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RESEARCH ARTICLE

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A novel early mobility bundle improves length of stay and rates of readmission among hospitalized general medicine patients

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ABSTRACT

Inpatient early mobility initiatives are effective therapeutic interventions for improving patient outcomes and decreasing use of hospital resources among adult ICU and general medicine patients. To establish and demonstrate guidelines for early patient ambulation, we developed and implemented a novel multidisciplinary mobility bundle utilizing the JH-HLM (Johns Hopkins Highest Level of Mobility) scale for mobility classification, on a single adult general medicine unit of a community hospital. Our results show that patients admitted to the unit after implementation of the mobility bundle had improved mobility scores, reduced rates of 30-day hospital readmission, and a shortened length of hospital stay. This study emphasizes the importance of measuring mobility using a systematic method, easing workflow among unit practitioners, and allowing mobility initiatives to be jointly driven by nursing, physical therapy, and physicians.

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Mobility; rehabilitation; general medicine; length of hospital stay; readmission

1. Introduction

Hospitalization for acute illness is associated with a decline in functional status, even when patients fully recover [1–4]. This decline in functional status is multifactorial in origin and has been attributed to poor pain management, improper nutrition, sleep disturbances, and as an effect of the illness which precipitated the admission [2,4–8]. In particular, prolonged immobilization and subsequent deconditioning is a very common cause of functional decline during hospitalization and many studies have demonstrated that hospitalized patients are mobilized infrequently and spend most of their time in bed [9–13]. As such, these patients are vulnerable to a host of hospitalization-related complications including the inability to preform activities of daily living, increased length of stay (LOS), frequent readmissions, and the need for discharge to rehabilitation facilities [2,14–18]. There are medical consequences as well, which include, but are not limited to, thromboembolism, muscle weakness, joint contractures, urinary incontinence, and skin breakdown [19,20].

Early mobilization has been demonstrated to be an effective therapeutic intervention for improving outcomes among both ICU and general medicine adult patients [21–31]. Prior studies consistently demonstrate decreased use of hospital resources as well as improvement in length of hospital stay, especially among patients with myocardial infarctions, total knee replacements, hip fractures, and community acquired pneumonia [24,32–39]. In 2013, *Engel et al.* demonstrated significant improvements in both physical and neurocognitive outcomes among ICU survivors who were subjected to early mobility and rehabilitation[40]. Furthermore, early mobility programs may even reduce the incidence of hospital acquired pneumonia in patients with hip fractures[41]. However, despite this data, there are currently no established consensus for guidelines or therapeutic protocols regarding early mobilization during hospitalization for adult patients in the ICU or on general medicine units.

Here, in an effort to establish and demonstrate guidelines at our institution for early patient ambulation, we developed a novel mobility bundle and investigated its effects on patient length of stay, 30-day readmissions, and discharge destination. The purpose of this study was not only to improve patient outcomes and reduce hospital resources, but also to evaluate the feasibility of implementing a unit wide mobility protocol as well as its effects on the ease of workflow among various groups of unit practitioners. Here, we present one of the first comparative analyses of patient populations before and after implementation of an early mobility protocol that is jointly driven by nursing, physical therapy, and physicians.

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2. Methods

The QI project setting was a single 26 bed general medicine unit at the Greater Baltimore Medical Center (GBMC), a community hospital in Towson, Maryland. We used the established JH-HLM (the Johns Hopkins Highest Level of Mobility) scale to document patient mobility milestones[37]. The six point mobility bundle included door signs for each room listing the JH-HLM chart and goals, and required JH-HLM documentation by nursing at admission and discharge with discussion of the assigned JH-HLM score at the daily multidisciplinary huddle. Each day, set up of the reclining chairs in every patient room was required prior to the morning change of shift. We established a daily unit metric for tracking chair set up with a goal of at least 80%. Additionally, we implemented a unit rule to have all patients out of bed by 2:00 PM each day with tracking. Finally, physician and nursing staff education regarding early mobility and the JH-HLM scale was conducted.

The planning phase of the QI project occurred in the early winter of 2019. This project was reported to the institutional review board (IRB) committee at GBMC for approval. It was deemed to meet the requirements of a QI research project, for which IRB oversight is not necessary. A pre-mobility bundle implementation phase of data collection to assess the unit's baseline occurred throughout the month of January 2020. This was followed by an education phase from 1 February 2020 to 15 March 2020. During the education phase, we involved key stakeholders (nurses, certified nursing assistants, physical therapists, administrators, and physicians) in the QI project team and worked to streamline implementation of the mobility bundle and identify barriers to improvement. A second phase of data collection occurred after the education phase from 16 March 2020 to 15 April 2020. Patient cases were excluded from assessment of daily mobility if they were noted to be hemodynamically unstable (HR >110 with BP <90/50), off the unit for surgery or extended testing for more than 4 h, or severely agitated requiring administration of restraints and/or antipsychotic medications. Exclusion on a - particular day did not prevent the patient from being assessed on the other days of their admission, particularly those patients that were excluded on a - specific day for surgery or extended testing.

Information extracted from patient charts includes patient demographics (age, weight, gender), documented JH-HLM scores, hospital length of stay (LOS), the occurrence of a readmission within 30 days of a patient's discharge date, falls, and inpatient physical therapy (PT) recommendations. The primary outcome was the occurrence of the mobility bundle as an intervention, allowing us to compare data from the pre-bundle implementation phase to the post-bundle implementation phase. Secondary outcomes include JH-HLM score improvement and hospital LOS.

In the bivariate analysis, categorical data were compared using the Fisher's exact test and Pearson's Chi-squared test. Non-categorical data were compared using the Mann–Whitney U test. Linear and logistic regression were used to examine the association of outcomes with patient, clinical, and mobility characteristics. P-values <0.05 were considered statistically significant. All tests were two sided. Statistical analyses were performed with GraphPad Prism 8.

3. Results

During the QI project period, a total of 340 patients were admitted and subsequently included in the analysis. One hundred and seventy-seven patients were admitted in the pre-bundle phase, and 163 in the post-bundle implementation phase. Overall, the mean daily percent of patients out of bed increased from 64.9% to 78.6% when comparing the pre and post phases. Baseline patient characteristics are summarized in Table 1.

3.1. The mobility bundle

After a 1-month period of observation to assess the unit's mobility baseline, a 6-week education phase occurred to allow for thorough and effective implementation of our novel mobility bundle. The six point bundle focuses on changing the behaviors of key unit stakeholders to improve daily patient mobility. This includes required JH-HLM documentation by nursing, door signs on every patient room listing the JH-HLM chart, daily chair set up prior to the morning change of shift, a daily unit LDM metric requiring chair set up of at least 80%, a unit rule to have all patients out of bed by 2:00PM each day, and physician/nursing education regarding early mobility and the JH-HLM scale.

Bivariate analysis (Table 2) showed that the mobility bundle was associated with increased odds of JH-HLM score improvement, which occurred in 31.3% of patients assessed after bundle implementation compared with 21.5% of those assessed prior (OR 1.67; 95% CI 1.02–2.69; P = 0.048). Additionally, the mobility bundle was associated with a decreased risk of hospital readmission within 30 days of discharge, dropping from 22% to 10.4% after mobility bundle implementation (OR 0.41; 95% CI 0.23–0.75; P = 0.005). Among noncategorical variables, a shortened length of hospital stay (mean time 5.8 days vs. 4.8 days; P = 0.013) was associated with implementation of the mobility bundle (Table 3). Our noted improvements in mobility were not associated with a statistically significant increased rate of injurious

Table 1. Patient demographics, clinical characteristics pre-bundle.

Variable	Value
Total Number of Patients	177
% Out of Bed, Daily	
Mean±SD	64.9 ± 10.4
Median	65.4
Age, years	
Mean±SD	66.9 ± 16.8
Median	70
>65	111 (62.7%)
Male	76 (42.9%)
Female	101 (57.1%)
Weight, lbs	
Mean±SD	180.4 ± 61.4
Median	168
JH-HLM Score at Admission	
Mean±SD	6.2 ± 2.3
Median	7
JH-HLM Score at Discharge	
Mean±SD	6.2 ± 2
Median	7
JH-HLM Score Improvement	38 (21.5%)
Length of Hospital Stay (days)	
Mean±SD	5.8 ± 5.8
Median	4
30 Day Readmission	39 (22%)
Discharge Destination	
Home	102 (57.6%)
Home with Therapy	33 (18.6%)
Rehabilitation Facility	42 (23.8%)
Inpatient PT/OT Assessment	84 (47.5%)
Falls	2 (1.1%)

Data are presented as Total Number of Patients (%) unless otherwise indicated.

Table 1B. Patient demographics, clinical characteristics post-bundle.

Variable	Value
Total Number of Patients	163
% Out of Bed, Daily	
Mean±SD	78.6 ± 6.9
Median	78.9
Age, years	
Mean±SD	67.4 ± 17
Median	69
>65	102 (62.6%)
Male	70 (42.9%)
Female	93 (57.1%)
Weight, lbs	
Mean±SD	186.5 ± 58.4
Median	179
JH-HLM Score at Admission	
Mean±SD	6 ± 2.4
Median	7
JH-HLM Score at Discharge	
Mean±SD	6.6 ± 1.6
Median	7
JH-HLM Score Improvement	51 (31.3%)
Length of Hospital Stay (days)	
Mean±SD	4.8 ± 4.5
Median	3
30 Day Readmission	17 (10.4%)
Discharge Destination	
Home	98 (60.1%)
Home with Therapy	18 (11%)
Rehabilitation Facility	47 (28.9%)
Inpatient PT/OT Assessment	82 (50.3%)
Falls	5 (3.1%)

Data are presented as Total Number of Patients (%) unless otherwise indicated.

falls. Our patient populations pre and post intervention were matched in age, weight, and gender. Additionally, the number of PT/OT inpatient assessments were equivalent between the two groups (47.5% vs. 50.3%).

Table 4 presents the independent variables that are predictive of the mobility bundle when evaluated by multivariable logistic regression analysis. Similar to the bivariate analysis, JH-HLM score improvement (OR 1.19; 95% CI 1.11–3.30; P = 0.021) was independently associated with implementation of the mobility bundle. Length of hospital stay (OR 0.94; 95% CI 0.89–0.99; P = 0.028), 30-day readmission (OR 0.39; 95% CI 0.20–0.73; P = 0.0042), and the need for home physical therapy at discharge (OR 0.28; 95% CI 0.09–0.78; P = 0.017) were inversely associated with implementation of the mobility bundle.

3.2. JH-HLM score improvement

Table 4 also presents the independent variables that are predictive of JH-HLM score improvement as a secondary outcome. Both mobility bundle implementation (OR 1.94; 95% CI 1.12–3.39; P = 0.019) and inpatient PT/OT (OR 2.75; 95% CI 0.98–7.32; P = 0.046) were independently associated with JH-HLM score improvement. Age, gender, weight, discharge to a rehabilitation facility, 30-day readmission, and the need for outpatient PT/OT were not statistically significant predictors.

3.3. Length of hospital stay

Table 5 presents the independent variables that are predictive of length of hospital stay (days) as a secondary outcome. In a multivariable linear regression analysis, mobility bundle implementation (Estimate −1.22; P = 0.022) was inversely associated with length of hospital stay, and discharge to a rehabilitation facility (estimate 3.56; P = 0.0014) was positively associated with length of hospital stay. Age, weight, gender, JH-HLM score improvement, 30-day readmission, and the need for outpatient PT/OT were not statistically significant predictors.

4. Discussion

Inpatient mobility initiatives in their various forms are effective interventions for decreasing length of hospital stay, lessening morbidity, and improving both strength and physical function [21–31]. However, many of these initiatives are limited in scope or address the actions of only one specific group of unit practitioners. Here, in an effort to improve patient outcomes, we conducted a QI project on one general medicine unit at a community hospital, and implemented a novel mobility bundle which

Table 2. Categorical patient and mobility characteristics by occurrence of the mobility bundle.

Variable	No (Pre-Bundle)	Yes (Post-Bundle)	P-value*	OR (95% CI)**
Age			1.0	0.99 (0.65–1.53)
<65	66 (37.3%)	61 (37.4%)		
>65	111 (62.7%)	102 (62.6%)		
Sex			1.0	1.00 (0.65–1.54)
Female	101 (57.1%)	93 (57.1%)		
Male	76 (42.9%	70 (42.9%)		
Discharge Destination			0.122	–**
Home	102 (57.6%)	98 (60.1%)		
Home with Therapy	33 (18.6%)	18 (11%)		
Rehabilitation Facility	42 (23.8%)	47 (28.9%)		
JH-HLM Score Improvement			***0.048***	***1.67 (1.02–2.69)***
No	139 (78.5%)	112 (68.7%)		
Yes	38 (21.5%)	51 (31.3%)		
30 Day Readmission			***0.005***	***0.41 (0.23–0.75)***
No	138 (78%)	146 (89.6%)		
Yes	39 (22%)	17 (10.4%)		
Inpatient PT/OT Assessment			0.66	1.12 (0.73–1.72)
No	93 (52.5%)	81 (49.7%)		
Yes	84 (47.5%)	82 (50.3%)		
Falls			0.27	2.77 (0.58–14.04)
No	175 (98.9%)	158 (96.9%)		
Yes	2 (1.1%)	5 (3.1%)		

Categorical data are presented as Total Number of Patients (%) unless otherwise indicated. *Fisher exact test was used to calculate p-values unless the contingency table >2x2, then a Chi-squared test was used to compute p-value. **Odds ratio cannot be calculated off of a 3 × 2 table.

engages several groups of key unit stakeholders. We then compared clinical and mobility related characteristics between patients admitted during the pre and post intervention periods to assess for factors associated with implementation of the bundle and improvements in mobility overall.

Our findings indicate that early mobilization through a standardized protocol has a significant impact on patient outcomes, especially length of stay, individual patient mobility, and 30-day readmissions, as well as the use of hospital resources. This is in keeping with the findings of *Pashikanti et al.* (2012) who conclude that well defined early mobility protocols provide the greatest impact[22]. However, patient benefits have been noted from very different types of mobility initiatives. Some beneficial interventions have focused on electronic health record tools, carefully assessing clinical issues precluding mobility, the availability of equipment, step tracking, and the designation of mobility representatives [24,26,41–43]. While many variations of early mobility initiatives have been successful in the short term, we posit that our modifications and novel bundle could be more successful long term due to its multidisciplinary approach.

One of the major barriers discussed in the planning phase of this project was the additional burden of work that mobility initiatives often place solely on nursing. This has been acknowledged in prior studies as an existing barrier that is often a concern for multiple groups of unit stakeholders, including physical therapy [44,45]. However, many existent studies are still solely nursing driven [21,37,46–48]. Our intervention established a multidisciplinary focus of incorporating nurses, certified nursing assistants (CNAs), physicians, and physical therapists to ease workflow and relieve this burden. First, we mobilized certified nursing assistants and resident physicians to assist with encouraging or physically maneuvering patients to get out of bed by 2PM each day, in addition to the daily efforts of physical therapy. Second, it was noted in the planning phase of this project that chair set up was left entirely to nursing and often couldn't be accomplished until late afternoon, if at all, due to the volume of tasks and meetings set in the first six to eight hours of the scheduled shift. We re-

Table 3. Non-categorical patient and mobility characteristics by occurrence of the mobility bundle.

Variable	Min.	1st Qu.	Median	Mean	3rd Qu.	Max	P-value*
Age (years)							0.78
No (Pre-Bundle)	21	57	70	66.9	79	95	
Post-Bundle Implementation	21	57	69	67.4	81	95	
Weight (kg)							0.19
No (Pre-Bundle)	88	137	168	180.4	208.5	469	
Post-Bundle Implementation	71.3	145	179	186.5	213	417	
Length of Hospital Stay (days)							***0.013***
No (Pre-Bundle)	1	3	4	5.8	7	40	
Post-Bundle Implementation	1	2	3	4.8	7	30	
JH-HLM Score (1–8) at Discharge							0.26
No (Pre-Bundle)	1	5.5	7	6.2	8	8	
Post-Bundle Implementation	1	6	7	6.6	8	8	

Non-Categorical data are presented with Minimum (Min.), 1st Quartile (Qu.), Median, Mean, 3rd Quartile (Qu.), and Maximum (Max). Units are indicated where appropriate. *Mann-Whitney U Test (Wilcoxon Rank Sum Test with continuity correction) was used to calculate p-values.

Table 4. Multivariable logistic regression model.

Outcomes and Covariates	OR	CI (95%)	p-value
Mobility Bundle Implementation			
Length of Hospital Stay	0.94	0.89–0.99	0.028
JH-HLM Score Improvement	1.19	1.11–3.30	0.021
30 Day Readmission	0.39	0.20–0.73	0.0042
Home Therapy (PT/OT)	0.28	0.09–0.78	0.017
JH-HLM Score Improvement			
Mobility Bundle Implementation	1.94	1.12–3.39	0.019
Inpatient PT/OT	2.75	0.98–7.32	0.046

Table 5. Multivariable linear regression model.

Outcomes and Covariates	p-value	Estimate
Longer Hospital Stay		
Mobility Bundle Implementation	0.022	−1.22
Discharge to Rehabilitation Facility	0.0014	3.56

delegated the task of chair set up to CNAs assigned to the night shift, and required at least 80% of chairs to be set up for patient use by the 7AM change of shift. A unit LDM metric was established to record chair set up and it was presented daily to executive management as part of the LDM curricula for the hospital. As such, we were not only able to effectively implement required chair set up, but we also made the process of getting patients into the chair less cumbersome for the day shift nurses during their medication rounds.

Of additional note is the issue of standardized quantification of mobility. A systematic method for assessing a patient's functional status can provide key data on tailoring mobility goals for an individual patient and identifying who is appropriate for mobilization. It also provides a mechanism for all groups of unit stakeholders to consider mobility in the same language and predict outcomes with regards to discharge disposition [49,50]. There are multiple systematic methods for assessing functional status, including the Activity Measure for Post-Acute Care (AM-PAC) Inpatient Mobility Short Form (IMSF), the JH-HLM Scale, and the de Morton Mobility Index (DEMMI), among others. Each has been demonstrated as a useful and predictive measurement of mobility [37,50–55]. However, the vast majority of the inpatient early mobility initiatives cited in this paper do not incorporate any systematic quantification method. While we relied on the JH-HLM scale, which we found easy to use and to incorporate into our practice, we posit that some form of systematic method can and should be utilized in all early mobility initiatives to provide not only a common platform of language between various groups of hospital practitioners but also to accurately track individual patient mobility improvements or declines.

This study is limited in several regards. First, this is a single site study focused on a single medical/surgical unit with a small sample size. Further research is needed to establish if this mobility bundle can be implemented successfully on a larger scale across multiple units. Second, this study occurs over a very limited frame. Future studies should focus on a longer course of assessment and data collection to determine if these improvements are reproducible over an extended period of time. Third, although patient characteristics are very similar between the two periods, we cannot rule out the possibility that various established LDM metrics as well as broader QI efforts at our institution contributed to this reduction in length of stay and 30-day readmissions. Fourth, this study occurred during the beginning of a national outbreak of COVID-19. While our general medicine unit was not a designated COVID-19 unit, it is unclear if the hospitalized patient population was affected by the pandemic. Lastly, while nursing and physical therapy consistently documented JH-HLM scores throughout the admission, this method of scoring mobility does not effectively address other critical factors such as the frequency with which patients were mobilized or the length of time patients engaged in a specific activity. Thus, while the JH-HLM score is a straightforward way to measure mobility, it cannot fully represent the activity of our patients *in totem*.

In conclusion, we developed and implemented a novel early mobility bundle with a distinct multidisciplinary approach that established and demonstrated guidelines for early patient ambulation in our hospital. Our results show that we improved patient outcomes regarding mobility, length of hospital stay, and 30-day readmissions while subsequently reducing hospital resources. Additionally, creating a mobility protocol jointly driven by nursing, physical therapy, and physicians eased workflow among the staff, made implementation of the protocol feasible, and actively addressed barriers to mobility that could have prevented a productive inpatient initiative.

Author contributions

E.A.S. Bergbower, J. Fuscaldo, and S. Benko designed the novel mobility bundle. Additionally, E.A.S. Bergbower collected data, designed the statistical analysis, interpreted data, and wrote the manuscript. C. Herbst was instrumental in data retrieval and analysis. A. Aversano and N. Cheng preformed physician and nursing education initiatives. K. Pasqualini, C. Hartline, C. Brewer, and D. Hamby enforced implementation of the mobility bundle and assisted with data collection.

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