Factors Associated with Palliative Withdrawal of Mechanical Ventilation and Time to Death after Withdrawal

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Abstract

Background: In imminently dying patients, mechanical ventilation withdrawal is often a comfort measure and avoids prolonging the dying process.

Objective: The aim of the study was to identify factors associated with palliative withdrawal of mechanical ventilation and time to death after extubation.

Methods: Logistic regression models were used to identify factors associated with palliative withdrawal of mechanical ventilation. Cox proportional hazards models were used to determine factors associated with time to death after extubation. We retrospectively evaluated 322 patients who died on mechanical ventilation or after palliative ventilator withdrawal at a single tertiary care center.

Results: Of the 322 ventilated deaths, 159 patients had palliative withdrawal of mechanical ventilation and 163 patients died on the ventilator. Clinical service was associated with palliative withdrawal of mechanical ventilation: Patients withdrawn from the ventilator were less likely to be on the surgery service and more likely to be on the neurology/neurosurgical service. The median time to death was 0.9 hours (range 0–165 hours). Fraction of inspired oxygen (FIO₂) greater than 70% (hazard ratio [HR] 1.92, 95% confidence interval [CI] 1.24–2.99) and a requirement for vasopressors (HR 2.06, 95% CI 1.38–3.09) were associated with shorter time to death. Being on the neurology/neurosurgical service at the time of ventilator withdrawal was associated with a longer time to death (HR 0.60, 95% CI 0.39–0.92).

Conclusions: Palliative withdrawal of mechanical ventilation was performed in only half of dying mechanically ventilated patients. Because clinical service rather than physiologic parameters are associated with withdrawal, targeted interventions may improve withdrawal decisions. Considering FIO₂ and vasopressor requirements may facilitate counseling families about anticipated time to death.

Introduction

IN THE INTENSIVE CARE UNIT (ICU), the highest level of care is provided to the sickest patients. Not surprisingly, death is common in the ICU; approximately 20% of all deaths in the United States occur in the ICU or soon thereafter,¹ and half of the patients who die in a hospital were in an ICU during their last 3 days of life.² Thus, it is imperative to provide effective end-of-life care in the ICU. Once it is determined that aggressive ICU treatment will not benefit a critically ill patient, life-sustaining interventions are no longer indicated. Under these circumstances, life-sustaining treatments may simply

prolong the dying process. Withdrawal of life-sustaining treatment is sometimes necessary to permit death.³ Mechanical ventilation is a key intervention to support life in the ICU,⁴ and it is the most common life-sustaining treatment withdrawn in anticipation of death.⁵ Palliative withdrawal of mechanical ventilation, defined as the withdrawal of a ventilator in a patient expected to die, is part of the transition to comfort-oriented care that is appropriate “once it is decided that further aggressive medical care is incapable of meeting the desired goals” for a patient.⁶ Consequently, continuation of mechanical ventilation in a patient who cannot benefit suggests obstacles to optimal decision making for the most

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vulnerable of ICU patients. Previous studies have shown that palliative extubation is associated with improved family satisfaction⁷ and decreased incidence of depression in family members.⁸ Yet, little is known about which patients are palliatively withdrawn from the mechanical ventilator versus which die while still mechanically ventilated. We compared these two groups of decedents to understand possible barriers to the transition to comfort-oriented care in dying ICU patients.

A nuanced aspect of palliative withdrawal of mechanical ventilation is the need to inform patients' families about what to expect during the dying process.⁹ Clinicians have little information to guide them in anticipating the time course after withdrawal of mechanical ventilation. The few studies that have addressed predictors of time of death after palliative withdrawal of mechanical ventilation focused on patients with severe neurological injury in the context of organ donation^{10,11} or only included patients who died within the ICU or shortly thereafter.¹² We sought to determine the factors associated with palliative withdrawal of mechanical ventilation in an unselected cohort of decedents at one facility and the time to death after withdrawal.

Methods

Study cohort

Our study cohort is obtained from a previous study on the quality of care provided in hospitalized patients at the end of life.¹³ In that study, all patients 18 years of age or older who died during a hospitalization of at least 3 days at the University of California, Los Angeles (UCLA) Medical Center between April 2005 and April 2006 were identified. Of the 500 decedents, complete terminal hospitalization medical records were available for 496 patients. Our study sample consists of the 322 patients who died while receiving mechanical ventilation or after palliative extubation. Of these 322 patients, 159 patients had palliative withdrawal of mechanical ventilation, and the time from extubation to death was available for 157 patients. The study was exempt from institutional review board (IRB) review because it involved only patients who died (IRB #G06-09-025-01).

Medical record abstraction

Information was obtained from the full medical record, including the hardcopy record, a partial electronic medical record, and a nursing electronic record. A medical record abstraction tool collected patient characteristics including demographics (age, gender, race, ethnicity, insurance, marital status), presence of an advance directive, and a variety of clinical variables (presence of end-stage disease, presence of cancer, consideration for transplant). We defined end-stage disease to include one or more of the following: end-stage pulmonary disease, end-stage heart failure, end-stage liver disease, end-stage renal disease, acquired immune deficiency syndrome (AIDS), or end-stage dementia. We also collected whether there was medical record documentation that a patient's death was expected. We defined "expected death" as any physician documentation that the patient was terminal, had a grave prognosis, was receiving hospice care, had imminently life-threatening disease in the context of a poor prognosis, or was dying. Experienced nurse abstractors were

intensively trained to use the abstraction tool including tandem abstraction and comparison, and reliable abstraction of five testing charts.

A supplemental chart abstraction tool was developed to collect time to death after palliative withdrawal of the mechanical ventilator, ventilator settings (fraction of inspired oxygen [FIO₂], positive end-expiratory pressure [PEEP], minute ventilation) within 12 hours prior to ventilator withdrawal, and receipt of other life-sustaining treatments at the end of life. Only invasive mechanical ventilation (not bilevel positive airway pressure [BPAP] or continuous positive airway pressure [CPAP]) was evaluated in this study.

Statistical analysis

Using Stata statistical software (version 11.1; StataCorp., College Station, TX), two main questions were addressed: What predicts palliative withdrawal of mechanical ventilation and for those who had mechanical ventilation withdrawn, what determines time to death? All variables that were *a priori* thought to be associated with terminal extubation and time to death were included in the multivariate regression models.

Terminal withdrawal of mechanical ventilation. Bivariate analysis was used first to compare patients who were withdrawn from mechanical ventilation with those who died on the ventilator. Categorical variables were compared by χ^2 test and continuous variables were assessed by *t* test. A logistic regression model of terminal withdrawal of mechanical ventilation included the following independent variables: gender, race, ethnicity, age, marital status, presence of end-stage disease, presence of cancer, primary service on admission, days on ventilator, the presence of an advance directive, and whether the patient was considered for an organ transplant. We also evaluated the interaction between end-stage disease and being considered for transplant, and the interaction between the surgical service and being considered for transplant. These interactions were not significant and subsequently were excluded from the models. To explore whether predictors of palliative withdrawal of mechanical ventilation were related to the expectation that the patient will die, we performed a sensitivity analysis by restricting the study sample to only those patients who were documented to have an "expected death." Because the two models were nearly identical, we present the model including all dying ventilated patients.

Time to death after terminal withdrawal of mechanical ventilation. A Kaplan-Meier curve was plotted to display time to death in the 157 patients who had palliative withdrawal of mechanical ventilation. Using *t* tests (and analysis of variance [ANOVA] where appropriate), differences in time to death between different groups of patients were evaluated in bivariate analyses of variables that were *a priori* hypothesized to be associated with time to death after mechanical ventilator withdrawal. A Cox proportional hazards model was used to determine independent predictors of time to death. A hazard ratio (HR) of <1.0 indicates an association with a longer time to death, whereas a HR >1.0 indicates an association with a shorter time to death. Because FIO₂ and PEEP were found to be highly correlated, only FIO₂ was used

in the Cox model. A sensitivity analysis showed that the model did not change when PEEP was used in place of FIO₂. The proportional hazards assumption was not violated ($p > 0.05$ for all variables in the model). To increase clinical relevance, we also studied the same model using logistic regression with two possibly clinically relevant time points to dichotomize the outcome: time to death of less than one hour and time to death greater than 10 hours after extubation.

Results

Among the 496 adult patients who died in the hospital during the studied year, 359 patients received mechanical ventilation during the admission with a median of 10 days on the ventilator (range 1–194 days). One hundred sixty-three patients died while continuing to receive mechanical ventilation and 159 had palliative withdrawal of mechanical ventilation.

Terminal withdrawal of mechanical ventilation

The 322 patients who died on the mechanical ventilator or after palliative withdrawal of mechanical ventilation were included in the analysis. In bivariate analyses, compared with patients who died while receiving mechanical ventilation, patients who received palliative withdrawal of mechanical ventilation were older (mean 58 years versus 62 years, respectively, $p = 0.009$), less likely to have end-stage disease

(48% versus 33%, $p = 0.006$), less likely to be uninsured (7% versus 1%, $p = 0.007$) or have Medicaid insurance only (13% versus 6%, $p = 0.03$), and more likely to have documentation of an “expected death” (79% versus 95%, $p < 0.001$). Compared with patients who died on the ventilator, patients withdrawn from the ventilator were less likely to be on the surgery service and more likely to be on the neurology/neurosurgical service (Table 1).

The multivariate analysis showed that, compared with patients with private insurance, uninsured patients were 90% less likely to undergo palliative withdrawal of mechanical ventilation. Similarly, compared with patients on the medicine service, patients on the surgery service were 70% less likely to undergo palliative withdrawal of mechanical ventilation, whereas patients on the neurology/neurosurgical service were more likely to undergo palliative withdrawal of mechanical ventilation (Table 2). In the sensitivity analysis, the study sample was restricted to the 280 patients who had documentation of an “expected death.” Similar results were found in this cohort, so only the analysis from the full cohort is presented.

Time to death after withdrawal of mechanical ventilation. There were 157 patients for whom the time could be computed between palliative withdrawal of mechanical ventilation and death. The median time to death was 0.9 hours with a range of seconds to 164.9 hours (interquartile range [IQR] 0.2–6.8 hours) (Fig. 1). Bivariate analysis showed that

TABLE 1. CHARACTERISTICS OF PATIENTS, COMPARING PATIENTS WHO DIED ON THE MECHANICAL VENTILATOR WITH PATIENTS WHO HAD PALLIATIVE WITHDRAWAL OF MECHANICAL VENTILATION

	Patients who died receiving mechanical ventilation (n = 163)	Patients with mechanical ventilation withdrawn expecting death (n = 159)	P value ^a
Male, n (%)	88 (54%)	86 (54%)	0.99
Age at death, years, mean (SD)	57.5 (17.6)	62.4 (16.2)	0.01
Married, n (%)	103 (63%)	98 (62%)	0.77
White, n (%)	128 (79%)	128 (81%)	0.66
Hispanic, n (%)	36 (22%)	25 (16%)	0.15
Insurance, n (%)			
Medicare	52 (32%)	63 (40%)	0.15
Private insurance	74 (45%)	81 (51%)	0.32
Medicaid only	21 (13%)	9 (6%)	0.03
Uninsured	12 (7%)	2 (1%)	0.01
Other insurance	4 (2%)	4 (3%)	0.97
Presence of any end-stage disease, n (%)	79 (48%)	53 (33%)	0.01
Pulmonary disease	19 (12%)	14 (9%)	0.40
Heart failure stage III or IV	12 (7%)	9 (6%)	0.54
End-stage liver disease	46 (28%)	23 (14%)	<0.01
End-stage renal disease	18 (11%)	13 (8%)	0.39
AIDS	0 (0%)	2 (1%)	0.15
Dementia, severe	0 (0%)	1 (1%)	0.32
Presence of end-stage cancer, n (%)	22 (13%)	22 (14%)	0.93
Presence of advance directive within 48 hours, n (%)	46 (29%)	44 (27%)	0.70
Considered for transplant, n (%)	70 (43%)	35 (22%)	<0.01
Surgery service is primary provider on admission, n (%)	71 (44%)	24 (15%)	<0.01
Neurology/Neurosurgical service is primary provider on admission, n (%)	13 (8%)	46 (29%)	<0.01
Medicine service is primary provider on admission, n (%)	78 (48%)	89 (56%)	0.15
Patient expected to die by physician, n (%)	129 (79%)	151 (95%)	<0.01
Days on ventilator, mean (SD)	17.8 (24.1)	15.9 (21.6)	0.46

^a χ^2 test was performed for categorical variables and one-sample t test was performed for continuous variables.

AIDS, acquired immune deficiency syndrome; SD, standard deviation.

TABLE 2. MULTIVARIATE MODEL OF PATIENT CHARACTERISTICS ASSOCIATED WITH PALLIATIVE WITHDRAWAL OF MECHANICAL VENTILATION

	Odds ratio (95% CI)
Gender	
Female	Reference
Male	1.16 (0.69–1.95)
Age	1.00 (0.99–1.02)
Married	0.77 (0.46–1.31)
Race	
Non-white	Reference
White	1.00 (0.52–1.90)
Ethnicity	
Non-Hispanic	Reference
Hispanic	0.72 (0.37–1.40)
Insurance	
Private insurance	Reference
Medicare	0.76 (0.41–1.42)
Medicaid only	0.46 (0.17–1.19)
Uninsured	0.06 (0.01–0.30)
Other insurance	1.09 (0.20–5.85)
End-stage disease	0.97 (0.52–1.78)
End-stage cancer	0.78 (0.37–1.65)
Presence of advance directive within 48 hours	1.17 (0.67–2.04)
Considered for organ transplant	0.63 (0.32–1.25)
Clinical service on admission	
Medicine	Reference
Surgery	0.32 (0.17–0.59)
Neurology/Neurosurgical	3.92 (1.69–9.12)
Days on ventilator	1.00 (0.99–1.02)

CI, confidence interval. Bold = p -value < 0.05.

patients on vasopressors, dialysis, and high ventilator settings had significantly shorter time to death after ventilator withdrawal (Table 3). Patients on the medicine and neurology/neurosurgical services had significantly longer times to death than patients on the surgery service ($p < 0.01$).

The multivariate Cox proportional hazards model shows that FIO₂ greater than 70% (HR 1.92, 95% confidence ratio [CI] 1.24–2.98) and a requirement for vasopressors (HR 2.05, 95% CI 1.37–3.07) are independently associated with shorter time to death after palliative withdrawal of mechanical ventilation (Table 4). Being on the neurology/neurosurgical service was associated with a longer time to death (HR 0.60, 95% CI 0.39–0.91). Table 5 shows multivariate logistic regression models (using the same independent variables) but studying associations with dichotomized outcomes at two potentially clinically relevant time cutoff points (1 hour, 10 hours). Patients on high FIO₂ were 5.6 times more likely to die within one hour after extubation but this association was not significant for the 10-hour cutoff. The use of vasopressors was strongly associated with death within one hour of ventilator withdrawal in both models ($p < 0.01$). In our sample, all surgical patients died within 10 hours of extubation.

Discussion

The goal of an ICU is to save lives. However, one fifth of ICU patients die during or shortly after a stay in the ICU.¹ Critical care specialists often can identify patients receiving life-sustaining treatments who will nevertheless die, and for these patients, continued life-sustaining treatments may prolong the dying process. This study provides a first step toward understanding the patterns of palliative withdrawal of mechanical ventilation in a large academic center. It also provides useful clinical information regarding the time frame for expected death after ventilator withdrawal that may be helpful to patients and families who have opted for palliative extubation.

In a previous study, Cook and colleagues also evaluated the predictors of palliative withdrawal of mechanical ventilation; however, their study included patients who were successfully weaned from the ventilator.¹⁴ Our study was of a decedent sample and therefore represented a sicker population of patients. In our study, patients on the neurology/neurosurgical service were more likely to receive

FIG. 1. Kaplan-Meier estimate of survival after withdrawal of mechanical ventilation. The graph shows proportion of patients alive by time after palliative withdrawal of mechanical ventilator at time 0. Fifty percent of patients died within 54 minutes.

TABLE 3. BIVARIATE ANALYSIS OF PATIENT CHARACTERISTICS AND TIME TO DEATH AFTER PALLIATIVE WITHDRAWAL OF MECHANICAL VENTILATOR

Variable	N	Time to death (hours)		P value
		Mean	95% CI	
Age < 65	90	8.5	3.6–13.5	0.20
Age ≥ 65	67	13.4	7.74–19.0	
Male	85	9.75	4.42–15.09	0.63
Female	72	11.58	6.43–16.73	
White	126	10.9	1.42–17.44	0.76
Non-white	31	9.4	6.67–15.09	
Hispanic	25	5.60	1.19–10.00	0.25
Non-Hispanic	132	11.54	7.23–15.85	
Presence of any end-stage disease on admission				0.07
No	104	13.0	7.99–18.0	
Yes	53	5.87	1.08–10.66	
Pulmonary disease				0.26
No	143	11.26	7.23–15.29	
Yes	14	3.79	–0.18–7.77	
Heart failure, class III or IV				0.18
No	148	11.21	7.31–15.11	
Yes	9	0.49	0.18–0.80	
End-stage liver disease				0.13
No	132	11.78	7.52–16.03	
Yes	23	3.68	–0.33–7.70	
End-stage renal disease				0.35
No	144	11.12	7.12–15.11	
Yes	13	4.78	–0.74–10.29	
AIDS				<0.01
No	155	9.97	6.47–13.46	
Yes	2	59.1	–653.7–771.9	
Presence of end-stage cancer				0.09
No	135	11.89	7.64–16.12	
Yes	22	2.7	–0.47–5.87	
Days on ventilator < 10 days	75	11.55	6.28–16.82	0.62
Days on ventilator ≥ 10 days	82	9.71	4.44–14.99	
Use of vasopressors within 12 hours of MV withdrawal				<0.01
No	65	19.9	12.2–27.5	
Yes	92	4.02	1.35–6.70	
Dialysis/CVVHD within 3 days of MV withdrawal				<0.01
No	101	15.25	9.7–20.7	
Yes	56	2.19	0.69–3.69	
Receiving nutrition within 24 hours of MV withdrawal				0.48
No	38	8.26	1.73–14.79	
Yes	119	11.34	6.89–15.78	
FIO ₂ < 70%	121	13.10	8.44–17.75	0.01
FIO ₂ ≥ 70%	36	2.18	–0.48–4.84	
PEEP < 8	113	13.72	8.78–18.65	0.01
PEEP ≥ 8	44	2.58	–0.05–5.21	
Minute ventilation < 12 L/minute	91	15.15	9.41–20.89	<0.01
Minute ventilation ≥ 12 L/minute	66	4.3	0.85–7.76	
Primary service				<0.01
Surgery	24	1.0	0.32–1.72	
Neurology/Neurosurgical	45	21.7	12.1–31.3	
Medicine	88	7.52	3.47–11.57	

AIDS, acquired immune deficiency syndrome; CI, confidence interval; CVVHD, continuous veno-venous hemodialysis; FIO₂, fraction of inspired oxygen; MV, mechanical ventilation; PEEP, positive end-expiratory pressure.

TABLE 4. MULTIVARIATE COX MODEL OF PATIENT CHARACTERISTICS ASSOCIATED WITH TIME TO DEATH AFTER PALLIATIVE WITHDRAWAL OF MECHANICAL VENTILATION

	Hazard ratio (95% CI)
Age > 65	0.79 (0.55–1.12)
Gender	
Female	Reference
Male	1.18 (0.82–1.68)
Race	
Non-white	Reference
White	1.09 (0.71–1.68)
Ethnicity	
Non-Hispanic	Reference
Hispanic	1.19 (0.76–1.86)
End-stage disease	0.81 (0.54–1.20)
End-stage cancer	1.27 (0.76–2.11)
On Ventilator for > 10 days	1.16 (0.80–1.68)
Vasopressors within 12 hours of MV withdrawal	2.05 (1.37–3.07)
Dialysis within 3 days of MV withdrawal	1.43 (0.92–2.23)
Nutrition within 24 hrs of MV withdrawal	0.91 (0.58–1.41)
FIO₂ > 70%	1.92 (1.24–2.98)
Minute ventilation > 12 L/minute	1.24 (0.86–1.81)
Primary service	
Medicine	Reference
Neurology/Neurosurgical	0.60 (0.39–0.91)
Surgery	1.40 (0.84–2.31)

CI, confidence interval; FIO₂, fraction of inspired oxygen; MV, mechanical ventilation. Bold = *p*-value < 0.05.

palliative mechanical ventilator withdrawal prior to death, which is consistent with the literature showing that the decision to withdraw life-sustaining treatment is common and often achieved the quickest in patients with poor neurological prognosis.^{15,16} On the contrary, surgery service patients are less likely to receive palliative withdrawal of mechanical ventilation prior to death, and when they do, these patients have the shortest time to death. These differences may be due to a variety of provider and patient factors and should be studied further. For example, surgical patients are likely to have different trajectories of dying compared with patients on the neurology/neurosurgical service that are not measured in the models. Surgical providers also have different communication styles and relationships with their patients compared with clinicians who are taking care of the patient only because of a recent neurological catastrophe. An integral part of successful provision of critical care is deciding who needs treatment in the ICU and when a transition to comfort-oriented care may be indicated.

The finding that the lack of insurance was less associated with palliative withdrawal of mechanical ventilation is consistent with a previous finding that uninsured patients are less likely to receive care aimed at palliation at the end of life.¹⁷ Further exploration of this phenomenon is needed, but may reflect limited access to care, lack of care continuity, and new presentation with more advanced disease, all of which may hinder the transition to comfort-oriented care.

TABLE 5. MULTIVARIATE LOGISTIC REGRESSION MODELS PREDICTING DEATH IN LESS THAN ONE HOUR AND IN LESS THAN 10 HOURS AFTER PALLIATIVE WITHDRAWAL OF MECHANICAL VENTILATION

	Time to death <1 hour Odds ratio (95% CI)	Time to death <10 hours Odds ratio (95% CI)
Age >65	0.54 (0.25–1.20)	0.74 (0.26–2.08)
Male	1.01 (0.45–2.27)	1.49 (0.52–4.20)
White	0.76 (0.28–2.05)	0.89 (0.24–3.30)
Hispanic	0.93 (0.34–2.54)	1.61 (0.42–6.20)
End-stage disease	0.91 (0.36–2.29)	0.70 (0.16–2.97)
End-stage cancer	1.11 (0.33–3.77)	5.01 (0.53–47.28)
On ventilator >10 days	1.44 (0.63–3.25)	1.59 (0.52–4.80)
FIO ₂ >70%	5.63 (1.91–16.59)	3.16 (0.54–18.34)
Vasopressors within 12 hours of MV withdrawal	4.22 (1.77–10.04)	4.53 (1.52–13.45)
Minute ventilation >12L	0.85 (0.35–2.06)	2.55 (0.78–8.36)
Dialysis within 3 days of MV withdrawal	1.69 (0.68–4.18)	2.82 (0.59–13.41)
Nutrition within 24 hrs of MV withdrawal	0.90 (0.35–2.34)	0.83 (0.22–3.10)
Primary Service		
Medicine	Reference group	Reference group
Neurology/Neurosurgical	0.52 (0.19–1.39)	0.30 (0.09–0.95)
Surgery	1.00 (0.30–3.38)	Omitted

All surgical patients died within 10 hours.

CI, confidence interval; FIO₂, fraction of inspired oxygen; MV, mechanical ventilation.

Bold = p -value < 0.05.

Our analysis on time to death after palliative withdrawal of mechanical ventilation provides clinicians with data to better inform patient's families of the expected course after the ventilator is turned off. Unlike Cooke's study on predictors of time to death after terminal mechanical ventilation withdrawal,¹² we did not exclude patients who took more than 30 hours to die after discharge from the ICU. The range of time to death was wide and up to 165 hours, but half of the patients died within one hour of ventilator withdrawal and the majority died by 10 hours. Dependence on life-sustaining therapy, particularly requiring FIO₂ greater than 70% and the use of vasopressors, was associated with a shorter time to death. Such information might be helpful in counseling patients' families. Neurology/neurosurgical patients had longer times to death after ventilator withdrawal, which is likely due to the lack of severe organ failure other than neurological catastrophe. Some centers are creating inpatient palliative care units in an effort to decompress the ICU and improve the quality of care in dying patients.¹⁸ These data may help clinicians identify patients appropriate for such units.

We recognize several limitations to our study. First, our study is from a single center with a relative small sample size and may not be generalizable elsewhere. Second, the study captured only dead patients and may have missed "terminally" extubated patients who survived. We believe this is rare. Third, given the cross-sectional nature of our study, it is hypothesis-generating and causal relationships cannot be determined. Nonetheless, our study identifies areas that warrant further exploration.

Conclusions

Our study shows that patterns of palliative withdrawal of mechanical ventilation vary by clinical service at one large academic center. The reason for this difference needs to be explored in future studies. We also show that consideration of FIO₂ and vasopressor requirements may facilitate counseling families about anticipated time to death.

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Author Disclosure Statement

No competing financial interests exist.

References

- Angus DC, Barnato AE, Linde-Zwirble WT, et al.: Use of intensive care at the end of life in the United States: an epidemiologic study. *Crit Care Med* 2004;32:638–643.
- The SUPPORT Principal Investigators: A controlled trial to improve care for seriously ill hospitalized patients. The study to understand prognoses and preferences for outcomes and risks of treatments (SUPPORT). *JAMA* 1995;274:1591–1598.
- Prendergast TJ, Claessens MT, Luce JM: A national survey of end-of-life care for critically ill patients. *Am J Respir Crit Care Med* 1998;158:1163–1167.
- Smedira NG, Evans BH, Grais LS, et al.: Withholding and withdrawal of life support from the critically ill. *N Engl J Med* 1990;322:309–315.
- Prendergast TJ, Luce JM: Increasing incidence of withholding and withdrawal of life support from the critically ill. *Am J Respir Crit Care Med* 1997;155:15–20.
- von Gunten C, Weissman DE: Ventilator withdrawal protocol. *J Palliat Med* 2003;6:773–774.
- Gerstel E, Engelberg RA, Koepsell T, Curtis JR: Duration of withdrawal of life support in the intensive care unit and association with family satisfaction. *Am J Respir Crit Care Med* 2008;178:798–804.
- Kross EK, Engelberg RA, Gries CJ, Nielsen EL, Zatzick D, Curtis JR: ICU care associated with symptoms of depression and posttraumatic stress disorder among family

- members of patients who die in the ICU. *Chest* 2011;139:795–801.
9. Curtis JR: Communicating about end-of-life care with patients and families in the intensive care unit. *Crit Care Clin* 2004;20:363–380, viii.
 10. Varelas PN, Hacein-Bey L, Schultz L, Conti M, Spanaki MV, Gennarelli TA: Withdrawal of life support in critically ill neurosurgical patients and in-hospital death after discharge from the neurosurgical intensive care unit. *J Neurosurgery* 2009;111:396–404.
 11. Lewis J, Peltier J, Nelson H, et al.: Development of the University of Wisconsin donation After Cardiac Death Evaluation Tool. *Prog Transplant* 2003;13:265–273.
 12. Cooke CR, Hotchkin DL, Engelberg RA, Robinson L, Curtis JR: Predictors of time to death after terminal withdrawal of mechanical ventilation in the ICU. *Chest* 2010;138:289–297.
 13. Walling AM, Asch SM, Lorenz KA, et al.: The quality of care provided to hospitalized patients at the end of life. *Arch Intern Med* 2010;170:1057–1063.
 14. Cook D, Rocker G, Marshall J, et al.: Withdrawal of mechanical ventilation in anticipation of death in the intensive care unit. *N Engl J Med* 2003;349:1123–1132.
 15. Mayer SA, Kossoff SB: Withdrawal of life support in the neurological intensive care unit. *Neurology* 1999;52:1602–1609.
 16. Lee DK, Swinburne AJ, Fedullo AJ, Wahl GW: Withdrawing care. Experience in a medical intensive care unit. *JAMA* 1994;271:1358–1361.
 17. Meyer EC, Burns JP, Griffith JL, Truog RD: Parental perspectives on end-of-life care in the pediatric intensive care unit. *Crit Care Med* 2002;30:226–231.
 18. Digwood G, Lustbader D, Pekmezaris R, et al.: The impact of a palliative care unit on mortality rate and length of stay for medical intensive care unit patients. *Palliat Support Care* 2011;9:387–392.

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