Implementation of an Electronic Data Collection Tool to Monitor Nursing-Sensitive Indicators in a Large Academic Health Sciences Centre

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Abstract

Background: Monitoring the quality of nursing care is essential to identify patients at risk, measure adherence to hospital policies and evaluate the effectiveness of best practice interventions. However, monitoring nursing-sensitive indicators (NSI) is a challenge. Prevalence surveys are one method used by some organizations to monitor NSI, which are patient outcomes that are directly affected by the quantity or quality of nursing care that the patient receives. **Objective:** The aim of this paper is to describe the development of an innovative electronic data collection tool to monitor NSI. **Methods:** In the preliminary development work, we designed a mobile computing application with pre-populated patient census information to collect the nursing quality data. In subsequent phases, we refined this process by designing an electronic trigger using The Ottawa Hospital's Patient Safety Learning System, which automatically generated a case report form for each inpatient based on the hospital's daily patient census on the day of the prevalence survey. **Observations:** Both of these electronic data collection tools were accessible on tablet computers, which substantially reduced data collection, analysis and reporting time compared to previous paper-based methods. The electronic trigger provided improved completeness of the data. **Conclusion:** This work leveraged the use of tablet computers combined with a web-based application for patient data collection at point of care. Overall, the electronic methods improved data completeness and timeliness compared to traditional paper-based methods. This initiative has resulted in the ability to collect and report on NSI organization-wide to advance decision-making support and identify quality improvement opportunities within the organization.

Background

Healthcare organizations are faced with many uncertainties including increased economic pressures and an increasingly aging population. These factors are creating an increased urgency for organizations to focus on designing and implementing sustainable solutions to improve quality, reduce costs and obtain better clinical outcomes. This shift is the basis for organizations to become more accountable and to integrate systematic quality improvement efforts to drive change. Several indicators have been developed over time to support quality improvement work and monitor quality outcomes.

Evidence shows a relationship between nursing care and patient outcomes (Doran et al. 2011; Jeffs et al. 2015a, 2015b, 2014; Montalvo 2007), and several quality measures have been identified as nursing-sensitive indicators (NSIs). These include patient outcomes such as physical function (e.g., bladder continence), symptom (e.g., pain, fatigue, dyspnoea), safety (e.g., falls, pressure ulcers) and self-care (Doran et al. 2011; Montalvo 2007). These patient outcomes are directly affected by the quantity or quality of nursing care that the patient receives.

Monitoring NSI is an essential activity to capture adherence to the hospital's programs and policies, identify patients at risk, evaluate the effectiveness of best practice interventions and drive continuous improvements. However, monitoring NSI is a challenge. While administrative data are recorded for each patient discharged from the hospital, previous surveys have shown that these data (including nursing documentation) lack accuracy and completeness (Doran et al. 2011; Hannah et al. 2009; Jeffs et al. 2012, 2013; Paans et al. 2010; Thoroddsen et al. 2012; Wang et al. 2011; White and Pringle 2005; Worster and Haines 2004). The incompleteness of nursing documentation may result in underestimation of the true burden of patient outcomes (Thoroddsen et al. 2012; Paans et al. 2010; Wang et al. 2011).

Based on the need to capture standardized nursing quality data (Doran et al. 2011; Hannah et al. 2009; Loan et al. 2011;), several nursing outcome databases were developed to standardize, capture and monitor NSI information. These databases are summarized in Table 1.

Table 1. Overview of nursing outcome databases

Database	Brief description	Data collection method
National Nursing Quality Report (C) (VanDeVelde-Coke et al. 2012)	Development of a national nursing report card initially consisting of pilot organizations from acute care, long-term care and mental health Academy of Canadian Executive Nurses (ACEN) and Canadian Nurses Association Benchmarking of Canadian pilot organizations, since 2010	Paper-based, unit-level data collected and submitted to the Patient Safety Metrics system (Canadian Patient Safety Institute) on a quarterly basis
Canadian Health Outcomes for Better Information and Care (C-HOBIC) (VanDeVelde-Coke et al. 2012, Nagle et al. 2010, White and Pringle 2005, Hannah and White 2012)	Data repository of patient outcomes data related to nursing care in acute care, long-term care, home care and chronic care settings for organizations in select provinces Initially funded by the Ontario Ministry of Health and Long-Term Care then partnered with the Canadian Nurses Association, Ministries of Health (Saskatchewan, Manitoba) Benchmarking of Canadian organizations, since 1999	Paper-based, unit-level data collection on admission and discharge (quarterly for long-term care and chronic care settings) submitted via the web to a provincial database Further developments are underway to abstract data directly from electronic health records
Nursing Quality Indicators for Reporting and Evaluation (NQuIRE) (RNAO 2012)	A nursing quality improvement database linking specific evidence-based interventions to NSI for organizations designated as RNAO Best Practice Spotlight Organizations Registered Nurses' Association of Ontario (RNAO) International benchmarking, since 2012	Paper-based, unit-level data collected and submitted to project database

Database	Brief description	Data collection method
National Database of Nursing Quality Indicators (NDNQI) (Montalvo 2007)	A national database of nursing quality indicators for organizations who subscribe (fee is dependent on the size of the organization) American Nurses Association International benchmarking, since 1998	Paper-based, unit-level data collected and submitted electronically on a quarterly basis
Collaborative Alliance for Nursing Outcomes (CalNOC) project (Donaldson et al. 2005, Brown et al. 2001, 2010)	A database of nursing quality indicators for organizations who subscribe (fee is dependent on the size of the organization) California state, since 1996 Expanded internationally (e.g., United Kingdom in 2009)	Paper-based, unit-level data collected and submitted electronically on a quarterly basis
Veterans Administration Nursing Outcomes Database Project	A database of nursing quality indicators for Veteran Affairs hospitals (adapted methods from CalNOC) United States, since 2002	Paper-based, unit-level data collected and submitted electronically on a quarterly basis
Military Nursing Outcome Database (MilNOD) Project (Patrician et al. 2010, Loan et al. 2011)	A quality improvement and research project consisting of a database of nursing quality indicators for military hospitals (adapted methods from CalNOC) United States, 1996-2009	Paper-based, unit-level data collected and submitted electronically on a quarterly basis
Belgium Nursing Minimum Data Set (B-NMDS) (Kleib et al. 2011)	A database focused on collecting data on practice variations of nursing interventions Ministry of Health, Belgium, since 1988	Mandatory reporting on a quarterly basis

These international, national and regional nursing outcome database projects provide important foundational work in the collection, analysis and reporting of patient outcome data related to nursing practice to drive quality improvement efforts. However, most of these programs use paper-based tools to aid data collection at the patient's bedside and therefore may be limited by several weaknesses, such as the possibility of fields left blank and the delay to analysis and reporting, because the data from each paper-based survey have to be manually entered into a computer database prior to data analysis.

Objective

To overcome some of the challenges related to paper-based NSI data collection, our organization has leveraged technology to collect and report on nursing performance data to drive higher-quality care. The overall aim of this paper is to describe the development of an innovative electronic data collection tool to monitor NSI in a large academic health sciences centre.

Context

Our organization includes a 1,149-bed academic hospital. Biannually, we conduct a one-day prevalence survey to measure the prevalence of the following NSI: pressure ulcers, in-hospital patient falls, use of both chemical and physical restraints, delirium, satisfaction with nursing care and pain management. These NSI were specifically chosen based on their relevance to the acute care setting and existing nursing quality programs developed and implemented within our organization.

Method

Our organization has implemented a hospital-wide, technology-based, cross-sectional prevalence survey to track and understand performance outcomes of nursing care. In this section, we describe the prevalence audit processes, the prevalence survey content and the technology-based data collection tools that were developed.

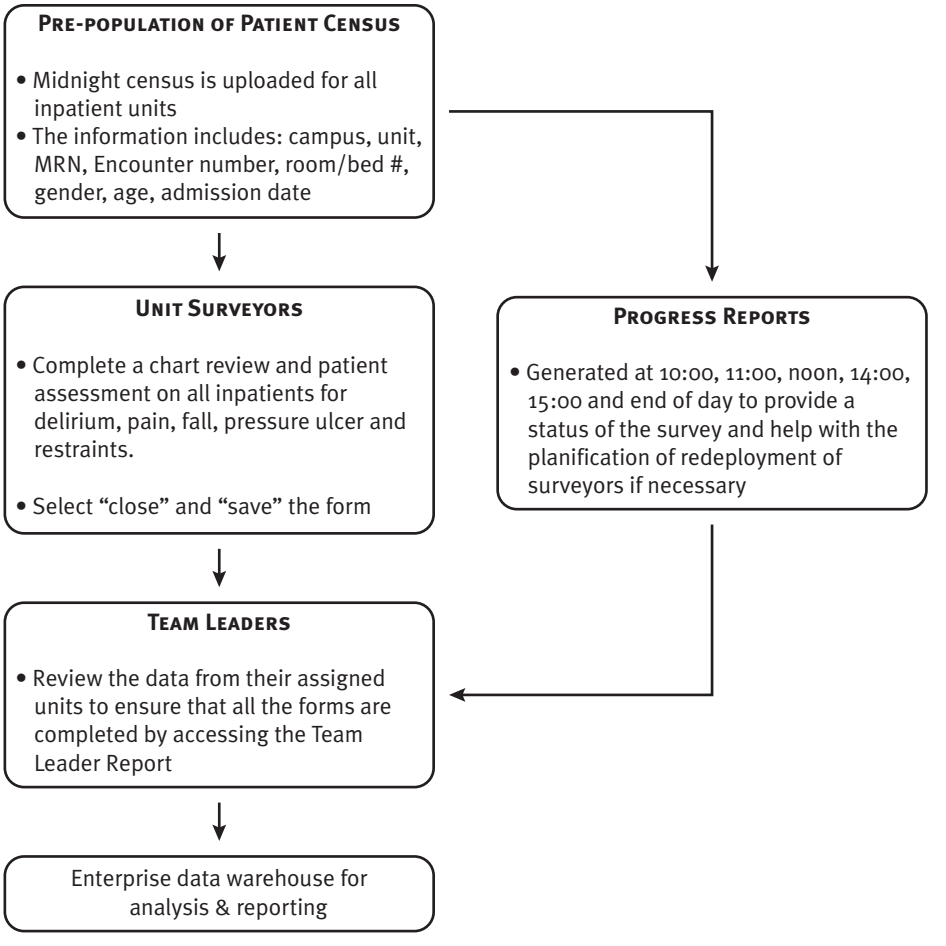
Prevalence audit processes

A minimum of two clinical staff members (e.g., nurse, physiotherapist and/or occupational therapist) from each participating inpatient unit are selected to be surveyors on day of prevalence survey. Surveyors must attend a 4-hour face-to-face group education session prior to their participation in the data collection. This training focuses on the patient assessment and chart review data collection processes. Each surveyor team is responsible for collecting data on all patients identified for their assigned unit. A team leader is assigned to a group of units to answer surveyor questions and to ensure that the required data are collected in a timely manner. In addition, the surveyors consult with each patient's assigned nurse to identify patients who are not able to participate in the survey according to the exclusion criteria. All patients, 18 years or older, appearing on the nursing unit census on the day of prevalence survery are eligible to be assessed. Patients unable to communicate in either English or French, refusing to participate in the survey, too ill to participate or off the unit during the prevalence survey hours are excluded. Eligible participants are approached by a surveyor who explains the prevalence survey and proceeds with the data collection. The overall surveyor prevalence day workflow can be found in Figure 1.

Prevalence survey

The survey is divided into two parts: (1) a chart audit and (2) a physical and environmental assessment. These sections contain fields that collect complementary information on both patient outcomes and adherence to corporate policies such as documentation and assessment of fall risk strategies, restraint use, pressure ulcer risk, delirium and pain management. For example, the chart audit section has

Figure 1. Nursing prevalence workflow



questions around documentation of pressure ulcers on admission and during the patient's stay, whereas the physical and environmental assessment section requires the surveyor to conduct a pressure ulcer assessment on the patient and to document the location and severity. This information is used to assess the ongoing compliance with expected documentation practices, and also to establish the prevalence of pressure ulcers acquired in the hospital and present at the time of admission.

Historically, this survey was conducted using a paper-based instrument (Figure 2). To facilitate and standardize the recording and collection of these NSI, we developed a mobile computing application in 2010, and, in 2013, we designed an improved data collection tool using the hospital's Patient Safety Learning System (PSLS; described below).

Figure 2. Paper-based form

Combined Prevalence Data Audit Tool

Individual Study Number: _____ / _____ / _____ / _____
Campus / Unit / Patient / Service

Combined Prevalence Study Data Collection Form

DEMOGRAPHICS

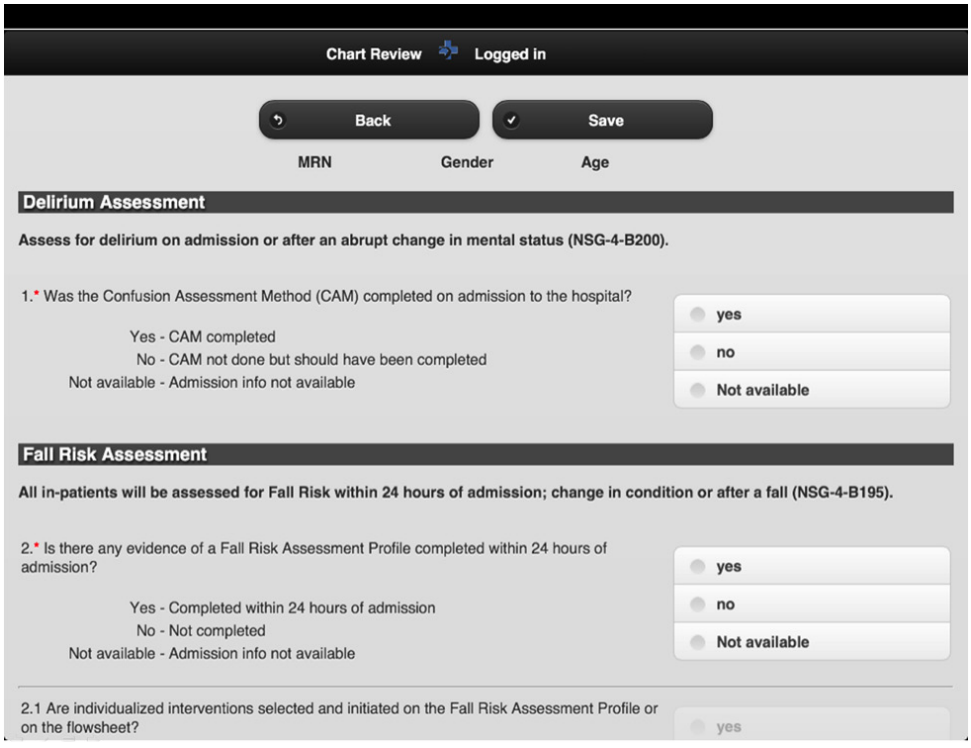
Patient Gender ☐ Male ☐ Female
Age _____ **Diagnosis** _____

QUESTION	Y	N	N/A	Additional Information or Comments
Delirium Assessment				
1. Was the Confusion Assessment Method (CAM) completed upon admission?	☐	☐		
2. Is there evidence of interventions attempted if delirium has been identified?	☐	☐	☐	☐ Integrated Progress Notes ☐ Physician Order ☐ Other, specify:_____
Fall Risk Assessment				
1. Has the Fall Risk Assessment Profile been completed: (a) Within 24 hours of admission? (b) If there was a change in the patient's condition (c) If the patient fell while in hospital	 ☐ ☐ ☐	 ☐ ☐ ☐	 ☐ ☐	
2. Is there any documentation that the patient had a fall in hospital?	☐	☐		
3. Are specialized interventions selected and initialed: (a) On the Fall Risk Profile (b) On the flowsheet	 ☐ ☐	 ☐ ☐	 ☐ ☐	
4. If the patient fell, is there evidence of additional interventions implemented?	☐	☐	☐	
Least Restraint Assessment				
1. Is there a restraint order within the past 24 hours?	☐	☐	☐	☐ Physical ☐ Chemical ☐ Both
2. For continued restraint use, is there evidence of a new order q 24 hours?	☐	☐	☐	
3. Is there documentation of consent obtained from the patient, family within 12 hours of the restraint order?	☐	☐	☐	☐ Formed under MHA
4. Are behaviours documented on the LRLR Daily Use of Record or integrated progress notes in the last 24 hours?	☐	☐	☐	☐ Agitation ☐ Impaired Mobility ☐ Unable to follow instructions ☐ Disorientation ☐ Movement disorder ☐ Memory deficit ☐ Combative ☐ Pulling tubes ☐ Other:
Pressure Ulcer Assessment				
1. Is a pressure ulcer documented on admission to the hospital?	☐	☐		
2. Was the Braden Scale completed upon admission?	☐	☐		Braden Score:____
3. Was the Braden scale completed within the last 48 hours or as per unit protocol?	☐	☐	☐	Braden Score:____

Technology-based data collection tools

In the first iteration of the transition from paper-based to electronic data collection, our Information Services department developed a mobile computing application (Figure 3). The tool was secure with standard user authentication and encrypted communications, and all information was saved directly to the hospital's servers, with no information retained on the tablet computers.

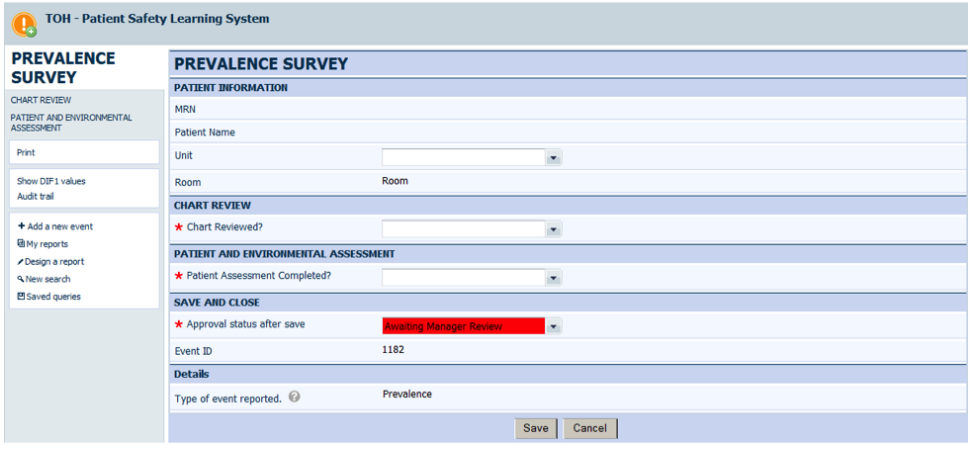
Figure 3. Mobile computing application screenshot



In the second iteration of electronic data collection, we transitioned to the PSLS (Figure 4). The PSLS is our organization's adverse event reporting system, using Datix Ltd® (UK) as a technical infrastructure. The PSLS is a web-based, multi-user platform, hosted on the hospital's servers, that combines multiple adverse event reporting methods, including voluntary reporting, and also provides the ability to design prospective surveillance methodologies such as clinical observation and electronic triggers. Moving to this platform provided added functionality and coordinated NSI collection with other quality and patient safety indicator collection mechanisms within the hospital. Again, the information is collected using computers or tablet computers, and data are not stored on the devices themselves but, rather, in a central secure data repository.

For the day of prevalence survey, we designed an electronic trigger to create a case report form based on the daily hospital inpatient census, using the admit/discharge/transfer database. An electronic trigger is a real-time alert that takes place when pre-defined criteria are met across integrated hospital information systems. At midnight of the day of prevalence survey, a simple electronic trigger

Figure 4. Patient safety learning system screenshot



generated an electronic data collection form in the PSLS for each inpatient that included pre-populated patient demographics such as: patient name, medical record number, age, gender, campus, unit and room number. This functionality eliminated the need to input this baseline information on each separate form.

Observations

Several factors were considered while comparing the paper and electronic data collection methods: (1) data completeness, (2) speed of data collection, (3) time from data collection to data entry, (4) accessibility, (5) connectivity, (6) privacy and (7) time for data analysis and reporting. The details are provided in Table 2.

Data completeness

In the paper-based tool and the mobile computing application, there were issues with missing information (i.e., fields left blank) and logic errors (i.e., hidden fields), respectively. These issues were identified upon prevalence survey completion and could not be remedied in real time; however, the PSLS allowed central monitoring of form submission and real-time feedback was possible. While the surveyors were on the units, central project team members could audit the submitted data and send back incomplete responses to the surveyors. In addition, all case report form fields were mandatory, which prevented surveyors from closing a case form without responding to all of the required questions. The built-in functionalities such as mandatory fields, drop-down menus, pre-populated patient information, immediate data quality checks and feedback and built-in form logic enhanced the completeness of the data.

Table 2. Comparison of different data collection methods

	Paper-based tool	Mobile computing application	Patient Safety Learning System
Completeness	Missing information due to incomplete responses	Missing information due to logic errors	All fields complete for eligible patients
Speed of data collection	12–16 hours	8–10 hours	8–10 hours
Time from data collection to data entry	Completed after the prevalence day; could take up to 4 weeks to complete based on the data clerk's availability	Instant	Instant
Accessibility	n/a	Mobile device only	Mobile device or computer
Connectivity	n/a	Less stable application	More stable web-based tool with fewer information technology problems
Privacy	1000 paper forms with data on them; Paper census	Password-protected, secure environment; Census pushed	Password-protected, secure environment; Census pushed
Time for data analysis/reporting	Approximately 9–12 months	Within a few weeks	Within a few days

Speed of data collection

The mobile technology also reduced the time required for data collection, likely resulting from several factors. On the paper case forms, surveyors had to populate demographic information for each patient, whereas these data were pre-populated by the electronic systems. Also, the paper-based forms were lengthier than the mobile case report forms because the surveyors had to read through all the questions on the paper forms for each patient, whereas, in the electronic data collection tools, certain information was greyed out or made invisible based on certain responses. For example, if the surveyor responded "No" to the question: "Is there documentation that this patient had pain during the hospital stay?", then follow-up questions related to pain management would not be presented to the surveyor. When the paper forms were in use, a 12-hour data collection period was scheduled. After the implementation of the first electronic data collection tool, this period was reduced to 8 hours.

Further, the PSLS data collection process allowed for improved project management on prevalence day. Hourly survey completion status reports could be generated easily, and the central project team could redeploy surveyors to units requiring additional support.

Time from data collection to data entry

The use of electronic data collection tools substantially reduced the time from data collection to data entry. Once the data were entered and the electronic reporting form saved, the results were sent automatically to the hospital's central servers and case completion progress was monitored in real time. This also saved resources by eliminating the need to hire a data entry clerk.

Accessibility and connectivity

The PSLS tool was accessible not only on mobile devices but also on computers. In addition, the tool was web-based with fewer technical issues and more stability than its predecessor application.

Privacy

When the paper-based tool was in use, a paper form was completed and collected for each eligible patient. The completed paper forms had to be carefully accounted for from the time of data collection to submission to protect patient privacy. Also, a paper census had to be printed for each unit. While no patient privacy issues were identified with the paper-based data collection method, the electronic mechanisms facilitated protection of privacy because all patient information was sent directly to a secure central data repository and census information was pushed directly to the tools from the hospital's data systems.

Time for data analysis and reporting

The data analysis and reporting processes were revised. Previously, data were analyzed and summarized by an external consultant. The detail involved in this reporting method led to lengthy delays, which reduced the timeliness and applicability of the results. With the transfer of the data collection function to electronic mechanisms, a decision was taken to streamline the report contents and use in-house data analysts. Within a few days of completing the survey, high-level results were available to present to senior leaders who endorsed this technology-based data collection method as a successful mechanism for timely data collection and reporting.

We did face some obstacles during the process of transitioning to an electronic data collection process. One challenge was to obtain a sufficient number of tablet computers for all of the surveyors to further reduce the need for paper documents. In addition, surveyors had varying levels of comfort with the mobile technology, so not all surveyors were as adept at completing the surveys. However, because we had real-time reporting of the numbers of surveys completed according to the unit, the central management team was able to redeploy surveyors to units where additional help was required. Additional computing power was also required to support the PSLS during the prevalence survey, as the number of concurrent users exceeded the existing system capacity.

Discussion

Although significant resources, expertise and commitment are needed, it is clear that measuring and reporting nursing quality is a crucial activity for organizations. The use of a technology-based instrument allowed us to expedite the collection and analysis of data, and the dissemination of results, allowing the opportunity to shift from primarily collecting data to making improvements.

In his article, Kurtzman said that "simply collecting nursing performance data is of limited benefit. These data must be studied, analyzed and interpreted. Most importantly, staff – at all levels – need to be empowered to act upon the data" (Kurtzman and Jennings 2008: 243). Committed leadership, technology and trained staff are important, but "the data generated from the performance measures must be translated into information that can be used in quality improvement and collaborative decision-making" (Kurtzman and Jennings 2008: 243). Ultimately, nurses need to be supported and held accountable to implement meaningful improvement efforts in their respective nursing units (Albanese et al. 2010; Jeffs et al. 2014, 2015; Rees et al. 2011).

The progression of the original paper-based method of collecting NSI to an electronic tool embedded in the hospital's PSLS – accessible either from a tablet or a desktop computer – demonstrates many human factors engineering improvements. The problem of missing information can be solved in electronic systems by using forcing functions (Cafazzo and St-Cyr 2012). Forcing functions that are included in the design of technology and systems ensure that humans cannot either deliberately or by mistake fail to include important information or steps in a process. In addition, one of the goals of human factors engineering – to improve human performance – has been achieved with the electronic NSI data collection tool. Fewer nurses are needed to collect the same information, the information is more complete and timely, the risk of data entry error is greatly reduced and the need to transcribe information from paper into a database has been eliminated. As with many healthcare projects, whether optimal performance has been achieved is unknown, as integrating human factors engineering and human–computer interaction evaluation methods into the design cycle in a hospital environment are still not common practice. Notable exceptions include those hospitals that have integrated human factors engineering into their hospital structure (e.g., Healthcare Human Factors group in Toronto, Ontario, Canada (<http://humanfactors.ca/aboutus/>), and the Armstrong Institute for Patient Safety and Quality in the United States at Johns Hopkins Hospital in Baltimore, Maryland (<http://www.hopkinsmedicine.org/armstrong_institute/>).

The methodology reported here bypassed some of the interim solutions used by several nursing outcome databases that involved writing the data on a paper form and transcribing the data from the paper form to a web portal (Brown et al. 2001;

Kleib et al. 2011; Loan et al. 2011; RNAO 2012; Montalvo 2007; Patrician et al. 2010; VanDeVelde-Coke et al. 2012). This semi-manual approach, while an improvement over pure paper-based methods, still has some limitations, specifically, as it involves the retranscribing of information including the need for additional resources to input the data.

Another challenge is that indicator definitions are often not standardized from one database to the other, making it difficult to make comparisons between databases and across organizations. Currently, the majority of the nursing outcome databases listed above collect and report on prevalence survey data. The prevalence methodology usually provides cross-sectional data captured during a moment in time and is not typically adjusted for any factors such as seasonal or temporal trends. The efficient conduct of cross-sectional surveys is critical to guide decisions about resource allocation and assess performance of individual nursing units.

Although this paper describes our experience with a new data collection instrument, it does not provide a formal evaluation of its success. In future work, we will look to compare our findings with other evaluation methodologies available, such as the discharge abstract summary data, patient satisfaction data (post-discharge surveys) and voluntarily reported adverse event data. These sources of information could be triangulated with the prevalence survey data to establish a more accurate picture of nursing quality and outcomes.

There was a considerable initial investment in the cost of the tablet computers for this work; however, the cost – compared to paper-based forms – may represent a valuable return on investment, when considering the factors we have discussed in this paper, such as shorter time to analysis and fewer surveyor-paid hours. In future, these factors should be used to inform a proper evaluation of the cost-effectiveness of implementing this electronic tool to measure NSI. Also, while this approach captures hospital-wide trending data, it does not provide peer benchmarking data. Future studies could evaluate the feasibility and comparability of implementing standard NSI collection approaches among comparable hospitals.

Conclusion

This work leveraged the use of tablet computers combined with a web-based application for patient data collection at point of care. Overall, the electronic methods improved data completeness and timeliness compared with traditional paper-based methods. This initiative has resulted in the ability to collect and report on NSI organization-wide to advance decision-making support and identify improvement opportunities within our organization. Our corporate clinical leaders recognized the value of the data to assist in improving quality and compliance to evidence-based best practices. The data generated from this

approach are now used as corporate quality indicators, are incorporated into annual performance reviews for nursing leaders and are a focus for targeted quality improvement work.

Future goals include building collaboration and partnerships with other organizations developing nursing outcome databases. This would help to facilitate consistent data collection and reporting implementation processes for widespread adoption, to expedite further refinement and standardization of nursing measures for benchmarking, to create a forum to share best practices in quality improvement and to increase transparency by publicly reporting nursing contributions to quality of care.

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