Vital Time Savings

Evaluating the Use of an Automated Vital Signs Documentation System on a Medical/Surgical Unit

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KEYWORDS

ABSTRACT

Vital signs documentation was the focus of this study, because multiplication errors, transcription errors, illegible results, late data entry, misidentification of the patient, undocumented readings and missed readings can lead to faulty data, as well as unnecessary and potentially dangerous interventions or withholding of treatments. Technology is now available to medical/surgical units that automate the vital signs documentation process.

This study compared the accuracy and time efficiency of manual-entry vital signs documentation with workflows that use a data management system to automatically transfer vital signs assessments from a bedside vital signs device into the electronic medical record. The study found that the automated vital signs documentation system was more accurate than manual documentation and errors were reduced by 75 percent. The wireless automated vital signs documentation system saved time compared to manual documentation: and combined vital-signs acquisition/documentation times were reduced on average by 96 seconds per reading.

At Anywhere Hospital it is 7:30 a.m. and the day shift is just beginning. Sue, a nurse's aide, begins to collect patients' vital sign assessments. She starts with room 5106 and moves through her assignment. She gathers the results and writes them on her assignment sheet to be documented in the electronic medical record (EMR) after she completes each of her five patients. Mr. Couldbeu is in room 5108 by the window. Sue notes that some of Mr. Couldbeu's readings are above his baseline, however the patient looks fine. She will mention it to the charge nurse when she sees her. Sue moves on to her next patient, but she is interrupted by Joan, a nurse taking care of patients on the other side of the unit. Sue is asked to help move a patient on the other side of the unit to a chair. At 7:39 a.m. Mr. Couldbeu pushes his call button. He has chest pain. The RN who answers his call takes his vital signs, administers his medication and checks the EMR to compare his current status to his morning assessments. They have not been charted and she cannot find Sue.

Vital signs (blood pressure, pulse, respiration, oxygen saturation and temperature) are indicators of body system health. They provide information on how patients are adapting to the changes brought on by illness and disease.[1] Treatment decisions are routinely made subsequent to the assessment of vital signs, one of the hallmarks of nursing care.

In addition, "Vital signs are a tool used to communicate patient deterioration to healthcare providers".[2] [(p478)] Endacott, Kidd, Chaboyer, and Edington found that both nurses and doctors relied on vital signs when identifying patient deterioration.[3] Assuring accurate and timely vital signs documentation may lead to improved patient care.

Vital signs documentation accuracy and clinician time efficiency were the focus of this study because technology is now available to medical/surgical units that automates vital signs documentation, transferring results from the automated bedside vital sign machine to the electronic medical record.

REVIEW OF LITERATURE

Hospitals have applied medical technology to reduce errors, but until recently have focused on the most critical care areas. Experience has shown that many hospitals under-take the move to new technology without fully understanding the impact on workload, patient safety and data accuracy. Healthcare providers are often told that a new piece of equipment will be safer for patients and a time saver for staff, only to find out that the system has a steep learning curve or takes more time than the "old way." This often results in frustration for frontline staff and a waste of scarce resources.

In an era of spiraling costs, competition and the advent of evidence-based practice, healthcare practitioners expect research studies to aid them in their clinical practice decisions. Evans, Hodgkinson, and Berry[4] found little evidence of study in the area of use of advanced technology in vital signs measurement and noted that these technologies have the potential to change current practice. Lockwood, Conroy-Hiller and Page[5] [(p208)] also noted the need to research "the role of new technology in patient monitoring."

ACCURACY IN DOCUMENTATION

While the vital signs acquisitions and documentation process is taught in the early weeks of most nursing programs, the documentation of vital signs can be fraught with problems. Patient identification is completed by asking the patient his or her name, and comparing one of two long series of numbers (potential patient misidentification). Results are gathered in 15- or 30-second timeframes and are documented as per-minute results (potential multiplication error). Clinicians memorize vital sign results (potential for forgetting result or remembering incorrectly), then, after the measurements are complete, write them down on scrap paper or paper towel (potential illegible result), later transferring them to paper forms or manually entering them into the electronic medical record (potential transcription errors and transposition of results).

When documenting a full set of vital signs (blood pressure (systolic/diastolic), pulse, respiration, oxygen saturation and temperature), there are six potential areas or errors. Further, what is often double documentation, first documenting on paper then in the electronic medical record, creates even more chances for human error.

The most precise vital signs assessment may not lead to an accurate response if it is not documented correctly and in a timely manner. Cioffi, Salter, Wilkes, Vonu-Boriceanu and Scott, in their

study of an emergency department, found that inadequate documentation was one of the main reasons clinicians failed to respond to patients with abnormal vital signs.[6] McGain et al., when looking at vital signs documentation during the first seven days after surgery, found significant levels of incomplete documentation.[7]

Multiplication errors, transcription errors, illegible results, late data entry, misidentification of the patient, undocumented readings and missed readings can lead to faulty data, as well as unnecessary and potentially dangerous interventions or withholding of treatments.

Chen et al., evaluating the Merit Study investigators, found in

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their randomized multi-site study "even in the hospitals that knew they were a part of clinical trials monitoring, documentation, responses to changes in vital signs were not adequate."[8] [(p2096)]

The authors further evaluated the Merit Study data and found that 77 percent of the patients' studied were missing one vital sign measurement prior to an adverse clinical event. The use of technology may help decrease these errors.

Technology has been applied to prevent errors in other areas of nursing care. Bar-coding is now being used to decrease the human error factor at the point of care, preventing misidentification of patients. Foote and Coleman found that, when used for medication administration, bar code technology reduced errors by 80 percent.[9] Adding the use of bar code technology to vital signs documentation could assure correct patient identification, making certain results are charted in the correct electronic medical record.

The advent of the electronic medical record system has helped the accuracy of patient documentation. Gearing et al., evaluated the use of the electronic record in vital signs documentation.[10] They found that out of 613 sets of vital signs taken on a medical/surgical unit and manually documented using paper records, 25.6 percent of the medical records had at least one error related to transcription or result omission. As for a cardiac step-down unit that utilized an electronic medical record system, 14.9 percent of the 623 records had one or more errors related to transcription or result omission. Smith et al. completed a post implementation study to using the Gearing results to determine the accuracy of an automated system that sends the vital sign measurements from the vital sign monitor to a PDA and then uploads them in the medical record.[11] They found that the error rate decreased to less than 1 percent.

CLINICIAN TIME

Clinician time is one of the most valued and costly resources in healthcare. "Because vital sign measurement in hospitalized patients is a frequently performed procedure, investigating the potential of cost containment in this practice is clearly warranted."[12] [(p244)] A recent time and motion study showed that nurses spent 35.3 percent of their working time completing all types of documentation.[13]

Storfjell, Omoike, and Ohlson looked at the costs of nurses completing patient care activities in 14 medical/surgical units in three hospitals.[14] They identified activities that did not benefit patient care and their associated costs. They found clinical record management was one of the activities with the highest amount of time wasted. There were different reasons for the wasted time for electronic and paper documentation, but no time difference. It was determined that the wasted time included in the clinical record task was $210,853 annually for an average medical/surgical unit.

The time associated with vital signs documentation was evaluated by Donati et al. while they were researching the impact of clinical information systems in the intensive care unit.[15] They found that the ICU nurses spent 12 minutes per patient per day manually charting vital signs results. After the implementation of the clinical information system that automated vital sign documentation, the time spent dropped to two minutes per patient, per day. Time spent on double documenting vital signs is time away from patients.

RESEARCH DESIGN

A quasi-experimental design was used to gather data pre- and post-implementation of a comprehensive automated vital sign capture and documentation system. This study included a review of current hospital procedures, observations of current practices and a workflow analysis as it relates to vital sign capture and documentation.

The study compared automated documentation workflows with the manual entry documentation workflow currently in use on the unit as they related to the accuracy of documentation and timeliness. Factors evaluated were workflow time studies and documentation error identification.

PROCESS

Time and motion studies were chosen for accuracy in obtaining more precise times for each activity.[16] It was felt that this method, although time intensive, would provide the most accurate and consistent results. Finkler, Knickman, Hendrickson, Lipkin and Thompson compared work sampling and time and motion techniques, finding that "the work-sampling approach, as commonly employed, may not provide an acceptably precise approximation of the result that would be obtained by time and motion observations."[17 (p577)]

Potential errors in vital sign documentation were researched and quantified.

Prior to the study, the potential errors were categorized as
• Transcription error. Transposed digits: e.g., writing 15 instead of 51.
• Typographic error. Types in computer incorrectly.
• Needed to repeat VS due to forgetting result which includes omission of result.
• Picked wrong patient on computer.
• Other. Unanticipated issuers resulting in errors.

Research documentation sheets were created for each workflow, and checkboxes were created to assure inter-rater reliability. For the purpose of this study, a set of blood pressure, pulse, respiration, temperature, and oxygen saturation is considered as one data point.

SettingThe study was conducted on an acute care medical/surgical unit at a midsize hospital from December 2007 to January 2008. The time and motion study was completed during two time periods—7 a.m. to 8:30 a.m., and 10 a.m. to 12 p.m.—four days a week for four weeks. The hospital's institutional review board approved the study prior to enrolling any subjects. As required, informed consent was obtained from the participating patients and unit staff prior to performing any study-related procedures.

SAMPLE

A convenience sampling of unit clinicians was invited to participate. There were no repercussions for not participating and no clinician names were collected during the study. An attempt was made to utilize the same clinicians for each documentation method; some clinicians did not participate in each of the workflows due to shift swings or staffing needs, while others utilized each method.

A convenience sampling of hospitalized patients was invited to participate. In ordered to be included in the study willing patients had to be capable of giving informed consent. Consent was valid until revoked and several patients participated more than once.

The unit clinicians, registered nurses, licensed practical nurses and nurse's aides were observed, and time studies were completed during routine vital sign assessments on consenting patients. Fifty-five patients were enrolled and 25 unit clinicians participated.

METHODS

The study compared the accuracy and time efficiency of:
1. The current vital sign machine and manual documentation workflow.

This involved the use of a vital sign machine to obtain blood pressure, pulse, temperature and oximetry readings. Pain and respiration results were obtained manually. Paper and pen were used to record vital signs assessments, which were then manually transferred into the electronic medical record using computers in the unit hallway. Or assessments were manually entered directly into the electronic medical record using a bedside computer. Handheld devices were available for manual input and automated transfer into the electronic medical record, but they were not preferred by the clinicians thus only one reading was completed with this tool.
11. The study vital sign machine and automated vital signs documentation system.

The vital sign machine's bar-code scanner was used to identify the patient and clinician, and the machine was then used to obtain blood pressure, pulse, temperature and oximetry readings. The pain and respiration results were obtained manually and entered into the vital sign machine. The clinician had the opportunity to verify the accuracy of the vital sign readings, and then pressed a button to send the results to the electronic chart. This system automatically transferred the vital sign results from the bedside to the electronic medical record, eliminating the need to manually document.

AUTOMATED VITAL SIGNS DOCUMENTATION SYSTEM

The automated vital signs documentation system utilized in this study was a commercially available product that has received 510(k) clearance from the FDA. With the software, vital signs assessments are automatically transferred from the bedside vital

sign machine into the electronic medical record. The method utilizes bar code technology to scan the patient's ID bracelet and an automated vital sign machine to capture the heart rate, blood pressure, temperature and oximetry.

The clinician assesses the patient's pain level, and observes and measures the patient's respirations, entering them both using the automated vital sign machine or laptop. The automated vital signs documentation system uses three methods to transfer vital signs results from the bedside vital sign machine to the electronic medical record - wireless, computer based and batch.

The automated vital signs documentation system sends the information to the patient's electronic medical record in one of three ways:

1. Wireless method. Wireless transfer of vital signs from the device to the electronic medical record.
2. Computer method. A mobile computer with a vital sign machine mounted on it transfers vital signs to the electronic medical record with bedside computer entry of pain and respiration assessment.
3. Batch method. Readings are stored in the vital sign machine, which is later manually docked at the computer station, allowing all readings to be imported into the electronic medical record.

The hospital's clinical systems analysts and information technology department, along with the manufacturers' representatives, worked together to interface the hospital's EMR with the automated vital signs documentation software. Methodical testing was completed in both test and live environments prior to research implementation.

Research assistants, staff educators and college of nursing faculty members were masters-prepared clinical experts, and not linked to the clinical unit staff in any way. They adopted a nonparticipant role when observing for errors in vital sign documentation. All research assistants were provided with descriptions of each error category, and the principal investigator was available during each observation session to answer questions concerning the categories. Research assistants spent a maximum of two hours and 30 minutes per observation session.

The research assistants used stopwatches to measure the time from application of the cuff to the end of the vital sign acquisition and documentation activities occurring in the patient room. Some of the workflows required leaving the patient's room for final documentation. For workflows requiring documentation outside the room, a second time testing occurred. For these workflows, the timing began when the unit clinician logged into the system and ended when they signed off. If the unit clinician was documenting for more than one patient, the total documentation time was measured and divided by the number of patients for which they were documenting. The documentation result was added to the vital signs acquisition time to create the total time (Total Time = Vital Sign Acquisition Time + Documentation Time Outside the Room, if applicable). The time lag between the acquisition of the vital sign measurements and

Table 1: Documentation Errors of Current Manual Vital Signs Documentation Workflow and Automated Vital Signs Documentation System.

Documentation Error Frequency (col. %)	Methods		Total
	Automated vital signs documentation system	Manual vital signs documentation	
With documentation error	3 (3.26)	7 (13.46)	10
No documentation error	89 (96.74)	45 (86.54)	134
Total	92	52	144

final documentation for those methods requiring the unit clinician to leave the room to document was not timed.

A complete study record included information on the accuracy in documentation of each vital sign (blood pressure, pulse, respiration, temperature and oxygen saturation), notation of the method that was being evaluated, and time result for vital sign acquisition and documentation as the method required. For the purpose of this study, a set of blood pressure, pulse, respiration, temperature and oxygen saturation is considered as one data point.

TRAINING

Participating clinicians did not have experience with the study vital sign machine and automated vital signs documentation system prior to the study. Training occurred on the unit the day prior to the start of testing; clinicians attended a one-hour orientation and educational session, which included a brief demonstration and hands-on session. All staff members had utilized other brands of mobile vital sign devices in the past.

STATISTICAL METHODS

The documentation error rate of the manual vital sign documentation system was compared with that of the automatic vital sign documentation system by a Fisher's exact test since one expected cell frequency is less than five.

Descriptive statistics were calculated for all time variables, followed by the Kolmogorov-Smirnov test to check the normality. Comparisons of total time by different methods were analyzed using t-tests if the data follow a normal distribution. For time variables with skewed distribution, the Mann-Whitney U test was employed to compare the medians.

The SAS® for Windows, v9.1.3. Cary, NC was used to conduct the data analysis. All statistical analyses were based on the significance level of 0.05.
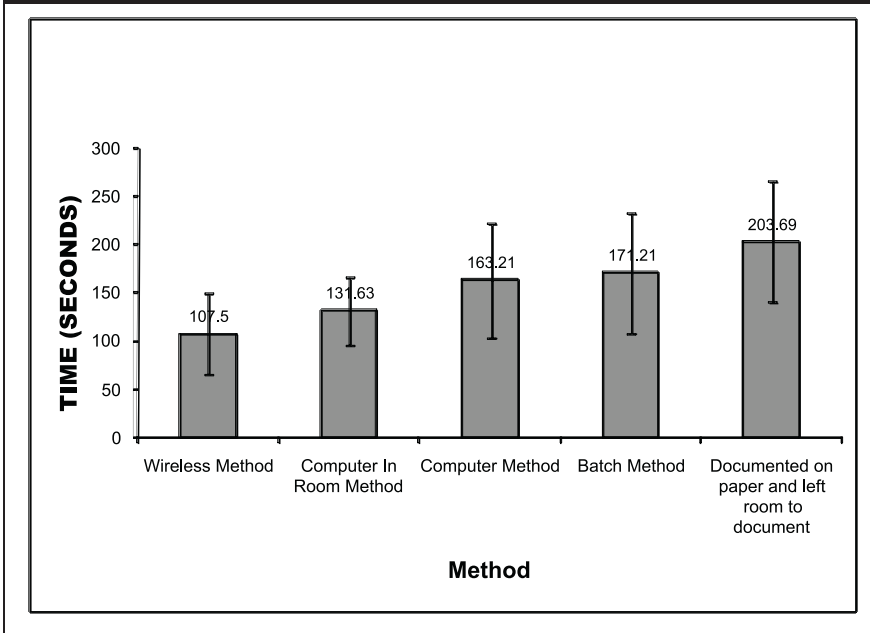
RESULTS

Accuracy in Documentation
Manual Documentation Method

Out of 52 sets of vital sign, with each set including blood pres-

Fig. 1: Total Vital Signs Time (acquisition + documentation) for Each Method.

Documentation for workflows requiring vital signs entry outside the room required separate time testing. The result was added to the vital signs acquisition time to create the total time (Total Time = Vital Sign Acquisition Time + Documentation Time Outside the Room, if applicable). If the clinician was documenting for more than one patient, the total documentation time was measured and divided by the number of clients for which they were documenting.

On average, clinicians spent the least time on capturing and documenting the patient's vital signs by using the wireless workflow (107.50 seconds ffl 41.87). The manual documentation method—documenting on paper and manually transferring the results to the electronic medical record—was the most time intensive (203.69 seconds ffl 62.88). The order of total time by different methods is presented in Figure 1.

Combining vital signs acquisition and documentation times, the wireless automated entry was the most time-efficient. On average, it saved significantly more time than the paper transfer method (107.50 seconds ffl 41.87 vs. 203.69 seconds ffl 62.88; $p < 0.0001$).

sure, pulse, respiration, temperature and oxygen saturation, seven (13.5 percent) errors occurred in the manual documentation method—four when manually documenting utilizing the current computer system present on the unit (two typographical error, one transcription error and one need to repeat due to forgetting the result), and three when the clinician documented on scrap paper and left the patient's room to manually enter the results using current computer systems in the hallway (one typographical error, one transcription error and one need to repeat due to forgetting the result).

Automated Documentation System

Out of 92 sets of vital sign, with each set including blood pressure, pulse, respiration, temperature, and oxygen saturation, three errors (3.3 percent) occurred in the automated documentation system, one error in each of the three workflows—wireless (other error—one difficulty scanning patient ID bracelet), batch (one typographic error) and computer method (other error—one omission, failure to enter required vital sign assessment).

SOFTWARE

During the study, the software transferred vital signs results from the bedside vital sign machine to the electronic medical record with 100 percent accuracy.

When compared to current manual documentation workflow, the automated documentation workflows overall reduced documentation errors by 75 percent (13.5 percent vs. 3.3 percent, Table 1, $p = 0.02$).

CLINICIAN TIME

The study evaluated whether the time required for vital signs acquisition and documentation was different between the methods.

LIMITATIONS OF THE STUDY

The timeframe for the post-implementation time and motion outcome evaluation was one day after a one-hour training session. This timeframe is less than ideal, as Butler and Bender emphasized the need to allow a six-month learning curve for adults prior to post-implementation studies.[18] The resulting time savings in the automated documentation wireless method suggest a shorter than average learning curve.

The computer hardware in which the automated vital sign documentation software was loaded in the computer-based workflow was new to the clinicians. A tablet-style computer was chosen for use in the study, which required the use of an electronic pen to move through the application. It proved to be difficult for the clinicians to utilize and was not needed for the software to function. This factor may have affected the documentation times. Repeating the study with a computer system that clinicians are more familiar with may lead to different results.

SUGGESTION FOR FUTURE STUDY

The time lag between the acquisition of the vital sign measurements and final documentation for those methods requiring the clinician to leave the room to document was not timed in this study, but would be of interest for future studies. Delays in entering the vital sign results into the electronic chart impede the ability of others to access the information and evaluate the results.

DISCUSSION

This study looked at potential improvements that can be made

in the care areas where the majority of the hospital's patients reside—medical/surgical units. This study found that the wireless automated vital sign documentation system saved time and was more accurate than the manual documentation methods.

The automated vital sign documentation system utilizing bar code technology at the point of care may decrease the potential for human error. Although clinicians who participated in this study only had one hour of training on the use of the automated documentation software, the vital signs process showed significant time savings. In this study, the automated documentation method reduced errors by 75 percent when compared to manual documentation. Automating the vital signs documentation process may reduce the labor required to document the results, as well as providing more accurate and timely data.

The wireless method was the most time-efficient in capturing and documenting vital signs. On average, it saved 96.19 seconds per reading over the manual documentation method. On a 36-bed unit with vital signs ordered on average of four times a day, this method could save almost 120 hours of staff time per month.

Changes in vital signs have been linked with increased risk for clinically adverse events.[19] If the documentation of patient vital signs is incorrect or missing, these changes will not be identified. In an era where medical mistakes make front-page news, automating the vital signs documentation process may speed vital sign results to care providers, allowing clinicians to more quickly react to important changes in patient health status.

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