International Journal of Nursing Studies 91 (2019) 35–46

Contents lists available at ScienceDirect

International Journal of Nursing Studies

journal homepage: www.elsevier.com/ijns

Factors associated with lift equipment use during patient lifts and transfers by hospital nurses and nursing care assistants: A prospective observational cohort study

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ARTICLE INFO

Article history:
Received 25 April 2018
Received in revised form 31 August 2018
Accepted 3 November 2018

Keywords:
Lift equipment use
Patient-handling
Patient lifting
Prospective

ABSTRACT

Background: Despite wide availability of patient lift equipment in hospitals to promote worker and patient safety, nursing staff do not consistently use equipment.
Objective: To determine the influence of factors on the use or non-use of lift equipment during patient lifts/transfers.
Design: Prospective observational cohort study.
Setting: One university teaching hospital and two community hospitals in a large health system in southeastern United States.
Participants: 77 nurses and nursing care assistants with patient handling duties in critical care, step-down and intermediate care units.
Methods: Participants recorded information about all patient lifts/transfers during their shifts during a 1 week period per month for three months: type of lift/transfer, equipment use, type of equipment, and presence of 20 factors at the time of the lift/transfer. With the patient lift/transfer as the unit of analysis, the association (risk ratios (RR) and 95% confidence intervals (CI)) between factors and equipment use was examined using multivariate Poisson regression with generalized estimating equations.
Results: Seventy-seven participants (465 person-shifts) reported 3246 patient lifts/transfers. Frequent lifts/transfers included bed-to-toilet (21%), toilet-to-bed (18%), bed-to-chair (13%), chair-to-bed (13%), chair-to-toilet (6%), and toilet-to-chair (6%). Equipment was used for 21% of lifts/transfers including powered floor based dependent lift (41%), powered sit-to-stand lift (29%), non-powered sit-to-stand lift (17%), air-assisted lateral transfer device (6%), ceiling lift (3%), and air-assist patient lift (3%). Factors associated with equipment use included: availability of equipment supplies (RR = 9.61 [95%CI: 6.32, 14.63]), staff availability to help with equipment (6.64 [4.36, 10.12]), staff preference to use equipment (3.46 [2.48, 4.83]), equipment required for patient condition (2.38 [1.74, 3.25]), patient inability to help with lift/transfer (2.38 [1.71, 3.31]), equipment located in/by patient room (1.82 [1.08, 3.06]), sling already under patient (1.79 [1.27, 2.51]), and patient size/weight (1.38 [0.98, 1.95]). Lower patient mobility score (3.39 [2.19, 5.26]) and presence of physical or mental impairments (2.00 [1.40, 2.86]) were also associated with lift equipment use. Factors associated with non-use of equipment included: patient/family preference (0.31 [0.12, 0.80]), staff assisting with lift did not want to use equipment 0.34 ([0.17, 0.68]), patient condition (0.48 [0.20, 1.20]), and patient almost fell (0.66 [0.45, 0.97]).
Conclusions: Patient, worker, equipment, and situational factors influence whether nursing staff used equipment to lift/transfer a patient. Quantifying and understanding these factors associated with lift

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https://doi.org/10.1016/j.ijnurstu.2018.11.006

equipment use and non-use provides specific information for hospitals and safety professionals to enhance effectiveness of future organizational and ergonomic intervention efforts to prevent work-related patient-handling injuries.

What is already known about the topic?

- Patient lift equipment reduces the biomechanical load and physical stress associated with patient lifting and transferring tasks.
- Despite wide availability of patient lift/transfer equipment, nursing staff do not consistently use the equipment.
- Barriers and facilitators of patient lift equipment use for patient lifts and transfers have been identified through cross-sectional surveys, interviews, and focus groups.

What this paper adds

- Lift equipment was used for 21% of patient lifts and transfers and differed by the type of lift/transfer performed.
- The following patient, worker, equipment, and situational factors played an important role in determining whether nursing staff used equipment to lift or transfer a patient: availability of equipment supplies, availability of staff to assist and staff preference to use equipment, whether equipment was required for the patient condition, patient ability to assist with lift, equipment in close proximity, patient mobility level, and patient impairments.
- Prospective assessment of factors and situations actually present or not present at the time of patient lifts and transfers provides useful information for hospital safety and administrative staff to improve the safety of patient handling activities.

1. Introduction

In 2015, of all United States (US) industries, nursing had the highest rate of non-fatal occupational injuries and illnesses with days away from work, restrictions, or job transfer (7.4 per 100 full-time workers) (Bureau of Labor Statistics, 2015a,b,c) and the second highest total injury rate (11.7 per 100 full-time workers) (Bureau of Labor Statistics, 2015a,b,c). Among nurses in acute care hospitals over 70% of musculoskeletal injuries reported to workers' compensation are due to patient handling activities (Schoenfisch et al., 2012). These injuries are responsible for half of patient caregivers' musculoskeletal injury workers' compensation costs (Lipscomb et al., 2012). In 2015, nursing care assistants reported 41,450 days away from work injuries with a median of 6 days away; an incident rate of 3 times greater than the rate for all workers (Bureau of Labor Statistics, 2015a,b,c).

In order to address these hazards, hospitals have adopted Safe Patient Handling and Mobility programs and policies and have purchased patient lift equipment for use on inpatient units. Early on, efforts were devoted to minimal manual lift environments; however, recent biomechanical analyses from the NIOSH lifting equation indicates a maximum weight limit of 35 pounds for safe patient handling if conditions are ideal (Waters, 2007). Ideal conditions are not often the norm in inpatient care settings. Ergonomics research of using proper body mechanics to manually lift patients indicates that there is no way to safely manually lift a patient (Zwerdling, 2015) and the focus has shifted to eliminating manual patient handling. In 2014 New York state enacted safe patient handling legislation becoming the 11th state to have such legislation (Powell-Cope and Rugs, 2015). Most recently in 2015, the American Nurses Association came out in support of the 2015 Nurse and Healthcare Worker Act in the US Congress (2015a,b) and any and all efforts to eliminate manual patient handling (American Nursing Association, 2015). Also in 2015, the US Occupational Safety and Health Association directed safety inspectors to include musculoskeletal injuries associated with patient handling among the occupational hazards they assess (Occupational Safety and Health Administration, 2015). While the federal bill was not enacted, these legislative and safety efforts illustrate the importance and critical need for research to determine how to improve the safety of patient handling tasks among nursing staff.

However, research indicates that nurses and nursing care assistants do not necessarily use lift equipment despite its availability (Schoenfisch, Myers et al. 2011; Myers et al., 2012). A survey with nurses and nursing care assistants indicated an average of 15% of nurses used lift equipment (range 6–34%) with lower frequency of use compared to nursing care assistants and other medical staff (Evanoff, Wolf et al. 2003). In the US about 33% of nurses with lift equipment available frequently used the lift equipment to transfer their patient (Lee et al., 2013; Lee and Lee, 2017). Recent surveillance from US National Institute for Occupational Safety and Health Occupational Safety and Health Network (NIOSH OSHN) indicates that lift equipment was not used for 82% of patient handling injuries and higher injury rates for non-use of equipment versus use (IRR = 4.71) (Gomaa, Tapp et al. 2015).

The provision of patient care is demanding. Further, it occurs in a highly dynamic environment, where patient care needs may outweigh workers' adoption of efforts perceived to address their own safety (Myers et al., 2012). Previous surveys and interviews with nursing staff found barriers to lift equipment use such as lack of time, training, or staff; patient acuity or patient preference; lack of supplies or environment not conducive to using the lift (Evanoff, Wolf et al. 2003; Engkvist, 2007; Schoenfisch, Myers et al. 2011; Myers et al., 2012; Noble and Sweeney, 2018). There can also be a lack of perceived need for lift equipment among the nursing staff (Li et al., 2004; Noble and Sweeney, 2018). These previous studies have focused on cross sectional surveys and interviews with nursing staff about perceived barriers; however it is unclear which factors present, or not present, at the time staff need to lift a patient will influence whether the lift equipment will be retrieved and used or whether the staff member will perform a manual lift. Understanding which factors are present and associated with lift equipment use and non-use could provide specific, actionable information for hospitals and safety professionals to enhance the effectiveness of future organizational and ergonomic intervention efforts to prevent work-related patient-handling injuries. Moreover, determining the specific factors present and their influence on whether nursing staff choose to use equipment at that moment in that situation provides insight into situational and contextual factors. Building on a baseline assessment (Schoenfisch et al., 2012), the purpose of this prospective study was to describe the factors present during patient lifts and transfers among inpatient hospital nurses and nursing care assistants and the factors' influence on the use or non-use of patient lift equipment.

2. Methods

Participants for this study included nurses and nursing care assistants working in three inpatient hospitals within a large

health system: a university teaching hospital and two community hospitals. Patient lifts and transfers of interest for this study were defined as lifts and transfers between bed, stretcher, chair, wheelchair, bedside commode, or toilet. Participants were instructed to "record information only about lifts and transfers – such as helping a patient get in or out of bed, or move around on the unit. Please do not record information about repositioning tasks, like scooting a patient up in bed." Lift equipment included ceiling lifts, powered floor based dependent lifts, powered sit-to-stand lifts, air-assisted lateral transfer devices, air-assisted patient lift devices, and non-powered sit-to-stand lifts. All study procedures were approved by the Institutional Review Boards of the [authors' universities; names removed for peer-review only].

2.1. Lift assessment tool development

This prospective study was part of a larger parent study [blinded for peer review] which had several components. A comprehensive review of the literature was conducted to identify exposures or factors related to the use or non-use of lift equipment. Following this review, interviews were conducted with 20 inpatient nurses and nursing care assistants to verify relevance of identified factors, identify new factors, and identify potential variability. We also asked about feasibility and ways participants preferred to collect information about lifts and transfers (e.g., paper versus electronic forms). This information was utilized to develop a baseline survey which was distributed to participants December 2015 through March 2016. The survey asked about participants demographics, work experience, training and usual experience with patient lifting and lift equipment use over the past four weeks, and presence of factors potentially associated with lift equipment use. Factors of interest were measured from determination of lift/transfer need through its completion and categorized in four domains based on models proposed by Hignett et al. (Hignett and Richardson, 1995) and Koppelaar et al. (Koppelaar, Knibbe et al. 2009): worker, patient, equipment, and situational. Additional methods and results of the baseline survey are presented in a companion paper (authors names blinded for peer review; in press at *Nursing Research*).

The lift assessment tool was based on Lift Counter methodology developed for home care nurses and ceiling lift use (Knibbe and Friele, 1999). The Lift Counter is a self-administered log of patient lifting activities over 7 consecutive days. Each day during the sampling period, participants record information about each patient lift performed. This tool was expanded to include an assessment of the presence or absence of relevant factors identified through the baseline survey. The lift assessment tool was pilot tested by nurses and nursing care assistants January 2016 to ensure comprehensi on, ease and efficiency of use as well as to refine data collection procedures. The tool and study procedures were finalized after pilot testing. Study participants recorded data in a paper booklet ("lift log") which included information about their shift (day/night, role), demographics about patients assigned and lifted/transferred that shift (age, height, weight, mobility level (as measured through the Bedside Mobility Assessment Tool (2018) derived from the Banner Mobility Assessment Tool (BMAT) for Nurses (Boynton, Kelly et al. 2014)), first day with patient, patient impairments and acuity), and each lift/transfer completed for each patient that shift. Lift/transfer information included: the type of lift/transfer (e.g., bed to chair); whether lift equipment was used (yes or no); and the presence of factors at the time of the lift/transfer (e.g., staff able to assist with transfer). If lift equipment was used, the type of equipment used was recorded (e.g., powered sit-to-stand). A complete list of lift/transfer types, equipment used, and factors of interest are in Fig. 2a and b; and Table 3. At the end of their shift, participants assessed the quality and accuracy of their data collection that shift and rated other shift characteristics (how busy they were, the physical demands, number of patients assigned, acuity of patients, and presence of unusual situations).

2.2. Recruitment and data collection

Study recruitment began November 2015. Research staff utilized in person and email methods to recruit inpatient nurses and nursing care assistants at three hospitals into the study. In person recruitment methods included presenting at hospital system executive nursing council meetings, nurse manager meetings, and individual unit visits at each of the three hospitals; posting fliers in break rooms and other common areas; speaking with nursing staff about the study, and presenting at unit meetings when invited. Emails about the study were also sent to nursing staff and brief advertisements were placed in unit emails and hospital e-newsletters.

Participants completed the baseline survey online from November 2015 to January 2016. At the end of the baseline survey, participants were asked if they would be interested in participating in a study to document patient lifts/transfers, equipment use, and the presence or absence of factors at the time of the lift/transfer over a 3- month period. Participants were offered an increasing incentive amount per weekly assessment for participating ($75 for 1 st assessment, $100 for 2nd assessment, $125 for 3rd assessment) for a total incentive of $300. Research staff contacted those interested to determine their eligibility and obtain mailing information. Eligibility criteria included inpatient nurses and nursing care assistants at least 18 years of age with patient handling duties working in critical care, intermediate care or step-down units. Participants from pediatric, labor/delivery, radiology, and emergency departments were not eligible due to the different patient handling demands in these units. Participants were mailed a study packet containing an instructional letter, consent forms, a training guide, lift assessment logs, and stamped return envelopes. Participants completed an online training module developed by the research team that included study definitions for lifts/transfers and equipment, and instructions on how to complete and return the lift assessments. Participants could complete consent forms online through a web-link or return the signed paper forms. After submitting their work schedule to research staff through the web-link, each participant was assigned to collect data for each shift for 1 week per month for a period of three months. For example, an individual working a 3-day shift during week 1 would record all lifts and transfers performed during each of their 3 shifts that week—completing a new log for each shift. Participants' assigned weeks were staggered throughout the month by unit to ensure that participants from the same unit were collecting data during different weeks. Researchers visited the hospital units before participants began collecting lift assessment data (December 2015–January 2016) and after participants had completed the data collection (July-August 2016) to assess access, availability, and operational status of lift equipment and other equipment and supplies.

Lift assessment data were collected from March to June 2016. The week before their scheduled collection, research staff emailed participants a reminder about their data collection week and provided a web link for participants to "check-in" the morning of each shift. The purpose of the "check-in" was to ensure that participants were ready to collect data that day. Research staff email or texted an additional reminder if the participant didn't check-in. Participants mailed each completed log back to research staff. Research staff reviewed and entered all information recorded on the log into an electronic database. Research staff contacted participants if there were questions, missing information, or other questions about the log. At the end of the data collection period, participants completed an exit survey and received their incentive.

To be included in the lift assessment analyses, the participant had to be assigned patients that day and lifted or transferred at least one patient. Lifts determined to be other patient handling or mobility tasks (patient repositioning, turning, ambulation assists) or lifts with use of ineligible equipment/assistive device types (lift belts, walkers, plastic liners, draw sheets) were excluded (Fig. 1).

2.3. Missing data

There were missing values for patient weight (17 patients, 21 lifts), patient age (13 patients, 28 lifts), and patient mobility level (63 patients, 145 lifts). Missingness of these patient attributes was distributed randomly among the shifts and participants and was not dependent on probability of exposure to these attributes. Therefore, missing at random (MAR) was a reasonable assumption for the missing data pattern in these analyses. Assuming MAR and a nonmonotone missing data pattern, values were imputed for these three variables using SAS 9.4 PROC MI and MIANALYZE. The variables used to impute values over 25 iterations included: patient characteristics – height, weight, mobility level; first day with patient, high fall risk, physical impairments present, mental/cognitive impairments present, medical equipment attached, or other relevant information; work characteristics – unit type, hospital type, job category; and participant characteristics – age, sex, baseline average lift frequency and lift equipment use. Imputation models achieved 99.9% efficiency.

2.4. Statistical analysis

Survey and lift log data were summarized with descriptive statistics including frequencies, percents, means, medians, and standard deviations (SD). Characteristics of the participant, shift, patients, and lifts were described. Since some patient characteristics change from shift to shift (e.g., mobility level), patient characteristics were measured each shift (patient-day). The occurrence and proportional distribution of factors (number of times present divided by the number of lifts) were stratified by use and non-use of equipment.

The unit of analysis was the patient lift or transfer and the outcome was use of a lift device (yes or no). Poisson regression models (Frome and Checkoway, 1985) were fit to the data to estimate the crude association between each factor and the rate of lift equipment use (or non-use) through rate ratios (RR) and 95% confidence intervals (CI). In this study patient lifts were clustered within patients within nursing staff. Generalized estimating equations (GEE) (Zeger and Liang, 1986) were used to account for this clustering (lack of independence) via a nurse ID-patient ID variable. All analyses were conducted in SAS version 9.4. Separate multivariate models were conducted for each factor to determine the association of the factors predictive of lift use adjusting for other confounding nurse, patient, and shift variables. Directed acyclic graphs (Textor, van der Zander et al. 2016) were utilized to determine the minimum adjustment variables for the factor-lift use association. A greater than 10% change in the log confounding risk ratio for any variable was used to determine the presence of confounding and the variable was retained in the model (lnCoIRR = |ln (crude IRR/adjusted IRR)|*100).

3. Results

Of the 108 who finished the baseline survey, 105 (97.2%) expressed interest in participating in the lift assessment study (Fig. 1). Of the 105 interested, 87 consented and completed the training (82.9%) and 81 (77.1%) participated in the lift assessment study. One person participated but did not record any patient lifts during the study period and two were not assigned any patients. Seventy-eight participants worked 495 shifts and recorded 4022 patient lifts/transfers (median = 6 lifts/transfers per participant per shift, range 1–47). Upon review, 249 assists with other lift equipment (belts, plastic liners, draw sheet, cane), 454 assists with specialty walkers, and 73 repositioning or ambulatory assists were excluded leaving 77 participants, 465 shifts, and 3246 patient lifts/transfers (median = 5 lifts/transfers per participant per shift, range 1–47) included in lift assessment analyses (Fig. 1).

3.1. Participant characteristics

Baseline demographic and work characteristics of the 77 lift assessment study participants are summarized in Table 1. The majority of participants were female (88.3%) and averaged 32.2 years of age (range 21–57). Most worked as nurses (76.7%) in the university hospital (64.9%) on mixed (medical and surgical) units (68.8%) and spent 75% or more of their time in direct patient care (89.6%). Over half had 3 or more years tenure in patient care while 29.9% had 3 or more years tenure on their current unit, 39% had 1–2 years tenure on their current unit, and 29.9% had less than 1 year tenure on their current unit (Table 1).

At baseline, most participants reported lifting patients on average 1–5 times per shift (45.0%) followed by 6–10 (22.5%) and 11–15 (21.3%) times per shift. The majority of participants used lift equipment on average less than half the time (55.0%); 28.2% used equipment half the time, 13.0% used it more than half the time but not always, and few used equipment always (2.6%) or never (1.3%) (Table 1). The most frequently used lift equipment was powered floor based dependent lift (76.6%), powered sit-to-stand lift (44.2%), non-powered sit-to-stand lift (37.7%), and ceiling lift (31.2%).

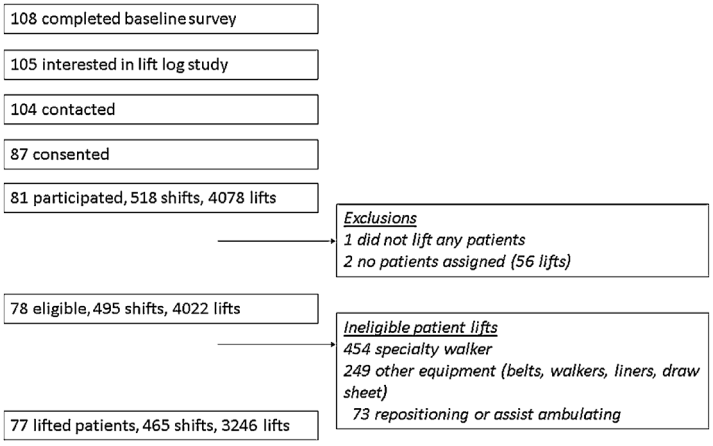

Fig. 1. Inclusion Flow Chart for Patient Lift Study Analyses.

Table 1
Distribution and Unadjusted Ratios and 95% Confidence Intervals (CI) of Participant Factors by Lift Equipment Use among Inpatient Hospital Nursing Staff (n = 77 nurses and nursing care assistants, 3246 lifts).

Table 1. Participant characteristic[a]	Total participants (column%)		Total lifts (column%)		Lifts with equipment Use (column%)		Percent lift use (row%)	Univariate Results[b]
	n	%	lifts	%	lifts	%	%	Ratio (95% CI)
Sex								
Female	68	88.3	2906	89.5	620	90.6	21.3	1.74 (0.91, 3.30)
Male	9	11.7	340	10.5	64	9.4	18.8	1.00
Age group								
20s	39	50.6	1449	44.6	142	20.8	9.8	1.00
30+	38	49.4	1797	55.4	542	79.2	30.2	0.33 (0.22, 0.47)
Hospital type								
Community hospitals	27	35.1	1185	36.5	448	65.5	37.8	2.20 (1.59, 3.05)
University hospital	50	64.9	2061	63.5	236	34.5	11.5	1.00
Job								
Nursing Care Assistant	18	23.4	1072	33.0	437	63.9	40.8	2.35 (1.71, 3.22)
Nurse	59	76.6	2174	67.0	247	36.1	11.4	1.00
Years of experience patient care								
<1 years	10	13.0	505	15.6	61	8.9	12.1	1.00
1–2 years	22	28.6	769	23.7	85	12.4	11.1	1.14 (0.59, 2.23)
3+ years	45	58.5	1972	60.8	538	78.7	27.3	3.05 (1.73, 5.37)
Years worked on current unit								
<1 years	23	29.9	879	27.3	79	11.7	9.0	1.00
1–2 years	30	39.0	1432	44.5	358	52.8	25.0	2.78 (1.68, 4.59)
3+ years	23	29.9	906	28.2	241	35.5	26.6	4.12 (2.54, 6.68)
Unit Classification								
Medical	15	19.5	680	20.9	160	23.4	23.5	1.37 (0.93, 2.01)
Surgical	9	11.7	217	6.7	24	3.5	11.1	0.70 (0.35, 1.40)
Mixed	53	68.8	2349	72.4	500	73.1	21.3	1.00
Average patient lift frequency per shift								
0–10 times	54	70.1	2306	71.0	557	81.4	24.2	1.00
11 or more times	23	29.9	940	29.0	127	18.6	13.5	0.58 (0.38, 0.89)
Average lift equipment use per shift								
Less than half the time	43	55.8	1937	59.7	320	46.8	16.5	1.00
More than half the time	34	44.2	1309	40.3	364	53.2	27.8	3.34 (2.29, 4.88)
Total	**77**	**100.0**	**3246**	**100.0**	**684**	**100.0**		

[a] From baseline survey.
[b] Univariate ratio measures from Poisson regression adjusted with Generalized Estimating Equations for nurse-patient-day clustering.

3.2. Prospective lift assessments

3.2.1. Compliance and data collection quality

The 77 participants collected data for 603 of 641 assigned shifts over the 3-month period for an average of 7.8 shifts per person (range 3–12 shifts). There were 109 logs with incomplete or missing information (18.1%, n = 33 missing patient information or n = 76 skipped questions about their shift at the end of the log). For a majority of the remaining 465 shifts included in the analysis, participants reported they recorded 100% of patient lifts on the log (46.0%), 29.7% recorded 75%–99% of patient lifts, 8.4% recorded less than 75% of lifts, and 15.9% did not respond to the question. The majority reported 75% or higher accuracy in their data recording that shift (79.1%), 4.5% reported less than 75% accuracy and 16.3% did not respond to the question.

3.2.2. Shift characteristics

Most data were collected on day shifts (67.3%). For 13 shifts (2.8%) the participant had a special role for that shift including charge nurse (n = 9), patient attendant (n = 1), or other (n = 4) (Table 2a). The majority of shifts were deemed by the participant as "average" in terms of how busy they were (52.7%), the physical demands (52.2%), number of patients assigned (77.9%), and patient acuity levels (68.4%) (Table 2a). Only 15.9% shifts were characterized by an unusual situation such as "higher than usual number of discharges and new admits", "stroke code on the unit affecting the entire unit", "alarms when patients attempted to get out of bed", etc.

3.2.3. Patient-day characteristics each shift

Participants reported 1066 patient-days. Patient mobility levels indicated most patients were ambulatory (42.5% of patient-days) or able to stand and transfer (29.8%) while 16.9% were chairfast and 11.7% were bedfast (Table 2b). Patient weight ranged from 19.3 to 220.9 kg (mean 90.6 kg), patient height ranged from 58 to 205 centimeters (mean 168 cm), and patient age ranged from 4 to 99 (mean 63.4). Participants reported: it was their first day with the patient (59.6%), patient was at high fall risk (76.8%), patient had physical (46.7%) or mental/cognitive (25.0%) impairments, medical equipment attached (50.8%), or other (16.8%).

3.2.4. Lift and transfer characteristics

Frequent lift/transfer types included bed-to-toilet (21%), toilet-to-bed (18%), bed-to-chair (13%), chair-to-bed (13%), chair-to-toilet (6%), and toilet-to-chair (6%). Lift equipment was used for 21% of patient lifts/transfers and lift equipment use varied by the type of lift/transfer. Among the most common lift types, lift equipment use was highest for stretcher-to-bed (35.5%), chair-to-bed (32.2%), bed-to-stretcher (28.4%), and bed-to-chair (27.2%) lifts followed by bed-to-toilet (18.5%), toilet-to-bed (18.6%), chair-to-toilet (13.5%), toilet-to-chair (7.7%), and other lifts (32.3%) (Fig. 2a). Powered floor-based dependent lift was the most frequently used lift equipment type (41%), followed by powered sit-to-stand lift (29%), non-powered sit-to-stand lift (17%), air-assisted lateral transfer device (5.6%), ceiling lift (2.6%), and air assisted lift device (2.5%).

3.2.5. Fixed or general factors associated with lift equipment use

Participants who were female, 20–29 years of age, nursing care assistants, working in community hospitals, medical or mixed medical and surgical units, with lower baseline average lift

Table 2
Distribution and Unadjusted Ratios and 95% Confidence Intervals (CI) of General Fixed Factors (a. Shift and b. Patient) by Lift Equipment Use among Inpatient Hospital Nursing Staff (n = 77 nurses and nursing care assistants, 3246 lifts).

Table 2a. Shift characteristics	Total shifts (column%)		Total lifts (column%)		Lifts with equipment Use (column%)		Percent lift Use (row%)	Univariate Results[a]
	shifts	%	lifts	%	lifts	%	%	Ratio (95% CI)
Shift type								
Day shift	313	67.3	2077	64.0	298	43.6	14.3	1.00
Night shift	152	32.7	1169	36.0	386	56.4	33.0	1.40 (1.03, 1.90)
Special role for shift								
Yes (charge nurse, sitter, other)	13	2.8	42	1.3	18	2.6	42.9	1.48 (0.91, 2.39)
No special role	452	97.2	3204	98.7	666	97.4	20.8	1.00
How busy were you?								
less than average	90	22.9	612	21.6	96	14.0	15.7	0.77 (0.55, 1.09)
an average day	207	52.7	1480	52.2	275	40.2	18.6	1.00
more than average	96	24.4	745	26.3	212	31.0	28.5	1.13 (0.87, 1.48)
Missing	72	–	409	–	101	–		
Physical demands of the day were:								
less than average	119	30.3	774	27.3	119	17.4	15.4	0.88 (0.67, 1.15)
an average day	205	52.2	1507	53.1	267	39.0	17.7	1.00
more than average	69	17.6	557	19.6	198	28.9	35.5	1.14 (0.80, 1.63)
Missing	72	–	408	–	100	–		
Number of patients assigned was:								
less than usual	56	14.4	380	13.6	82	12.0	21.6	0.93 (0.63, 1.38)
typical	303	77.9	2243	80.1	457	66.8	20.4	1.00
more than usual	30	7.7	178	6.4	18	2.6	10.1	0.95 (0.71, 1.27)
Missing	76	–	445	–	127	–		
Acuity of the patients assigned was:								
lower than usual	80	20.4	621	22.0	70	10.2	11.3	0.80 (0.60, 1.05)
typical	269	68.4	1943	68.8	441	64.5	22.7	1.00
higher than usual	44	11.2	259	9.2	58	8.5	22.4	1.37 (1.06, 1.76)
Missing	72	–	423	–	115	–		
Any unusual situations on your shift?								
Yes	62	15.9	563	20.2	124	18.1	22.0	0.77 (0.58, 1.02)
No	327	84.1	2226	79.8	454	66.4	20.4	1.00
Missing	76	–	457	–	106	–		
Total	**465**	**100.0**	**3246**	**100.0**	**684**	**100.0**		

Table 2b. Patient-day characteristic	Total patient-days (column%)		Total lifts (column%)		Lifts with equipment use (column%)		Percent lift use (row%)	Univariate Results[a]
	patient-days	%	lifts	%	lifts	%	%	Ratio (95% CI)
Patient mobility score								
1 or 2=Bedfast or chairfast	287	28.6	728	23.5	426	62.3	58.5	3.39 (2.19, 5.26)
3 or 4=Stand and transfer or Walk	716	71.4	2373	76.5	222	32.5	9.4	1.00
Missing	63	–	145	–		–		
First day with patient								
Yes	635	59.6	1881	58.0	347	50.7	18.4	0.91 (0.74, 1.11)
No	431	40.4	1365	42.0	337	49.3	24.7	1.00
High fall risk								
Yes	819	76.8	2446	75.4	607	88.7	24.8	1.12 (0.79, 1.59)
No	247	23.2	800	24.6	77	11.3	9.6	1.00
Medical equipment attached								
Yes	542	50.8	1637	50.4	251	36.7	15.3	1.05 (0.84, 1.31)
No	524	49.2	1609	49.6	433	63.3	26.9	1.00
Other information								
Yes	179	16.8	595	18.3	43	6.3	7.2	0.69 (0.48, 0.99)
No	887	83.2	2651	81.7	641	93.7	24.2	1.00
Physical or mental impairments								
Yes	296	57.1	1633	50.3	471	68.9	28.8	2.00 (1.40, 2.86)
No	222	42.9	1613	49.7	213	31.1	13.2	1.00
Total	**1066**	**100.0**	**3246**	**100.0**	**684**	**100.0**		

[a] Univariate ratio measures from Poisson regression adjusted with Generalized Estimating Equations for nurse-patient-day clustering.

frequency, higher baseline lift equipment use (Table 1), or night shift workers were more likely to use lift equipment (Table 2). Those with 3 or more years of patient care experience and those with 2 or more years on their current unit were also more likely to use lift equipment (Table 1). Patient-day characteristics associated with higher use of lift equipment included: patients with lower mobility levels, physical or mental/cognitive impairments (Table 2b). First day with patient, high fall risk, having medical equipment attached were not associated with lift equipment use.

3.2.6. Proximal patient, worker, equipment, and situational factors associated with lift use

Factors most often present during patient lifts overall and stratified by when equipment was used or not used are reported in Fig. 2b and Table 3. Overall, the most frequent factors present included: availability of supplies (25.3%), patient size or weight (21.3%), staff able to assist with lift equipment (21.3%), and patient unable to help (19.2%). Factors least present included: patient fell (0.2%), patient almost fell (1.3%), couldn't get lift under the bed/

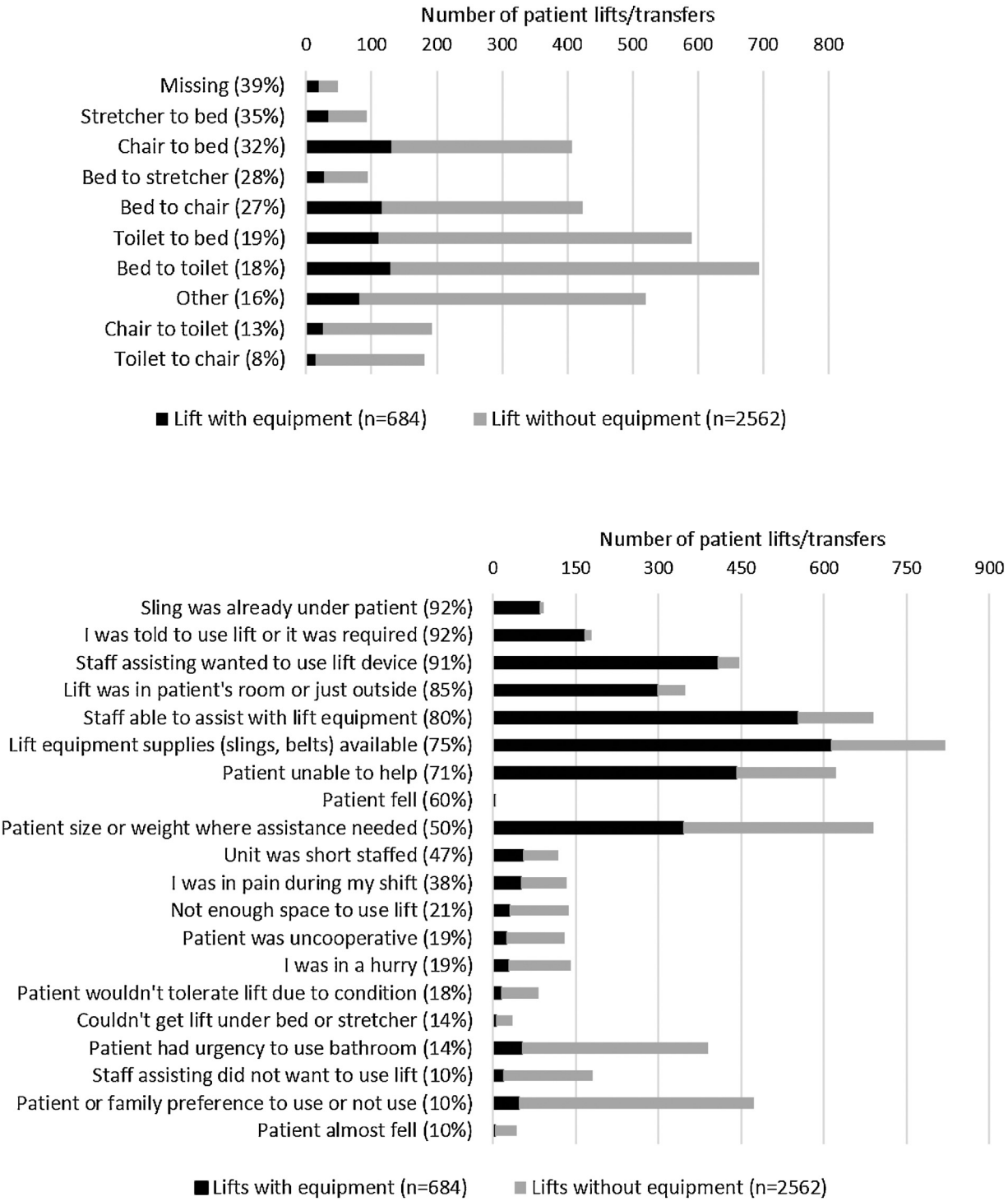

Fig. 2. Frequency of Patient Lift and Transfers Stratified by Lift Equipment Use (% is Proportion of Lift/transfer Type with Lift Equipment Use): (a) Frequency of Lift/transfer Types (b) Frequency of Factors (Patient, Worker, Equipment, and Situational).

stretcher (1.1%), patient wouldn't tolerate lift due to condition (2.5%), and sling already under the patient (2.8%).

Factors most often present when lift equipment was used included: availability of supplies (89.6%), staff able to assist with lift equipment (80.7%), patient unable to help (64.3%), staff assisting wanted to use the lift (59.5%), patient size or weight (50.4%), and lift was inside or just outside the patient's room (43.6%) (Fig. 2b and Table 3).

Factors associated with higher or greater equipment use included (Table 3): patient inability to help with lift/transfer (RR = 3.79 [95% CI: 2.50, 5.73]), patient size/weight (2.11 [1.51, 2.97]), equipment required for patient condition (3.67 [2.47, 5.45]), staff availability to help with equipment (9.93 [6.81, 14.47]), staff preference to use equipment (5.16 [3.47, 7.69]), availability of equipment supplies (13.76 [9.04, 20.95]), equipment located in/by patient room (2.76 [1.48, 5.17]), and sling already under patient

Table 3
Distribution of Lifts by Lift Use and Factor Presence, with Unadjusted and Adjusted Ratios and 95% Confidence Intervals (CI) for the Association between Lift Equipment Use and Factors Related to Patients, Staff, Equipment, and Situation among Inpatient Hospital Nursing Staff (n = 77 nurses and nursing care assistants, 3246 lifts).

		All lifts (column%)		Lifts with equipment use (column%)		Percent lift use (row%)	Univariate results[i]	Adjusted results[i]
	Value	lifts	%	lifts	%	%	Ratio (95% CI)	Ratio (95% CI)
Patient Factor								
Patient physically, mentally, medically unable to help[b]	Present	622	19.2	440	64.3	70.7	3.79 (2.50, 5.73)	2.38 (1.71, 3.31)
	Not present	2624	80.8	244	35.7	9.3	1.00	1.00
Patient of size or weight where I needed assistance[b]	Present	690	21.3	345	50.4	50.0	2.11 (1.51, 2.97)	1.38 (0.98, 1.95)
	Not present	2556	78.7	339	49.6	13.3	1.00	1.00
Patient wouldn't tolerate lift due to patient condition[b]	Present	82	2.5	15	2.2	18.3	0.80 (0.28, 2.29)	0.48 (0.20, 1.20)
	Not present	3164	97.5	669	97.8	21.1	1.00	1.00
Patient or family preference to use or not use[b]	Present	473	14.6	46	6.7	9.7	0.26 (0.10, 0.74)	0.31 (0.12, 0.80)
	Not present	2773	85.4	638	93.3	23.0	1.00	1.00
Worker Factor								
Staff able to assist with lift equipment[c]	Present	690	21.3	552	80.7	80.0	9.93 (6.81, 14.47)	6.64 (4.36, 10.12)
	Not present	2556	78.7	132	19.3	5.2	1.00	1.00
Staff assisting wanted to use lift device[c]	Present	446	13.7	407	59.5	91.3	5.16 (3.47, 7.69)	3.46 (2.48, 4.83)
	Not present	2800	86.3	277	40.5	9.9	1.00	1.00
Staff assisting did not want to use lift[d]	Present	181	5.6	18	2.6	9.9	0.32 (0.18, 0.59)	0.34 (0.17, 0.68)
	Not present	3065	94.4	666	97.4	21.7	1.00	1.00
Equipment Factor								
Lift equipment supplies (slings, belts) available[e]	Present	820	25.3	613	89.6	74.8	13.76 (9.04, 20.95)	9.61 (6.32, 14.63)
	Not present	2426	74.7	71	10.4	2.9	1.00	1.00
Not enough space to use lift[f]	Present	138	4.3	29	4.2	21.0	1.07 (0.66, 1.75)	0.71 (0.36, 1.41)
	Not present	3108	95.7	655	95.8	21.1	1.00	1.00
Couldn't get lift under bed or stretcher[f]	Present	36	1.1	5	0.7	13.9	0.39 (0.18, 0.83)	0.72 (0.63, 0.82)
	Not present	3210	98.9	679	99.3	21.2	1.00	1.00
Situational Factor								
Patient fell[b]	Present	5	0.2	3	0.4	60.0	0.92 (0.39, 2.18)	1.06 (0.27, 4.11)
	Not present	3241	99.8	681	99.6	21.0	1.00	1.00
Patient almost fell[b]	Present	42	1.3	4	0.6	9.5	0.50 (0.36, 0.69)	0.66 (0.45, 0.97)
	Not present	3204	98.7	680	99.4	21.2	1.00	1.00
Patient was uncooperative[b]	Present	129	4.0	25	3.7	19.4	0.65 (0.36, 1.16)	0.42 (0.16, 1.07)
	Not present	3117	96.0	659	96.4	21.1	1.00	1.00
Patient had urgency to use bathroom[a]	Present	390	12.0	53	7.7	13.6	0.72 (0.49, 1.06)	0.89 (0.61, 1.30)
	Not present	2856	88.0	631	92.3	22.1	1.00	
I was in a hurry[d]	Present	141	4.3	27	3.9	19.2	1.14 (0.80, 1.64)	1.11 (0.73, 1.71)
	Not present	3105	95.7	657	96.1	21.2	1.00	1.00
I was told to use lift or it was required[b]	Present	179	5.5	165	24.1	92.2	3.67 (2.47, 5.45)	2.38 (1.74, 3.25)
	Not present	3067	94.5	19	75.9	16.9	1.00	1.00
I was in pain during my shift[d]	Present	133	4.1	50	7.3	37.6	1.20 (0.75, 2.00)	1.06 (0.68, 1.65)
	Not present	3113	95.9	634	92.7	20.4	1.00	1.00
Unit was short staffed[d]	Present	118	3.6	55	8.0	46.6	1.65 (1.17, 2.31)	1.32 (0.94, 1.87)
	Not present	3128	96.4	629	92.0	20.1	1.00	1.00
Lift was in patient's room or just outside[b]	Present	349	10.8	298	43.6	85.4	2.76 (1.48, 5.17)	1.82 (1.08, 3.06)
	Not present	2897	89.2	386	56.4	13.3	1.00	1.00
Sling was already under patient[b]	Present	92	2.8	85	12.4	92.4	2.94 (2.13, 4.07)	1.79 (1.27, 2.51)
	Not present	3154	97.2	599	87.6	19.0	1.00	1.00
Total		3246	100.0	684	100.0	–		

[i]Univariate and adjusted ratio measures from Poisson regression adjusted with Generalized Estimating Equations for nurse-patient-day clustering.
[a] Adjusted for shift type, patient mobility score, patient age.
[b] Adjusted for patient mobility score, patient weight, patient age.
[c] Adjusted for shift type, patient mobility score, patient age, acuity of patients during shift, and job.
[d] Adjusted for patient mobility score, patient age, acuity of patients during shift.
[e] Adjusted for shift type, patient mobility score, and patient has physical or mental impairments.
[f] Adjusted for patient mobility score, patient age, and patient has physical or mental impairments.

(2.94 [2.13, 4.07]). Participant experiencing pain during their shift (1.22 [0.75, 2.00]) was associated but not statistically significant.

Factors associated with less or decreased equipment use included (Table 3): patient/family preference (0.26 [0.10, 0.74]), staff assisting with lift did not want to use equipment (0.32 [0.18, 0.59]), could not get the lift under the bed/stretcher (0.39 [0.18, 0.83]), patient almost fell (0.50 [0.36, 0.69]). Patient wouldn't tolerate the lift (0.80, [0.28, 2.29], patient uncooperative (0.65 [0.36, 1.16]) and patient urgency to use bathroom (0.72 [0.49, 1.06]) were associated but were not statistically significant. Not enough space to use the equipment, patient fell, or staff being in a hurry were not associated with lift equipment use (Table 3).

Adjusting for confounding variables, associations for factors did not substantially change and tended to decrease in strength of association (Table 3).

4. Discussion

Among nurses and nursing care assistants working in inpatient hospital settings, lift equipment was utilized for 21% of patient lifts/transfers. Lift equipment use varied by the type of lift/transfer performed (35.5% stretcher-to-bed to 7.5% toilet-to-chair) as well as the factors present at the time of the lift and transfer (92% lift was required and sling already under the patient to 10% patient almost fell; patient or family preference; and staff did not want to use). Factors associated with 50% or greater lift equipment use suggest that nursing staff will more likely use the lift equipment and use it consistently when convenient, when administration and other staff support equipment use, and when clearly required by patient and mobility status.

4.1. Patient factors

Lift equipment was more likely to be used when patients were able to provide assistance (physically, mentally, or medically), when the patient size or weight required assistance, and with patients of lower mobility (bedfast or chairfast). Patient ability to assist (Engkvist, 2007) and size and weight (Engkvist, 2007; Schoenfisch, Myers et al. 2011) are supported as influential factors by previous work. The ability of patients to understand and follow instructions are important if the lift equipment is to be used safely. Likewise the ability of the patient to physically assist (tilt up, lift arms, etc.) enhances use when setting up the equipment. In contrast, patient medical conditions (Evanoff, Wolf et al. 2003; Engkvist, 2007; Schoenfisch, Myers et al. 2011) and patient and/or family preferences (Owen et al., 1992; Evanoff, Wolf et al. 2003; Engkvist, 2007; Alamgir, Li et al. 2009) were associated with lower equipment use. Patients may be connected to machines with lines and cables where the use of equipment would be difficult or even contraindicated. Interviews with participants indicated that nurses and nursing care assistants on critical care units often manually move the patient for these reasons; however, these units generally have higher nursing staff-to-patient ratios which means more nursing staff are available to assist with a manual lift/transfer. Training on equipment use that includes situational training where nursing staff practice the lifts in situations considering these obstacles would be valuable. Education of patients and families on the importance of lift equipment for patient and nursing staff safety may address that barrier.

4.2. Worker factors

When nursing staff are available to assist with lift equipment and indicate a preference for the use of lift equipment, nursing staff are more likely to use lift equipment (Engkvist, 2007; Alamgir, Li et al. 2009; Schoenfisch, Myers et al. 2011; Myers et al., 2012). This is supported by our study results; however, when nursing staff who are assisting do not want to use the equipment, the equipment is less likely to be used. This finding demonstrates the strong influence of both nursing staff availability and the preferences of assisting nursing staff which ultimately decide how a patient is lifted and transferred. For most lifts/transfers 2 people are recommended whether equipment is used or not and the preferences of the helper influence and may overrule the initiator. These preferences can be related to: time (e.g., takes too much time to get the equipment and person asking for help doesn't want to inconvenience the helper), comfort with the equipment (e.g., person assisting is comfortable/experienced or not with the equipment), perception that equipment isn't needed and a hassle (e.g., nursing staff think they can safely and more easily and quickly move the patient manually), and seniority or tenure of the helper (e.g., nursing care assistants less likely to insist when nurse prefers not to).

Previous studies have found that support from nurse management, lift champions or coaches (a unit level peer leader assigned to educate and advocate for lift equipment use on their unit), and other healthcare staff such as physical therapy are critical to whether lift equipment is used or not (Engkvist, 2007; Schoenfisch, Myers et al. 2011; Myers et al., 2012). When nursing management actively support the use of equipment via encouragement and/or providing training and access to lift coaches, nursing staff feel they can take the time to get the equipment, helping nursing staff are less likely to refuse equipment, and using the equipment more often increases overall level of comfort with the equipment. Other nursing staff-related factors associated with lift use included nursing staff were told to use the lift or it was required and the unit was short staffed. Staffing issues have been reported in other studies (Garg et al., 1992; Schoenfisch, Myers et al. 2011) as barriers to lift use.

4.3. Equipment factors

The availability (Garg et al., 1992; Engkvist, 2007) and accessibility (Garg et al., 1992; Alamgir, Li et al. 2009; Schoenfisch, Myers et al. 2011) of the lift equipment is a strong and critical predictor of equipment use which was supported by this study. Availability is related to whether the unit has that equipment and/or whether they share it with another unit, whether it is functional or in need of repair, and how many patients on the unit require the use of it. Accessibility relates to where the equipment is stored (e.g., storage closet, hallway) and how easy it is to get to it (e.g., blocked by other equipment). This study illustrates that when the lift is located in or in close proximity to the patient's room, the equipment is more likely to be used. When provided, ceiling lifts are the most available and accessible as they are in the room with the patient and many hospitals have invested in ceiling lifts for that reason. By addressing this barrier of availability and accessibility with a ceiling lift, it is hoped that nursing staff will use the lifts. However, in this study ceiling lifts were the least frequently used lift (2.6%). Ceiling lifts were not available on every unit in the current study, and if they were available, they were not available in every room. If the ceiling lift was in the room, interviews with participants indicated that different types of ceiling lifts are more useful than others and depend on the configuration of the ceiling mount (e.g., U-track versus H-track) or the operation (e.g., lever versus button operated). Finally, ceiling lifts may not reach all room locations (e.g., bathroom).

Availability of lift equipment supplies was the most frequent factor present when lifts were used (92%) and a strong overall determinant of lift equipment use in this study. Availability (Evanoff, Wolf et al. 2003) and other equipment related factors such as whether the battery was charged and equipment was functioning properly (Ronald, Yassi et al. 2002; Engkvist, 2007; de Ruiter and Liaschenko, 2011), have also been shown to have an important influence. When the sling was already under the patient, nursing staff were more likely to use the equipment. When staff have moved a patient from bed-to-chair, they may leave the sling while the patient rests in the chair knowing that they will be moving the patient back to the bed soon. However, this practice is not recommended or practiced universally as slings left under patients may get soiled and may contribute to adverse outcomes such as pressure injuries. Slings may also slide and staff have to reposition the sling under the patient prior to lifting them.

4.4. Situational factors

Situational factors are those that are unique to that nursing staff member, for that patient, for that lift/transfer, on that day, and at that time. Situational factors may be of short or long duration but are generally viewed as transient in nature. Patient falls have been indicated in previous studies as situations where lift equipment is used to get the patient back into the bed safely without injury. In this study, participants reported 5 patient lifts/transfers associated with patient falls (0.2% of lifts) and lift equipment was used 60% of the time; however, with so few instances, risk ratio estimates were not reliable. Of these 5 falls, 2 patients were bedfast or chairfast (40%) and 3 patients were high fall risk (60%). However, there were 42 patient lifts/transfers (1.2% of lifts) where a patient almost fell and this was associated with lower equipment use (10% use and RR = 0.66). Of these 42 near-falls, 9 patients were bedfast or chairfast (21%) and 29 patients were high fall risk (69%). These situations may be characterized by patients who may appear to be stable and/or mobile so equipment was not used and the patient

almost fell because they weren't stable or independently mobile. It could also be reflective of patients who attempt to get out of bed on their own and almost fall. This finding illustrates the dynamic and variable nature of patient care needs in hospital settings. Previous research supports this finding for falls (Myers et al., 2012) and nursing staff reported the need to be vigilant about their patient condition and their own safety. This finding combined with patient mobility level would suggest additional training and education to address this concern and/or greater precautionary use of lift equipment regardless of mobility levels.

Another situation assessed in this study included an uncooperative patient which was associated with lower use of equipment. A previous study found that an uncooperative or combative patient was a barrier to lift equipment use (Engkvist, 2007). Healthcare staff are trained and hospitals have policies on how to handle uncooperative patients and if healthcare staff (or the patient) perceive the lift equipment as a danger to the patient, staff are less likely to use the lift equipment. Further, patient comfort was reported in previous studies as an influential factor in lift equipment use (Owen et al., 1992; Alamgir, Li et al. 2009; de Ruiter and Liaschenko, 2011; Myers et al., 2012). An uncooperative patient may simply refuse the lift equipment whereas a combative or aggressive patient may actively resist any effort to be lifted/transferred. Unlike the former situation where nursing staff may be able to educate and redirect the patient, the latter situation could be a contraindication to lift equipment use (e.g., a combative patient may attempt to get out of the lift and suffer injury).

A patient's urgency to use the bathroom, also associated with lower use of equipment (14% lift equipment use; RR = 0.89), illustrates a similar situation where patient dignity and desire for independence may drive a nursing staff members' decision to not use lift equipment. It takes time to get the equipment set up, to secure the patient in the equipment, and to lift/transfer the patient to a bedpan, bedside commode, or bathroom. Nurses who feel a patient can't wait to be secured in the lift equipment, may decide more often in this situation to manually lift/transfer the patient.

Previous studies have universally found time (e.g., not enough, constraints) and nursing staff task demands (e.g., competing tasks) to be a major barrier to lift equipment use (Garg et al., 1992; Evanoff, Wolf et al. 2003; Li et al., 2004; Engkvist, 2007; Alamgir, Li et al. 2009; de Ruiter and Liaschenko, 2011; Schoenfisch, Myers et al. 2011). A previous study reported that bed-to-chair transfers took significantly longer when powered floor based dependent lifts were used versus ceiling lifts (mean time 287.9 vs 111.8 s) (Alamgir, Li et al. 2009). The preparation and set up phase took 3 times longer for floor lifts compared to ceiling lifts (183.3 vs 59.7 s) and the actual lift time was 2 times longer (104.6 vs 52.1 s). In this study, participants were asked questions that involved a time component: participants reported they were in a hurry during 4.3% of patient lifts and this was not associated with lift use (RR = 1.11). However these factors captured a limited view of time which previous studies indicate is much more complex (Schoenfisch, Myers et al. 2011). Finding ways to improve the efficiency of lift equipment use (e.g., additional equipment; convenient equipment storage locations; increased accessibility of lift equipment and supplies) as well as other measures to address nursing staff time and activity demands (e.g., increasing nursing staff-to-patient ratios) may improve equipment use.

A number of other general factors were found to be associated with lift equipment use in this study. These findings indicate the importance of individual preferences for equipment use based on characteristics such as gender (e.g., females more likely to use equipment than males), job (e.g., nursing care assistants more likely to use equipment compared to nurses), job tenure and patient care experience (e.g., higher use for those with >2-3 years' experience), and prior equipment use. Organizational and unit level factors also play an important role where community hospitals and medical and mixed unit types were more likely to use equipment. This information is useful for focusing hospital safety and administrative staff efforts to address facilitators and barriers to lift equipment use.

4.5. Strengths and limitations

Strengths of this study include prospective assessment of patient lifts, lift equipment use and the presence of factors when the lift/transfer was performed. Establishing outcomes and exposures simultaneously enables an assessment of the *actual, proximal* influence of these factors on nursing staff patient lifting and transfer decision making. Participants were asked to report the presence of factors at the time of the lift/transfer and we could not validate the presence of these factors. We sought to measure and quantify the factors present at the time of the lift/transfer *as perceived by the participant*. By definition, these are subjective, non-validatory measures related to participants' own experiences. If a participant self-reports they did not have time to use the lift, it is irrelevant whether that response is validated because their perceived experience or reported reasoning are the factors we were interested in capturing. Preliminary interviews with nurses and nursing care assistants informed the factor development and selection, data collection methodology, and interpretation of the study findings. Finally, this study comprised a multi-disciplinary team of researchers, practitioners, and administrators with expertise in epidemiology, ergonomics, health care administration, nursing, and physical therapy.

Despite these strengths, this study had the following limitations. First, participants in this study constitute a volunteer sample of nurses and nursing care assistants working in a university medical center and two community hospitals within one healthcare system. Results may not be generalizable to other hospital systems with different policies, resources, or patient and nursing staff profiles. Sample size goal of 100 participants was based on estimated 12 patient lifts/transfers per person per weekly period and 25% lift equipment use for 3 lifts/transfers with equipment use per person per weekly period (Knibbe and Friele, 1999) providing as estimated 900 lifts/transfers with equipment use over the 3 month study. Analyses of baseline survey data comparing individuals who participated in the lift assessment study versus those who didn't revealed that participants were more likely to be from the university hospital system, a nurse at level clinical nurse II, and 10 or more years' tenure on their current unit. Second, some participants did not complete all questions in the log and there were missing values for some patient characteristics, lift characteristics, and lift log quality and compliance measures. Multiple imputation methods were utilized to impute values for patient weight, height, and mobility status to enable multivariate analyses. However, other values could not be imputed. In addition, validation of the actual lifts, types, and lift use through direct measurement was outside the scope of this study. Such direct observation would have required entering patient rooms which would have required patient consent and HIPAA authorization. However, we did ask participants about the accuracy of their reporting to get at this indirectly. The factor associations observed in this study did not differ when limited to shifts with >75% lift recording rates or >75% accuracy of data collection. The factors and situations in this study may have occurred in combination; however we did not have enough study power to assess the combined impacts of these factors. Finally, the unit of analysis was the patient lift/transfer and lifts/transfers were clustered by nurse, by patient and by shift-day. Generalized estimating equations accounted for clustering by nurse and patient-day in both univariate and multivariate models. However, patients were not

identified and therefore could not be linked from day-to-day in this study, therefore regression models do not completely account for clustering by patient.

5. Conclusions

Previous research indicates that patient-lifting injury rates were lower on units that utilized lift equipment more (Evanoff, Wolf et al. 2003) suggesting that strategies to maximize lift use, when appropriate, are warranted. This study found that factors related to patient and mobility status, convenience, and administration and nursing staff support of equipment use were important and strong predictors of lift equipment use. Patient mobility and condition factors included: patient unable to help with the lift, patient size and weight requires lift equipment, and patient mobility status. When nursing staff can identify the patient's mobility status, they can determine how to assist the patient with the lift equipment based on the type of lift/transfer. Patient size and weight will also drive equipment use and is strongly related to accessibility and availability of equipment. Convenience factors included: lift and supplies available and accessible, lift equipment in or near room, and sling already under the patient. Ensuring that all supplies are available and accessible by setting up a sustainable process is important and is similar to having gloves in every room. Accessibility of lift equipment suggests that equipment needs to be both available on the unit and in close proximity to the patient. Some units may need more than one piece of equipment to achieve this. Administrative or nursing staff factors included: being told to use lift equipment/it was required, staff able to assist with lift equipment, and staff assisting wanted to use lift equipment. Expectations from administration (i.e. manager) that nursing staff should use the lift equipment consistently when it is appropriate for the task or transfer can be facilitated by: provision of resources to support lift equipment availability, providing nursing staff adequate time to be trained (and retrained) on the equipment, ensuring adequate nurse staffing ratios, and the presence of lift coaches on all units and on all shifts. When nursing staff feel supported by administration, peers, and other healthcare staff that the use of lift equipment is an expectation they may be more likely to overcome identified barriers. The more nursing staff use the equipment, the more familiar and comfortable they will be using it.

Quantifying the presence and influence of factors that serve as promotors or barriers to lift equipment use by nursing staff provides critical information for safety and administrative staff as they work to improve the safety of patient handling activities in the acute care hospital setting. The information from this study can inform lift equipment training education and other strategies. Real-world scenarios based on the factors assessed in this study (e.g., bathroom urgency, staff assisting do not want to use lift, patient or family preferences) could be developed to assist nursing staff in their decision making regarding lift equipment use. Such scenarios can also be incorporated into ongoing education efforts as well as topics for nursing staff to discuss during unit meetings. Incorporating the actual experiences of nursing staff into education, training, and policy may improve the translation of these measures to actual improvements in adoption and use.

Conflicts of interest

See attached conflict of interest disclosure statements [not listed for blinded peer review].

Acknowledgements

This study was funded by a grant from the National Institute for Occupational Safety and Health, United States (NIOSH R21 OH010542). Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the National Institute for Occupational Safety and Health, the Centers for Disease Control and Prevention, or the Department of Health and Human Services. We thank the nurses and nursing care assistants who participated in this study.

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