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Pressure Injury Prevention: Outcomes and Challenges to Use of Resident Monitoring Technology in a Nursing Home

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ABSTRACT

PURPOSE: We examined the usability, user perceptions, and nursing occupational subculture associated with introduction of a patient monitoring system to facilitate nursing staff implementation of standard care for pressure ulcer/injury prevention in the nursing home setting.

DESIGN: Mixed methods, pre-/posttest design.

SUBJECTS AND SETTING: Resident (n = 44) and staff (n = 38) participants were recruited from a 120-bed nursing home in the Southeast United States.

METHODS: Digital data on frequency and position of residents were transmitted wirelessly from sensors worn on each resident's anterior chest to estimate nursing staff compliance with repositioning standard of care before and after visual monitors were activated to cue staff. The validated Nursing Culture Assessment Tool was used to determine changes in nursing culture. Benefits and challenges of implementation were assessed by 2 focus groups composed of 8 and 5 female members of the nursing staff (RN, LPN, CNA), respectively, and led by the three authors. Descriptive statistics were used for all quantitative variables, and inferential statistics were applied to categorical variables (χ^2 test or Fisher exact test) and continuous variables (analyses of variance or equivalent nonparametric tests), respectively, where a 2-sided *P* value of <.05 was considered statistically significant.

RESULTS: System use significantly (*P* = .0003) improved compliance with every 2-hour repositioning standards. The nursing culture normative ranking percentage increased from 30.9% to 58.2%; this difference was not statistically significant. Focus groups expressed satisfaction with the monitoring system and recommended improvements to support adaptation and use of technology.

CONCLUSIONS: Study findings support the usability of the patient monitoring system to facilitate repositioning. Implementation of multiple strategies for training, supplies, and communication may enhance uptake and effectiveness.

KEYWORDS: Electronic monitoring, Nursing occupational subculture, Pressure injury, Pressure ulcer, Prevention, Repositioning, Triaxial-accelerometer.

INTRODUCTION

A pressure injury (PrI) is any localized damage to the skin and underlying soft tissue usually over a bony prominence or related to a medical or other device resulting from prolonged exposure to pressure with or without shear, which may cause capillary occlusion, tissue necrosis, and eventually death.[1] According to Pieper's review,[2] prevalence of PrI in US long-term care (LTC) facilities ranged from 8.2% to 32.2%; incidence varied widely from 3.6% to 59%. Damage can cascade into complications such as amputation, septic infection, impaired health-related quality of life, and premature death.[3] Annual treatment costs in the United States are estimated at $9.1 to $11.6 billion,[3] far greater than prevention costs.[4-6] Given the rising proportion of older adults in the population, prevention should be a priority.[7]

Residence in LTC facilities is a risk factor for PrI.[8] New technologies used to prevent PrI include high-density foam support surfaces, more frequent electronic medical risk reports, and digital auditory cues to facilitate on time repositioning.[9] More recently, patient monitoring (PM) systems that use individual wireless sensors have been placed on residents to record position and movement.[10,11] A clinical trial[12] in nursing homes (NHs) is underway that uses a PM system to track resident movement and position to examine the effectiveness of 3 different resident repositioning intervals (every 2, 3, and 4 hours). This article reports the feasibility study that examined usability

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of a PM system in an NH prior to implementation of a larger clinical trial.

The use of new technologies to cue nursing staff to reposition NH residents exemplifies the technical and adaptive challenges presented in the Adaptive Leadership Framework for Chronic Illness.[13] Briefly, the framework suggests that, in adopting a PM system, NH administration, nursing staff, and residents collaborate to reduce PrIs. Effective prevention requires monitoring, assessing, and planning care in the context of emerging situational information and shared meanings. Adaptive challenges include situations that require new values, attitudes, skills, knowledge, and behaviors from stakeholders. Challenges emerge where technical solutions and expertise are required for resolution. To understand this process, we examined both quantitative data (compliance with repositioning protocols) and qualitative data (perceptions of usability) of the nursing staff. Study aims were to (1) compare nursing staff compliance with repositioning protocols before and during 18-day PM system implementation, (2) describe prevalence of PrIs before and after and incidence during implementation, and (3) assess the nursing occupational subculture before and after implementation and staff perceptions of adaptive and technical challenges during implementation.

METHODS

We used a convergent mixed-methods pre-/posttest design. We examined the nursing occupational subculture, repositioning frequency, and protocol compliance during a 3-day baseline period and an 18-day intervention period, using a wireless 24-hour PM system. We also assessed the nursing staff's perspectives on adaptive and technical challenges in improving protocol compliance.

Participants were recruited from a 120-bed NH in the Southeastern United States. The NH had 2 wings, each with 2 hallways (AB, CD) that were staffed by 1 set of nurses who worked at a nurse's station at their intersection. Prior to the study, the 3-month facility-acquired PrI prevalence rate was 7.3% (national average: 7.4%).[14] The NH used as the setting for this study based their protocol on recommendations from the NPUAP/EPUAP/PPPIA 2014 guidelines requiring all residents to change position or be repositioned every 2 hours.[15] Skin integrity was assessed upon admission and weekly by licensed nursing staff and documented in the electronic medical record. Certified nursing assistants (CNAs) made daily skin observations during routine care and reported skin changes to a licensed nurse for further assessment.

The target population was RNs, LPNs, and CNAs employed full- or part-time in direct resident care; participation in surveys and focus groups was voluntary. Brochures and posters in break rooms and nursing stations described the study. First, staff participants were invited to complete an anonymous online 5- to 10-minute survey before and after system implementation; participation implied consent. Second, English-speaking staff members were invited and consented to attend one of two 1-hour focus groups, held in a well-lit, private, conference room at the NH. Sessions were recorded; participants received a $30 department store gift card for participation.

The director of nursing served as primary contact person for the research team and ensured availability of staff members for training, performance of PrI risk assessments, and communication with residents and families. The Institutional Review Board for Clinical Investigations, Duke University Health System, Durham, North Carolina, reviewed and approved the study procedures, including waivers of consent (IRB #Pro00064606).

Instrument and Study Procedures

Compliance with the repositioning protocol was measured using the Leaf patient monitoring system (Leaf Healthcare, Pleasanton, California).[11-12,16] The monitoring system comprises a single-patient use triaxial-accelerometer sensor with medical-grade adhesive backing; the device is adhered to the upper chest and programmed to repositioning standards of care. Data are communicated wirelessly to a central monitoring station. An LCD screen in each nurse's station displays each resident's repositioning history in minutes. Each resident's status is color-coded as red (overdue >120 minutes since last turn), yellow (105-120 minutes since last turn), or green (0-105 minutes since last turn); the LCD screen also displays positional status (left, back, right, upright, prone); compliance score by resident, wing, and shift; and presence of an unattached sensor. Nursing staff may "pause" the cue in the monitoring system for up to 2 hours and document the reason (eg, clinical circumstances, resident refusal, resident off unit, procedure in progress). Self-repositioning by residents automatically resets the system to begin the countdown until the next 2-hour turn is due. Sensors detect position changes based on degrees of roll angle across specified thresholds.

Turn alert hours was calculated as the (sum of red/overdue minutes >120)/60 for whatever set of hours was specified. Options included red/overdue minutes for a resident during an 8-hour shift, for an NH wing during a 24-hour day, or for all residents during the 18-day intervention period. Total monitoring time was operationally defined as the sum of minutes the sensor(s) were active for the time specified. Compliance was calculated as (1 – [Turn alert hours for the time specified]/[Total monitoring time in hours for the time specified]).

Following PM system installation and 2 days prior to system activation, each resident and/or family member was provided a letter on NH letterhead describing use of the PM as standard of care. The LCD screens at each nurse's station were not activated during the 3-day baseline period. On day 1 of the 3-day baseline period, all resident participants were fitted with a sensor affixed to the mid-sternum, thus activating wireless data reception. At that time, researchers employed a "just-in-time" training technique comprising a 5-minute demonstration of attachment and a handout, which was reinforced at shift changeovers. On day 3 of the baseline period and day 1 of the intervention period, the research team trained nursing staff in 10 sessions across all shifts on PrI etiology and prevention, repositioning techniques, and digital measures of compliance captured by the PM system. Unit based champions were recruited from training sessions for an additional 30 minutes of training to provide additional PM system expertise. On day 1 of the 18-day intervention period, the LCD screens at each nurse's station were activated, displaying all residents' repositioning status and providing the first visual cueing to staff.

Rolling admission of resident participants included those without a PrI and rated as mild, moderate, or high risk of PrI development. The Braden Scale for Pressure Sore Risk (Braden Scale) was used to measure PrI risk.[17] The Braden Scale measures 6 factors linked to PrI risk, moisture, activity, mobility, nutrition, friction/sheer, and sensory perception (range: 6-23); higher scores represent lower risk; and the instrument has undergone extensive validation.[18,19] Residents scoring more than 18 (no risk) and less than 10 (severe risk) were excluded, the latter already having individualized repositioning schedules. If eligible, newly admitted residents were included.

Surveys were administered electronically using a tablet device. Two demographic variables (age and gender) and 2 employment variables (length of time employed in years and current job category) items were measured, in addition to assessment of the nursing occupational subculture of the study site, using the Nursing Culture Assessment Tool (NCAT), at baseline and after the intervention.[16]

Occupational subculture exerts latent influence on the quality of work produced and the effectiveness of a workforce.[20,21] Our previous work supports use of the NCAT as a stable, valid, and reliable instrument to screen nursing's occupational subculture in LTC settings.[18,19] The NCAT contains 19 declarative statements scored on a 4-point ordinal scale ranging from strongly disagree (1) to strongly agree (4) that load on 6 factors: expectations, behavior, satisfaction, teamwork, communication, and professional commitment related to nursing practice.[18] Raw scores range from 19 to 76; they are converted to normative ranking percentages (0%-100%) for purposes of data analysis.[19] High cumulative NCAT scores potentially represent a beneficial influence of the nursing occupational subculture on the planned change in resident monitoring technology, on the advancement of best practices of repositioning, and on the improvement in outcomes such as prevention of PrIs.

Challenges and adaptation strategies were measured via semistructured questions designed for focus groups. The questions were based on Diffusion of Innovation[22] and Adaptive Leadership[23] models, using a standardized topical guide. Probes focused on expectations prior to implementation; burden; perceived outcomes; changes required in attitudes, behaviors, or skills; technical problems; and proposed improvements to PM system. Two 1-hour focus group sessions led by the 3 authors were held during, each, first and second shifts and audiotaped for verbatim transcription. Participants received a $30 department store gift card for participation.

DATA ANALYSIS

Descriptive statistics were used to summarize resident positions, changes in position, repositioning frequency, on time compliance percentages, overall staff on time mean repositioning compliance by wing and shift, and NCAT subscale and total scores before and during the intervention. For categorical variables, we used χ^2 test or Fisher exact tests to determine the significance of univariate differences. For continuous variables, we used analyses of variance or equivalent nonparametric tests, depending on variable distributions. A 2-sided P value of $<.05$ was considered statistically significant.

Qualitative analyses derived from focus group data were conducted using directed content analysis applying Adaptive Leadership theory to guide initial coding.[13] Verbatim transcripts with field notes were checked against original recordings for accuracy and analyzed using NVivo 10 (QSR International Pty Ltd, https://www.qsrinternational.com/nvivo/home)[24] Each researcher highlighted the text using predetermined categories and then examined it for subcategories. Matrices organized the data, and summaries of emergent categories were developed. Analytical goals included credibility, dependability, confirmability, and transferability.

RESULTS

Resident participants were predominantly older than 65 years, female, and distributed relatively based on PrI risk (Table 1). The maximum number of resident participants monitored simultaneously with the PM system on the 2 wings was 17 and 21. Forty-four residents were monitored for 2 to 21 days. Ten residents declined participation; refusal to participate was provided by 8 residents and 2 family members; 3 residents subsequently agreed to participate.

Thirty-four staff participants completed surveys before the intervention and 38 completed surveys following data collection. The majority were CNAs (61%), who typically provide 80% to 90% of direct care in NHs.[25] After all English-speaking staff members were invited to attend focus groups, those participating were consented and attended one of two 1-hour focus groups, held in a well-lit, private, conference room at the NH. A group was held during, each, first (n = 8 female African American CNAs) and second shift (n = 1 African American RN, 1 African American LPN, and 3 white CNAs, all female) shifts. All participants had 6 months of job experience or more.

Repositioning Protocol Compliance

The mean percentage of on time repositioning compliance for all units during the baseline and intervention periods by work shift is summarized in Table 2. Resident participant repositioning occurred 53,753 times, most often during the 7 AM to 3 PM shift and least often overnight. Resident participants were monitored for a total of 11,632.9 hours during the 21 days of the study. On day 21, 18 of 44 (41%) residents were wearing sensors.

During the 3-day baseline period, repositioning compliance ranged from 7.0% to 100% for each monitored resident (mean compliance = 61.4%). During the 18-day intervention, repositioning compliance ranged from 50.6% to 100% for each monitored resident (mean compliance = 81.5%). Over the 18-day intervention period, nursing staff used the pause function 342 times, an average of 16 times per resident for 37 of the 44 residents; 7 resident participants were never paused. Pauses used were primarily attributable to procedures (37%) and refusals to reposition/be repositioned (21%).

The mean repositioning compliance during the intervention period was significantly higher than the baseline period (t = 4.42, P = .0003), with significant improvements on the 3 PM to 11 PM (P = .02) and 11 PM to 7 AM shifts ($P < .0001$). No new PrI developed during the baseline or intervention periods.

Effects on Nursing Occupational Subculture

The internal consistency (Cronbach α) of the NCAT pre- and postintervention surveys was 0.93 and 0.94, respectively. No statistically significant differences in NCAT scores before or following the intervention were observed in relation to age, job category, or years of experience working at the NH. Mean scores for all individual items and the 6 NCAT subscales were higher after the intervention period than before (Table 1). Total NCAT scores were 56.6 preintervention and 60.1 postintervention, which were not statistically significantly different. Overall nursing culture normative ranking percentage increased from 30.9% to 58.2%.

Among the NCAT subscales, only the communication subscale scores improved significantly (F = 4.605, P = .035). Selected items on NCAT subscales for communication (no. 11—Use of appropriate language with other staff—F = 6.63, P = .012) and satisfaction (no. 15—Overall culture of organization

TABLE 1.
Characteristics of Resident Participants (n = 44) and Staff Participants on Pre- (n = 34) and Postintervention (n = 38) Surveys

Characteristics	n (%)		Mean		Range	
Residents						
Age, y						
<60	2 (4.5)		79.44		27-105	
60-65	5 (11.4)					
66-75	9 (20.5)					
76-85	9 (20.5)					
86-90	9 (20.5)					
>90	10 (22.7)					
Gender						
Male	13 (29.5)					
Female	31 (70.5)					
Braden Risk Score			13.5		10-18	
Mild (15-18)	13 (29.5)					
Moderate (13-14)	15 (34.0)					
High (10-12)	16 (36.4)					
No. of days monitored			12.23		2-21	
2-7	19 (43.2)					
8-14	4 (9.1)					
15-21	21 (47.7)					
	Pre	**Post**	**Pre**	**Post**	**Pre**	**Post**
Staff						
Age, y						
21-25	0	1 (2.6%)				
26-35	6 (17.6%)	11 (28.9%)				
36-45	15 (44.1%)	11 (28.9%)				
46-55	7 (20.6%)	13 (34.2%)				
56+	6 (17.6%)	2 (5.3%)				
Gender						
Male	2 (5.9%)	0				
Female	32 (94.1%)	38 (100.0%)				
Years worked at NH			8.45	7.90	1-33	1-32
Job category						
RN	8 (23.5%)	4 (10.5%)				
LPN	8 (23.5%)	8 (21.1%)				
CNA	18 (52.9%)	26 (68.4%)				
Nursing culture						
Expectations			8.85	9.32	3-12	3-12
Behaviors			8.71	8.92	5-12	3-12
Teamwork			10.79	11.63	5-16	5-16
Communication			8.79	9.55	3-12	6-12
Satisfaction			5.50	6.01	2-8	3-8
Commitment			13.97	14.61	11-16	10-16
Total			56.62	60.08	35-75	34-76

Abbreviation: NH, nursing home.

is positive and supports high-quality care—$F = 5.34$, $P = .024$) significantly increased following the intervention.

User Perceptions

Staff responded positively to the PM repositioning cues and described an enhanced sense of collaborative teamwork, stating that usual care was provided in a timelier manner. Focus groups discussed technical challenges posed, recommended improvements in implementation strategies, and expressed a desire to continue using the PM system. Three thematic categories emerged related to using the monitoring system.

Adaptive Challenges

Staff described changes in individual and group behaviors and evaluations, with an accompanying positive sense of accomplishment. One participant said, "It helps me keep up because—having 12 or 13 patients and trying to remember to get back in time—it helps me keep up. When I go past the monitor: 'Ok, I got an hour on her, I got such-and-such on her.' I know who to go back to and get turned and dry, who's due, who's not. It helps. I like it." Another reported on collaborative adaptation related to the particularities of her shift. "I think it's an excellent system. Just like first shift, like you said, our staff didn't really

TABLE 2.
Turns/Repositioning and Average Compliance by Shift for Staff Participants During 3-Day Baseline and 18-Day Intervention Periods

	Turns	Monitoring Time, h	Movement, Turns/h	Compliance[a]
Baseline total[b]	14237.0	2631.4	5.4	61.4%
Shift 1 (7 AM-3 PM)	6466.0	752.5	8.6	69.1%
Shift 2 (3 PM-11 PM)	5679.0	934.9	6.1	62.7%
Shift 3 (11 PM-7 AM)	2092.0	944.0	2.2	53.8%
Intervention total[c]	39516.0	9001.5	4.7	81.5%
Shift 1 (7 AM-3 PM)	23710.0	3025.9	8.4	81.1%
Shift 2 (3 PM-11 PM)	15933.0	3004.0	5.3	76.5%
Shift 3 (11 PM-7 AM)	759.0	2971.6	0.3	86.8%

[a]Calculated as [1 − (No. of turn alert [overdue] hours for period of interest)/(Total monitoring time in hours for period of interest)].
[b]Based on monitoring 24 hours a day over the 3-day period (Friday through Sunday), during which time sensors were placed on residents, but LCD screens were not turned on.
[c]Based on monitoring 24 hours a day over a 21-day period during which time sensors remained on residents and LCD screen were turned on.

change too much. It's just fast-paced. It's a fast-paced shift of time frame. So therefore, we did have one person who was like our captain. So, she'll come out and say, 'Oh, you know it's time for you to reposition him.' Or 'You know it's time.' Somebody that's keeping up on it. And that made it better for you. It was a constant reminder that you had, you know: turn and reposition somebody." Staff members with assigned residents closer to the monitor provided an informational safety net for staff members working further from the cueing screen.

Technical Challenges

A primary technical challenge was insufficient monitor screens. Having a screen nearer the residents' rooms would have enhanced their ability to turn on time. As one participant noted, "We needed to have another screen down the hall; we can't keep going up to the station to see who is due for a turn."

A second technical challenge involved "detached sensors discovered in the bed." Sensors became unattached because of resident picking behaviors (especially self-soothing behaviors among residents with dementia), moist skin under the sensor, or application of leave-on skin products such as creams or ointment on the skin prior to sensor application. Staff were further hampered in resolving this challenge because they had difficulty in both locating and assigning the new sensor's number to the appropriate resident as well as neglecting to refer to the available tip sheet.

A third technical challenge was the availability of sufficient numbers of wedges and pillows to position residents in accordance with prescribed sensor settings for threshold angles. They appreciated training on correct positioning. "It showed how to position better with the pillows. [Prior to this study] we were using pillows or whatever you could find. I had put teddy bears behind them. Wedges positioned better than pillows." Another staff participant remarked, "Different sizes of wedges would help," particularly for the approximately one-third of residents who were overweight and obese.

Planning the Work

Repositioning all residents was valued as a shared goal, regardless of individual staff assignments: "It lets the other ones know or just go do it. And let the other ones know, 'I just turned her; you got another two hours before you got to turn her again', or whatever. Yeah, it makes a difference." The goal of patient-centered care planning was particularly salient for the staff: "It helped us keep up with the patients."

DISCUSSION

We evaluated the usability of a PM system to improve compliance with every 2-hour repositioning protocols among residents of an NH. Usability of a new technology is an underspecified construct in the literature, but health institutions are assumed to be key stakeholders, and the findings of this study support its emerging dimensions, including resources to ensure safe implementation, practical risk assessment, development of best practices for small institutions, customization, workflow, and training.[26] Our results suggest that an electronic PM system may be safely implemented in a small LTC setting to assess changes over time in percentage compliance with repositioning standards, but end users had multiple recommendations for optimal customization, more efficient workflow, and effective training. This study builds on our prior work and that of others by assessing dimensions of usability for a cueing system previously untested in LTC settings.[8,27] The findings informed the implementation of our follow-up research on adherence to repositioning protocols in a large clinical trial.

Our study was the first to use the NCAT and user focus groups to assess how this new cueing technology affected the nursing occupational subculture of a small LTC organization, as well as ascertain what were user perceptions of the safety, reporting, workflow, and training for this planned change. The overall NCAT scores, although not statistically significantly different before and after implementation, suggested the potential of PM system for improving teamwork and communication. This finding was reinforced in the focus groups, in which staff participants expanded on how the PM system improved communication, satisfaction, and professional commitment. User perceptions focused primarily of the usability dimensions of patient safety, customization, and training. There are 4 insights that should inform implementation of such a system in the clinical setting for research or practice. They are: (1) minimize negative influence of technical challenges, (2) maximize sensor usage, (3) maximize adaptation to system via training, and (4) maximize staff investment in shared meaning of compliance as the outcome (Table 3). These findings from the NCAT and focus groups may inform the methodological strategies of clinical trials that involve planned change through introduction of new technologies intended to promote compliance with repositioning protocols.

Technical challenges encountered by nursing staff during the trial included placement of the sensor, positioning the resident, and location of the monitor that displayed the cues for

TABLE 3.
Suggested Improvements to Implementation of Patient Monitoring System Based on Study Findings

Minimize technical challenges
Supply individual packets of skin prep for initial and replacement sensor attachment
Supply adequate repositioning supports, including multiple wedges for larger-sized residents and sufficient pillows and pillow cases, with instructions for disposal or cleaning
Provide adequate monitor visibility, either stationary or mobile, as funds allow
Maximize sensor usage
Formalize system of documentation of sensor removal and cause
Include Braden Scale for Pressure Sore Risk reassessment at least once a week to optimize enrollment and participation
Refine communication to family and residents to include rationale and benefits to PM systems
Maximize adaptation via training
Include evidence of compliance benchmarks associated with facility itself and wider industry
Require return demonstration for initial place and replacement of sensors
Program opportunities for role play for interactions with hesitant residents and family members
Expand training opportunities to accommodate late comers and booster sessions
Set minimum requirement for participation of facility staff
Maximize staff investment in shared meaning of compliance
Improve investment of champions through training, ongoing support, and rewards
Increase investment of directors of nursing by fostering early adoption/commitment to project and benefits to NH
Formalize training and booster sessions for unit managers that include frequent contact with trainers and responsiveness to feedback

Abbreviations: NH, nursing home; PM, patient monitoring.

required repositioning. We found that staff needed clear, concise instructions and skin preparation supplies that were inexpensive, allergy-free, prepackaged, and lightweight. For correct repositioning, staff needed adequate physical supports, preferably 40° wedges. To aid in side-lying positioning of residents who were dependent on assistance to move, we recommended 5 pillows or 3 pillows plus 2 wedges (40° TurnWedge—https://turnwedge.com/) per resident to be made available for nursing staff use.

The placement of monitors only at nursing stations was a significant challenge for staff-assigned residents at the far ends of the wings. Staff adapted their teamwork such that staff closer to the monitor alerted more distant staff to the changing cues. Depending on restrictions regarding cost, privacy, and Occupational Safety and Health Administration regulations, incorporation of the monitoring system in powered mobile computer carts or wall-mounted kiosks may be an option.

Time, date, and serial number were automatically recorded in the PM system when a sensor was applied or removed; however, our study design did not include an additional tracking mechanism for nursing's application, change, or removal of a sensor. In order to overcome this limitation, on-site researchers noted all removals and reasons in a study log. We recommend ongoing reassessment of change in PrI risk status to determine appropriateness of continued sensor use and to inform care decisions regarding potential need for a more frequent individualized repositioning schedule. Weekly reassessment of all residents is recommended via the Braden Scale, which has demonstrated reliability and validity as a screening tool for risk of PrI in the NH.[28]

We encountered some residents who refused application of the sensor. Earlier notification of residents and families at least 10 days prior to adoption of the PM system could be used to address such refusals. Staff could be provided with key talking points for responding to refusals such as reminders that there is no additional charge for sensor use and reassurance that use will help staff maintain a regular repositioning schedule as part of a PrI prevention protocol. Improved communication between NH leadership, bedside caregivers, and residents/families supports shared meaning and collaboration described by Anderson and colleagues.[13]

Shared meaning would also be supported if training included scientific evidence for the benefits and limitations of traditional repositioning processes, benchmarks for compliance, and historical trends in the local facility, wings, and shifts. Practice replacing the sensors initially and in booster sessions may produce more reliable results. Role play could provide opportunity for bedside staff to practice interactions with residents who resist placement of sensors, especially residents with cognitive challenges, and with families. In order to minimize staff absences, minimum requirements for video and classroom training should be set in advance. Enforcement of 80% to 90% participation rates would support optimal resident care. We also recommend establishing a plan for evaluation and return demonstrations of system use prior to its implementation.

Finally, although "champions" of the project had been designated, some stakeholders were unaware of who they were, perhaps diminishing their effectiveness in supporting implementation. Focused training and rewards with "swag" items might foster stronger investment among champions.

STRENGTHS AND LIMITATIONS

This study examined the usefulness of a digital system for cueing nursing staff, which had not previously been tested in NHs. Compliance with every 2-hour repositioning standards significantly improved, especially during the evening and overnight shifts. Study findings suggest that implementation of a technological change in NHs, when informed by the Adaptive Leadership Framework,[11] may be associated with positive changes in the occupational nursing subculture, specifically improved teamwork and communication, as reflected in NCAT scores. This finding builds on recent evidence that the NCAT predicts government ratings of quality of care in NHs.[29] Finally, this study provided NH staff an opportunity to contribute situational information on the adaptive and technical challenges to implementation of a technological change, as well as qualitative data on ways to develop a shared meaning for the intervention, as described in the guiding framework.

Limitations included the small sample size, single facility study setting. These limitations did not allow meaningful analyses of subgroups with risk profiles that varied by demographics, diagnoses, or other factors. Improved compliance with care standards was achieved and rich data on benefits and challenges for staff were analyzed in the short term, that is, 18 days; however, conclusions about sustainability of compliance and acceptability by users await accumulation of outcome data over a longer time period. Third, the research team was gaining familiarity with the sensor technology alongside the staff, which may have posed increased challenges to the staff. Strategies suggested by lessons learned remain untested with respect to lowering barriers to effective adoption of this technology.

CONCLUSIONS

Our findings suggest that a PM system such as that tested may be usable as a means to cue staff to comply with repositioning standards in LTC over the short term and that its implementation in an adaptive leadership context may improve elements of the occupational nursing culture and inform problem solving for better adaptation to the change. To maximize implementation of, and acclimation to such a planned technological change, we recommend resourcing the clinical environment according to staff need and workforce flow, specifying best practices for documentation of the nursing process, and expanding and improving training and/or communication opportunities among stakeholders.

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