Clinical Outcomes of Patient Mobility in a Neuroscience Intensive Care Unit

CE 2.5 ANCC Contact Hours

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ABSTRACT

Background: Patients treated in a neuroscience intensive care unit (NICU) are often viewed as too sick to tolerate physical activity. In this study, mobility status in NICU was assessed, and factors and outcomes associated with mobility were examined. **Methods:** Using a prospective design, daily mobility status, medical history, demographics, Acute Physiology and Chronic Health Evaluation (APACHE) III score, and clinical outcomes were collected by medical records and database review. Depression, anxiety, and hostility were assessed before NICU discharge. Analyses included comparative statistics and multivariable modeling. **Results:** In 228 unique patients, median (minimum, maximum) age was 64.0 (20, 95) years, 66.4% were Caucasian, and 53.6% were men. Of 246 admissions, median NICU stay was 4 (1, 61) days; APACHE III score was 56 (16, 145). Turning, range of motion, and head of bed of >30° were uniformly applied (n = 241), but 94 patients (39%) never progressed; 94 (39%) progressed to head of bed of >45° or dangling legs, 29 (12%) progressed to standing or pivoting to chair, and 24 (10%) progressed to walking. Female gender ($p = .019$), mechanical ventilation ($p < .001$), higher APACHE score ($p = .004$), and 30-day mortality ($p = .001$) were associated with less mobility. In multivariable modeling, greater mobility was associated with longer unit stay ($p < .001$) and discharge to home ($p < .001$). Psychological profile characteristics were not associated with mobility level. **Conclusion:** Nearly 40% of patients never progressed beyond bed movement, and only 10% walked. Although limited mobility progression was not associated with many patient factors, it was associated with poorer clinical outcomes. Implementation and evaluation of a progressive mobility protocol are needed in NICU patients. Video Abstract: For more insights from the authors, see Supplemental Digital Content 1, at http://links.lww.com/JNN/A10.

Keywords: APACHE III score, early mobility, neurological intensive care, primary neurological injury, ventilator

In intensely ill adults, advances in medical technologies promote improved outcomes but, sometimes, at the cost of functional decline. In multiple reports of patients cared for in intensive care units (ICUs), researchers reported improved long-term survival and decreased hospital-acquired conditions such as ventilator-associated pneumonia and pressure ulcers (Bailey et al., 2007; Perme & Chandrashekar, 2009). In addition, intensively ill adults were prone to functional decline, which was in turn associated with prolonged immobilization while in an ICU environment (Perme & Chandrashekar, 2009). Patients treated in an ICU rarely received rehabilitation therapy because they were viewed as too sick or too heavily sedated to tolerate physical activity (Korupolu, Gifford, & Needham, 2009; Needham, 2008).

Prolonged immobilization is often a complication of an ICU environment. Prolonged immobilization led to disuse atrophy of muscles and other physiological changes that decreased patients' ability to tolerate physical activity (Korupolu et al., 2009; Morris & Herridge, 2007). Muscle atrophy begins within hours of immobilization, leading to a 4%–5% loss of muscle strength for each week of bed rest (Korupolu et al., 2009; Morris & Herridge, 2007). Neuromuscular complications in the neurological ICU (NICU) may be associated with the area of injury or surgical site or complications of bed rest. Furthermore, functional decline was often associated with neuromuscular complications that were sometimes severe and long lasting (Korupolu et al., 2009; Morris & Herridge, 2007).

Mobility

Since the 1940s, healthcare providers recognized the harmful effects of bed rest and the beneficial effects of early mobilization (Korupolu et al., 2009). In many

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ICUs, researchers learned that early mobility was safe and feasible, even if receiving mechanical ventilation (Bailey et al., 2007; Burtin et al., 2009; Morris et al., 2008, 2011; Stiller, 2007). Early mobility was associated with short-term benefits, such as more ventilator-free days, shorter duration of delirium, lower mean daily sedative doses (Banerjee, Girard, & Pandharipande, 2011; Needham et al., 2010; Schweickert et al., 2009), reduced length of critical care and hospital stay (Morris et al., 2008), less ventilator-associated pneumonia (Caravello, Nemeth, & Dumas, 2010), improved functional outcomes (Burtin et al., 2009; Schweickert et al., 2009), improved quality of life, reduced overall hospital costs (Perme & Chandrashekar, 2009), survival (Morris et al., 2011), and less physical disability (Bailey et al., 2007) in the first year after hospital discharge.

In an NICU, the frequency that patients get out of bed, weight bear, and walk is unknown. Physical therapy personnel may not routinely evaluate patients' functional status because of physical limitations related to neurological injuries. Often, multidisciplinary team members discuss physical therapy and mobility once patients are transferred to an intermediate care unit or a neurology floor. To date, mobility status in adult patients with primary neurological injuries in an NICU setting is not well described. It is unknown if patient characteristics and clinical outcomes are associated with mobilization of patients treated in NICU. Furthermore, no literature was available about the psychological profiles of patients treated in an ICU related to mobility status. The purpose of this study was to assess patient characteristics and clinical outcomes of patients treated in an NICU based on level of highest mobility achieved. The following research questions were studied: (1) Were patient characteristics (including comorbidity level) associated with progression in mobility during the NICU stay? (2) Did clinical outcomes vary by highest mobility achieved during the NICU stay, specifically length of hospital stay, discharge disposition to home, and 30-day mortality? (3) Before NICU discharge, did differences exist in psychological profiles (depression, anxiety, and hostility) of patients based on highest mobility level? (4) Compared with patients who had only one NICU stay during a hospitalization event, were there differences in highest mobility achieved in patients who returned to the NICU environment for multiple stays during a hospitalization event?

Methods

We conducted a pre–post quasiexperimental study. The research questions answered in this report were part of the preintervention phase of the study. This preintervention study used descriptive, correlational methods to answer research questions. The institutional review board approved the study before initiation; all patients who completed surveys gave verbal informed consent and received a research information sheet. Patient data collected on patient mobilization, characteristics, medical history from administrative databases, and the medical record were approved by the institutional review board with a waiver of consent.

In this quasi-experimental study, the researchers examine both patient characteristics and clinical outcomes related to mobility in the NICU.

Setting and Sample

This study was conducted in an urban quaternary-care academic hospital with 1,200+ beds in Northeast Ohio. The hospital is certified as a stroke center by the American Heart Association. The NICU has 22 beds that are managed by one unified medical team; one nurse leadership team composed of a nurse manager, assistant nurse managers, a clinical nurse specialist, and a clinical instructor; and ICU trained nursing staff. The unit census is generally high; rarely does the NICU receive off-service patients. Before study initiation in 2009, mean (standard deviation) NICU length of stay was 5.28 (6.69) days.

Over a 4-month period, all adults aged 18 years and older being treated for a primary neurological injury were enrolled in the study. Sample size was calculated for the prestudy–poststudy design. Ignoring possible loss-to-follow-up or dropout, with 150 total patients in each cohort, there would be 80% power to detect decreases in mean length of stay of at least 30%. The calculation assumed that length of stay would be distributed log-normally with a coefficient of variation of 1.25, that a two-sided t test would be used, and that the significance level of .05 would be used for the comparison.

There were no enrollment exclusion criteria specific to research questions on mobility. For the psychological profile assessment, exclusions included non-English-speaking patients, confusion, perceived delirium, combativeness, comatose at or near the time of NICU discharge, NICU death, or patient refusal. Furthermore, some patients were excluded because NICU discharge was unexpected or on a weekend and the primary data collector was unavailable. Because the rate of collection of psychological profile data was below the anticipated level of 40% of the initial sample; data collection continued until we had a minimum of 60 psychological profile surveys completed. A sample size of 60 respondents was sufficient to have variability in responses. In total, 228 patients with 246 NICU admissions were included; of which, 64 completed psychological profile data.

Outcomes and Measures

Highest mobility level was assessed using an investigator-developed mobility assessment tool. Mobility was categorized into 16 levels, ranging from level 1, "bed rest without passive range of motion," to level 16, "walk independently." Mobility levels (Table 1) were based on natural progression of mobility of patients in an ICU environment and standard care procedures of nurses when mobilizing patients. The tool contained space to document the highest level of mobility each day for a 12-day period. A 12-day limit was selected because the upper limit of the 95% confidence interval for the mean length of NICU stay in 2009 was 12 days.

Data about patients' prehospitalization gait and barriers to mobility (wheelchair; walker; oxygen use; ventilator; poor eyesight; and conditions that affect mobility such as foot drop, extremity wounds, torn ligaments, or broken bones) were collected using an investigator-developed case report form. Variables were selected that were meaningful to this study and could be retrieved from the patient's medical record.

TABLE 1. Mobility Levels

1. Bed rest without passive range of motion
2. Bed rest with passive range of motion
3. Bed rest with active range of motion
4. Turn and position every 2 hours
5. Head of bed routinely for <30°
6. Head of bed elevated to ≥30°
7. Continuous lateral rotation
8. Head of bed elevated to ≥45°−<65° × 60 minutes
9. Head of bed elevated to ≥45° + legs in a dependent position × 60 minutes
10. Head of bed elevated to ≥65° and legs in dependent position × 60 minutes (beach chair)
11. Meets no. 8, 9, or 10 but for <60 minutes
12. Dangle with assistance
13. Stand at side of bed
14. Stand and pivot to chair
15. Walk with assistance
16. Walk independently

The Charlson Comorbidity Index was used to assess patients' level of comorbidity. The questionnaire was developed to classify comorbid conditions that might change the risk of mortality. It was found to be reproducible and valid (Charlson, Pompei, Ales, & MacKenzie, 1987), and the index score predicted in-hospital mortality (Sundararajan et al., 2004). After calculating a total score based on 19 chronic medical conditions, scores were categorized into three groups (scores of 1–2 = 1, 3–4 = 3, and 5 or more = 5) with a higher group score reflecting higher comorbidity level.

Demographic characteristics, acuity level on admission, and clinical outcome data were retrieved from multiple administrative databases used for billing and acuity assessment. Data included age, gender, race, primary neurological diagnosis, NICU length of stay, hospital discharge date, discharge disposition, payor type, 30-day mortality, and Acute Physiology and Chronic Health Evaluation (APACHE) III score. The APACHE III score provided initial risk stratification of critically ill patients. Score range is 0–299, with higher scores reflecting higher acuity (Knaus et al., 1991). In addition, the following data were retrieved from the patient's electronic medical record: history of walking barriers (weak or impaired gait) and use of walking aids and oxygen.

Psychological profiles for depression, anxiety, and hostility were assessed using three dimensions (subscales) of the Brief Symptom Inventory (BSI-DAH; Derogatis, 1993). The BSI-DAH survey used 17 simple statements and a 5-point Likert-type response set ranging from 0 = *not at all* to 4 = *extremely*. Each BSI dimension had convergent and discriminant validity, construct validity, and predictive validity in nonpatient adults and multiple patient populations (Derogatis, 1993; Perpina-Galvan & Richart-Martinez, 2009). The anxiety and depression dimensions were assessed in patients with traumatic brain injury and found to have incremental validity in predicting concurrent functional, psychosocial, and psychological status and be moderately reliable on test–retest assessment (Meachen, Hanks, Millis, & Rapport, 2008). In this preintervention analysis, patient responses were assessed by highest mobility achieved and also to normative means for nonhospitalized adults, as described in the literature (Derogatis, 1993).

Data Collection

The case report form that included prehospital gait, barriers to mobility, 12-day mobility level, and Charlson Comorbidity Index was placed at the patient's bedside. Study investigators collected data that were available in the electronic medical record (e.g., comorbidity data, barriers to mobility, and conditions that affected mobility), and patient caregivers documented daily mobility status. Patients were approached on the day of NICU discharge to complete the psychological profile survey. The survey was investigator administered. For patients who had a depression or anxiety score reflecting moderate-to-severe symptoms, patients' physicians were notified to allow for medical treatment, as desired. Data were retrieved from administrative databases by finance and operations personnel and received in Excel files. Data collected at the bedside were placed in an SPSS (IBM v19, Chicago, IL) database.

Statistical Analysis

Patient characteristics and outcomes were summarized using frequencies and percentages for categorical measures and rates for events that recurred throughout the NICU stay, and mean, standard deviation, and percentiles were calculated for continuous measures. Characteristics of patients at admission to the NICU were compared using Pearson chi-square tests and two-sample *t* tests. The 16 levels of mobility were combined into four groups to assess highest NICU mobility level. Group 1 included mobility levels 1–7 and represented turning every 2 hours, receiving range-of-motion (ROM) exercises and elevating the head of bed (HOB) to less than 45°. Group 2 included mobility levels 8–12 and represented elevating the HOB to 45° or higher and dangling legs at the bedside with assistance. Group 3 included mobility levels 13–14 and represented bearing weight and pivoting to a chair. Group 4 included mobility levels 15–16 and represented walking with or without assistance.

Associations with highest mobility level were assessed using logistic regression models with generalized estimating equations to account for the association between repeat admissions in the same patient. Similar methods were used for ordered variables, except that cumulative logit models were used. In these models, the odds of a higher response are compared between groups. For continuous measures, repeated-measure analysis of variance models were used. In all cases, except the cumulative logit models, a compound symmetry correlation structure was assumed, meaning that responses from the same patient were equally correlated. If models did not converge and in cumulative logit models, independent correlation structures, which adjusted the standard error measures only, were used instead. Data management and all statistical analyses were performed using SAS software (SAS Institute, Inc., version 9.2; Cary, NC). A $p < .05$ was considered statistically significant.

Results

Overall, 246 admissions to the NICU in 228 unique patients occurred over the 4-month study period, from late July to early November 2011. In five admissions, patients were unable to be evaluated for mobility status because of a critical status culminating in death. These patients were excluded from comparative analyses involving mobility status but were included in patient characteristics. Thus, of 246 admissions to the NICU in 228 patients, the median (minimum, maximum) patient age was 65.0 (20.0, 95.0) years, and the mean (*SD*) was 63.1 (16.4) years; 65% were Caucasian, and 52% were men. The mean APACHE III score was 59.3 ± 24, reflecting an average medical/surgical ICU acuity but considered high acuity for a neurological ICU. Other characteristics are in Table 2.

Almost all patients were routinely turned in bed, had ROM exercises, and had the HOB elevated to >30°. Nearly 80% of patients never progressed beyond level II group, HOB > 45°, or dangling legs; and only 10% progressed to the highest mobility level (see Table 3). Most patient characteristics were not associated with highest mobility level, except that mobility was lower in women ($p = .019$), patients receiving mechanical ventilation ($p < .001$), and those with a higher APACHE III score ($p = .001$). Younger patients ($p = .067$) and those with less comorbidity ($p = .064$) trended toward higher mobility while in the NICU. Mean depression and anxiety levels were higher than that of adult nonhospitalized subjects, and mean hostility level was lower than levels experienced by adult nonhospitalized subjects from the literature.

Psychological Profile and Clinical Outcomes by Mobility Level

The median (minimum, maximum) NICU length of stay was 4 (1, 61) days; and the mean NICU length of stay was 7.3 ± 8.2 days. Higher mobility group status was associated with shorter lengths of stay ($p < .001$), discharge to home (rather than transfer to a skilled nursing facility/hospice or acute rehabilitation, $p < .001$), and less 30-day mortality ($p < .001$). There were no differences in depression, anxiety, and hostility scores by highest mobility level (see Figure 1).

After controlling for gender, ventilator status, and Charlson Comorbidity Index, psychological profile remained unassociated with higher mobility group status (all *p*s = .30–.96), APACHE III score was no longer associated with mobility group status ($p = .071$), and discharge disposition to home remained associated with higher mobility group status ($p < .001$). Length of stay in days varied by mobility group status ($p < .001$), but generally, longer length of stay was associated with higher mobility level (see Table 4).

Discussion

In this study, all NICU patients were turned every 2 hours and received ROM, and most were able to have the HOB elevated to greater than 30°. However,

TABLE 2. Sample Characteristics by Highest Mobility Level

	Mobility Levels: *n* (%), Unless Indicated[a]				
Factor	**All**	**1–7**	**8–12**	**13–16**	***p***
Age (years), mean (*SD*)	63.1 (16.4)	66.3 (17.1)	63.2 (15.2)	58.0 (16.2)	.067
Payor type[b]	228 (100)				.99
Private	114 (50.0)	39 (47.0)	48 (52.7)	26 (51.0)	
Medicare	88 (38.6)	39 (47.0)	28 (30.8)	19 (37.3)	
Medicaid or self-pay	26 (11.4)	5 (6.0)	15 (16.5)	6 (11.8)	
Marital status: married	106 (46.5)	44 (53.0)	39 (42.9)	22 (43.1)	.40
Race: Caucasian	149 (65.4)	54 (65.1)	55 (60.4)	38 (74.5)	.16
Gender: male	119 (52.2)	34 (41.0)	49 (53.8)	33 (64.7)	.019
Walking aid; yes	33 (13.5)	16 (17.0)	11 (11.8)	6 (11.3)	.56
Oxygen: yes	9 (3.7)	3 (3.2)	4 (4.3)	2 (3.8)	.92
Walking barrier: yes	6 (2.5)	3 (3.2)	2 (2.2)	1 (1.9)	.86
Mechanical ventilation: yes	124 (51.5)	46 (48.9)	61 (66.3)	16 (30.2)	<.001
Charlson Comorbidity Index	2.5 (2.1)				.064
0	45 (18.4)	13 (13.8)	16 (17.2)	16 (30.2)	
1 or 2	92 (37.7)	37 (39.4)	34 (36.6)	19 (35.8)	
3 or 4	63 (25.8)	23 (24.5)	28 (30.1)	12 (22.6)	
5 or more	44 (18.0)	21 (22.3)	15 (16.1)	6 (11.3)	

[a]246 admissions were treated in the NICU during the study period, of which 228 were unique patients.
[b]More than one option could have been selected per patient.

nearly 80% of patients never progressed beyond bed mobility regardless of acuity level. Patients requiring mechanical ventilation were less likely to achieve higher mobility levels. At 30 days after discharge, mortality was higher and discharge disposition to home was lower in patients who did not advance in mobility while in the NICU. There is only one study in the literature of the effects of early mobility in patients being treated in an NICU (Titsworth et al., 2012). In the report, 32% of patients were ventilated, but investigators did not report factors associated with an increase in mobility. Furthermore, they did not report outcomes related to 30-day postdischarge mortality and discharge disposition.

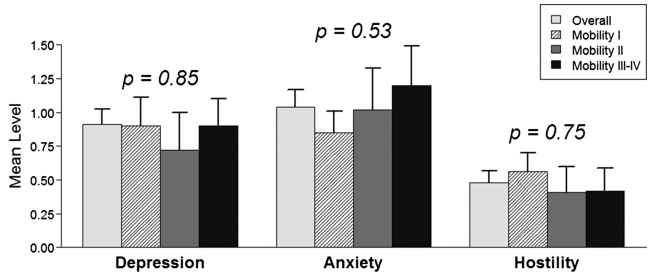
Although learning that nearly 80% of patients never got out of bed during the NICU stay was surprising to researchers, it was common to find similar results in the literature before implementing an early progressive

TABLE 3. Clinical Outcomes by Highest Mobility Level

		Mobility Levels			
Factor	**All, *N* = 241[a]**	**1–7, *n* = 94 (39%)**	**8–12, *n* = 94 (39%)**	**13–16, *n* = 53 (22%)**	***p***
Length of stay (days), mean (*SD*)	7.1 (8.0)	4.8 (7.8)	10.4 (8.7)	5.4 (3.8)	<.001
APACHE III score, mean (*SD*)	59.2 (24.1)	64.7 (26.7)	60.6 (22.7)	47.8 (17.3)	<.001
30-day mortality, yes (%)	35 (15.4)	21 (25.3)	14 (15.4)	0 (0.0)	<.001
Disposition, %					<.001
Home care	59 (25.9)	18 (21.7)	14 (15.4)	25 (49.0)	
Acute rehab	43 (18.9)	14 (16.9)	13 (14.3)	16 (31.4)	
Skilled nursing or hospice	89 (39.0)	30 (36.1)	48 (52.7)	10 (19.6)	
Expired	37 (16.2)	21 (25.3)	16 (17.6)	0 (0.0)	

Note. APACHE = Acute Physiology and Chronic Health Evaluation.
[a]Five cases not included in mobility status groups.

FIGURE 1 Psychological Profile Based on Mobility Status ($N = 64$)



Note. For depression, anxiety, and hostility, lines represent standard error of the means.

mobility protocol in an ICU setting (Hildreth et al., 2010; Schweickert et al., 2009). In some ICU studies of early mobility, as high as 90% of patients never progressed beyond bed mobility before the intervention (Bailey et al., 2007; Martin et al., 2005). Nurses may be uncomfortable mobilizing patients with multiple devices, equipment, and intravenous or intra-arterial lines because of fear of dislodging devices, equipment, or lines; expectation of little patient benefit; and minimal training in mobilization techniques (Korupolu et al., 2009; Perme & Chandrashekar, 2009; Zanni & Needham, 2010). Tasks such as hanging multiple infusions and performing high-technology procedures are seen as lifesaving events, whereas mobilization may be viewed as an activity that can occur after transitioning out of the ICU (Korupolu et al., 2009).

In the NICU environment, severity of illness trended toward being a factor associated with level of mobility, reflecting that nurses and physicians may have been less likely to consider progressive mobility when patients appeared highly acutely ill or there was a perceived risk to patients from a safety standpoint. The APACHE III scores in the NICU were not as high as seen in the literature for other ICU environments (Winkelman & Peereboom, 2010) and, based on our results, should not be a factor when making a decision to implement progressive mobility. When barriers and facilitators were assessed in nurses regarding use of progressive mobility, patients' acuity on admission was associated with less planned activity (Winkelman & Peereboom, 2010; Morris & Herridge, 2007). Healthcare providers may need to be educated about misperceptions related to acuity and progressive mobility. Of note, in an NICU environment, patients may have a greater degree of physical handicaps because of neurological impairment that are not accounted for with traditional acuity screening. Although APACHE III score (Knaus et al., 1991) addresses illness severity based on medical conditions, physical handicaps and functional capabilities are not addressed. Future research is needed to learn if physical handicaps and functional limitations are associated with lack of early mobility progression in an NICU and if the association is warranted to insure patient safety. Sufficient staff must be available to support patients and devices and ensure safety during mobility procedures. In the NICU, cognitive and physical limitations of patients may require increased unit and personnel resources.

TABLE 4. Influence of Highest Mobility After Adjusting for Significant Patient Factors

	Adjusted Model[a] Mean (Standard Error of the Mean) by Mobility Level Except Where Indicated			
Factor	**Levels 1–7**	**Levels 8–12**	**Levels 13–16**	***p***
Depression symptoms	0.64 (0.21)	0.79 (0.26)	0.75 (0.29)	.89
Anxiety symptoms	0.68 (0.22)	1.06 (0.27)	1.11 (0.30)	.33
Hostility symptoms	0.50 (0.15)	0.49 (0.18)	0.50 (0.20)	.99
Length of stay, days	5.08 (0.81)	9.82 (0.79)	7.01 (1.08)	<.001
APACHE III score	65.4 (2.68)	60.2 (2.63)	55.4 (3.49)	.071
Disposition[b]	4.03 (1.97, 8.27)	3.81 (1.92, 7.56)	1.0 reference	<.001

Note. APACHE = Acute Physiology and Chronic Health Evaluation.
[a]Adjusted for gender, use of respiratory ventilation, and Charlson Comorbidity Index Score.
[b]Results are odds ratio (95% confidence interval).

In this study, nurses were reluctant to progress activity beyond bed movement in patients requiring mechanical ventilation. Immobilization secondary to sedation is well known in the literature (Bailey et al., 2007; Morris et al., 2008; Perme & Krishnan, 2008; Schweickert et al., 2009; Titsworth et al., 2012). However, when mechanically ventilated, sedated, critically ill adults were randomized to usual care or exercise and mobilization during daily interruption of sedation, return to independent functional status at hospital discharge was higher in the intervention group. Furthermore, patients in the intervention group had shorter duration of delirium and more ventilator-free days, and only 4% of patients had to discontinue exercise and mobilization because of adverse events (Schweickert et al., 2009). Other critical care researchers found that mechanical ventilation was not an impediment to early mobilization (Bailey et al., 2007; Morris et al., 2008), including research in an NICU environment (Titsworth et al., 2012). Nurse education regarding pivoting and mobilization techniques for physically handicapped and mechanically ventilated patients may be needed. Physical therapists who are experts in pivoting and mobilization techniques should work collaboratively with nurses to implement an effective mobility protocol. It may also be important to conduct anticipatory education with families about the need for patients to advance in mobility, even when ventilated.

It seems intuitive that patients with longer lengths of NICU stay would be more likely to reach a level of mobility beyond the HOB elevated to 30°, as found in this study. However, patients who were able to weight bear, stand, and walk had shorter lengths of stay than patients whose highest mobility levels were midrange (HOB elevated to 45° or higher and dangling legs at the bedside with assistance). Our length-of-stay results could be a reflection of acuity, in that patients not needing an NICU environment were transferred out of the unit to a long-term acute care facility earlier in their course of care and patients who were able to get to the dangling level of mobility were able to be transferred to a hospital floor after a longer NICU stay but were not too sick to require a long-term acute care environment. In other reports, findings on ICU length of stay by mobility status were mixed; some reported that higher ICU mobility status was associated with lower unit length of stay (Morris et al., 2008; Needham et al., 2010; Titsworth et al., 2012), and others found no differences between groups (Hildreth et al., 2010; Schweickert et al., 2009).

Early postdischarge mortality rates decreased as highest mobility level increased. No patient who progressed to the highest mobility level expired within 30 days of discharge. It is unknown if these findings were because of lower acuity or other unstudied factors. It may be that patients who progressed to a higher mobility level had fewer physical disabilities and were considered to be less acutely ill. In one study of ICU patients in acute respiratory failure, 1-year mortality was lower in patients assigned to early mobility (Morris et al., 2011). Future research is needed on short- and long-term survival after implementing an early mobility program.

Compared with nonhospitalized adults (controls from the literature), patients who completed the psychological profile before transfer from the NICU had slightly higher than normal hostility and higher depression and anxiety levels. Psychological profile scores were not associated with higher mobility level while in the NICU; however, because so few patients reached the highest mobility level, future research is needed to learn if depression, anxiety, and hostility decrease when patients are more mobile.

Even without intervening in patient care by using a mobility protocol, this study highlights the beneficial effects of early mobility on NICU patient outcomes. In the only NICU early mobility publication, mobility scores increased and events, such as ventilator-associated pneumonia, urinary catheter days, hospital-acquired infections, and days in restraints, all decreased after implementation of an early mobility program (Titsworth et al., 2012). Although the published report was an important addition to the primary neurological injury literature, the study spanned 15 months, and the preintervention period spanned 10 months, allowing for an internal validity concern of maturation. There may have been unstudied factors associated with changes in events from premobility to postmobility protocol implementation.

In many studies of early mobility, physical rehabilitation specialists or physical therapists carried out the early mobility protocols (Morris et al., 2008; Needham et al., 2010; Schweickert et al., 2009) rather than having nurses complete the steps as part of usual care. It is unclear whether a progressive mobility protocol, led by nursing staff, would be effective in improving NICU-based and hospital-based outcomes and if the protocol would be maintained over time once research-based data collection was completed. Further research is needed to assess early mobility in patients with primary neurological injury.

Limitations

This was a single-center study of high-acuity NICU patients cared for in a quaternary care medical center by neurointensivist specialty teams. It is not known if results are generalizable to other patients treated for neurological injury in an ICU. Data collected by medical record review and from administrative databases could have had missing or incorrectly inputted data. Some patients who were enrolled had a very short NICU stay preventing mobility progression; whereas other patients had a prolonged NICU stay, and mobility progression could have been missed because data were collected for only the first 12 days of the ICU stay. The sample size for the psychological profile assessment was smaller than the overall sample because of NICU death, inability to assess patients because of exclusion criteria, or patients preference not to participate in this component of data collection. It is not known if patients who did not complete the psychological profile assessment were similar in characteristics to those who completed it. In this study, data on patient safety issues, from a nurse's perspective, were not collected. Future research should assess the prevalence of safety issues in patients with neurological injury.

Conclusion

Nearly 40% of NICU patients never progressed in ambulation beyond movement in bed, and less than 10% were standing/weight bearing and walking while in the NICU. Female gender, higher acuity, and respiratory barriers (ventilator) were the only factors associated with failure to progress in mobility. After controlling for significant patient factors, poor mobility was associated with nonlinear unit length of stay, discharge to nursing facility, and higher mortality. Findings indicate a need for NICU nurses to develop and implement a progressive mobility protocol and assess its effectiveness on patient safety and quality metrics and clinical and psychological outcomes. For a mobility protocol to be successful, a unit culture of teamwork is needed, especially if additional personnel and assistive device resources are not available. Future research is needed to determine if results in this study regarding the percentage of patients who achieved weight bearing before mobility protocol initiation are consistent with other NICU settings. In addition, it will be important to explore relationships between mobility progression and patient levels of anxiety, depression, and hostility to determine the importance of mobility on psychological status. Although standard clinical NICU practice suggests that presence of intracranial monitors, central lines, and patient comorbidities may be barriers to mobility, potential barriers can be addressed and overcome.

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