many of whom considered some disease states, including requiring a breathing tube to live, to be worse than death.⁸

Therefore, emergency mechanical ventilation in older adults is a high-risk intervention with uncertain or variable efficacy to meet the patient's goals. Early serious illness conversations eliciting patients' values, care goals, and shared decision-making regarding the intensity of medical care has been increasingly recognized as a central component of providing goal-concordant care.^{9–13} Understanding patient wishes and communicating the long-term prognosis of mechanical ventilation become important in the acute care setting, where shared decision-making is necessary. Given these considerations, the National Quality Forum (NQF) endorsed a quality measure to document a serious illness conversation with vulnerable older adults within 48 hours of their admission to the intensive care unit (ICU).^{9,14}

Shared decision-making rests upon a foundation of data on the consequences of available actions. However, lack of data on the long-term prognosis of older patients undergoing mechanical ventilation who survive to hospital discharge limits clinicians' ability to help patients and surrogates decide to initiate or continue mechanical ventilation. Previous studies have limited their scope to in-hospital mortality,^{4,15} minor sub-population receiving

prolonged mechanical ventilation,^{16,17} and have not assessed the long-term prognosis after hospital survival and the discharge locations. Furthermore, the frequency of serious illness conversation among these vulnerable patients, as recommended by the NQF within 48 hours of hospitalization, remains unknown. Data specific to the long-term prognosis among older adults after surviving mechanical ventilation are needed to inform shared decision-making in serious illness conversations.

We examined electronic medical records (EMR) of patients over 75 years of age admitted to the ICU from the emergency department (ED) who are mechanically ventilated within 48 hours of their stay to characterize long-term prognosis and the frequency of serious illness conversations per NQF recommendation.

Methods

Study Type

This is a retrospective cohort study involving analysis of EMR and ICU data collected between 2008 and 2012.

Data Source

We utilized the Multi-Parameter Intelligent Monitoring of Intensive Care (MIMIC) III database, developed by the Massachusetts Institute of Technology (MIT) and the Beth Israel Deaconess Medical Center (BIDMC).¹⁸ This database provides de-identified demographic, administrative, and clinical data for patients with critical illness consecutively admitted between 2001 and 2012 at BIDMC. The database also links individual patients to the social security death registry, allowing access to information on mortality. From 2008, the database also provided free-text clinician (MD, DO, nurse practitioner, and physician assistant) notes associated with each ICU admission. This was the subset of data we focused on since our research required exploring the free-text clinician notes for evidence of serious illness conversations. The Institutional Review Board of BIDMC and MIT have approved the use of the MIMIC-III database by any investigator who fulfills data-user requirements. This research was deemed exempt by the Partners HealthCare Institutional Review Board. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines to ensure clear and complete reporting of our study design, conduct, and findings.¹⁹

Study Population

The study population included adults over the age of 75 emergently admitted to the medical and surgical ICUs between 2008 and 2012 who underwent mechanical ventilation within 48 hours of their admission and who survived at least 48 hours. We chose this group because they include patients who are intubated in the ED²⁰ and are the target population for the NQF measures and also have a high mortality rate.^{9,14,21} Specifically, the age cutoff of 75 was chosen to remain consistent with the NQF care measure⁹, which cites the ACOVE guidelines' definition of a "vulnerable elder" as an individual 75 years of age or older¹⁴, and to remain consistent with the deep learning algorithm, which has only been validated in individuals 75 and older.²² In addition, individuals who undergo early mechanical

ventilation are less likely than other ICU patients to receive serious illness conversations.²³ We chose emergent admissions order to focus on critically ill older adults and to exclude those intubated and admitted for less emergent reasons (i.e., following elective surgery).

Measures

Our primary outcome was the long-term prognosis after leaving the hospital. Long term prognosis of patients who survived to discharge was determined through linkage to the Social Security Death Index, which provides mortality information up to four years post discharge. Discharge location, Sequential Organ Failure Assessment (SOFA) score, demographic information, and comorbidities for each patient were directly coded within the MIMIC III database.

Our secondary outcome was the frequency of documented serious illness conversations and discharge location. To determine the presence of serious illness conversations, we utilized a previously validated neural network described by Chan et al. to identify the documentation of such conversations among free-text clinician notes.²² The network was developed using machine learning algorithms to identify phrases associated with care preference documentation in these notes and demonstrated a sensitivity of 93.5% and specificity of 91.0% when compared to manual review by physicians. Only notes written by physicians were included in the search.

Several domains of serious illness conversations were considered. “Care Preference” documentation included any documentation of a patient who expressed a specific care preference pertaining to hospital care. “Goals of Care Conversation” documentation included any documentation of a conversation with the patient, family members, caregivers, or surrogates regarding care preferences. “Code Status Limitation” documentation included any documentation of restriction on resuscitation efforts (i.e., do-not-resuscitate order), while “Full Code” documentation included any documentation that there were no restrictions on resuscitation with evidence of a conversation about patient care preferences. Finally, “NQF Conditions Met” included those patients who met either the “Goals of Care Conversation” or “Code Status Limitations” documentation requirements within 48 hours of admission as specified by the NQF.

Statistical Analysis

Analyses were performed using R Statistical Software from June to August, 2019.²⁴ All analyses were performed at the ICU admission level, not the individual patient level, allowing us to account for the experience of patients with multiple admissions. For all categorical data, p-values were determined using Chi-squared analysis, and p-values for relative risks were calculated using Fisher’s Exact Test. For all numerical data, p-values were determined using the Wilcoxon Rank-Sum test. Kaplan-Meier plots were used to illustrate the long-term prognosis of survivors stratified by discharge location.

Results

Of 7,564 consecutive, individual patients admitted to the hospital ICU (8,981 consecutive hospital admissions) between 2008 and 2012, 2,398 patients were over the age of 75. Of

these, 1,091 patients were admitted emergently and survived at least 48 hours. We excluded 672 patients (832 hospital admissions) who were not mechanically ventilated and four patients with unknown discharge disposition, leaving us with the final cohort of 415 patients (454 hospital admissions, Figure 1). Of this cohort, 54% were female, 78.2% were white, non-Hispanic, and 85.5% were English-speaking. The median age for this cohort of patients was 82.6 years. Most (63.2%) were admitted to the medical ICU, and the majority (80.0%) were admitted from the ED. The in-hospital mortality rate was 36.6% (166 encounters). The discharge dispositions were the following by frequency: 48.3% (139 encounters) to skilled nursing facilities; 32.3% (93 encounters) to long-term acute care hospitals (LTACH); 15.6% (45 encounters) to home with home care; and 3.8% (11 patients) to hospice care. Overall, patients survived a median of 163.5 days after discharge, with a high degree of variability (IQR 37.5–476.8). Only 49.1% of patients had the NQF care measure satisfied. No statistically significant variance was observed in the clinical parameters such as SOFA scores or Elixhauser Comorbid scores (Table 1).

Figure 2 depicts the relationship between in-hospital mortality and survival after discharge stratified by different discharge location. Among 262 patients who were emergently intubated and survived the hospitalization, the total 1-year mortality was 68.2%. Expectedly, the long-term survival was different depending on the discharge disposition. All patients who were discharged to hospice died within six weeks. The majority of patients (59 out of 93 patients, 63.0%) who were discharged to LTACH died by six months, and only 20% of them remained alive at one year. Other than hospice, the rate of death was fastest for patients discharged to LTACH, and slowest for patients who were discharged to home with home care (23 out of 45 patients, 51.0% survived at one year).

Discussion

Our study describes the long-term prognosis and discharge disposition of seriously ill older adults who survived emergent mechanical ventilation. These patients survived a median of 163.5 days (IQR 37.5–476.8) after hospital discharge, and over half (68.1%) died by one year regardless of discharge location. The majority (77.8%) of survivors were discharged to places other than home. Furthermore, only 45.2% of these patients had documentation of serious illness conversations within 48 hours of admission, as recommended by the NQF.

This study provides a holistic, long-term prognosis of older adults who underwent emergent mechanical ventilation and is consistent with prior studies that showed high in-hospital mortality for these patients.^{4,15,21} Previous studies have focused on prolonged intubation (beyond 14 days)^{16,17,25} while the average length of ventilation for patients in our cohort was 4.3 days. Previous studies have also not assessed long-term prognosis at different discharge locations. Moreover, this study demonstrated the low frequency of documented serious illness conversations even among these highly vulnerable patients in the ICU. Taken together, these results may provide further impetus to proactively discuss care goals with seriously ill older adults at risk of emergent mechanical ventilation, and may be used to inform shared decision-making surrounding mechanical ventilation and discharge disposition.

Of note, 32.3% of the patients in our study were discharged to an LTACH, and 80% of this cohort did not survive past one year. Quality of life is intimately linked to discharge location, with discharge to an LTACH posing a considerable risk to a patient's functional status and quality of life.^{26–29} After hospitalization, 55% of older adults experienced new or worsening physical ability, and 21% experienced new or worsening incontinence.²⁷ These patients are bedbound, 40% remain ventilated, and 68% report a worsened quality of life since the ICU.²⁸ Discharge to an LTACH may represent an undesirable outcome for previously ventilated patients, as over 50% of patients with serious illness consider being unable to get out of bed and relying on a breathing machine to live to be states worth than death itself.⁸

By way of contrast, most patients identify going home as an ultimate goal after a major hospitalization;³⁰ home health care is associated with lower levels of perceived life stress and loneliness, and increased levels of life satisfaction.³¹ When considering quality of life in the final months of life, most patients wish to die at home, with inpatient hospice as the second-most desirable option.³¹ As patients approach the end of their lives, discharge location becomes even more important, as it may determine where and how they spend their final months.

Where patients find joy and quality of life, and how that weighs in the balance of quantity of time spent on Earth is an intensely personal judgement. The aim is not to villainize LTACHs as necessarily “worse than death” for any individual patient nor to laud dying at home as a globally preferred outcome. However, when asked about end of life care, 96% of seriously ill patients indicated that it was important to them to know what to expect about their physical condition and 90% felt it was important to have a physician with whom they could discuss their fears.³² Therefore, an assessment of the circumstances surrounding quality of life post-intubation, as well as survival time, may be prudent information for patients to consider when discussing values and care goals during serious illness conversations-- conversations which less than half of the patients in our study were able to have.

Our study is limited by a small sample size based on data from a single tertiary care hospital. However, this setting is unlikely to be significantly different from other ICU settings in urban areas within the United States. In addition, we used consecutive data from all ICU admissions to maximize internal validity. Moreover, we may be excluding patients who had serious illness conversations with an outpatient clinician, but for whom there is no formal documentation in the ICU notes. It should be noted that it is not possible to determine from the deep learning algorithm whether serious illness conversations took place with patients, family members, or caregivers. Similarly, we restricted the study to conversations that took place in the first 48 hours based on the NQF measure definition—for longer hospital stays, serious illness conversations may have taken place later. In addition, patients may have been ventilated after the first 48 hours of admission. Therefore, the generalizability of our study is limited to those patients who are emergently mechanically ventilated at or soon after admission. Finally, because we do not have information about patient living situation or functional status prior to intubation, we cannot directly attribute specific outcomes to mechanical ventilation itself, but merely describe these outcomes in our population. Further

studies with larger sample sizes and more granular data may help reveal the relationship between long-term mortality and documentation of serious illness conversations.

Conclusion

This study demonstrated the long-term prognosis of adults over 75 who are mechanically ventilated within 48 hours of emergent ICU admissions and characterized the discharge location of these patients, most of whom were discharged to a skilled nursing facility or LTACH. Despite outcomes potentially non-concordant with patient care goals, serious illness conversations were often not documented, which may be associated with discharge location. These results may be used to inform shared decision-making regarding the mechanical ventilation and subsequent discharge location of older adults.

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Key Message

This retrospective cohort study describes the long-term prognosis of older adults who survived emergent mechanical ventilation.

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Figure 1:
Multi-Parameter Intelligent Monitoring of Intensive Care, MIMIC-III; Long-term acute care hospital, LTACH; Skilled nursing facility, SNF.

Figure 2:
Long-term acute care hospital, LTACH; Skilled nursing facility, SNF.

Table 1.**Cohort Demographics**

		Survivors and discharge disposition						
Vital status at hospital discharge		Overall	Expired	Home Health Care	Hospice	Long Term Care Hospital	Skilled Nursing Facility	p value
Number of hospital admissions (N)		454	166	45	11	93	139	
Age, median (IQR)		82.6 (79.0 – 87.4)	82.5 (80.1 – 86.8)	91.4 (85.7 – 91.4)	82.5 (78.2 – 88.2)	82.6 (79.1 – 87.5)	82.2 (78.6 – 86.5)	0.033
Age group, n (%)	75–79	144 (31.7)	57 (34.3)	10 (22.2)	1 (9.1)	31 (33.3)	45 (32.4)	0.005
	80–84	144 (31.7)	53 (31.9)	19 (42.2)	1 (9.1)	24 (25.8)	47 (33.8)	
	85–90	82 (18.1)	36 (21.7)	8 (17.8)	2 (18.2)	18 (19.4)	18 (12.9)	
	90+	84 (18.5)	20 (12.0)	8 (17.8)	7 (63.6)	20 (21.5)	29 (20.9)	
Sex, n (%)	Male	209 (46.0)	75 (45.2)	19 (42.2)	4 (36.4)	46 (49.5)	65 (46.8)	0.879
	Female	245 (54.0)	91 (54.8)	26 (57.8)	7 (63.6)	47 (50.5)	74 (53.2)	
Ethnicity, n (%)	Black/Other	99 (21.8)	36 (21.7)	6 (13.3)	1 (9.1)	25 (26.9)	31 (22.3)	0.359
	Non-Hispanic White	355 (78.2)	130 (78.3)	39 (86.7)	10 (90.9)	68 (73.1)	108 (77.7)	
Language, n (%)	English	388 (85.5)	149 (89.8)	37 (82.2)	9 (81.8)	78 (83.9)	115 (82.7)	0.408
	Other	66 (14.5)	17 (10.2)	8 (17.8)	2 (18.2)	15 (16.1)	24 (17.3)	
Marital status, n (%)	Single	272 (59.9)	94 (56.6)	25 (55.6)	7 (63.6)	53 (57.0)	93 (66.9)	0.364
	Married	182 (40.1)	72 (43.4)	20 (44.4)	4 (36.4)	40 (43.0)	46 (33.1)	
Intensive care unit type, n	(%) Surgical	167 (36.8)	80 (48.2)	8 (17.8)	4 (36.4)	25 (26.9)	50 (36.0)	<0.001
	Medical	287 (63.2)	86 (51.8)	37 (82.2)	7 (63.6)	68 (73.1)	89 (64.0)	
Admission location, n (%)	Emergency department	363 (80.0)	134 (80.7)	34 (75.6)	10 (90.9)	66 (71.0)	119 (85.6)	0.015
	Physician Referral	10 (2.2)	2 (1.2)	4 (8.9)	0 (0.0)	2 (2.2)	2 (1.4)	
	Transfer from Hospital/SNF	81 (17.8)	30 (18.1)	7 (15.6)	1 (9.1)	25 (26.9)	18 (12.9)	
NQF care measure, n (%)	No	231 (50.9)	72 (43.4)	23 (51.1)	2 (18.2)	54 (58.1)	80 (57.6)	0.012
	Yes	223 (49.1)	94 (56.6)	22 (48.9)	9 (81.8)	39 (41.9)	59 (42.4)	
Prior hospitalization, n (%)	0	429 (94.5)	158 (95.2)	43 (95.6)	10 (90.9)	87 (93.5)	131 (94.2)	0.952
	>= 1	25 (5.5)	8 (4.8)	2 (4.4)	1 (9.1)	6 (6.5)	8 (5.8)	
Top 5 principal diagnoses	Acute respiratory failure	54 (11.9)	14 (8.4)	5 (11.1)	0 (0.0)	12 (13.0)	23 (16.1)	0.083

				Survivors and discharge disposition				
Vital status at hospital discharge		Overall	Expired	Home Health Care	Hospice	Long Term Care Hospital	Skilled Nursing Facility	p value
	Septicemia	52 (11.5)	23 (13.9)	3 (6.7)	2 (18.2)	13 (14.1)	11 (7.7)	
	Intracerebral hemorrhage	22 (4.8)	12 (7.2)	2 (4.4)	1 (10.1)	2 (2.2)	5 (3.5)	
	Aspiration pneumonitis	17 (3.7)	6 (3.6)	3 (6.7)	0 (0.0)	3 (3.3)	5 (3.5)	
	Acute on chronic respiratory failure	13 (2.9)	4 (2.4)	0 (0.0)	0 (0.0)	7 (7.6)	2 (1.4)	
SOFA score, median (IQR)		5.0 (3.0 – 8.0)	6.0 (4.0 – 10.0)	5.0 (3.0 – 7.0)	5.0 (3.5 – 6.5)	5.0 (3.0 – 8.0)	5.0 (3.0 – 7.0)	<0.001
Elixhauser comorbidities, median (IQR)		5.0 (3.0 – 6.0)	5.0 (3.0 – 6.0)	5.0 (3.0 – 6.0)	5.0 (4.5 – 6.0)	5.0 (3.0 – 7.0)	5.0 (4.0 – 7.0)	0.352
Length of stay, median days (IQR)		7.6 (4.6 – 12.9)	5.4 (3.0 – 11.2)	7.2 (4.8 – 9.5)	4.9 (3.5 – 16.3)	10.8 (6.2 – 17.2)	8.0 (5.7 – 12.9)	<0.001
ICU length of stay, median days (IQR)		4.2 (2.4 – 8.4)	4.5 (2.5 – 8.5)	2.2 (1.6 – 4.2)	3.2 (2.0 – 8.5)	6.94(4.0 – 11.9)	3.7 (2.3 – 6.4)	<0.001
Days until death from discharge, median (IQR)		163.5 (37.5 – 476)	NA	384.0 (71.0 – 667.0)	10.0 (4.5 – 12.0)	133.0 (50.0 – 283.0)	229.0 (41.5 – 574.0)	<0.001