Implementation of the ICU Liberation Bundle to Decrease Ventilator Time in the Critically Ill Patient

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Abstract

Background: Prolonged ventilator support has been identified as a risk factor for complications including delirium, infections, decreased mobility, and prolonged hospital duration. Interventions highlighted in the ICU liberation bundle have been shown to improve outcomes and decrease duration of ventilator support.

Methods: Baseline review of patient records in the medical intensive care unit requiring mechanical ventilation in the winter of 2024 was used to evaluate duration of support, post-extubation outcomes and duration of hospital stay. Further data was collected in the winter of 2025 to compare outcomes following bundle implementation.

Interventions: ICU Liberation Bundle implementation during daily rounds was introduced in the fall of 2024. Expectations set for documentation of each bundle variable in daily progress notes. Chart review and round auditing completed to evaluate compliance.

Results: 20 patients evaluated in initial group averaged 5.5 days of mechanical ventilation with a standard deviation of 6 days. The average hospital stay was 9.3 days with standard deviation of 7.5. Post implementation group included 10 patients after exclusion criteria, with a mean ventilator duration of 2.6 days with standard deviation of 1.6. Hospital stays averaged 6.3 days with a standard deviation of 4.7 days. Statistical analysis of total days on ventilator following bundle implementation revealed a P value of 0.054. Alternatively, the statistical significance of total days in hospital revealed a P value of 0.20.

Conclusions: Implementation of the ICU Liberation Bundle revealed a decreased duration of mechanical ventilation and average hospital length of stay. Conclusions are limited by small sample size given large percentage of patients terminally extubated in both groups as well as the heterogeneity of MICU patient population.

Problem Description

Patient: Critical care providers in the medical intensive care unit at a university medical center

Intervention: Implementation of the ICU liberation bundle as part of daily rounds and patient management interventions as supported by the Society of Critical Care Medicine (SCCM). Daily discussions of each variable including a smart set to populate in provider notes. Evaluation of pre-implementation data on ventilator duration in the medical ICU compared to post-implementation data.

Comparison: As part of larger project aimed at implementation of the ICU liberation bundle, specific aims at pre-intervention all-cause ventilator time vs post-implementation ventilator time in the MICU.

Outcome: Improved compliance with daily ICU liberation strategies on each patient and effect on ventilator time in critically ill patients.

Time: Over the course of 6+ months, the compliance of daily ICU liberation bundle documentation should be 100% on each patient in the medical intensive care unit. 3 months of pre-intervention ventilator date mined from epic chart review compared to 3 months post-intervention data.

Available Knowledge

Caring for critically ill patients requires an integrative approach based on clinical studies and up to date literature. The data is clear that addressing pain, sedation, mobility, social concerns, and other aspects of patient care is important, but these variables are often overlooked during the acute management of patients (Negro et al., 2022). Interventions aimed at addressing important patient care measures can be optimized with structured protocols such as the ICU liberation bundle (Balas et al., 2013). Addressing each of the components improves

interdisciplinary communication and implementation of evidenced based guidelines to optimize outcomes and minimize the sequela of critical illness (Balas et al., 2013). The ICU Liberation Bundle, also commonly referred to as the 'A-F Bundle', highlights important variables to be addressed in patient care including analgesia (A), breathing support (B), choice of sedation (C), delirium (D), early mobility and engagement (E), and family empowerment (F). This bundle is used to address many of the common complications that arise when caring for critically ill patients. At a local level, this framework is not being formally utilized, creating potential gaps in care that should be addressed. The following is a brief review of the specific elements highlighted in the literature.

Pain is often under-reported and undertreated in the intensive care unit and can worsen the patient experience (Kang et al., 2023). The combination of critical illness, invasive equipment and aggressive procedures can lead to significant discomfort for patients and the development of post-intensive care syndrome (PICS) (Kemp et al., 2019). Appropriate assessment and choice of analgesia is associated with fewer days on mechanical ventilation, decreased ICU length of stay, decreased delirium and reduced overall mortality rates (Nordness et al., 2021).

Similarly, prolonged mechanical ventilation can worsen outcomes and lead to increased risk of delirium (Devlin et al., 2018). Early weaning with daily spontaneous awakening trials (SAT) and spontaneous breathing trials (SBT), work synergistically to decrease duration of ventilator support and hospital length of stay (Klompas et al., 2015). Minimal levels of sedation, as assessed with the Richmond Agitation-Sedation Scale (RASS), are associated with improved outcomes including shorter duration of mechanical ventilation and shorter ICU stay (Barr et al.,

2013). Implementation of protocol-directed bundles have been shown to reduce ventilator time and improve outcomes in critically ill patients (Hansen et al., 2008).

Conversely, the complications related to prolonged ventilator support include delirium and impaired mobility. Delirium is experienced by 50-80% of mechanically ventilated patients and contributes to prolonged hospitalization and increased costs (Devlin et al., 2018). The Confusion Assessment Method for the ICU (CAM-ICU) screening tool should be completed at least once per shift to identify and treat delirium (Barr et al., 2013). Early mobilization is supported in the literature of ICU patients as it has been shown to decrease delirium, improve functional outcomes and be cost effective (Dubb et al., 2016). There are few contraindications to basic patient mobility and the limiting factors are often related to time restraints and staff workload (Bakhru et al., 2016). Daily discussion of mobility levels can help to address barriers and encourage patient participation as appropriate (Dubb et al., 2016).

Finally, promoting family presence, as highlighted in the ICU liberation bundle, can decrease patient anxiety, confusion and delirium while promoting effective communication and patient advocacy (Davidson et al., 2017). Limited discussions and updates from providers can promote distrust, confusion, and increase stress among family members (Davidson et al., 2017). Daily discussions with family involvement can help to improve satisfaction and decrease post-ICU complications (Davidson et al., 2017).

Rationale

The consequences of prolonged mechanical ventilatory support have been well established in the literature (Barr et al., 2024). Implementation of the ICU liberation bundle has been endorsed by Society of Critical Care Medicine (SCCM) with the goal of improved outcomes, including reduced time on mechanical ventilation (Barnes-Daly et al., 2018). Both

pharmacological and non-pharmacological interventions are supported in the bundle and have been shown to improve outcomes in the critically ill (Inoue et al., 2024). Despite the available knowledge, the implementation of a consistent framework is often lacking (Negro et al., 2022). The use of a standardized protocol (ICU-liberation bundle) targeting each of these variables can contribute to thoughtful adjustments to patient care and improve outcomes (Negro et al., 2022). Previously, no dedicated framework had been utilized to address each of these variables in the medical intensive care unit (MICU) of the local academic medical center. To assess objective benefit, duration of mechanical ventilation is used to evaluate improved outcomes.

The Institute for Healthcare Improvement (IHI) Model for quality improvement focuses on identifying an issue, considering measurable variables and analyzing outcomes following intervention with the goal to improve practice strategies (Langley, 2009). Utilizing the Plan, Do, Study, Act principles, this quality improvement project investigated the impact of the ICU liberation bundle implementation on duration of mechanical ventilation in the MICU.

It was assumed in this quality improvement study that addressing bundle variables during rounds led to interventions targeting gaps in patient care. As a quantifiable measurement, time on ventilator for critically ill patients was evaluated pre and post implementation. Secondary evaluation of the data can identify gaps in implementation and identify underutilized interventions within a single academic medical center's MICU.

Specific Aims

Specific aims for this quality improvement project included evaluating the time on ventilator for critically ill patients prior to and following the implementation of the ICU liberation bundle. The literature supports the use of the ICU liberation bundle to improve

outcomes and the effect of daily discussions during interdisciplinary rounds is evaluated with a change in duration of mechanical ventilator support.

Methods

Context

This quality improvement study was conducted within a 16-bed medical intensive care unit at a local academic medical center. The multidisciplinary care team consisted of intensivists, residents, advanced practice providers, students, nurses, pharmacists and respiratory therapists. The patient population included a variety of complex diagnoses including, but not limited to, acute respiratory distress syndrome, heart failure, sepsis, cardiac arrest, and encephalopathy. Patients of interest in this study included those requiring mechanical ventilation for an acute illness. Tracheostomies, extracorporeal membrane oxygenation (ECMO) patients and primary surgical patients were excluded from the population given their unique circumstances. Chart review was utilized to establish baseline characteristics of patients including: number of days on ventilator, duration of hospitalization and secondary outcomes including death. The data was collected and compared to a second set of patients within the MICU, following bundle implementation. Additional insights evaluated included post extubation status (alive or deceased), hospitalization duration, and discharge status (alive or deceased). See appendix B for table including raw data collected.

Statistical analysis was used to assess for significance and to describe how bundle implementation affected time on mechanical ventilator support.

Interventions

Preliminary data was gathered through electronic medical records (EMR) over the course of 10 weeks' time from Jan 2024 through March 2024. Review of previously compiled database

information identifying patients on mechanical ventilator support in the MICU was utilized. Patients requiring mechanical ventilatory support were identified, with further investigation of patient hospitalization course and outcomes. Implementation of the ICU liberation bundle was implemented in the fall of 2024 at the expectation of MICU leadership, with reminders directed to staff to chart on and review important variables of the bundle during daily rounds. Expectations were set to document A-F bundle variables in daily progress notes by the medical residents on each patient. Once the expectations were clear and the educational barriers were addressed, data was re-collected in the first quarter (Jan through March) of 2025. A day in December 2024 was chosen for auditing of multidisciplinary rounds with observation of rounding discussions and bundle implementation dialogue. Additional chart review of post implementation patients was completed to identify written documentation of bundle variables.

Study of the Interventions

Pre and post bundle implementation evaluation of duration of mechanical ventilation for critically ill MICU patients was evaluated. Trends in patient outcomes including post extubation status and duration of total hospital stay were identified.

Measures

Time on ventilator (days) pre and post ICU liberation bundle implementation was measured. This variable was chosen as a quantifiable measurement given the expansive literature supporting the use of the bundle and its effect on reducing duration of mechanical ventilation (Barr et al., 2024). Any calendar day that included support on mechanical ventilation was included as a full day of ventilator use. Similarly, any time spent in the hospital on a given day was considered an entire day of hospitalization. This evaluation was used to support bundle implementation as a part of daily rounds. Review of documentation provided insight into

compliance of bundle variables (A-F bundle documented in progress note), identifying potential gaps in implementation.

Analysis

Quantitative measures evaluated time on mechanical ventilator support. Given variability in unit census, attempts were made to compare similar months of the year (winter) to optimize pre and post implementation variables. Qualitative evaluation of barriers to implementation or conflicts that arise in provider discussion or evaluation of ICU liberation bundle interventions require further consideration.

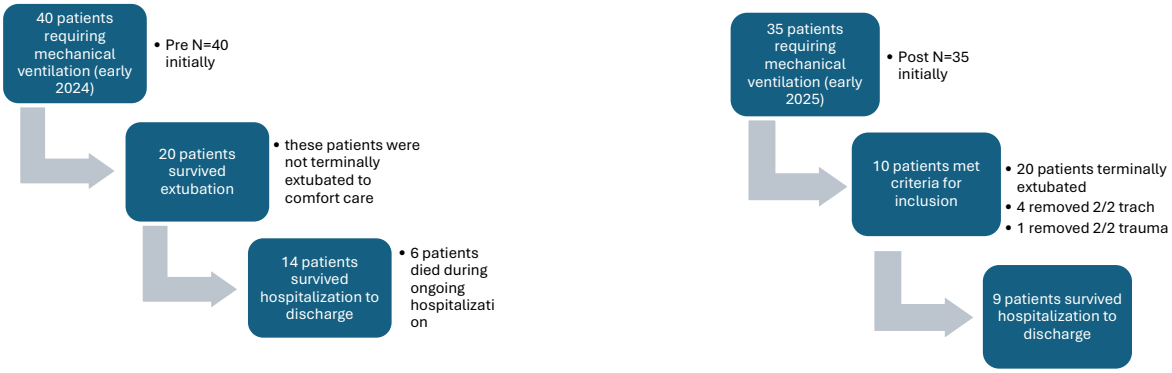
Ethical Considerations

ICU liberation bundle implementation supports the evidence-based process endorsed by the Society of Critical Care Medicine. The literature has shown improvements in patient outcomes identified by decreased ventilator duration, rates of delirium, and times to transfer and discharge (Barr et al., 2024). The bundle implementation does not change standards of care but instead promotes the discussion of issues that have been shown to positively affect patient outcomes. No conflicts of interest exist in this quality improvement project.

Results

A total of 40 patients requiring mechanical ventilation in the MICU were examined in the pre-intervention group. The sample size was adjusted with 20 of the patients (50%) excluded due to death on the ventilator or terminal extubation orders. Of the 20 patients that remained in the preliminary sample set, an average duration of mechanical ventilation was calculated to be 5.5 days with a standard deviation of 6 days. The duration ranged from 1 to 22 days with a median of 3 days. The average hospital stay was 9.3 days with standard deviation of 7.5. Hospitalization time ranged from 2 to 29 days with a median of 7 days. These patients required ventilator

support for 59% of the total hospital days and had a (post successful extubation status) death rate of 30% during hospital stay.



Following implementation of the ICU liberation bundle, a total of 35 patients were evaluated. 20 of the 35 patients were excluded from the sample set due to death during mechanical ventilation or terminal extubation. Additionally, 4 patients were excluded due to tracheostomy placement requiring prolonged weaning of ventilator support. One additional patient was excluded due to injuries requiring trauma management with frequent trips to the operating room, altering ventilator duration. The 10 patients included in the post-intervention group had a mean ventilator duration of 2.6 days with standard deviation of 1.6. Duration of support ranged from 1 to 5 days with a median duration of 2 days. This group had an average hospitalization stay of 6.3 days with standard deviation of 4.7 days. Total stay in the hospital ranged from 2 to 18 days with a median of 6 days. The data shows a 56% proportion of total hospital days spent on the ventilator with a 10% proportion of death during hospitalization (following successful extubation). Hospitalization outcome for all comers who were on mechanical ventilator support revealed 50% of patients in the pre intervention group died during hospitalization (20/40), while 66% (20/30) of those in post intervention group died during hospitalization (see figure 4).

Statistical analysis of total days on ventilator data following bundle implementation revealed a P value of 0.054. Alternatively, the statistical significance of total days in hospital revealed a P value of 0.20. The data is represented in the charts below, see figures 1 through 4 for complete graphical representation.

Days on Mechanical Ventilation (see figure 1):

	Pre (N=20)	Post (N=10)
Mean (SD)	5.5 (6.0)	2.6 (1.6)
Median (min, max)	3 (1, 22)	2 (1, 5)

P-value = 0.054

Total Days in Hospital (see figure 2):

	Pre (N=20)	Post (N=10)
Mean (SD)	9.3 (7.5)	6.3 (4.7)
Median (min, max)	7 (2, 29)	6 (2, 18)

P-value = 0.20

Hospitalization outcomes (of those who survived extubation) (see figure 3):

	Pre (N=20)	Post (N=10)
Proportion of days on ventilator	59%	56%
Death during hospitalization	30%	10%

Compliance with rounds and chart auditing: Daily round auditing was completed in December 2024, with 15 patients discussed and 3 actively requiring mechanical ventilation. Of those three, 2 patients were discussed with the ICU liberation bundle variables. The third was summarized without individual bundle variables addressed.

Chart auditing of the 10 post implementation patients who survived extubation revealed 6 of the 10 (60%) had documentation of the A-F bundle in a daily progress note by the resident, 4 had no specific bundle variables addressed.

Discussion

Summary

Following implementation of the ICU liberation bundle as a part of daily discussion and documentation, there is an observed decrease in duration of mechanical ventilation for a select

group of critically ill patients in the medical ICU. Additionally, patients experienced fewer total days in the hospital and were less likely to die during hospitalization if they survived extubation.

Interpretation

This quality improvement project supports a trend towards improved outcomes with utilization of the ICU liberation bundle. There is an associated decreased in duration of mechanical ventilation in the intervention group with statistical analysis revealing a P value of 0.054. The probability value supports the causative relationship between the intervention and outcome with 94% likelihood based on significance testing (Kwak, 2023). Secondary outcomes including duration of hospital stay and death during hospitalization are less convincing but may be further evaluated with larger sample sizes.

The decrease in mechanical ventilation duration is consistent with previously established outcomes in the literature. Recently published data found a decrease in ventilator duration of 0.6 days and a decrease in ICU length of stay by 0.5 days following implementation of the ICU liberation bundle (Barr et al., 2024).

There are no significant monetary costs associated with this intervention, instead it can improve efficiency with decreased duration of ventilator support and overall hospitalization duration. Time is a limiting factor as each variable needs to be discussed to optimize the patient care plan and avoid missing opportunities for intervention. There is little risk in implementation of the bundle based on the data as it is involves evidence based interventions discussed in previous studies and supported by the SCCM (Barr et al., 2024).

Limitations

Despite best efforts to compare similar patient groups in this study, the heterogeneity of MICU patients made the task difficult. Given the complexities of these patients, there are often

multiple variables contributing to their outcomes, including those related to duration of mechanical ventilation, hospital length of stay and death. This is apparent in the sample population as a significant number of patients were terminally extubated (50% of pre-intervention group and 67% of post-intervention group). The large percentage of terminal extubations limited the sample size utilized for data collection and evaluation. Given the small number of patients in both groups, the study is likely underpowered and although trends can be evaluated, generalizability is lacking. Additionally, the ICU liberation bundle presents several variables to be addressed, and this study does not specify which of those may provide a greater impact on patient outcomes. The expectation of implementation does not necessarily mean the variables are all addressed, and limited opportunity to audit daily rounds is a limiting factor in the interpretation of the data.

Conclusions

There is an overall trend towards reduced mechanical ventilation duration and hospital length of stay with the implementation of the ICU liberation bundle. Given the improved outcomes, bundle implementation should continue to be utilized as a part of daily rounding in the MICU. Ultimately, a larger, more robust sample size is needed to confirm causation of improved outcomes due to bundle implementation.

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Appendix A:

Figure 1:

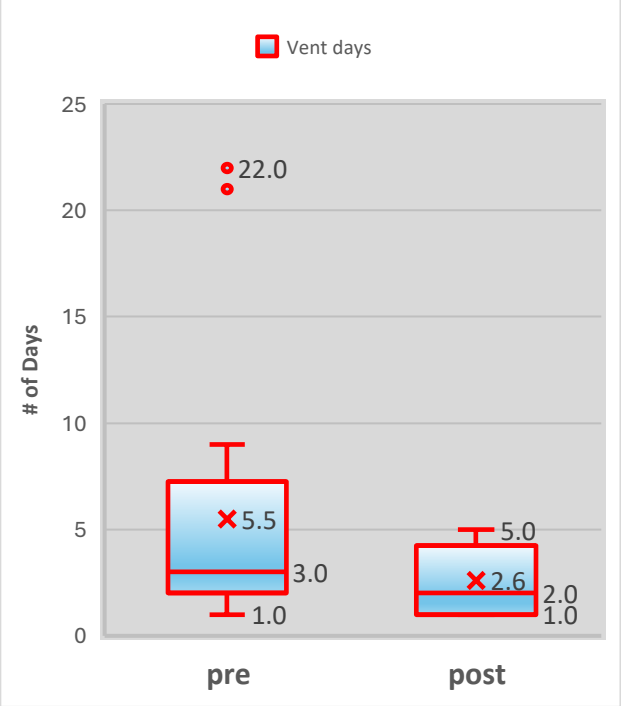


Figure 2:

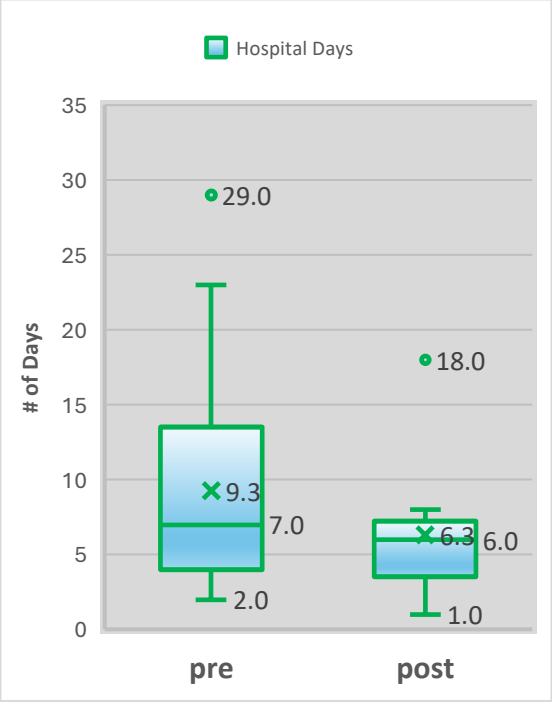


Figure 3:

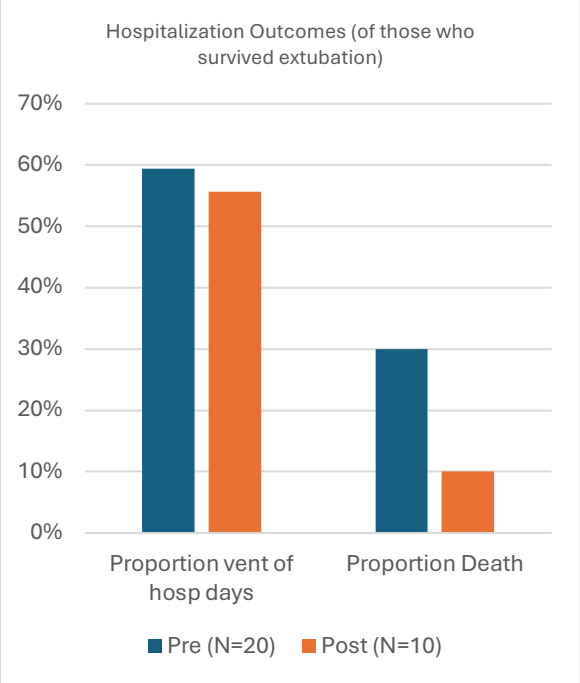
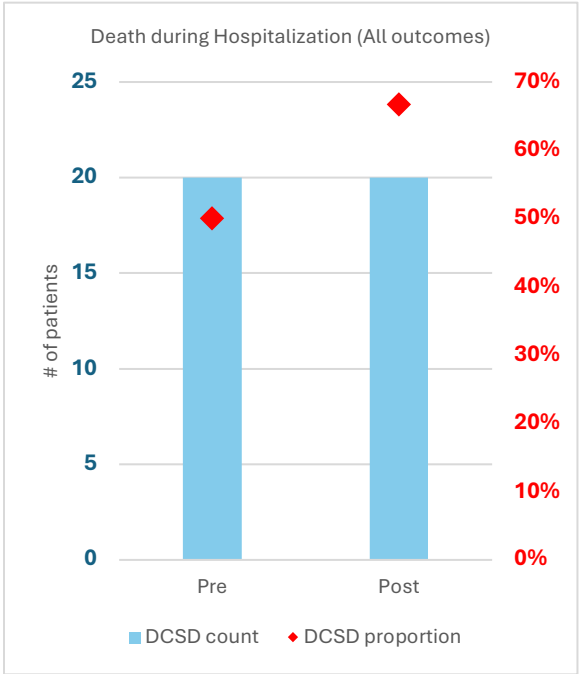


Figure 4:



Appendix B:
Raw Data Collection

pt #	time	Admit date	DC date	Dx (primary)	Vent days	Hosp Days	Ext status	Death during hosp	Doc (post)
1	pre	1/2/24	1/3/24	Hemorrhagic shock	1	1	dcsd	yes	
2	pre	1/1/24	1/8/24	Assault	1	7	alive	no	
3	pre	12/28/23	1/6/24	ARDS 2/2 flu	8	9	alive	no	
4	pre	12/20/23	1/5/24	Hemorrhagic shock, AMS	9	16	alive	no	
5	pre	12/24/23	1/12/24	Hypotension, shock	5	19	alive	yes	
6	pre	12/28/23	1/24/24	ARDS	trach	27	dcsd	yes	
7	pre	11/27/23	1/24/24	MDS, ARDS	14	58	dcsd	yes	
8	pre	1/6/24	1/17/24	Shock, AHRF	2	11	dcsd	yes	
9	pre	12/18/23	1/22/24	AHRF, CA	6	34	dcsd	yes	
10	pre	1/15/24	1/23/24	AMS, AHRF	5	8	alive	no	
11	pre	1/18/24	1/19/24	Hemorrhagic shock	2	2	dcsd	yes	
12	pre	1/15/24	1/26/24	AHRF, PVD	2	11	dcsd	yes	
13	pre	1/24/24	1/26/24	Overdose	2	2	alive	no	
14	pre	1/28/24	2/4/24	AHRF, AMS	4	7	alive	no	
15	pre	1/19/24	1/30/24	AHRF, hemoptysis	4	11	dcsd	yes	
16	pre	1/31/24	2/7/24	AHRF	4	8	alive	no	
17	pre	1/29/24	2/2/24	AHRF, ALS	2	4	alive	yes	
18	pre	2/4/24	2/8/24	AMS	2	4	alive	no	
19	pre	2/2/24	2/24/24	AHRF, Sepsis	22	23	alive	yes	
20	pre	2/3/24	2/9/24	OD, Cardiac arrest	6	6	dcsd	yes	
21	pre	1/29/24	1/29/24	AMS, Cardiac arrest	1	1	dcsd	yes	
22	pre	2/4/24	2/18/24	Cardiac arrest	9	14	alive	yes	
23	pre	1/27/24	2/27/24	Pancreatic CA, AHRF	21	29	alive	no	
24	pre	2/4/24	2/6/24	SAH	3	3	dcsd	yes	
25	pre	2/16/24	2/18/24	Sepsis	3	3	dcsd	yes	
26	pre	2/14/24	2/14/24	Pulmonary Embolism	1	1	dcsd	yes	
27	pre	2/16/24	2/20/24	Vocal cord paresis	1	4	alive	no	
28	pre	2/16/24	2/18/24	Mass debulking procedure	2	3	alive	no	
29	pre	2/20/24	2/22/24	SVT, cardiogenic shock	3	3	dcsd	yes	
30	pre	2/22/24	2/28/24	ESLD, hematemesis	3	7	alive	no	
31	pre	2/23/24	2/23/24	HCC, AMS	1	1	dcsd	yes	
32	pre	2/26/24	2/29/24	Pancreatic CA, ARDS Flu	3	4	alive	yes	
33	pre	2/29/24	3/11/24	ICH, AHRF	3	12	alive	yes	
34	pre	2/29/24	3/2/24	AMS, Suicide attempt	2	3	alive	no	
35	pre	3/7/24	3/8/24	AHRF, hemoptysis	2	2	dcsd	yes	
36	pre	3/7/24	3/13/24	AHRF, NSCLC	7	7	dcsd	yes	
37	pre	3/16/24	3/17/24	AMS	2	2	alive	no	

38	pre	3/17/24	3/17/24	Hemorrhagic shock	1	1	dcsd	yes	
39	pre	3/8/24	3/27/24	B cell lymphoma	6	20	dcsd	yes	
40	pre	3/12/24	3/13/24	Hyperkalemia, cardiac arrest	2	2	dcsd	yes	
1	post	12/24/24	1/23/25	CVA, MSSA sepsis	trach	29	trach	no	
2	post	12/28/24	12/30/24	AMS, laryngeal CA	trach on admit	3	trach	no	
3	post	1/4/25	1/7/25	ARDS 2/2 flu	4	4	dcsd	yes	yes
4	post	1/1/25	1/5/25	PEA arrest	5	5	dcsd	yes	yes
5	post	12/18/24	1/6/25	MM, fever	3	21	dcsd	yes	yes
6	post	12/29/24	1/6/25	ARDS - pulm abscess	8	8	dcsd	yes	yes
7	post	12/21/24	1/23/25	Trauma	x	33	alive	no	x
8	post	12/28/24	1/7/25	ARDS 2/2 flu	11	11	dcsd	yes	yes
9	post	1/2/25	1/3/25	Resp fail 2/2 AMS	2	2	alive	no	yes
10	post	1/7/25	1/14/25	Cardiac arrest	5	8	alive	no	yes
11	post	1/12/25	1/15/25	Hypothermia, drowning	3	4	alive	no	yes
12	post	1/10/25	1/13/25	Chronic resp failure	trach on admit	4	trach	no	yes
13	post	1/10/25	1/16/25	AMS, hypothermia	4	7	alive	no	yes
14	post	1/11/25	1/28/25	Meningitis, CVA	2	18	alive	yes	no-
15	post	1/10/25	1/28/25	Resp fail 2/2 flu	19	19	dcsd	yes	yes
16	post	12/20/24	1/7/25	Shock	2	19	dcsd	yes	yes
17	post	1/6/25	1/12/25	Cardiac arrest, seizure	7	7	dcsd	yes	yes
18	post	12/29/24	1/6/25	Sepsis, CNS mets	9	9	dcsd	yes	yes
19	post	1/8/25	1/9/25	ARDS	2	2	dcsd	yes	no
20	post	1/10/25	1/16/25	GIB	1	7	alive	no	yes
21	post	1/16/25	admitted	ARDS 2/2 flu	trach 2/7	ongoing	trach	unknown	yes
22	post	1/18/25	2/8/25	ARDS, ECMO	22	22	dcsd	yes	yes
23	post	1/21/25	1/25/25	AHRF, CAP	2	5	alive	no	yes
24	post	1/24/25	1/24/25	AMS OD	1	1	alive	no	no
25	post	1/11/25	1/26/25	AMS- CML	3	16	dcsd	yes	no
26	post	2/1/25	2/6/25	ARDS 2/2 flu	6	6	dcsd	yes	no
27	post	1/30/25	2/1/25	SCLC	2	2	dcsd	yes	no
28	post	1/26/25	1/29/25	Cardiac arrest	4	4	dcsd	yes	yes
29	post	2/2/25	2/8/25	ARDS, PAH	7	7	dcsd	yes	no
30	post	2/6/25	2/12/25	AHRF	5	7	alive	no	no
31	post	2/9/25	2/13/25	Cardiac arrest 2/2 OD	5	5	dcsd	yes	no
32	post	2/4/25	2/12/25	SZ, Cardiac arrest	9	9	dcsd	yes	no
33	post	2/9/25	2/10/25	AHRF, Flu	2	2	dcsd	yes	ECMO
34	post	2/12/25	2/15/15	AMS, Cardiac Arrest	1	4	alive	no	no
35	post	2/13/25	2/14/25	Cardiac arrest	2	2	dcsd	yes	no