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The Economic and Clinical Impact of an Early Mobility Program in the Trauma Intensive Care Unit: A Quality Improvement Project

Beth A. Falkenstein, BSN, RN, CEN, TCRN ■ Chelsea K. Skalkowski, DPT, PT, CCS ■ Kathleen D. Lodise, RRT ■ Marian Moore, BSN, RN, CCRN, TCRN ■ Brian F. Olkowski, DPT, PT, NCS ■ Yuri Rojavin, MD, FACS

ABSTRACT

Traumatic injury survivors often face a difficult recovery. Surgical and invasive procedures, prolonged monitoring in the intensive care unit (ICU), and constant preventive vigilance by medical staff guide standards of care to promote positive outcomes. Recently, patients with traumatic injuries have benefited from early mobilization, a multidisciplinary approach to increasing participation in upright activity and walking. The purpose of this project was to determine the impact of an early mobility program in the trauma ICU on length of stay (LOS), ventilator days, cost, functional milestones, and rehabilitation utilization. A quality improvement project compared outcomes and cost before and after the implementation of an early mobility program. The trauma team assigned daily mobility levels to trauma ICU patients. Nursing and rehabilitation staff collaborated to set daily goals and provide mobility-based interventions. Forty-four patients were included in the preintervention group and 43 patients in the early mobility group. Physical therapy and occupational therapy were initiated earlier in the early mobilization group ($p = .044$ and $p = .026$, respectively). Improvements in LOS, duration of mechanical ventilation, time to out-of-bed activity and walking, and discharge disposition were not significant. There were no adverse events related to the early mobility initiative. Activity intolerance resulted in termination of 7.1% of mobility sessions. The development and initiation of a trauma-specific early mobility program proved to be safe and reduce patient care costs. In addition, the program facilitated earlier initiation of physician and occupational therapies. Although not statistically significant, retrospective data abstraction provides evidence of fewer ICU and total hospital days, earlier extubations, and greater proactive participation in functional activities.

Key Words

Cost, Early mobility, Intensive care unit, Quality improvement, Trauma

Traumatic injury survivors often face a difficult recovery. Surgical and invasive procedures, prolonged monitoring in the intensive care unit (ICU), and constant preventive vigilance by medical staff guide standards of care to promote positive outcomes. Traumatic injuries can be devastating as many patients experience a decline in function and quality of life years after their initial injury (Kaske et al., 2014; Livingston, Tripp, Biggs, & Lavery, 2009; Ranier et al., 2014; Ringburg et al., 2011). Complications such as venous thromboembolism (VTE), pneumonia, and delirium are common and increase mortality, length of stay (LOS), and cost (de Jongh, Bosma, Leenan, & Verhofstad, 2011; Hemmila et al., 2008; Moore, Stelfox, & Turgeon, 2012; Moore et al., 2014; Shafi et al., 2010). The ABCDEF bundle (**A**ssess, prevent, and manage pain; **B**oth spontaneous awakening trials and spontaneous breathing trials; **C**hoice of analgesia and sedation; **D**elirium, assess, prevent, and manage; **E**arly mobility and exercise; and **F**amily engagement and empowerment) reduces the complications associated with critical illness and improves the outcomes of patients admitted to the ICU (Balas et al., 2014; Devlin et al., 2018; Pun et al., 2018).

Early mobilization, a multidisciplinary approach to increasing patient participation in upright activity and walking, reduces the complications associated with critical illness. Initial early mobilization studies focused on patients in acute respiratory distress syndrome (ARDS) who were receiving mechanical ventilation. Early mobility programs were found to be safe and feasible, shorten LOS, improve function, and reduce complications (Kamdar et al., 2016; Needham, 2008; Needham et al., 2012; Schweikert et al., 2009). The savings associated with improved outcomes have funded early mobilization programs in the ICU (Hester et al., 2017).

Author Affiliations: Bristol-Myers Squibb Trauma Center (Mss Falkenstein and Moore and Dr Rojavin), Department of Rehabilitation (Drs Skalkowski and Olkowski), Department of Respiratory Care (Ms Lodise), and Division of Trauma and Acute Care Surgery (Dr Rojavin), Capital Health Regional Medical Center, Trenton, New Jersey.

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Correspondence: Beth A. Falkenstein, BSN, RN, CEN, TCRN, Bristol-Myers Squibb Trauma Center, Capital Health Regional Medical Center, 750 Brunswick Ave, Trenton, NJ 08638 (bfalkenstein@capitalhealth.org).

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More recently, patients with traumatic injuries have benefited from early mobilization with few adverse events (AEs) and have experienced fewer complications such as pneumonia and VTE (Booth et al., 2016; Clark, Lowman, Griffin, Matthews, & Reiff, 2013). Early mobility programs in critically ill patients with traumatic injuries typically include absolute contraindications to participation such as active resuscitation, unstable fractures, spinal instability, acute myocardial infarction, unstable airway, and the withdrawal of care (Booth et al., 2016; Clark et al., 2013; Engels et al., 2013). Once participation criteria are met, patients are placed into mobility levels based on sedation, agitation, neurological presentation, and cardiopulmonary capability (Booth et al., 2016; Calthorpe et al., 2014; Clark et al., 2013; Engels et al., 2013; Zomorodi, Topley, & McAnaw, 2012). The mobility levels range from supine with more passive interventions and progress to more vertical positions with active interventions such as walking (Booth et al., 2016; Calthorpe et al., 2014; Clark et al., 2013; Engels et al., 2013; Zomorodi et al., 2012).

Aware of the complications resulting from bed rest and immobility, this multidisciplinary trauma team developed and implemented an early mobility program for critically ill patients with traumatic injuries. The purpose of this study was to determine the impact of an early mobility program in the trauma ICU on quality and cost.

METHODS

Design

The institutional review board approved a pre- and postintervention quality improvement project.

Setting

The mobilization initiative took place in a 14-bed, mixed trauma/surgical/medical ICU of a verified Level II trauma center and Magnet-accredited health system.

Subjects

Patients admitted to the trauma ICU after sustaining a traumatic injury were included in the quality improvement project. Exclusion criteria identified only those who received withdrawal of care. A comparative analysis studied consecutive patients in a historical cohort from January to April 2017 and consecutive patients in the prospective intervention cohort from October 2017 to January 2018.

Early Mobility Program

Prior to implementation of the early mobility program, patients in the trauma ICU received mobilization therapy by physical therapists, occupational therapists, and nurses. Early mobilization practices were not standardized and collaboration did not occur at multidisciplinary rounds. A multidisciplinary early mobility committee consisting of a trauma surgeon, a trauma nurse, a clinical nurse specialist, a respiratory therapist, a physical therapist, an occupational therapist, and a clinical pharmacist convened to develop an early mobility program for patients in the trauma ICU. The meetings focused on the following: patient eligibility criteria, early mobility levels, daily mobility goals, mobility-related interventions, equipment identification, staff education, and program implementation.

The team developed mobilization criteria using hemodynamic stability as a focal point. Successful, preestablished early mobility programs served as design models for this initiative (Booth et al., 2016; Clark et al., 2013; Hester et al., 2017; Needham et al., 2012; Schweikert et al., 2009). Absolute contraindications to participation in the early mobility program were active resuscitation, active seizure, care withdrawn, active myocardial infarction, unstable airway, and unstable spine or skeletal condition. Trauma ICU patients without absolute contraindications received a daily mobility level (1–4) based on the Richmond Agitation-Sedation Scale (RASS). The daily mobility-level assignment guided mobility-related interventions with the outcome of the patient achieving the daily mobility goal (Figure 1). The staff discussed eligibility for early mobilization and barriers to the achievement of the daily mobility goal at daily multidisciplinary rounds. Early mobility program sessions were terminated because of the activity intolerance, which was defined as a heat rate increase of more than 30 bpm, respiratory rate of more than 40 bpm, systolic blood pressure (SBP) change of ±30 mmHg, Sao_2 less than 88%, new cardiac arrhythmia, ventilator asynchrony, or signs of acute distress.

Patients unable to actively participate in nursing and rehabilitation interventions due to sedation or agitation (Levels 1–2) received passive interventions aimed at improving flexibility, alertness, and upright position in preparation for more active interventions. Passive cycling programs for bedridden patients offer a safe alternative to maintain joint flexibility and proven feasible for critically ill patients (Kho et al., 2015). Mobility Level 1 and 2 interventions included passive in-bed cycling (MotoMed Letto; RECK-Technik GmbH & Co., Betzenweiler, Germany).

Patients who met active participation criteria received mobility interventions focusing upright activities such as standing and walking (Levels 3–4). Relative contraindications to out-of-bed activity were as follows: FIO_2 (fraction of inspired oxygen), 60% or more; positive end-expiratory pressure, more than 8 cmH_2O; intracranial pressure, more than 20 mmHg; Sao_2, 88% or less; open abdomen; and SBP, less than 90 or more than 180 mmHg.

Levels 3 and 4 included active in-bed cycling to maintain strength and flexibility. Ambulatory patients used a multifunction mobility platform (PACE; Livengood, Fort Collins, CO) to manage medical equipment (portable

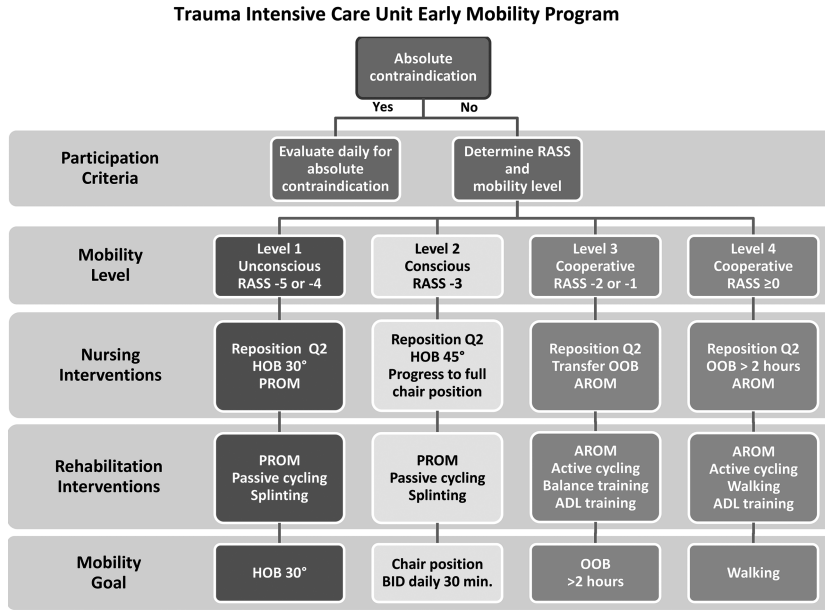

Figure 1. Trauma intensive care unit early mobility program used at the Capital Health Regional Medical Center. ADL = activities of daily living; AROM = active range of motion; BID = twice a day; HOB = head of bed; OOB = out of bed; PROM = passive range of motion; RASS = Richmond Agitation-Sedation Scale.

ventilator, portable cardiac/hemodynamic monitor, chest tube drainage systems, and intravenous pumps). The multifunction platforms also improved process efficiency by reducing the number of staff required to assist with patient ambulation. Mobility levels and corresponding interventions are given in Figure 1.

Mechanical ventilation did not preclude participation in the early mobility program. Under direction of the trauma surgeon, the respiratory therapist and the nurse would initiate a daily spontaneous awakening and breathing trial before morning rounds. Patients participating in weaning would have sedation held, starting at 0500. Those who could not tolerate intubation without sedation would remain lightly sedated to reduce the occurrence of agitation and prevent weaning failure. Patients who failed weaning remained on the ventilator and were assigned a daily mobility level based on their RASS score. A respiratory therapist and a nurse were present during Level 3 and 4 mobility-related interventions performed on patients receiving mechanical ventilation.

The early mobilization committee developed a formal educational program consisting of online modules, interactive classroom seminars, and educational videos. Scheduled education sessions took place over a 3-week time period for nursing and rehabilitation staff to promote optimization and dissemination of program didactics. Online modules were accessed through an organizational web-based management system. The online format allowed the learner to complete the program at his or her convenience within the allotted 3-week period. The performance management system provided a completion log for compliance tracking.

Nursing and rehabilitation staff provided 2-hr interactive classroom seminars that educated staff on the following key concepts: physical and psychosocial aspects of care for the severely injured trauma patient, concepts of early mobility, contraindications to early mobility, the determination of mobility levels, early mobility program interventions, equipment use, staff and patient safety, and documentation. The rehabilitation therapists developed an educational video, demonstrating passive range-of-motion exercises for upper and lower extremities for patients who could not participate in active mobility exercises. Pre- and posteducation testing assessed knowledge and comprehension of the education provided for the online modules and classroom seminars. Demonstration and return demonstration competency laboratories provided instruction in the use of the overhead ceiling lift, the MotoMed Letto passive in-bed cycling system, and the Livengood mobility platform.

Prior to the start of the early mobility program, members of the early mobilization committee scheduled huddles within the ICU to provide reinforcement of the following: role identification and responsibilities of multidisciplinary staff members, process and protocol including identification and tracking of early mobilization patients, documentation, and handoff reporting at shift change. Staff members were encouraged to provide feedback on all aspects of the early mobility program, and early mobility committee members met weekly to

review staff feedback and suggestions. An early mobility flow sheet was used to document the RASS, daily mobility level, nursing interventions, rehabilitation session completion, achievement of mobility goal, and barriers to early mobilization. Beginning 24 hr after program implementation, early mobility committee members reviewed mobility flow sheets for compliance, efficacy, and safety. The committee maintained formal bimonthly meetings during the early phases of initiation and transitioned to monthly meetings after satisfactory adoption of the early mobility was established.

Data Analysis

Data obtained from the ACS Trauma Quality Improvement Program registry included discharge disposition, age, gender, mechanism of injury, injury severity score, and LOS. Data obtained from retrospective electronic record review included the assessment of mobility post-acute care, ventilator days, mobility milestones, and rehabilitation therapy utilization. In-hospital mortality, activity intolerance, and mobility-related AEs such as extubation, vascular line decannulation, chest tube dislodgement, falls, and neurological or cardiac event were determined for the early mobility group from retrospective electronic record review. The organization's patient accounting system provided direct variable costs to assist with pre- and postfinancial analyses.

Descriptive statistics summarized distribution, central tendency, and dispersion of demographic and clinical characteristics. The chi-square test or Fisher's exact test compared categorical variables, and an SPSS Version 22.0 (IBM Corporation, Armonk, NY) conducted a bivariate analysis. Independent-samples *t* test monitored continuous data comparison. Continuous variables were reported as means with a standard deviation, and categorical variables were reported as percentages. A significant association or interval difference was set as a priori at a *p* value less than .05. A financial modeling analysis determined the economic impact of the early mobility program on direct variable cost (Lord et al., 2013).

RESULTS

Eighty-seven patients met inclusion criteria for the project, which included 44 patients in the preintervention group and 43 patients in the postintervention early mobility group. There were no statistical differences ($p > .05$) in demographic or clinical characteristics (Table 1). Physical therapy and occupational therapy were initiated sooner in the early mobility group ($p < .05$). There were no statistical differences ($p < .05$) in hospital LOS, ICU LOS, time on mechanical ventilation, time to out-of-bed activity, time to walking 50 ft, and discharge between the preintervention and postintervention/early mobility cohorts. Outcomes are summarized in Table 2.

The number of physical and occupational therapy sessions in the ICU was similar for both groups ($p > .05$). Two hundred nine mobility sessions conducted by physical and occupational therapists in the early mobility group indicated that only 7.1% of the sessions resulted in termination from activity intolerance. The most common reasons for activity intolerance were vital sign deviations out of established parameters during mobilization. There were no mobility-related AEs and no patients expired during the hospitalization for both groups. The direct variable cost to care for patients in the early mobility group was $354,277 less than the cost to care before the early mobility resulting in an average direct variable cost savings of $8,239 per patient. The direct variable cost saving projection is $2,352,744 annually (Table 3).

DISCUSSION

Early mobilization reduces the complications associated with ICU admission after a traumatic injury (Booth et al., 2016; Clark et al., 2013). Patients in the early mobility group,

TABLE 1 Patient Demographic and Clinical Characteristics[a]

Characteristic	Early Mobility (*n* = 43)	Control (*n* = 44)	Test of Association[b]
Male, *n* (%)	29 (67.4)	32 (72.7)	0.596
Age	50.9 ± 21.5	51.9 ± 22.4	0.824
ISS	16.12 ± 7.74	15.66 ± 8.85	0.798
Injury type, *n* (%)			
Blunt trauma	36 (83.7)	37 (84.1)	0.827
Penetrating trauma	7 (16.3)	7 (15.9)	
Admission AM-PAC mobility	14.0 ± 5.8	13.3 ± 6.0	0.593

Note. AM-PAC = assessment of mobility post-acute care; ISS = injury severity score.
[a]*Values are mean ± standard deviation unless otherwise indicated.*
[b]*Tests of association are chi-square test except age and ISS (t test).*

TABLE 2 Clinical Outcomes[a]

Outcome	Control (n = 44)	Early Mobility (n = 43)	Test of Association[b]
Hospital LOS	12.3 ± 10.7	9.9 ± 11.3	0.328
ICU LOS	6.9 ± 8.7	5.5 ± 7.1	0.446
Ventilator days	3.5 ± 5.9	2.1 ± 3.9	0.205
Admission to initiation of physical therapy	1.5 ± 3.6	0.3 ± 1.0	0.044*
Admission to initiation of occupational therapy	2.0 ± 4.1	0.5 ± 1.2	0.026*
Admission to OOB	3.9 ± 5.3	2.9 ± 3.5	0.294
Admission to walking 50 ft	6.0 ± 8.8	4.7 ± 5.4	0.486
ICU physical therapy sessions	3.0 ± 4.1	2.9 ± 3.5	0.953
ICU occupational therapy sessions	2.1 ± 2.4	2.0 ± 1.8	0.833
Discharge destination, *n* (%)			
Home	23 (52.3)	22 (51.2)	0.556
IRF	16 (36.4)	20 (46.5)	
Other	5 (11.3)	1 (2.3)	

Note. IRF = inpatient rehabilitation facility; LOS = length of stay; OOB = out of bed.

[a]*Values are mean ± standard deviation unless otherwise indicated.*

[b]*All tests of association are chi square test except patient age (t test).*

**p < .05*

TABLE 3 Financial Model for a Trauma ICU Early Mobility Program[a]

Row	Description	Value	Calculation
A	ICU LOS before intervention, days	6.89	Actual
B	Floor LOS before intervention, days	5.41	Actual
C	Reduction in ICU LOS, %	19.0	Actual
D	Reduction in floor LOS, %	19.3	Actual
E	Reduction in ICU LOS, days	1.31	A × C
F	Reduction in floor LOS, days	1.04	B × D
G	ICU LOS after intervention, days	5.58	A – E
H	Floor LOS after intervention, days	4.37	B – F
I	Direct variable cost before intervention	$30,496	Actual
J	Direct variable cost after intervention	$22,257	Actual
K	Direct variable cost savings per patient	$8,239	I – J
L	Annual number of trauma ICU admissions[b]	302	Actual
K	Annual direct variable cost savings	$2,488,178	K × L
N	Annual early mobility program cost[c]	$135,434	Actual
O	Projected annual savings of early mobility program	$2,352,744	K – N

Note. All averages are means unless specified. ICU = intensive care unit; LOS = length of stay.

[a]*From "ICU Early Physical Rehabilitation Programs: Financial Modeling of Cost Savings," by R. Lord, C. Mayhew, R. Korupolu, E. Mantheiy, M. Freidman, J. Palmer, and D. Needham, 2013, Critical Care Medicine, 41(3), pp. 717–724. doi:10.1097/CCM.0b013e3182711de2. Copyright 2013 by the Society of Critical Care Medicine and Lippincott Williams & Wilkins. Adapted with permission.*

[b]*Number of trauma ICU admissions July 1, 2017, to June 31, 2018.*

[c]*Salary of 0.5 full-time physical therapist and rehabilitation technician, equipment costs.*

regardless of the severity of their injuries, received mobility-related interventions from nurses, physical therapists, and occupational therapists aimed at improving participation in out-of-bed activity and walking. Patients admitted to the trauma ICU, who met participation criteria, were eligible to begin early mobility on admission Day 1. However, most patients experienced a temporal progression toward higher mobility levels. The early mobility program proved to be safe and feasible within the institution as there were no mobility-related AEs. Activity intolerance resulting in regression or program discontinuation was rare. Overall, the early mobility program fostered better collaboration between nurses, surgeons, and therapists (respiratory, physical, and occupational). The multidisciplinary collaboration developed staff confidence and comfort levels. The culture of the unit changed, resulting in a proactive approach to early mobility of the critically injured trauma patient.

The program encountered challenges unique to early mobilization in the trauma ICU. Survivors of trauma often experience a greater incidence of musculoskeletal and neurological injuries (fracture, traumatic brain injury, spinal cord injury) than patients in prior early mobilization studies (Kamdar et al., 2016; Needham, 2008; Needham et al., 2012; Pohlman et al., 2010; Schweikert et al., 2009). The most common reason early mobilization was contraindicated was due to an unstable orthopedic condition, which delayed the initiation of the early mobility program. Many of the patients experienced musculoskeletal pain, which required frequent team collaboration to ensure pain did not prevent participation in the early mobility program. Likewise, the nature of the traumatic injuries required the skills of all members of the early mobility team, including the rehabilitation therapists, who have extensive experience mobilizing patients with orthopedic and neurological conditions. As a result, early mobilization was initiated by physical and occupational therapy earlier in the trauma ICU.

The cost of a hospitalization typically comprises fixed costs (salaries, physical maintenance, equipment, etc.) and direct variable costs (medications, consumables, diagnostic tests, etc.). Although fixed costs comprise the majority of hospitalization costs, direct variable costs remain the more appropriate measure of cost-effectiveness (Karabatsou, Tsironi, Boutzouka, Katsoulas, & Baltopoulos, 2016; Wilcox & Rubenfeld, 2015). The early mobility program reduced the average direct variable cost of the hospital admission by $8,239 per patient. Mechanical ventilation has been shown to significantly increase direct variable cost (Dasta, McLaughlin, Mody, & Piech, 2005), whereas posttraumatic ARDS can increase the cost of hospitalization fourfold (Robles et al., 2018). Although the LOS reduction may have indirectly affected direct variable cost, a large component of reported savings in the early mobility group results from a reduction in the duration of mechanical ventilation.

Although additional rehabilitation staff members were required for the success of the early mobility program, patients received the same frequency of physical and occupational therapy sessions in the ICU when compared with preimplementation. This is attributed to nursing's active role in early mobility-related interventions, especially interventions in Levels 1 and 2. Increasing nurse-driven, mobility-related interventions allowed physical and occupational therapists to spend more time performing the mobility-related interventions on patients in Levels 3 and 4, which focused on out-of-bed activity and walking. Concurrently, patient would demonstrate a higher degree of fitness and tolerance for Level 3 and 4 interventions due to the earlier focus on promoting tolerance to upright positioning in Levels 1 and 2 prior to the Level 3 and 4 interventions.

The results of the early mobility quality improvement project in the trauma ICU resulted in a ripple effect for the other specialty ICUs within the health system (medical, surgical, and neurological). The program success prompted them to improve their early mobility programs. Standardization of mobility levels, interventions, and goals ensured that all clinical and nonclinical ICU staff members used the same "early mobility" terminology. Participation criteria meet the unique clinical presentation of the patient population in each specialty ICU. Absolute and relative contraindications may differ slightly from the trauma ICU participation criteria.

The success of the early mobility initiative for the traumatically injured ICU population has led to a significant program expansion. Additional organizational financial support will provide the additional resources to initiate early mobilization in the remaining ICUs within the health system. The funding facilitates the purchase of overhead ceiling lifts and slide tubes to prevent staff injuries during patient mobilization. Concurrently, each ICU will also receive a MotoMed and Livengood platform system to assist with mobility goals.

LIMITATIONS

The quality improvement project utilized a pre- and postintervention study design. Randomization would have yielded results that are more generalizable, but it would have made the project more difficult to conduct in the same ICU. The quality improvement project took place at a single institution, which also limited the generalizability. Although there was a trend toward better outcomes, many results did not meet the threshold of statistical significance. The small sample size limited the statistical power, and a study with more subjects may have yielded evidence that is more empirical. In the future, data aggregation will include a larger group of trauma ICU patients.

CONCLUSION

The implementation of an early mobility program for patients recovering from traumatic injuries in the ICU was safe and reduced the cost of the hospitalization. Physical therapy and occupational therapy were initiated sooner, and although not statistically significant, patients in the early mobility program were discharged faster, spent less time on mechanical ventilation, and participated in functional activities sooner.

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KEY POINTS

- Development of an early mobility program for critically ill patients with traumatic injuries involves multidisciplinary collaboration with trauma surgery, nursing, respiratory therapy, physical therapy, occupational therapy, and pharmacy.
- Daily multidisciplinary rounds resolved early mobilization barriers to facilitate mobility goal achievement and maximize outcomes.
- The early mobility program for patients recovering from traumatic injuries in the ICU reduced the cost of the hospitalization and resulted in earlier initiation of physical and occupational therapy.

REFERENCES

Balas, M., Vasilevskis, E., Olsen, K., Schmid, K., Cohen, M., Shostrom, V., … Burke, W. (2014, May). Effectiveness and safety of the awakening and breathing coordination, delirium monitoring/management, and early exercise/mobility bundle. *Critical Care Medicine*, *42*(5), 1024–1036. doi:10.1097/CCM.0000000000000129

Booth, K., Rivet, J., Flici, R., Harvey, E., Hamill, M., Hundley, D., … Collier, B. (2016, September). Progressive mobility protocol reduces venous thromboembolism rate in trauma intensive care patients: A quality improvement project. *Journal of Trauma Nursing*, *23*(5), 284–289. doi:10.1097/JTN.0000000000000234

Calthorpe, S., Barber, E., Holland, A., Kimmel, L., Webb, M., Hodgeson, C., & Gruen, R. (2014, January). An intensive physiotherapy program improves mobility for trauma patients. *Journal of Trauma and Acute Care Surgery*, *76*(1), 101–106. doi:10.1097/TA.0b013e3182ab07c5

Clark, D., Lowman, J., Griffin, R., Matthews, H., & Reiff, D. (2013, February). Effectiveness of an early mobilization protocol in a trauma and burns intensive care unit: A retrospective cohort study. *Physical Therapy*, *93*(2), 186–196. doi:10.2522/ptj.20110417

Dasta, J., McLaughlin, T., Mody, S., & Piech, C. (2005, June). Daily cost of an intensive care unit day: The contributions of mechanical ventilation. *Critical Care Medicine*, *33*(6), 1266–1271. doi:10.1097/01.CCM.0000164543.14619.00

de Jongh, M., Bosma, E., Leenan, L., & Verhofstad, M. (2011, November). Increased consumption of hospital resources due to complications: An assessment of costs in a Level I trauma center. *The Journal of Trauma*, *71*(5), 102–109. doi:10.1097/TA.0b013e31820e351f

Devlin, J., Skrobik, Y., Gélinas, C., Needham, D., Slooter, A., Pandharipande, P., … Alhazzani, W. (2018, September). Clinical practice guidelines for the prevention and management of pain, agitation/sedation, delirium, immobility, and sleep disruption in adult patients in the ICU. *Critical Care Medicine*, *46*(9), e825–e873. doi:10.1097/CCM.0000000000003299

Engels, P., Beckett, A., Rubenfeld, G., Kreder, H., Finklestein, J., da Costa, L., … Tien, H. (2013, July). Physical rehabilitation of the critically ill trauma patient in the ICU. *Critical Care Medicine*, *41*(7), 1790–1801. doi:10.1097/CCM.0b013e31828a2abf

Hemmila, M., Jakubus, J., Maggio, P., Wahl, W., Dimick, J., Campbell, D., & Taheri, P. (2008, August). Real money: Complications and hospital costs in trauma patients. *Surgery*, *144*(2), 307–316. doi:10.1016/j.surg.2008.05.003

Hester, J., Guin, P., Danek, G., Thomas, J., Titsworth, W., Reed, R., … Fahy, B. (2017, June). The economic and clinical impact of sustained use of a progressive mobility program in a neuro-ICU. *Critical Care Medicine*, *45*(6), 1037–1044. doi:10.1097/CCM.0000000000002305

Kamdar, B., Combs, M., Colantuoni, E., King, L., Niessen, T., Neufeld, K., … Needham, D. (2016, August). The association of sleep quality, delirium and sedation status with daily participation in physical therapy in the ICU. *Critical Care*, *20*, 261. doi:10.1186/s13054-016-1433-z

Karabatsou, D., Tsironi, M., Boutzouka, E., Katsoulas, T., & Baltopoulos, G. (2016, August). Variable cost of ICU care, a micro-costing analysis. *Intensive and Critical Care Nursing*, *35*, 66–73. doi:10.1016/j.iccn.2016.01.001

Kaske, S., Lefering, R., Trentzsch, H., Dreissen, A., Bouillon, B., Maegele, M., & Probst, C. (2014, October). Quality of life two years after severe trauma: A single center evaluation. *Injury*, *45*(3), 100–105. doi:10.1016/j.injury.2014.08.028

Kho, M., Martin, R., Toonstra, A., Zanni, J., Mantheiy, E., Nelliot, A., & Needham, D. (2015, December). Feasibility and safety of in-bed cycling for physical rehabilitation in the intensive care unit. *Journal of Critical Care*, *30*(6), 1419.e1–1419.e5. doi:10.1016/j.jcrc.2015.07.025

Livingston, D., Tripp, T., Biggs, C., & Lavery, R. (2009, August). A fate worse than death? Long term outcome of trauma patients admitted to surgical intensive care unit. *The Journal of Trauma*, *67*(2), 341–348. doi:10.1097/TA.0b013e3181a5cc34

Lord, R., Mayhew, C., Korupolu, R., Mantheiy, E., Freidman, M., Palmer, J., & Needham, D. (2013, March). ICU early physical rehabilitation programs: Financial modeling of cost savings. *Critical Care Medicine*, *41*(3), 717–724. doi:10.1097/CCM.0b013e3182711de2

Moore, L., Lauzier, F., Stelfox, H., Le Sage, N., Bourgeois, J., Shemilt, M., & Turgeon, A. (2014, August). Complications to evaluate adult trauma care: An expert consensus study. *Journal of Trauma and Acute Care Surgery*, *77*(2), 322–330. doi:10.1097/TA.0000000000000366

Moore, L., Stelfox, H. T., & Turgeon, A. (2012, October). Complication rates as a trauma care performance indicator: A systematic review. *Critical Care*, *16*(5), R195. doi:10.1186/cc11680

Needham, D. (2008, October). Mobilizing patients in the intensive care unit: Improving neuromuscular weakness and physical function. *JAMA*, *300*(14), 1685–1690. doi:10.1001/jama.300.14.1685

Needham, D., Davidson, J., Cohen, H., Hopkins, R., Weinert, C., Wunsch, H., … Harvey, M. (2012, February). Improving long-term outcomes after discharge from intensive care unit: Report

from a stakeholders' conference. *Critical Care Medicine*, *40*(2), 502–509. doi:10.1097/CCM.0b013e318232da75

Pohlman, M., Schweickert, W., Pohlman, A., Nigos, C., Pawlick, A., Esbrook, C., … Kress, J. (2010, November). Feasibility of physical and occupational therapy beginning from initiation of mechanical ventilation. *Critical Care Medicine*, *38*(11), 2089–2094. doi:10.1097/CCM.0b013e3181f270c3

Pun, B., Balas, M., Barnes-Daly, M., Thompson, J., Aldrich, J., Barr, J., … Ely, E. (2018, January). Caring for critically ill patients with the ABCDEF bundle: Results of the ICU liberation collaborative in over 15,000 adults. *Critical Care Medicine*. Advance online publication. doi:10.1097/CCM.0000000000003482

Ranier, T., Yeung, J., Cheung, S., Yuen, Y., Poon, W., Ho, H., … Graham, C. (2014, May). Assessment of quality of life and functional outcome in patients sustaining moderate and major trauma: A multicentre, prospective cohort study. *Injury*, *45*(5), 902–909. doi:10.1016/j.injury.2013.11.006

Ringburg, A., Polinder, S., van Ierland, M. P., Steyerberg, E., van Lieshout, E. M., Patka, P., … Schipper, I. (2011, April). Prevalence and prognostic factors of disability after major trauma. *TheJournal of Trauma*, *70*(4), 916–922. doi:10.1097/TA.0b013e3181f6bce8

Robles, A., Kornblith, L., Hendrickson, C., Howard, B., Conroy, A., Moazed, F., … Callcut, R. (2018). Healthcare utilization and the cost of posttraumatic acute respiratory distress syndrome care. *Journal of Trauma Acute Care Surgery*, *85*(1), 148–154. doi:10.1097/TA.0000000000001926

Schweikert, W., Pohlman, M., Pohlman, A., Nigos, C., Pawlik, A., Esbrook, C., … Kress, J. (2009, May–June). Early physical and occupational therapy in mechanically ventilated, critically ill patients: A randomized controlled trial. *Lancet*, *373*(9678), 1874–1882. doi:10.1016/S0140-6736(09)60658-9

Shafi, S., Barnes, S., Nicewander, D., Ballard, D., Nathans, A., Ingraham, A., … Gentilello, L. (2010). Health care reform at trauma centers—Mortality, complications and length of stay. *The Journal of Trauma*, *69*(6), 1367–1371. doi:10.1097/TA.0b013e3181fb785d

Wilcox, M., & Rubenfeld, G. (2015, June). Is critical care ready for an economic surrogate endpoint? *Critical Care*, *19*(1), 248. doi:10.1186/s13054-015-0947-0

Zomorodi, M., Topley, D., & McAnaw, M. (2012, July). Developing a mobility protocol for early mobilization of patients in a surgical and trauma ICU. *Critical Care Research and Practice*, *2012*, 964547. doi:10.1155/2012/964547

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