CURRENT ISSUES

Implementation Strategies to Improve Knowledge and Adherence to Spinal Cord Injury Guidelines

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Abstract

Purpose: The purpose of this study was to evaluate a bundle of implementation strategies (local opinion leaders, printed educational materials, and educational outreach) to increase neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines.
Design: A preprogram, postprogram, and follow-up design was used to evaluate outcomes.
Methods: Adherence was measured via self-reported anticipatory adherence; knowledge was measured by an author-developed assessment. Repeated measures ANOVA was used for data analysis.
Findings: Improvements in nursing knowledge and adherence were found from preprogram to postprogram to follow-up time points.
Conclusions: Outcomes noted in this study provide additional support for using this bundle of implementation strategies, and were consistent with previous research documenting the usefulness of these strategies.
Clinical Relevance: Although further research is needed, this study highlighted a systematic way of implementing evidence-based practices to improve neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines.

Background

Spinal cord injuries can have devastating effects on individuals. Secondary injuries, such as psychosocial ramifications, complications and other adverse events may contribute additional harm (DeJong et al., 2013; Munce et al., 2013). Approximately, one-third of all spinal cord injury patients are rehospitalized within 12 months due to various complications such as urological, respiratory, and musculoskeletal issues (Munce et al., 2013). Also, spinal cord-injured patients have an increased length of hospital stay compared with other medical patients, with an average of 3.3 more days spent in acute care (DeJong et al., 2013; Munce et al., 2013).

Nursing care within the acute phase of spinal cord injury, per evidence-based guideline recommendations, is essential to promote optimal care and prevent secondary injury (Wuchner, Bakas, Adams, Buelow, & Cohn, 2012). Clinical practice guidelines for the care of the acute spinal cord injury patient, including activities specific to nursing, are available through the Consortium for Spinal Cord Medicine (endorsed by the American Association of Neuroscience Nurses) and *Journal of Spinal Cord Medicine* (Marsolais et al., 2008; Wing et al., 2008). It has been

noted, however, that upwards of 50% of all medical patients do not receive healthcare based on scientific evidence, and approximately 25% of patients may receive unnecessary or even harmful care (Grol & Grimshaw, 2003). Nurses are in a unique position to provide evidence-based care to this vulnerable patient population, as nurses spend the most time in direct contact with patients.

Only a scant amount of literature exists regarding how to improve nursing adherence to neuroscience specific guidelines (Reynolds, Murray, McLennon, & Bakas, 2016). The emerging field of implementation science is the study of processes and strategies used to successfully implement evidence into practice, thereby improving adherence to evidence-based guidelines (Grimshaw, Eccles, Lavis, Hill, & Squires, 2012; Grol & Grimshaw, 2003). Multifaceted strategies tailored to local determinants (i.e., barriers and facilitators) are noted to be most successful, yet there is still a gap regarding which bundle of implementation strategies is most effective (Grimshaw et al., 2012; Powell et al., 2015). In a previous study (Reynolds et al., 2016), the implementation strategies of local opinion leaders, printed educational materials, and educational outreach were used to improve neurocritical care nurses' knowledge of and adherence to stroke guidelines (i.e., Stroke Competency Program); after implementation of the Stroke Competency Program, improvements were noted in both nursing knowledge and adherence. Further research is needed to understand if this bundle of strategies is translatable to other practice guidelines and yields similar positive results. As such, this study seeks to replicate these strategies with spinal cord injury guidelines among the same group of neurocritical care nurses.

Purpose

The purpose of this study was to examine neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines following implementation of a tailored, multifaceted competency program. A secondary purpose was to determine if neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines differed based on nursing participants' demographic characteristics. Based on a needs assessment per local nursing discussion and through the NeuroTrauma Committee led by neurocritical care nurses, opportunities were noted for improving evidence-based care to the acute spinal cord injury patient. Deficiencies were noted in nursing's knowledge of and adherence to the following evidence-based activities: (a) frequency of spinal assessments, (b) integumentary/mobility/respiratory interventions, (c) bowel and bladder interventions, and (d) patient/family education and psychosocial support (see Table 1). As such, implementation strategies used previously for the tailored, multifaceted Stroke Competency Program were replicated with content and procedures modified to be commensurate with spinal cord injury guidelines. The Spinal Cord Injury Competency Program sought to address the identified deficiencies and improve nurses' knowledge of and adherence to the evidence-based guideline recommendations (Table 1).

The primary outcome was nursing knowledge of and adherence to spinal cord injury guidelines. Knowledge was measured by an author-developed spinal cord injury knowledge assessment. Due to the low volume of spinal cord injury patients at this facility, pre- and post-competency program documentation audits would not yield sufficient data to statistically measure adherence. Consequently, a self-reported anticipatory adherence assessment was utilized. This study was approved by the university Institution Review Board for the protection of human subjects.

Methods

Implementation Steps

Grol and Wensing's (2013) model of implementation was used to guide the overall implementation process (figure can be found in Reynolds et al., 2016). First, determinants (i.e., barriers, facilitators) were identified via local nursing discussions. Barriers to consistently providing evidence-based care by nurses included a lack of knowledge, time, motivation, and perceived importance of the guidelines among nurses; these barriers have also been identified in the literature (Johnson & Bakas, 2010). Further barriers included the perception that the guidelines were complex and difficult to understand. Similar findings were noted by Reynolds et al. (2016) before beginning their Stroke Competency Program; as such, tailored implementation strategies of local opinion leaders, printed educational materials, and educational outreach were matched to these perceived determinants. After completion of the Stroke Competency Program, a positive trend toward improved knowledge of and adherence to evidence-based stroke practices was noted (Reynolds et al., 2016). This bundle of implementation strategies was

Table 1 Description of best-practice nursing activities for the care of the spinal cord injury patient (Marsolais et al., 2008; Wing et al., 2008)

Nursing Activities	Description
Spinal assessments	• Motor spinal assessments need to be completed upon admission and every hour until the patient is stable enough to go to surgery for fusion of spinal injury • Post operatively, motor spinal assessments need to be completed every hour for the first 24 hours, then every 2 hours for 24 hours, then every 4 hours until transfer from the critical care unit • Sensory assessments need to be completed at least twice a day and with any neurological change
Integumentary/mobility/ respiratory interventions	• Thorough integumentary assessments need to be completed as spinal cord injury patients are at an increased risk for skin breakdown • Waffle cushions should be used when patients are seated • Cervical collar pads need to be changed daily and when soiled, with assistance from another healthcare provider to prevent secondary injury • Range of motion needs to be performed approximately three times daily • Aggressive pulmonary toileting (i.e., progressive mobility, oral care) should be instilled to prevent respiratory complications • Measures should be taken to prevent orthostatic hypotension when mobilizing patients (i.e., sitting patients up slowly)
Bowel and bladder interventions	• When the patient is medically stable, the indwelling urinary catheter should be removed and routine intermittent catheterizations need to be instituted to prevent urinary tract infections; collaborate with ordering provider to determine frequency of routine intermittent catheterizations (i.e., every 4–6 hours) • Spinal cord injury patients need to follow a rigorous bowel management program, including daily rectal suppositories and digital stimulation
Patient/family education and psychosocial support	• Education needs to be provided to patients/families regarding spinal cord injury diagnosis, depression, skin assessments, etc. • Communication boards and development of daily schedules with input from the spinal cord injury patient can promote independence and decision making

replicated for this study regarding translation of spinal cord injury guidelines. A checklist was used to ensure all major components of the Spinal Cord Injury Competency Program were covered (Borek, Abraham, Smith, Greaves, & Tarrant, 2015).

Local Opinion Leaders

To develop the Spinal Cord Injury Competency Program, an implementation team was formed consisting of the unit's Clinical Nurse Specialist, clinical educator, and local opinion leaders. The local opinion leaders were experienced direct care nurses considered by their peers and unit leadership to be informal leaders and spinal cord injury experts. According to Powell et al. (2015), local opinion leaders can improve others' attitudes and behavior to improve their practice through peer motivation. The local opinion leaders assisted with developing new printed educational materials, and were involved with the educational outreach sessions described below.

Printed Educational Materials

New printed educational materials were developed by the implementation team and included evidence-based nursing practices for the care of the spinal cord injury patient (Table 1). As many nurses perceived the guidelines as difficult to understand, the new printed educational

materials were streamlined into a colorful resource packet. Also, to decrease complexity, several guideline recommendations were placed in a table format for easier readability (Powell et al., 2015). Furthermore, several copies of these resource packets were distributed around the unit to be more accessible to nurses.

Educational Outreach

The educational outreach sessions consisted of a onetime one-to-one, face-to-face educational session with each of the 75 neurocritical care nurses employed on the unit. These educational outreach sessions, offered over the course of 1 month, occurred on the nursing unit during the nurses' working hours. Each session lasted approximately 10–15 minutes. Two members of the implementation team facilitated the sessions: a local opinion leader and the Clinical Nurse Specialist. Both members had over 8 years of neuroscience nursing experience and were certified in neuroscience (CNRN) and critical care (CCRN). To ensure consistent messaging between these two members, a script was developed as a guide (Powell et al., 2015).

During the sessions, the facilitators reviewed the evidence-based printed educational materials. In addition, the nurses were asked to demonstrate how to document the various interventions in the electronic medical record. Finally, the nurses were encouraged to ask any clarifying questions regarding the care of the spinal cord injury patient.

Outcomes

A preprogram, postprogram, and follow-up design was used to evaluate the Spinal Cord Injury Competency Program. Outcomes included nursing knowledge of and adherence to spinal cord injury guidelines. Adherence was measured via self-reported anticipatory adherence assessments, with knowledge measured by an author-developed assessment. Both assessments were provided to neurocritical care nurses prior to the start of the program (preprogram), immediately following (postprogram), and 3 weeks after completion of the program (follow-up). Assessment item development was guided by evidence-based recommendations for spinal cord injury care and examined for face validity by two content experts (Marsolais et al., 2008; Wing et al., 2008).

All nurses employed on the neurocritical care unit were invited to participate in the assessments through a Survey Monkey™ link sent in an e-mail. In the body of the e-mail, information was provided to the nurses regarding the purpose and voluntary nature of the study, as well as an acknowledgment of institutional review board approval; consent was implied by clicking on the survey link. The assessment consisted of a total of 37 questions. The first question directed the nurses to create a personal 8-digit identification number. This number was known only by individual participants and used solely to match preprogram, postprogram, and follow-up assessment scores. Ten demographic questions were included, followed by 16 questions assessing nurses' knowledge of the spinal cord injury guideline recommendations. The knowledge assessment was categorized into five subscales: (a) spinal assessments (three questions; range 0–3), (b) integumentary/mobility/respiratory interventions (four questions; range 0–4), (c) bowel and bladder interventions (three questions; range 0–3), (d) patient/family education and psychosocial support (two questions; range 0–2), and (e) neurogenic shock/autonomic dysreflexia knowledge (four questions; range 0–4).

The final 10 questions asked the nurses to provide self-reported anticipatory adherence to certain spinal cord injury guideline recommendations. Nurses answered the questions as to *how they would care for a spinal cord injury patient.* A Likert-type scale included choices for anticipated frequency of adherence to activities with a range from 1 = Never to 7 = Every time. These questions were categorized into four subscales: (a) spinal assessments (one question; range 1–7), (b) integumentary/mobility/respiratory interventions (four questions; range 4–28), (c) bowel and bladder interventions (three questions; range 3–21), and (d) patient/family education and psychosocial support (two questions; range 2–14). To promote participation in the assessments, nurses were given a candy bar and entered into a raffle for one of two $25 gift cards for completion of all three assessments.

The knowledge assessment was author-developed and did not undergo substantial psychometric testing prior to dissemination. *Post hoc* item analyses, including difficulty and discrimination indices, however, were calculated for the preprogram assessment results. Results from these analyses suggest further revisions of the assessment are warranted (see Table 2). A potential ceiling effect was identified on some assessment items: Nine of the 16 questions had an item difficulty index of greater than 0.8, indicating that the majority of nurses answered the question correctly, with three of these questions having a difficulty index of 1.0, signifying that all nurses answered the

Table 2 Item analysis report of spinal cord injury knowledge assessment

Item	Key	A	B	C	D	E	F	G	Difficulty Index*	Discrimination Index†
1	C	0	0	12	1	1	–	–	.86	.04
2	B	0	10	4	0	–	–	–	.71	.67
3	D	3	0	0	11	–	–	–	.79	.21
4	D	0	0	0	14	–	–	–	1.00	.00
5	D	1	2	0	11	–	–	–	.79	.21
6	G	1	0	0	1	0	0	12	.86	.04
7	C	4	0	8	2	0	0	–	.57	.71
8	C	0	0	14	0	–	–	–	1.00	.00
9	B	0	14	–	–	–	–	–	1.00	.00
10	E	1	1	0	0	12	–	–	.86	.33
11	G	0	2	0	0	0	1	11	.79	.21
12	F	0	0	0	0	1	12	1	.86	.04
13	C	0	2	12	0	–	–	–	.86	.33
14	E	0	0	1	4	9	–	–	.64	−.04
15	C	1	0	13	0	–	–	–	.93	.17
16	C	2	0	12	0	–	–	–	.86	.33

*Difficulty index: Measure of the test-item difficulty, with scores ranging from 0.00 to +1.00. Desirable values should be between .20 and .80.

†Discrimination index: Indicator of test-item quality. Scores range from −1.00 to +1.00 with higher positive scores signaling better test items (Oermann & Gaberson, 2014).

question correctly (Oermann & Gaberson, 2014). Internal consistency of the assessment was calculated per the Kuder-Richardson formula; in SPSS, this yielded a low Cronbach's α (.33), suggesting that this assessment should not be used without further revision.

Repeated measures ANOVAs were completed to determine improvements over time (i.e., between preprogram, postprogram, and follow-up program timeframes) in nursing knowledge and adherence scores. Also, Spearman rho correlations and *t* tests were completed to examine associations and differences, respectively, among nurses' knowledge and adherence based on nursing participants' demographic characteristics (i.e., age, years of experience, certifications).

Findings

Nurse Demographics

Of the 75 nurses employed on the neurocritical care unit, 14 nurses completed all three Spinal Cord Injury Competency assessments (19% response rate). Of those 14, all were female with a mean age of 38.5 years. Years of nursing experience ranged from 3 to 35 years, with a mean of 13.6 years. On average these nurses had approximately 11 years of experience in neurocritical care nursing. There was a mixture of participants from each shift, with more participating from the day ($n = 9$) than night shift ($n = 5$); most worked full-time. Furthermore, all participants held Bachelor's degrees. Seven (50%) of the participants held a certification with three others noting that they planned on becoming certified.

Self-Reported Anticipatory Adherence

Nurses' adherence to the spinal cord injury guidelines was measured by a self-report of anticipatory adherence. There were four subscales on the self-reported adherence measure. A repeated measures ANOVA was conducted to determine changes over time in the preprogram, postprogram, and follow-up adherence scores (see Table 3). Improvements were found in the integumentary/mobility/respiratory interventions subscale scores, $F(2, 12) = 5.143$; $p = .013$, the bowel and bladder interventions subscale scores, $F(2, 12) = 13.910$; $p = .001$, as well as the patient/family education and psychosocial support subscale score, $F(2, 12) = 5.571$; $p = .010$. Further, an improvement was noted for the total self-reported anticipatory adherence scores, $F(2, 12) = 15.06$; $p = .001$. Paired-samples *t* tests were conducted to determine differences between postprogram and follow-up program self-reported anticipatory adherence scores. No

Table 3 Comparison of spinal cord injury self-report anticipatory adherence at each time point (pre and postprogram and follow-up)

Scale and Subscales	Preprogram Assessment Mean (*SD*)	Postprogram Assessment Mean (*SD*)	Follow-Up Assessment Mean (*SD*)	F(X, X)	*p*
Spinal assessment (range 1–7)	5.93 (0.83)	6.14 (0.77)	6.14 (0.66)	0.432 (2, 12)	.579
Integumentary/mobility/respiratory interventions (range 4–28)	20.86 (3.94)	23.64 (3.48)	23.86 (2.35)	5.143 (2, 12)	.013
Bowel and bladder interventions (range 3–21)	13.21 (1.97)	17.36 (3.05)	17.42 (3.01)	13.910 (2, 12)	.001
Patient/family education and psychosocial support (range 2–14)	9.14 (2.07)	10.93 (2.23)	10.57 (2.03)	5.571 (2, 12)	.010
Total score (range 10–70)	49.14 (6.06)	58.07 (7.80)	58.0 (5.70)	15.06 (2, 12)	.001

significant differences were noted, indicating short-term maintenance of improvements with anticipatory adherence.

Spearman rho correlations were calculated to identify associations between adherence scores at each time point and the participants' age, years of nursing experience, and years of neurocritical care nursing experience. The Spearman rho test was used, as opposed to Pearson correlations, due to the small sample size and lack of a normal distribution (Gravetter & Wallnau, 2013). There was only one significant positive correlation, between experience as a neurocritical care nurse and the preprogram spinal assessment subscale, $r_s = .543$, $p < .05$, indicating nurses with more neurocritical care experience scored higher on this preprogram subscale.

A series of *t* tests were used to calculate differences in self-reported anticipatory adherence scores based on certification (Certification or No Certification). There was a significant difference in self-reported anticipatory adherence between those who were certified ($M = 14.67$, $SD = 1.86$) versus those who were not certified ($M = 12.13$, $SD = 1.25$) for the preprogram bowel and bladder interventions subscale, $t(12) = -3.070$, $p = .010$. Those nurses holding a certification had higher self-reported anticipatory adherences scores on this subscale than those who were not certified.

Nursing Knowledge

A repeated measures ANOVA was conducted to determine changes over time in participants' knowledge scores (i.e., between preprogram, postprogram, and 3 week follow-up program timeframes) (see Table 4). Knowledge was measured with an author-developed spinal cord injury knowledge assessment with 16 questions, including five subscales. There was a significant improvement in knowledge for the integumentary/mobility/respiratory interventions subscale, $F(2, 10) = 5.649$; $p = .026$, as well as the total knowledge assessment score, $F(2, 10) = 3.57$; $p = .045$. Paired-samples *t* tests were also conducted to determine differences between postprogram and follow-up program knowledge scores. There were no

Table 4 Comparison of spinal cord injury knowledge assessment scores at each time point (pre and postprogram and follow-up)

Scale and Subscales	Preprogram Assessment Mean (*SD*)	Postprogram Assessment Mean (*SD*)	Follow-Up Assessment Mean (*SD*)	F(X, X)	*p*
Spinal assessment (range 0–3)	2.36 (0.84)	2.71 (0.61)	2.79 (0.58)	1.947 (2, 12)	.163
Integumentary/mobility/ respiratory interventions (range 0–4)	3.17 (0.83)	3.75 (0.45)	3.83 (0.39)	5.649 (2, 10)	.026
Bowel and bladder interventions (range 0–3)	2.85 (0.38)	2.92 (0.28)	2.85 (0.38)	0.316 (2, 11)	.732
Patient/family education and psychosocial support (range 0–2)	1.57 (0.65)	1.57 (0.51)	1.36 (0.63)	1.315 (2, 12)	.286
Neurogenic shock/autonomic dysreflexia (range 0–4)	3.21 (0.80)	3.50 (0.65)	3.29 (0.61)	0.707 (2, 12)	.502
Total score (range 0–16)	13.00 (2.22)	14.50 (1.00)	13.92 (1.24)	3.57 (2, 10)	.045

differences, indicating short-term maintenance of improvements in knowledge.

Spearman rho correlations were calculated to identify associations between knowledge scores at each time point and the participants' age, years of experience as a nurse, and years of neurocritical care nursing experience. There were significant negative correlations between several postprogram and follow-up assessments with these demographic variables (see Table 5). Interestingly, these negative correlations indicated that the younger, less experienced nurses who participated had higher scores on the knowledge assessment for the postprogram spinal assessment subscale and the follow-up spinal assessment and bowel and bladder interventions subscales. A series of *t* tests were also used to calculate differences in knowledge scores based on certification (Certification or No Certification). No significant differences were noted between nurses' knowledge and whether or not they held a certification.

Discussion

Implementation Strategies

The purpose of this study was to evaluate a multifaceted program aimed at improving neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines. Our study found improvements in self-reported anticipatory adherence (i.e., integumentary/mobility/respiratory interventions, bowel and bladder interventions, patient/family education and psychosocial support, and total score) and nursing knowledge (i.e., integumentary/mobility/respiratory interventions and total score) following the intervention, that were additionally

Table 5 Spearman rho correlation of spinal cord injury knowledge assessment with nursing demographics

	Nurses' Age	Experience as a Nurse r_s	Experience as Neurocritical Care Nurse r_s
Preprogram assessment: spinal assessment	−.073	.101	.257
Preprogram assessment: integumentary/mobility/respiratory interventions	−.422	−.492	−.320
Preprogram assessment: bowel and bladder interventions	−.216	−.433	−.455
Preprogram assessment: patient/family education and psychosocial support	.176	.154	.288
Preprogram assessment: neurogenic shock/autonomic dysreflexia	−.225	−.074	−.087
Preprogram assessment: total score	−.172	−.131	.004
Postprogram assessment: spinal assessment	−.601*	−.603*	−.571*
Postprogram assessment: integumentary/mobility/respiratory interventions	−.259	−.390	−.303
Postprogram assessment: bowel and bladder interventions	−.463	−.387	−.309
Postprogram assessment: patient/family education and psychosocial support	.179	.305	.377
Postprogram assessment: neurogenic shock/autonomic dysreflexia	−.312	−.346	−.250
Postprogram assessment: total score	−.708**	−.684**	−.491
Follow-up assessment: spinal assessment	−.603*	−.611*	−.509
Follow-up assessment: integumentary/mobility/respiratory interventions	.324	.324	.259
Follow-up assessment: bowel and bladder interventions	−.608*	−.609*	−.507
Follow-up assessment: patient/family education and psychosocial support	.138	.223	.352
Follow-up assessment: neurogenic shock/autonomic dysreflexia	.463	.315	.200
Follow-up assessment: total score	−.022	−.124	−.011

*$p < .05$; **$p < .01$.

maintained at follow-up. Use of multifaceted strategies has been shown to be beneficial when implementing guidelines into practice. The bundle of implementation strategies used for this study (i.e., local opinion leaders, printed educational materials, and educational outreach) was replicated from a previous study that sought to implement stroke guidelines (Reynolds et al., 2016). Other studies have used various pairings of these types of strategies (Wuchner, 2014); however, insufficient details regarding how these strategies were operationalized has made comparisons across studies difficult (Proctor, Powell, & McMillen, 2013; Wuchner, 2014).

Adherence Outcomes

Adherence was measured via self-reported anticipatory adherence assessments, given at three different time points. Although this measure of adherence is not commonly utilized, other studies have previously adopted this outcome measure and found similar, positive trends after educational initiatives (e.g., Brown, Aitken, Leggat, & Speare, 2010). Furthermore, a systematic review conducted by Eccles et al. (2006) noted that there can be a predictable relationship between self-reported intentions of healthcare professionals and their subsequent behavior. Albeit self-reported adherence may incur social desirability bias, other measures of adherence (i.e., documentation audits, observation) were deemed unfeasible for this study (Krumpal, 2013).

There were improvements noted in self-reported anticipatory adherence in three of the four subscales (i.e., integumentary/mobility/respiratory interventions, bowel and bladder interventions, patient/family education and psychosocial support), as well as the total score. Improvements were identified in the subscale Integumentary/mobility/respiratory interventions for both self-reported anticipatory adherence and knowledge scores. Nurses may have lacked knowledge of the guidelines surrounding these care activities before the program. Implementation of the program may have helped improve knowledge of these needed interventions, leading to both higher knowledge scores as well as higher self-reported anticipatory adherence scores. These significant gains were also maintained from the Postprogram to follow-up assessment timeframes. Understanding the sustainability of results is a noted need in implementation research (Chaudoir, Dugan, & Barr, 2013; Powell et al., 2015). Albeit short term, these findings provide preliminary evidence of the sustainable effects of this type of implementation program.

Following the Spinal Cord Injury Competency Program, self-reported anticipatory adherence scores were also significantly higher for the bowel and bladder interventions subscale; however, knowledge scores for this subscale did not improve significantly. Nurses may have had the knowledge regarding guideline recommendations for these activities, yet may have had a perception that such activities were not important or lacked motivation for completing them. Our program may have fostered understanding of the rationale behind these activities, leading to higher self-reported anticipatory adherence scores.

The spinal assessments subscale did not show significant improvements over time. These null findings could be due to relatively high preprogram assessment anticipatory adherence scores for this particular guideline recommended activity. The small number of participating nurses could have also confounded identifying significant changes.

Significant positive correlations between neurocritical care nursing experience and the spinal assessments subscale indicated that nurses with more neurocritical care experience tended to report higher anticipatory adherence to this guideline activity. Not surprisingly, these nurses may have felt more confident and/or clinically able to complete these necessary recommendations for spinal cord injury patients, as experience has been noted as a facilitator of clinical guideline use (Abrahamson, Fox, & Doebbeling, 2012). After implementation of the program, less experienced nurses may have felt more confident with performing this guideline activity, lending to the lack of significant correlations at the Postprogram and follow-up program timeframes between experience and anticipatory adherence scores.

Independent *t* tests were used to identify possible adherence score differences based on certification. It was found that nurses holding a certification self-reported higher anticipatory adherence compared to those with no certification for the preprogram bowel and bladder interventions subscale. This finding mirrors results in Reynolds et al. (2016). Likewise, nurses holding a certification have been shown to have higher levels of knowledge and skills within their profession (Duffy et al., 2015). This difference related to certification status, however, was only significant within the preprogram assessment. Although those holding certifications may have been more apt to report adherence to these guideline recommendations (i.e., bowel and bladder interventions) before the program, implementation of the Spinal Cord

Injury Competency Program may have improved nurses' knowledge/ability, including those without certification, leading to nonsignificant findings in the Postprogram and follow-up anticipatory adherence scores.

Knowledge Outcomes

As noted during local nursing discussions, knowledge deficits in the evidence-based care of the spinal cord injury patient were present. In an effort to tailor the program to the determinants of practice, printed educational materials were created to improve nurses' knowledge of the guidelines. These materials were reviewed during the one-on-one educational outreach sessions to further enhance the nurses' knowledge. As such, knowledge was included as an outcome for this study. Knowledge improved after implementation of the Spinal Cord Injury Competency Program for one subscale (i.e., integumentary/mobility/respiratory interventions) and the total score. Improvements in knowledge after implementation of educational programs have been cited in the literature (Reynolds et al., 2016; Wuchner, 2014). Furthermore, these improvements were sustained between the Postprogram and follow-up assessment, indicating short-term maintenance. This type of finding, although short term, is needed to progress implementation research (Chaudoir et al., 2013; Powell et al., 2015). The lack of significant improvements in other knowledge subscales was likely related to high preprogram scores, as well as the small participant sample size.

Interestingly, Spearman rho correlations yielded significant negative associations between several Postprogram and follow-up knowledge scores and nurses' age, nursing experience, and neurocritical care nursing experience. These findings indicated that younger, less experienced nurses scored higher on the knowledge assessment at these time points. Although such results are not common in the literature (e.g., Seliman, Morsy, Sultan, Elshamy, & Ahmed, 2014), there are several possible explanations for this relationship pattern. Newer nurses participating in the assessments may have been more exposed to updated guideline recommendations during their recent educational years. Also, many less experienced nurses stated that they were not confident in caring for spinal cord injury patients; this may have led them to being more interested and inquisitive during the educational outreach sessions. Although these results are intriguing, they should be acknowledged cautiously, as this study included a very small sample. Older, more experienced nurses may not have been as attentive during the educational outreach sessions, lending to a lack of significant improvements in knowledge over time.

Limitations

This study found improvements in self-reported anticipatory adherence and knowledge after implementation of the Spinal Cord Injury Competency Program; however, several limitations exist. To begin, there are limited ways to accurately measure adherence to evidence-based guideline recommendations. As this facility admits a low volume of spinal cord injury patients, it was felt that adherence could not adequately be measured by documentation audits, as previously used in prior implementation investigations (e.g., Reynolds et al., 2016). As such, self-reported anticipatory adherence assessments were used to measure adherence. Due to social desirability bias, however, actual behavior by nurses may differ (Krumpal, 2013). Although other outcome measures such as documentation audits and observation also have limitations, these measures may have yielded different results.

The spinal cord injury knowledge assessment did not undergo substantial psychometric testing, yielding poor item difficulty and discrimination indices, as well as a low Cronbach's alpha. *Post hoc* item analyses of the spinal cord injury knowledge assessment suggest a need for further revision of the assessment. The low number of assessment items may have contributed to the low internal consistency for the knowledge measure. In the future, adding items may be an option; however, this shorter assessment was developed to minimize participation burden. Items that were deemed "easy" could be dropped from the assessment and further additional items that are more difficult could be added to improve the Cronbach's alpha. Furthermore, this assessment measured five different subscales; although they were all geared toward care of the spinal cord injury patient, they may not have been deemed interrelated. Further research in nursing and implementation science is needed to provide higher quality outcome measures with better evidence of reliability and validity. These assessments were voluntary, and those taking the assessment may have been more knowledgeable/confident on the subject and more motivated to take the exam.

It must be acknowledged that strong conclusions cannot be made from this study, as the sample size included a small number of nursing participants with a low response rate of 19%. Although not well powered with only 14 participants, this study provides a blueprint for how this

Key Practice Points

- This study replicated the implementation strategies used in a previous competency program to understand reproducibility of strategies.
- This study sought to evaluate neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines before, immediately after, and 3 weeks following implementation of a Spinal Cord Injury Competency Program.
- Correlations between nurses' knowledge and adherence scores and nursing demographic information were identified during data analysis.
- Findings supported the use of three implementation strategies to deliver a tailored, multi-faceted program to enhance neurocritical care nurses' knowledge of and adherence to spinal cord injury guidelines.

type of program may be implemented in the future (Gravetter & Wallnau, 2013), and still identified several significant outcomes. Further, this study was conducted at one hospital in one neurocritical care unit, limiting generalizability of findings. It would be beneficial for future research to utilize these implementation strategies in other facilities with a larger sample size. Last, short-term sustainability of results was noted for both the self-reported anticipatory adherence and knowledge scales. Although the maintenance of these findings is noteworthy, future research should seek to determine long-term sustainability of improvements (i.e., 6 months, 12 months).

Implications

Recent implementation studies have included strategies that were not conceptually defined or theoretically justified, and have lacked detailed information regarding how strategies were operationalized (Grol & Wensing, 2013; Proctor et al., 2013). Furthermore, multifaceted strategies are proposed to be more useful than single passive strategies, such as didactic education; however, it is unknown which multiple strategies are most effective for translating evidence-based guidelines into practice. This study sought to replicate a bundle of strategies used in a previous study aimed at translating evidence-based stroke practices (Reynolds et al., 2016), and found similar positive trends regarding increased nursing knowledge and adherence. The strategies of local opinion leader, printed educational materials, and educational outreach sessions, when bundled together, may be beneficial to improve neurocritical care nurses' knowledge of and adherence to guideline recommendations in the acute care of stroke as well as spinal cord injury patients. Further replication of these strategies with other nursing populations is warranted to establish the breadth of their commutability.

Conclusion

Spinal cord injury patients require detailed, evidence-based nursing care to decrease and/or prevent secondary injury and harm. Available nursing guidelines need to be translated into practice to assure patients receive optimum care. Tailored, multifaceted strategies can be effective in closing this research-practice gap; however, few studies have sought to identify which multiple strategies are most beneficial. Findings from this study assist in closing this gap as to which strategies should be used. Future studies should consider replicating these strategies with larger participant samples to strengthen the literature in this needed area, as well as improve the reliability and validity of outcome measures.

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