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Data Entry Automation Improves Cost, Quality, Performance, and Job Satisfaction in a Hospital Nursing Unit

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OBJECTIVE: An Automated Data Entry Process Technology tool was developed to free nurses from data entry tasks, thus creating time for patient care and other activities associated with improvements in performance and job satisfaction.

BACKGROUND: Manually transferring data from patient measurement devices to electronic health records (EHRs) is an intensive, error-prone task that diverts nurses from patient care while adversely affecting job performance and employee satisfaction.

METHODS: Performance improvement analytics were used to compare matched sets of manual and automated EHR data entries for 1933 consecutive vital signs records created by 49 RNs and certified nursing assistants in a 23-bed medical-surgical unit at a large tertiary hospital. Performance and quality effects were evaluated via nurses' responses to a postintervention survey.

RESULTS: Data errors decreased from approximately 20% to 0; data transfer times were reduced by 5 minutes to 2 hours per measurement event; nurses had more time for direct patient care; and job satisfaction improved.

CONCLUSION: Data entry automation eliminates data errors, substantially reduces delays in getting data into EHRs, and improves job satisfaction by giving nurses more time for direct patient care. Findings are associated with improvements in quality, work performance, and job satisfaction, key goals of nursing leaders.

Two of today's "trending" topics in healthcare, job dissatisfaction and electronic health records (EHRs), share a common perception: counterproductive effects of the time caregivers spend collecting and recording data. Data entry is associated with loss of joy in nursing and is a leading reason why health professionals are burning out and giving up.[1-4] Nursing administrators are compelled not only to understand the problem because staff nurses bear the brunt of it, but also to develop long-term solutions instead of short-term workarounds. This study presents the results of a 2-stage (preintervention and postintervention) performance improvement project that measured cost, quality, and work problems associated with manual data entry and tested a data automation tool developed specifically to solve them.

Significant operational challenges are generated by taking and recording vital signs (V/S), essential tasks in delivery of quality care to hospitalized patients. Although measurement devices and patient records have been digitized over the past decade, the manual interface between them is still stuck in the 20th century. Unnecessary costs and unacceptable outcomes regularly result from delayed reporting, incomplete records, and transcription errors.[5,6] Clinicians feel more like data entry clerks than health professionals, forced to collect data for inefficient EHRs rather than interact meaningfully with patients.[7]

As leaders in their respective fields, patient care and medical technology, Dignity Health and Applied Science, Inc, formed a partnership to solve these

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problems. This joint venture at a Dignity Health flagship hospital is developing Automated Data Entry Process Technology (ADEPT™) to automatically transfer V/S and other essential patient data (eg, weight, diet, fluid input/output, pain scale, supplemental oxygen) from dedicated measurement devices to patient records. Nurse-generated data can also be entered directly to patient records via ADEPT. In addition to saving money by improving workflow and enhancing quality, the tool is specifically engineered to meet the nursing staff's need to spend more time interacting directly with patients, a key component of job satisfaction.

This initiative started with an in-depth study to quantify the hospital's current system that requires an RN or certified nurse assistant (CNA) to manually transfer V/S from a measurement device's screen to the EHR. Nurses typically wrote the device-displayed values on paper (occasionally on their clothing or hands) at the bedside and then went to a desktop computer or workstation on wheels at another location to enter the data into the EHR. The manual process was not standardized to ensure consistency or accuracy. Different nurses used different methods. Entries were often batched; that is, V/S for several patients were handwritten on the same temporary transfer medium until recorded electronically at a workstation. Lost scraps of paper also resulted in delayed or missing entries. Although published literature suggests this aspect of data entry's impact on the delivery of care is a problem in hospitals in the United States,[8-10] Dignity Health's institutional review board (IRB) determined that the project's quality improvement focus did not require IRB approval because the research automated an existing process; it did not change the way patient care was provided.

Consistent with the referenced studies that reveal problems in manual transfer of V/S from measurement devices to medical records, phase 1 focused on understanding 4 specific problem areas:

1. differences between values measured by the device and corresponding values in the EHR;
2. delays between time of device measurement and time of EHR data entry;
3. differences between actual time data entered in EHR and reported by caregiver; and
4. differences in performance by credentials (RN or CNA) and employee.

The magnitude of cost problems (eg, inefficient use of time, other tasks that could have been performed) and quality problems (eg, measurement errors, delayed reporting) revealed by phase 1 data clearly supports automating the device-EHR interface. The error rate of manual data transfer was clinically and economically unacceptable. The findings established baselines for subsequent analysis of automation's impact on cost, quality, productivity, and related problems created by manual interfaces.

Background

V/S are among the most important observations a clinician considers when making a diagnosis and following a treatment plan.[11] As fundamental indicators of a patient's condition over time, V/S help determine required interventions, essential components in the chain of prevention required to avoid deterioration, cardiac arrest, and death.[12] History and physical findings are essential, but not solely sufficient to guide appropriate and timely care. Missing, outdated, or incorrect V/S can lead to avoidable adverse outcomes. Some of the blame is due to errors created at the interface between devices that take measurements and patient records that caregivers review. Resulting error rates, discrepancies between measured and recorded values, reported in the published literature are as high as 35%.[13-17] Pooled data from all reviewed studies yielded an average error rate of 20.2%.

In other words, approximately one-fifth of all V/S values manually transferred from measurement devices to patient records may not be current and/or correct. Some errors are not clinically significant, but management engineering focuses on eliminating all errors. Accepting clinically insignificant errors can lead to serious problems with the quality of patient care and regulatory compliance. Indeed, if some errors are unimportant, why are the measurements even being made? Any error represents a potential problem in quality of care.[18,19] Given the imperative for caregivers to focus on value, every healthcare delivery organization should be working to eliminate V/S errors in patient records. Therefore, the data automation tool was used to compare exact values of selected V/S (eg, systolic and diastolic blood pressure [B/P]) reported by the GE Healthcare (Chicago, Illinois) and Welch Allyn (Skaneateles, New York) V/S monitors, with the corresponding values ultimately entered in the hospital's Cerner (North Kansas City, Missouri) EHR, with the goal of driving the error rate to zero (0).

Methodology

The study was conducted for 3 weeks in March 2016 on a busy medical-surgical unit at a large tertiary care hospital. A sample of 1933 consecutive, matched records was selected for analysis. A matched record consisted of the V/S value reported on the measurement device's screen and the corresponding data entered manually in the hospital's Cerner EHR by an

RN or CNA. Technical architecture of the automated data transfer channel begins with a dongle plugged into the measurement device's data port. This wireless component transmits the V/S values via a secure and encrypted signal to the ADEPT application for display on an iPad Mini screen at the measurement site. The nurse who took the measurements accepts the V/S data displayed on the iPad's screen, which then transmits the data to the ADEPT backend application. This process allows the nurse to review and validate the data on the iPad before they are entered into the EHR. The nurse also has the option to retake the V/S in case of problems that lead to anomalous results, such as patient movement during measurement or misplaced cuffs.

The ADEPT technology allows the nurse to enter additional data, such as food and fluid intake and pain measurement. The interface also displays hospital-established normal values. The nurse-validated data entries are then transmitted instantaneously from the iPad Mini to the hospital's EHR in a HIPAA-compliant cloud via an HL-7 transaction. A time stamp is attached to the data as they are entered in the EHR, along with a record of the RN or CNA who took the V/S measurements. The data set in the EHR provides a complete audit trail of all measurements and related work tasks.

For purposes of this study, an error was defined as any inconsistency between the actual device measurement and the corresponding value entered in the EHR by the nurse. A data entry delay was defined as the elapsed time, in seconds, between the time the measurement device reported the V/S values and the time the corresponding data were recorded in the EHR.

Inadequacy of Standard Definition of Errors

Our phase 1 study of matched device-to-EHR data pairs found an overall error rate of 19%, at the middle of the range of rates reported in the literature. The error rate varied widely from day-to-day, with a range from 7% to 29% of all data pairs. The study also evaluated the frequency of all errors made by observed caregivers, as summarized in Figure 1. These data clearly demonstrate that errors are spread across the team of caregivers who record and report V/S data in the EHR. Only 9 employees (15%) made no errors as measured by phase 1 data. Fifty-one RNs or CNAs (85%) made 1 or more errors during the continuous 3-week monitoring.

In-depth multidimensional analysis of data found that the literature's standard practice of estimating a single error rate (ie, the number of values in the EHR that differ from the measurement device's values, as a percentage of all pairs in the data base) is misleading. Our analysis suggests that studies reporting a single composite measure of error oversimplify the range of mismatches between measured and recorded values, for reasons discussed below. Data revealed distinctly different problems that are obscured by the standard practice of combining all errors into 1 summary statistic. Important keys to improving quality and reducing costs are correspondingly absent from the current literature.

Report and Analysis of Different Error Problems

Differences Between Device Measurements and EHR Values

As noted above, our literature review produced a fairly consistent picture of how often information in medical records deviates from the corresponding source data provided by V/S measurement devices, but it does not fully depict the range of reasons for the discrepancies. (Accuracy of the values reported by the measurement devices was not addressed in this study.) The following types of disagreement between measured and recorded values were identified in our phase 1 study:

- typographical errors (eg, character transpositions, meaningless characters)
- rounding errors (eg, device values ending in any digit rounded to a number ending in 0 in the EHR)
- double counting (eg, >1 entry of a single episode of measurement, same data entered by 2 caregivers)
- missing values (eg, device provided a value, but corresponding field left blank in EHR)
- unexplained values (eg, EHR entry with no corresponding record of a device measurement)
- values entered in wrong patient record (eg, measurements identified with 1 patient at the recording device and entered in a different patient's EHR)

Delays Between Time of Device Measurement and Time of EHR Data Entry

Referenced articles identified the problem of gaps between the exact time V/S are displayed by a measurement device and the exact time they are entered in the EHR. However, the length of the gap is less well documented in the literature, and some existing studies are flawed because time measurements were not synchronized across the continuum of discrete V/S events. The longer the gap, the less likely the V/S in the EHR accurately represent a patient's current condition, increasing the chances of deficient care. Essential responses to a critical drop in B/P, for example, are unlikely to be initiated on a timely basis if documentation of the patient's deteriorating condition is delayed more than a few minutes. Real-time, accurate

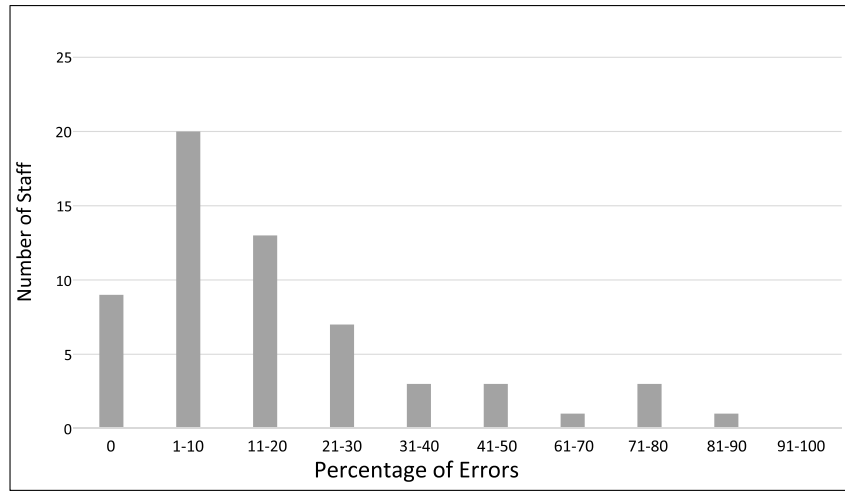

Figure 1. Percentage of manual entry errors by number of staff.

information can be the difference between life and death. Based on a standardized clock for all measurements, our findings are summarized in Figure 2. Visual analysis of the data distribution shows that very few entries matched the clock's real-time (ie, zero delay) transfer of data into the EHR, regardless of whether the data contained errors. The median delay was 5.63 minutes; the range was from 0 seconds to 395 minutes.

Differences Between Actual Time Data Entered in EHR and Reported by Caregiver

Meaningful measurement of the delay between device measurement and EHR entry assumes standardization (ie, exact calibration) of the time sources used to set the 2 endpoints. However, the study identified some discrepancies at the EHR endpoint, between the time the RN or CNA reported entering the data and the time the data were entered according to the digital time stamp. For example, the digital clock on the measurement device and the wristwatch or wall clock used by the caregiver are not calibrated to the same time standard (eg, WWV). These deviations are not directly related to cost or quality, but they must be eliminated. Hence, our research suggested that the patient record must include a single, correct, and consistent time stamp in order to conduct accurate studies of other problems created by manual data transfer.

Differences in Performance by Credentials (RN or CNA) and Employee

The study enabled an unprecedented analysis of individual performance of tasks associated with the manual transfer of data from measurement device to EHR. Overall, RNs and CNAs had relatively low error rates. The rates observed in this study may be normal, but

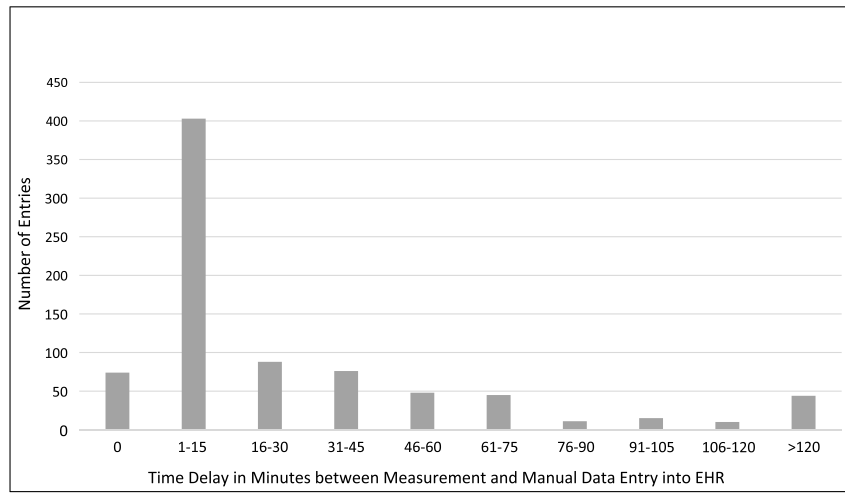

Figure 2. Frequency of time delays between measurement of V/S and manual data entry into EHR.

phase 1 was not designed to test for variations from an expected or acceptable error rate. We identified several caregivers with error rates that are clearly unacceptable. Two caregivers had verifiable error rates of 73% and 50% in their data entries, and 10 (17% of all RNs and CNAs included in this analysis) had estimated error rates of 40% or higher. Identifying these outliers is an extremely important finding. It allows nursing administrators to initiate appropriate steps for improving performance of employees whose errors may be reducing quality of patient care and/or increasing costs.

Nursing Performance and Job Satisfaction

A written survey was given to all 49 RNs and CNAs who participated in the comparison of manual and automated data entry. Forty complete surveys with usable responses were returned, for an 81.6% response rate. Thirty-three of the 40 respondents (82.5%) had used the automated data entry tool for 6 months or more prior to the data collection period. For all 40 respondents, the automated data entry tool was used for an average of 362 patients per caregiver. The survey instrument, available upon request from the corresponding author, was pretested and validated before being administered to the 49 RNs and CNAs.

Based on their experience with both manual and automated data entry processing technology (ADEPT), 35 of 40 nurses (87.5%) preferred to use the automated data entry tool. Reasons for this preference are identified by responses to the following questions:

- How did ADEPT affect the overall task of collecting other data, such as fluids, supplemental oxygen, and pain scale?
- Does ADEPT affect the total time you spend collecting and reporting data?
- Did using ADEPT affect errors in transferring data from measurement devices to the EHR?
- What is ADEPT's impact on the time that you have to spend on direct patient care and other tasks?

Survey responses to each question and their rates are presented in Figure 3.

In responding to an open-ended question on the survey form, nurses listed 34 discrete tasks they were able to undertake with the time saved by the automated tool for transferring data and capturing workflow measures. Responses fell into 4 distinct categories for the use of additional time: direct patient care, extended patient assessment, patient education, and medication management. The study identified several other benefits of automating data transfer. ADEPT generated operational data to assess nurses' preferences for different devices. Use patterns revealed that 1 manufacturer's V/S monitor was used by nearly 75% of the nurses, even though several vendors' devices were available on the unit. Transitioning all nurses to the single, preferred V/S monitor could eliminate the expense of maintaining lesser-used units. New operational data revealed significant variation in the time nurses devoted to measuring and recording V/S, which allowed nurse

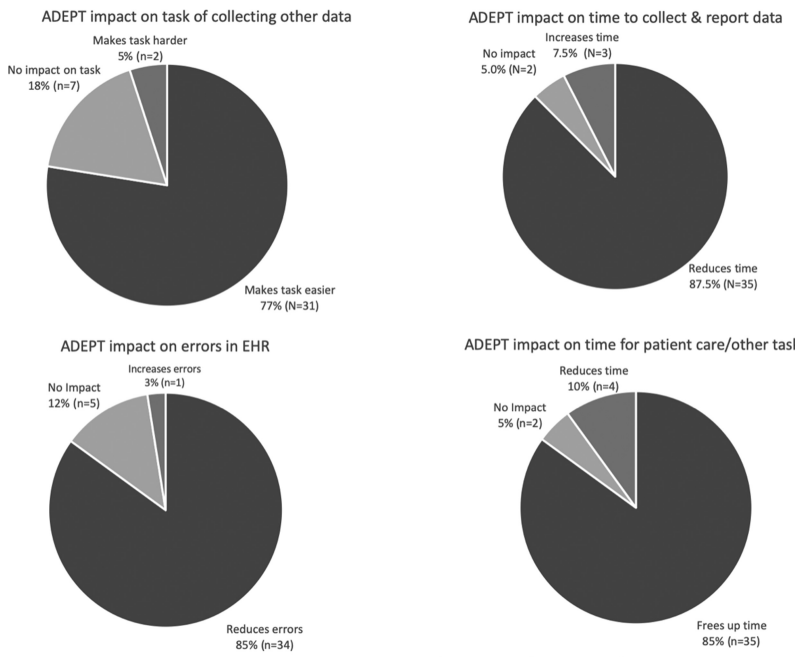

Figure 3. Nurses' perception of impact of the automated data entry tool.

administrators to target additional training to the staff nurses who were least efficient at the tasks being studied.

Discussion and Conclusions

This institutional quality improvement study provided proof of concept for a new technology that automated data transfer between a hospital's V/S measurement devices and electronic medical record. It identified not only improvements in nursing workflow and productivity created by data automation, but also widespread user satisfaction with the new technology. A written survey revealed that key job satisfaction parameters, as addressed in the literature,[20-23] were improved on the nursing unit as a result of implementing the automation technology. Potential cost savings and quality improvements were generated as nursing time was liberated from manual clerical tasks to patient care tasks that correlate positively with employee and patient satisfaction scores.[24] These gains are being quantified and studied in subsequent phases of the research and development project. However, the device developed and tested in the first phase produced total elimination of data errors, clinically significant reductions in data transfer time, and nearly unanimous staff nurse preference for a tool that automates transfer of data from V/S measurement devices to EHRs. Automation of data entry is a promising solution to several serious problems that confront staff nurses daily.

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