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Clinical Decision Support and Perioperative Peripheral Nerve Injury

A Quality Improvement Project

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Decision support at the point of care has been demonstrated to be an effective tool in providing a safe environment and improving patient outcomes. The operating room is typically an area where advanced technology is introduced to nurses on a regular basis. This quality improvement project focused on preventing a peripheral nerve injury, which is an example of a postoperative adverse event that is considered preventable. Injury of a peripheral nerve is the result of compression, hyperextension, flexion, or ischemia surrounding the nerve. The goals for this project were to improve the knowledge of peripheral nerve injury of the operating room nurses, design and implement a peripheral nerve injury assessment screen that could provide decision support within the operating room record, improve the nursing documentation of peripheral nerve injury interventions, and (long term) decrease the incidence of peripheral nerve injury. A decision support screen within the operating room record was designed to supplement the operating room nurse's risk assessment for peripheral nerve injury. The components of this project involved a preliminary and postproject surveys on peripheral nerve injury knowledge, an educational presentation, and a retrospective random review of nursing documentation in the operating room electronic health records. Project results demonstrated a significant increase in nursing documentation of peripheral nerve injury interventions (63%–92%) and a positive attitude toward their exposure to basic decision support ($P = .046$). Recommendations for future studies and establishing a standardized coding system for peripheral nerve injury identification were identified.

KEY WORDS

Nursing • Decision support • Patient positioning • Perioperative care • Peripheral nerve injury

Positioning patients in the perioperative setting requires knowledge about human anatomy and the individual characteristics of the human body. Surgical nurses or operating room (OR) nurses work diligently to keep patients safe, especially during positioning when the patient is anesthetized, using evidence-based nursing interventions. From past research studies, there are several known risk factors that increase a patient's susceptibility for a peripheral nerve injury (PNI).[1–6] Anticipating and diagnosing the risk for injury are paramount to intervene with special nursing interventions.

Often the OR nurse is not informed of an injury because of the lack of standardization in identification and reporting of a PNI. By the time an OR nurse learns about the injury, the actions taken related to positioning intervention during the procedure are forgotten when not documented. The incidence rate of PNI may be higher than originally reported because of a lapse in time in identification or injury.

The implementation and adoption of clinical decision support within the electronic OR record have the potential to raise the OR nurses' awareness about PNI and subsequently diagnose a patient's risk for injury based on

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these known risk factors. Clinical decision support refers broadly to providing clinicians or patients with clinical knowledge and patient-related information to enhance patient care.[7] Clinical decision support has also been described as the successful integration of knowledge into electronic health records to enhance nursing decision making and to drive evidence-based practice.[8] The purpose of clinical decision support is to assist, enhance, and support current practice and guidelines for the healthcare provider at the optimal time during patient care.

There have been few studies that have compared nursing documentation before and after a computer system was implemented.[1,9,10] A method of influencing the nurses to add detail to their documentation could help to demonstrate how technology has the potential to improve patient outcomes by increasing communication and continuity of care between caregivers.

In this article, we describe a PNI, the factors that influence a patient's risk, and a literature review of this topic. The literature review discusses several evidence-based nursing interventions and how there is inconsistency among institutions in reporting PNIs.

This quality improvement project began with a 2-month review of OR patient positioning documentation. Specifically, we searched for wording that would describe extra padding applied to high-risk areas for PNI, correct anatomical placement of security belts and/or tape on the patient, and description of arms (eg, supine, prone, less than 90 degrees). A PNI knowledge assessment survey was e-mailed to establish a baseline of what the OR nurses knew, followed by a PNI education presentation to the OR nursing and technician staff for all three shifts. Implementation of a PNI assessment screen was introduced and for 3 months was monitored for its usage rate by the OR nurses. Documentation of positioning was also audited for improvement. During this time, OR visits were made to answer nurses' questions about the screen and/or project and to assess issues that might have been discovered. This reinforced project objectives and goals, as well as established evidence-based nursing interventions, and also helped to keep interest in the project.

BACKGROUND

Peripheral Nerve Injury Review

A PNI is defined as the interruption of electrical activity that affects either the sensory, motor, or both nerve functions resulting in a deficit.[11] The yearly incidence of PNI to upper and lower extremities has a widely reported range of 0.02% to 21%[12,13] in surgical patients because of the absence of standardized methods to document an actual PNI. This is similar to finding anywhere from 2 to 21 surgical patients per month being diagnosed with a PNI, which is preventable. Two of these studies concluded there were time limitations associated with the identification of PNI, and the incidence and prevalence rates may in fact be higher than actually reported.[12,13]

The literature research on PNI encompassed several medical, nursing, physical therapy, and anesthesia journals, which were found after searches were conducted using MEDLINE, EBSCO, PubMed, CINAHL, Pegasus (Microsoft, Redmond, WA), and Google (Google Inc, Mountain View, CA) search engines. One of the conclusions drawn from the literature review was that PNIs are considered multifactorial, and the exact mechanism of injury remains unknown. The most common internal risk factors identified in the literature include patients who have diabetes, extremes in body mass, peripheral vascular disease, arthritis, alcohol and/or tobacco use, advanced age, gender, any condition that interrupts circulation and temporarily blocks the blood supply to the nerves, and extremely thin or obese patients.[1–6,14–20] Diabetic patients are at risk for neuropathy complications; therefore, they are at a greater risk for developing a PNI.

There are external factors that must be considered in assessing the risk of developing a PNI. These include hypothermia, use of retractors, tourniquets, patient positioning, and length of surgery that is more than 2 to 4 hours.[2,4,21–25] The type of patient position and the length of surgery together were two external risk factors that either increased or decreased a patient's risk for developing a PNI. Surgeries lasting more than 4 hours incorporating the lithotomy and supine position have been specifically identified in the literature as key contributors for developing a PNI.[4,21,23–27]

Several studies have pointed to gender as a risk factor for developing a PNI. One study indicated that men were more susceptible to ulnar nerve injuries because of the anatomical differences and the difference in the amount of subcutaneous fat present around the extremities.[28] Another study consisted primarily of men and concluded males were more susceptible to a PNI.[15] To contradict these results, a study indicated that females were more susceptible, especially in total hip arthroplasty.[21] Furthermore, there were two studies that reported there was no viable evidence that supported either gender as more susceptible to PNIs.[22,23]

The wide variety of injuries reported are due to lack of standardization in identification of injury types and the variety of reporting systems used among healthcare organizations. Some healthcare institutions use Current Procedural Terminology billing codes or International Classification of Disease, Ninth Edition or 10th Edition (*ICD-9* or *ICD-10*) event codes or may use quality indicators that include following a PNI trend. With the absence of standardization to identify a PNI, several studies concluded that the incidence and prevalence rates may be higher than actually reported.[12,13]

Although the exact etiology of PNIs may be difficult to determine, there have been several court judgments against anesthesiologists because of the absence of documentation on padding placement or positioning.[29] The American Society of Anesthesiologists Closed Claims Study reported that nerve injuries accounted for 15% of total claims and that upper extremities experience a higher incidence rate than lower extremities.[30] This also holds true for the OR nurse. Detailed documentation of patient care and positioning demonstrates that the nurse served as the patient's advocate while they were unconscious. Consequently, a lack of detail in a nurse's documentation on specific patient positioning may predispose them to a PNI liability claim. Recognition of risk factors, diagnosis of risk for injury such as PNI, and the documentation of appropriate use of evidence-based nursing interventions demonstrate the nurses upheld the standard of care during surgical procedures.

OBJECTIVES OF THE PROJECT

There were three areas targeted for improvement with this project. It was anticipated there would be a direct measurable increase in the awareness and knowledge about PNI by the OR nurses, and an increase in the quantity and quality of nursing documentation, specifically of PNI interventions.

The project was designed to assess the impact of using basic decision support documentation screen within the electronic health record (EHR) and to measure the number of nurses who voluntarily used the PNI assessment screen. The project hypothesis primary statement stated that when the interventions were applied and documented, the patients would be less likely to develop PNI. A second hypothesis was that increasing the OR nurses' awareness and knowledge about PNI would result in a decrease in the PNI incidence rate. An overall project aim was to answer the following question: Does the implementation of decision support for OR nurses help to prevent PNI in surgical patients?

INSTITUTIONAL REVIEW BOARDS

To protect patient and OR nurse confidentiality, all information collected was deidentified for the baseline nursing documentation, the manual review of OR records during the project to determine PNI assessment screen usage, and for the collection of PNI incidence rates. The patient's OR EHR with identified data was stored behind the corporate systems firewall. Only the primary investigator (PI) had access to this secure file.

The risks were minimal because the interventions were evidence based and reinforced or duplicated current positioning and preventing patient injury policies in the OR.

The PNI assessment screen usage was voluntarily and anonymously completed by the OR nurses and remained active in the OR computer record for 2 months. It was also determined that the decision support screen and reminders would not print out on the final OR record. This quality project was deemed exempt from review by the Loyola University Chicago institutional review board (IRB) and received expedited approval from the hospital IRB.

METHODS

Setting and Design

This quasi-experimental, quality improvement project was conducted at a 739-bed, not-for-profit teaching hospital in the Northeast. The OR consisted of 173 OR nurses to staff 44 ORs. This facility performs approximately 48 000 surgeries annually. All 44 ORs at the main campus facility were involved with the addition of the PNI assessment screen and placement of two reminders.

Sample

Prior to beginning this study, it was agreed in collaboration with the OR leadership that the PNI assessment screen was voluntarily completed by the OR nurse. It was also decided that anyone who completed the pre- and post-PNI surveys would remain anonymous. The average weekly number of OR EHRs evaluated for analysis ranged from 81 to 94 per week. This was due to the variation in surgery volume, which included weekends and holidays

Because of the high volume of daily operations, and variables involved with nurses staffing a room, a systematic selection of rotating ORs were done on a rotating basis each day for the purpose of recording usage rate of the PNI assessment screen and documentation of patient positioning. Rooms were chosen for data collection using the following method: If the surgical specialty used a minimum of three ORs every weekday, then two rooms were chosen for that day's data collection. Rooms picked within each surgical service were then rotated and chosen 5 days in advance. For example, if cardiac occupied four rooms every weekday, then two rooms were chosen for Day 1 data collection. The two cardiac rooms that were not chosen for Day 1 were then chosen for Day 2 data collection. To decrease researcher bias, the choice of ORs was occasionally changed during the day of analysis because of some surgeons prefer familiar staff and rooms. Although this method of picking rooms may contain internal error, it was the best approach to ensure that all the nurses, surgical services, and shifts had an opportunity to participate in the projects.

The usage rate using the PNI assessment screen was determined by a manual daily review of OR EHRs. The

information collected from each EHR was the service, if the PNI screen risk factor items were checked, and a copy of the nursing documentation of interventions.

INTERVENTIONS

Peripheral Nerve Injury Education Sessions

First, an hour's educational presentation on PNI was given to the OR staff for all shifts, 2 weeks prior to releasing the PNI assessment screen in the OR EHR. The content in this PNI presentation was validated with two physical therapists and OR nurse experts. The OR experts consisted of OR nurses and nurse educators who had from 2 to 20 years' experience in the OR. The slides contained information on PNI studies, how a PNI occurs and prevention, and nursing and medical evidence-based interventions. The preproject survey, which was also validated with the OR experts, was also reviewed with the OR staff. This part of the presentation focused on the correct answers to two of the questions: how long it takes for PNI signs and symptoms to occur after surgery, and how long it takes to injure a motor nerve. This was followed by a brief announcement of the release of the PNI assessment screen within the OR EHR the following week. The presentation was posted on the OR SharePoint Web site (Microsoft, Redmond, WA) for the nurses and staff to view at their convenience and was available for those who were unable to attend the meeting.

Second, it was critical to explain to the OR staff when the PNI assessment screen was added to the OR nursing EHR and how to use it. This occurred during the time set aside for OR staff to hold educational presentations for continuing educational units, staff meetings, or announcements. This was called our "Go-Live" day for releasing the PNI assessment screen. A 15-minute presentation was made to all shifts showing the screen's appearance and how to use it. It also informed the OR nurses that this change was implemented in all 44 ORs, where the PNI assessment screen was located in the OR EHR, and that it was voluntary to click on the PNI assessment button.

The presentation included the definition of clinical decision support and how it was used in healthcare settings to help the nurses understand how technology can support nurses in providing quality care and potentially improve patient outcomes. Information was given to the staff on the length of the project and its purpose and goals and that the screen would not print out on the final OR record. Upon conclusion of the "Go-Live" presentation, a pamphlet about the PNI screen and project information was distributed to the OR staff. It contained the project and contact information, along with the dates and times of the OR clinic site visits to answer any questions or concerns.

Peripheral Nerve Injury Assessment Screen

Third, the screen was designed to capture information about risk factors for PNI. The screen was approved by the Perioperative Informatics Management (PIMS) Team II. The PIMS Team II consisted of the OR informatics director and six OR nurses who had experience in several surgical specialties for several years. This team was instrumental in designing the current OR EHR and was composed of super users. Their input was instrumental in making the screen easy to use and comprehend. The evidence based PNI screen assisted the OR nurse in identifying patients with more than two risk factors (Figures 1 and 2). If the patient qualified, then the decision support recommended nurse evidence-based interventions that go beyond the standard of care and reminded them to document patient positioning.

The placement of the PNI assessment screen within the current OR record, and reminders, was agreed upon by the PIMS Team II and the OR practice committee. The OR practice committee was a larger group of OR nurses and OR nurse educators who met monthly to discuss issues or concerns that involved nursing or patient care. The design of the PNI assessment screen went through many modifications to ensure ease of use and comprehension.

Assessing and evaluating the functions of the PNI assessment screen to ensure that it would work within the OR record and the nurses' workflow were an important step in the building of the PNI screen. A use-case specifications document is strongly recommended when modifying or changing an existing system. A use-case document is basically a functional description of the program or technology to be implemented and describes a set of activities or workflow items performed by the user (healthcare provider) to produce an output result.[25,30] A use-case document assesses the usability or functionality of a change within an EHR. It assists in reviewing several technical scenarios or what a typical end-user might face when using the system. It was a helpful document when requesting a change with an EHR because it ensured the modifications necessary for the new screen would work within the current EHR system. For this project, several limitations were identified in the proposed assumptions and prompted several revisions for the PNI screen. This development and design process involved several types of testing of the screen to ensure the risk factors and the checkboxes remained checked once the nurse closed or completed the documentation screen.

DATA COLLECTION AND MEASUREMENTS

This project used various measurements to evaluate the effectiveness of the interventions for this project. Data were collected and recorded manually by the PI. There were measurements in place to meet standards of content

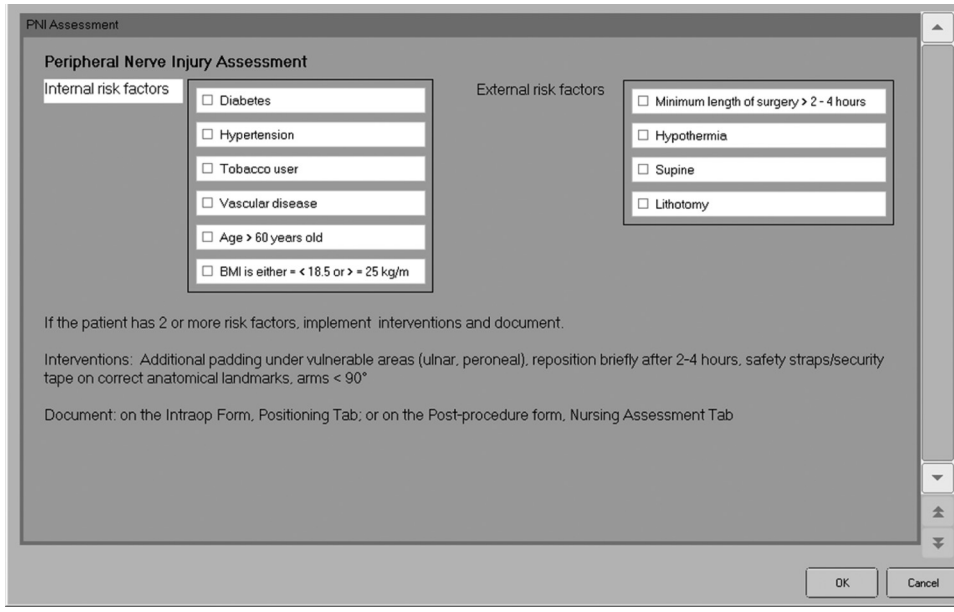


FIGURE 1. Peripheral nerve assessment screen.

validity. This was accomplished by collaborating with a survey expert in validating the preproject and postproject survey questions. The statistical analyses were validated with the PI's doctoral committee members for this project.

Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Brigham and Women's Hospital. REDCap is a secure, Web-based application designed to support data capture for research studies, providing (1) an intuitive interface for validated data entry, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for importing data from external sources.

Initially, a retrospective 2-month audit of information that contained nursing documentation on patient positioning along with a 1-year time period of PNI incidence rates was collected for baseline data. An online survey using REDCap e-mailed to the OR nursing staff 2 weeks prior to the PNI educational presentation was used as a reference point to measure the baseline nursing knowledge about PNI. The next phase of the project was the educational component on PNI, followed by the introduction of the PNI assessment screen and several scheduled clinical OR site visits by the PI. The final phase included the evaluation of the effectiveness of a simple, clinical decision support screen in increasing nursing documentation using REDCap and monthly PNI incidence rates during the project.

The preproject and postproject surveys used a 0- to 10-point rating scale, with the higher number indicating a more positive attitude. The questions asked in the preproject survey focused on the OR nurses' knowledge on PNI and decision support. The postproject survey contained questions from the first survey, along with four additional questions on their opinions on the new PNI assessment screen and capstone project overall. The content of the questions was validated with experienced OR nurse experts from diverse surgical services and five OR nurse educators. The survey results reported the data using the mode, mean, median, and SD of the preproject and postproject results. The independent variable (education presentation) was used to determine if the presentation increased the nurses' PNI knowledge (dependent variable). A Wilcoxon signed rank test was used to test for differences from baseline in nursing knowledge of PNI and completeness of documentation.

Because of the lack of standardization in reporting PNI, we chose the PNI incidence rates by using the *ICD-9* codes for this project. This was the only method of identifying whether patients were diagnosed and/or discharged with a PNI. A total of 33 *ICD-9* codes that indicated some form of a PNI were found and validated with an *ICD-9* expert.

The 1-year time period consisted of patients from all surgical and medical services beginning on July 1, 2011, through June 30, 2012. A total of 267 patients were identified with the primary or secondary *ICD-9* code diagnosis of a PNI. There were 48 651 total surgeries, which resulted in a 0.01% incidence rate. Although the incident rate may be statistically small, the average number of patients who suffered a PNI during this time period was estimated to be 22 injuries per month.

During the 2 months, the PI would review the OR EHRs and logged the PNI screen usage rate, surgical service, length of surgery, nursing documentation, and where it was located. The only identifier on this data collection was the surgical services. An update e-mail of the PNI

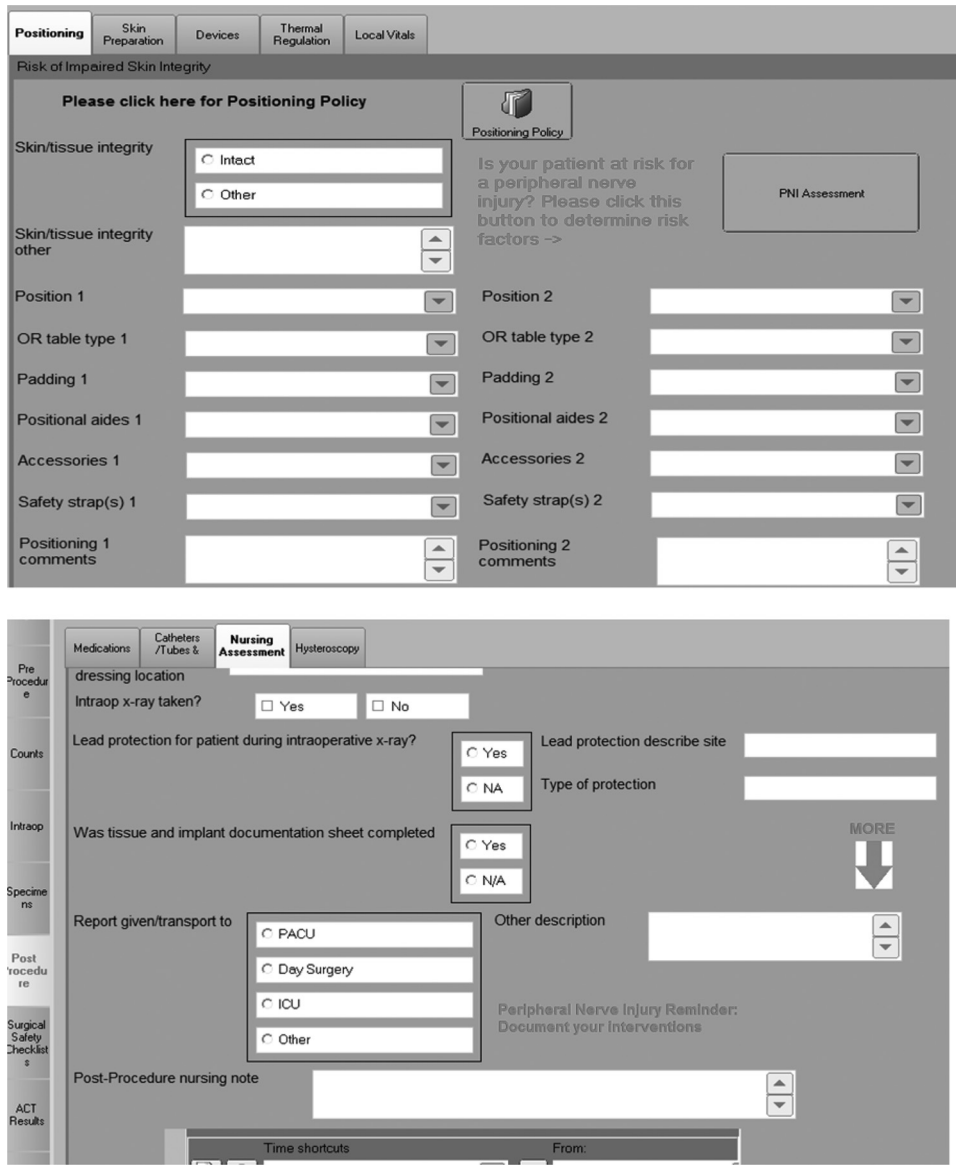


FIGURE 2. Placement of PNI screen and reminders.

screen usage was sent out biweekly to the OR staff. These e-mails shared the status on the project and provided positive comments on their improvement in documentation. This was influential in showing an upward and positive affect with the PNI screen usage rates shortly after the PI OR clinical site visits.

Because of the OR system limitations, PNI usage data and nursing documentation could not be collected electronically; they were collected manually. Because this was a pilot study and posed no risk to the patient, a decision was made between the IRB and OR leadership that the addition of the PNI assessment screen would be temporary. The postproject survey was distributed the day after the PNI assessment screen was taken out of the OR nursing record. The nurse champions were also useful in engaging their coworkers to participate in the postproject survey by encouraging them to participate and offer their recommendations or comments for future projects.

INCLUSION/EXCLUSION CRITERIA

The inclusion criteria for this project were all inpatient and outpatient surgeries. The age population for this project consisted of adults older than 18 years. Although outpatient surgery routinely lasts less than 4 hours, the literature maintains that a PNI can occur within 15 minutes of positioning and stretched by as little as 10% to 15%.[24,26,27] Outpatient and discharge data were used in the project calculations to determine if there was an increase or decrease in PNI population.

The exclusion criteria consisted of obstetrics, infants, neointensive care units, and the satellite site. No children were involved with this project.

Data Analysis

The outcomes of this project were evaluated in four areas: the preproject and postproject quantitative and qualitative analysis of the nursing documentation of PNI prevention interventions, the preproject and postproject survey results on OR nursing PNI knowledge and decision support, the PNI screen usage rate, and the PNI incidence rates using *ICD-9* codes. Descriptive statistics, the Pearson χ^2 test, and nonparametric tests were used to test for significance and differences. A probability of less than .05 was considered significant.

Baseline qualitative data collected for this project began with a retrospective review of the patient positioning nursing documentation for 2 months prior to the PNI presentation. Because of the high volume of weekly cases performed at this institution, it was agreed to use 10%, or a total of 155 OR records, from all surgical services and shifts to record and analyze nursing documentation on patient positioning for baseline data. Any documentation that contained a PNI intervention was given a code. These codes were used to determine if the nurses were already using the PNI evidence-based interventions. The same codes were used to determine if there was an increase in patient positioning documentation during the project. To determine an improvement in the quality of nursing documentation of PNI interventions, the baseline data from January and February 2013 were compared with the nursing documentation during the project. To detect a difference in the quality of nursing documentation of PNI interventions before and during the intervention, a Pearson χ^2 test was done using the SPSS program version 19 for Windows 7 (IBM Corp, Armonk, NY).

RESULTS

One of the key improvements from this project was demonstrated in the substantial increase in documentation of PNI interventions and the decrease in a blank positioning comments field. A baseline audit of the presence of nursing documentation of PNI interventions demonstrated presence of documentation in 94 of 150 EHRs (63%). Compared with baseline, the review of the OR EHRs during the project period revealed 684 of 745 EHRs (92%) had PNI documentation. The baseline audit also recorded when the OR EHR was missing or had no documentation on the patient positioning page. The baseline audit data showed 39 OR EHRs (26%) that were found with this area as empty. During the project, the number of empty nursing documentation fields on patient positioning was 143 from 745 EHRs (19%).

The quality of the nursing documentation also increased during the project. The typed-in "free text" areas that showed a significant increase were arms positioned on arm boards less than 90 degrees (P = .00), the placement of a pillow under the knees (P = .01), and head in neutral position (P = .02). Additional documentation of interventions did not change significantly in improving the description of where the tape was placed using an anatomical landmark (P = .06), when the patient was repositioned (P = .06), and the description of how the hand(s) was positioned (P = .06).

The response rates for the preproject and postproject surveys were 39% and 29%, respectively. Incomplete responses were discarded from the final data analysis. In the preproject assessment of PNI knowledge, the OR nurses rated themselves on a scale from 0, being not at all confident, to 10, as extremely confident in their ability to recognize risk factors for PNI (mean, 7.00 [SD, 1.73]).

The nurses agreed that PNI is a significant problem for surgical patients (mean, 7.88 [SD, 2.05]) but were not familiar with PNI studies (mean, 3.41 [SD, 2.84]). It was agreed upon, fairly strongly, that decision support in the OR has the potential to improve patient outcomes (mean, 8.04 [SD, 2.08]).

In the postproject survey, the nurse's familiarity with PNI studies (P = .019) and their agreement that clinical decision support has the potential to improve patient outcomes (P = .046) demonstrated a significant change. Additional questions in the survey that did not demonstrate significant changes were that nurses think PNI is a significant problem (P = .06), and the nurse is informed when their patient experiences a PNI (P = .08). Overall, there were no significant changes in the nurse's confidence in recognizing risk factors for PNI, and that decision support helped in their assessment for patient risk factors for PNI. However, there was an increase in correct answers on the two specific questions on PNI displayed in Table 1.

There were additional questions in the postproject survey that related to the PNI assessment screen and project overall. The responses were overwhelmingly favorable.

Table 1

Survey Questions on PNI

Question	Preproject	Postproject
Signs and symptoms appear within 48 h of surgery. (answer = false)	32% Correct	42% Correct
How long does it take to injure a motor nerve? (answer = 1 min)	8.9% Chose 1 min	9.6% Chose 1 min

The nurses agreed that the PNI screen was easy to read (mean, 8.46 on a 10-point scale), the design made sense to them (mean, 8.27), and the placement worked well with their workflow (mean, 8.00). The comments varied from enjoying the research and wanted to see more for their patients, to concerns that the screen was hard to save when trying to close it.

The PNI decision support usage rate was determined by manually reviewing 725 OR EHRs, from the day (7 AM to 3:30 PM), evening (11 AM to 11 PM), and night shifts (11 PM to 11 AM), 7 days a week, for the months of April and May 2013. The weekly PNI screen usage was recorded as being used by the nurse if the risk factor boxes were checked. The rate calculation for the usage rate took the total number of cases when the decision support screen was used in the numerator, divided by the total number of cases for that day.

During the 2-month project period, a total of 373 OR nurses (51%) voluntarily used the PNI assessment screen. A trend analysis was performed on the PNI assessment screen usage and recorded daily and weekly (Figures 3 and 4). The project survey participation result was 50%, and the usage rate of the PNI assessment screen was 60%. All surgical services were included in the analysis. The early adopters and the services that maintained the overall highest PNI screen usage rate were the ear, nose, and throat (ENT) team with 70.0%; cardiac (69.9%); general (69.1%); and vascular (65.6%) (Table 2). The ongoing OR site visits by the PI were effective in increasing usage of the PNI screen, as demonstrated by the slight rise in usage rate seen in the timeline diagram (Figure 3).

The PNI incidence rate was determined by collecting surgical and nonsurgical patients, discharged with *ICD-9* coded data for both primary and secondary PNI diagnoses, for the months of April and May 2013. These rates will be compared with the PNI incidence rates for April and May 2012. A Poisson regression rate ratio was used to report significance for a change in PNI incidence.

The PNI incidence rates did not show a significant change in the monthly results between April and May 2012 and 2013. The Poisson regression rate ratio was 0.863 with 90% confidence interval (P = .863; 90% confidence interval, 0.490–1.384). These data will be reviewed for the year prior to the project and the year after the project to determine differences. However, the data collected comparing April and May 2012 and 2013 were consistent with the literature. The ulnar nerve, followed by the sciatic nerve, had the highest incidence rate of injury (Table 3).

RELATION TO EVIDENCE

These key findings support the previous studies and best practices for implementing interventions that could potentially prevent a PNI. Although the literature recognizes that there is no standardization in reporting or identifying a PNI, the implementation of a decision support screen with two reminders demonstrated the effectiveness of technology. This was noted in the documentation of patient positioning using the PNI evidence-based interventions.

The PNI incidence rate and the common areas of injury from this project are consistent with the previous studies that the highest areas of injury are the ulnar and sciatic nerves. As noted above, the highest number of PNIs that occurred in April and May 2012 and 2013 were the sciatic and the ulnar nerves. Table 3 demonstrates an increase or decrease in the most common areas of injury according to the list of *ICD-9* codes found for this project.

Nursing documentation of PNI prevention interventions demonstrated the nurses' critical thinking to diagnose

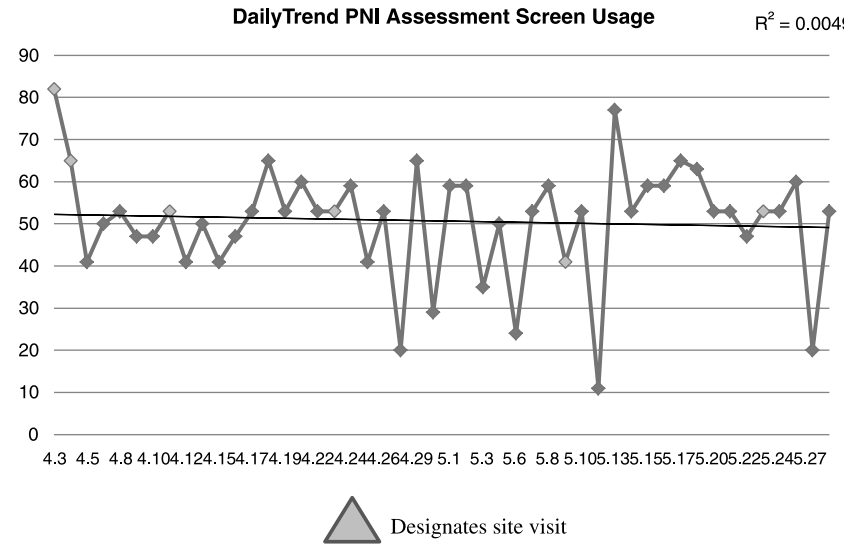


FIGURE 3. Daily PNI screen usage by OR nurses following investigator clinical site visits.

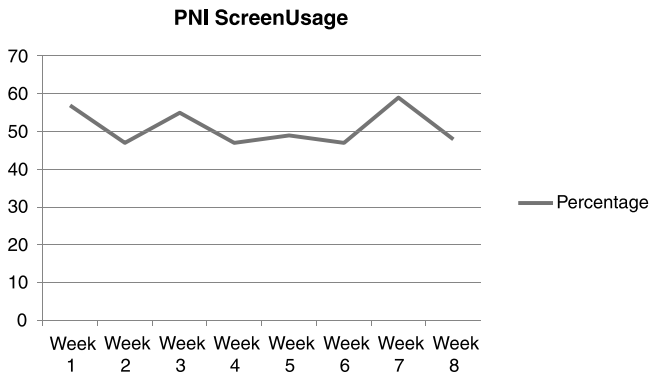


FIGURE 4. Weekly PNI assessment screen usage.

patients at risk of injury and to provide a protective and safe environment.

DISCUSSION

There are at least three areas of improvement that came from this project. First, the project outcomes suggest that an educational program on PNI for the OR nurses can raise their awareness. Recognizing risk factors for PNI using a basic decision support screen appeared to assist the nurses to document their interventions. The surveys were scored using a 10-point scale that quantified the changes between the preproject and postproject results. The surveys were perceived as an effective measuring tool in demonstrating an improvement in the knowledge and understanding of PNI and decision support. Although the response rate did not reach project goal of 50%, the return rate was considered above average return for the institution (20%).

Second, the placement of two reminders had a positive effect on documenting patient care and PNI interventions. The nursing documentation of PNI interventions increased significantly following the PNI educational presentation and during the time of the project. The daily collection of nursing documentation was positively affected by the reminders and decision support. The reminders may also have influenced the 26.9% decrease in the number of empty patient positioning comments area.

Third, the impact of decision support was reported to be minimal in their workflow in the postproject survey results. The educational presentation was effective in reinforcing that early recognition and treatment for PNI provide better outcomes for patients. During more than one OR clinic site visit, it was revealed to the PI that the decision support screen assisted in reminding them to pass on to the recovery room nurse that their patient was at higher risk for PNI.

Our target for PNI average usage rate was 60% because it was voluntary. This target goal was reached by four of 10 surgical services: ENT, cardiac, vascular, and general. The participation from nurse champions in these areas was deemed effective in encouraging their fellow nurses to use the screen.

The value of the OR clinical site visits during this project by the PI was crucial for its sustainability and interest in using the PNI assessment screen during the 2 months of the project. The interactions and visibility of the PI with the OR nurses helped to address any issues with the screen or project objectives and provided an opportunity for great discussions, specifically for filling out the PNI assessment screen. The primary reason for resistance in using the PNI screen came from nurses who felt they did not need to fill it out because they knew how to provide care for their patients while they were anesthetized and positioned. This was not challenged, but it opened the opportunity to discuss patient risk factors for PNI, providing evidence-based nursing prevention interventions, and their documentation is where best practices are noted in the OR EHR.

This project also provided an opportunity for the nurses to discuss PNI with their surgeons and whether any of their patients ever had this type of injury. Nurses want to know

Table 2

PNI Screen Usage Rate According to Surgical Service for April and May 2013

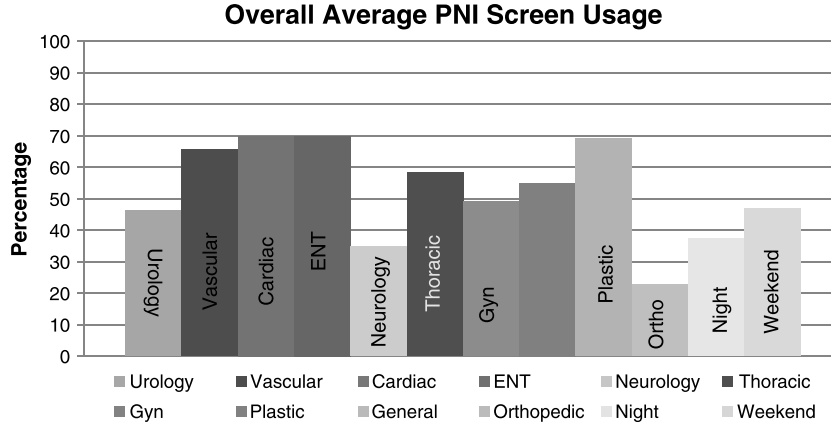
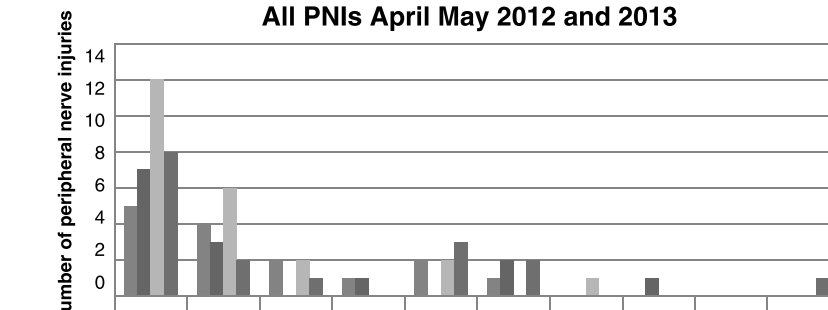


Table 3

Areas of All Possible PNI According to ICD-9 Codes



	Sciatic	Ulnar	Upper limb	Lower limb	Radial	Other (median)	Popliteal	Peroneal	Brach Plex	Femoral
April 2012	5	4	2	1	2	1	0	0	0	0
April 2013	7	3	0	1	0	2	0	1	0	0
May 2012	12	6	2	0	2	0	1	0	0	0
May 2013	8	2	1	0	3	2				

that what they did in the OR kept their patient safe from injury. This level of interprofessional collaborative practice and discussion has the potential to lead to improved awareness and care by the entire team. It was shared with the PI on one of the clinical visits that one surgeon discussed a possible PNI event with the OR team during the project. Unfortunately, the surgical procedure took place 3 months prior; therefore, the nurse could not remember the patient. The nurse informed the surgeon that there was a current project in the OR that incorporated a PNI assessment screen into the nursing EHR to assist in their determination of patients at higher risk and to encourage their documentation. Overall, the comments and suggestions were primarily positive.

These key findings from this project demonstrate how technology can support a nurse's assessment and documentation of patient care. Although it has not as yet been demonstrated that there has been a significant change in the PNI incidence rate, this pilot study influenced nurses in having their awareness raised for PNI, to take credit for their critical thinking to provide prevention interventions and document their patient positioning.

LIMITATIONS

This project faced a few challenges during the 2 months the PNI screen was released. There were a few technical problems with the PNI assessment screen during Week 2 that resulted in the screen position being off-center after the button for the decision support screen was initiated. Also, if the nurse did not click on the OK button after completing the PNI screen, the data were lost. The IS developer was contacted but because of limitations of this program, she was unable to fix the problem. This may have discouraged many of the nurses from using it, and the actual usage rate may have been higher than recorded. Also, the system does not allow a count of how many times the PNI assessment screen was opened or how many times the presentation was accessed by OR nurses on a common OR share point Web site. If the patient did not have any of the risk factors, then the boxes would have remained blank and be subsequently recorded in the "no" for usage. Therefore, the reported usage rate may be underestimated. This also points to another limitation of this project that the sample size was small because of the limitation of the PNI screen for one OR site.

The small number of surveys returned is another limitation. All responses were anonymous; therefore, any nurse could complete the survey more than once, which was a limitation of this project.

It was also determined that the OR nurses' knowledge around PNI would have been significantly increased if the postproject survey was distributed the next day after the presentation on PNI. This was not distributed until the completion of the project, which may have affected the response rate and results.

Because of the short project time period, the numbers were not large enough to determine significance but may deserve another review at the end of the year. There is also no method to realistically assess the effect of increased attention, which could actually raise reported PNI incidence rates. The results demonstrate that there is a need for standardization and reporting of PNIs. The *ICD-9* event codes are not detailed enough to determine which peripheral nerve was injured, which explains why there were 33 event codes used for the baseline.

RECOMMENDATIONS

Recommendations for future projects are to establish a standard process for PNI identification and implement a coding system for PNI that is specific in its description. Anesthesiologists are familiar with this type of injury and are the only profession to date that has a database for all types of nerve injuries. Establishing a procedure that involves a neurologist, physical therapist, anesthesiologist, nursing, and the OR would build a collaborative effort in following this type of injury. One of the OR nurses recommended having a yearly presentation given by the OR nurse experts from each service on patient positioning. This recommendation was relayed to the OR nurse educators to implement in their future schedule for staff education. Staff also requested that the PNI assessment screen return to the OR nursing record. It is also recommended that similar research could be performed over longer periods.

The implementation of a decision support screen supported the OR nurses with patient assessment and diagnosing for PNI risk factors and offered evidence-based nursing interventions, which is paramount in the practice of nursing. Technology can be an effective tool in supporting these nursing decisions to care for patients, especially if they are at higher risk for injury.

The reminders were effective in increasing the nursing documentation of PNI interventions. Although screen usage was voluntary, this project demonstrated that, provided with the opportunity and tools, nurses want to provide the best care for their patients and will use available technology to improve patient care. Because of the success of this pilot project, it was decided with OR leadership that the PNI assessment screen will become part of the OR nursing EHR for its Epic implementation.

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