Use of a Clinical Decision Support System to Improve Hypoglycemia Management

Roberta L. Harrison, Sonia L. Stalker, Rochelle Henderson, and Frank Lyeria

Currently, over 10.9 million U.S. residents age 65 or older have a diagnosis of diabetes. An estimated 79 million U.S. residents age 20 or older have pre-diabetes (Centers for Disease Control and Prevention [CDC], 2011). In the United States, diabetes remains the 7th leading cause of death. Serious complications also are associated with diabetes, including heart disease, kidney failure, vision loss, and amputation (CDC, 2011). A current debate centers on whether practitioners should enforce stringent glycemic control. A recent meta-analysis (Murad et al., 2012) found stringent glycemic control carries an increased risk of hypoglycemia. Therefore, one of the concerns around stringent blood glucose control is the increased risk for hypoglycemic events. In the hospital setting, paper-based guidelines often promote normal blood glucose. However, adherence to the paper-based hypoglycemia treatment guidelines has been poor (Maynard, Huynh, & Renvall, 2008).

In this study, the research team implemented a nursing clinical decision support system (CDSS) in the form of electronic hypoglycemia management guideline advice. Interactive guidelines were embedded within the nursing documentation section of the electronic health record (EHR). The primary purpose was to improve nursing adherence to hypoglycemia management guidelines and improve compliance tracking. The secondary purpose was to determine the impact of change of work shift on guideline adherence.

The number of persons with diabetes who enter the health care system continues to grow. Stringent glycemic management increases the risk for hypoglycemia. The use of a clinical decision support system to assist nurses in treating hypoglycemia accurately may be useful in improving adherence to specific hypoglycemia management guidelines and compliance tracking.

Review of the Literature

Hypoglycemia

Hypoglycemia is defined as blood glucose of less than 70 mg/dL (Pagana & Pagana, 2010). In the hospitalized patient, hypoglycemia is associated with adverse drug reactions, decreased caloric intake, failure to adjust medications that lower blood glucose, and missing meals due to diagnostic testing requiring the patient to be away from the unit (Anthony, 2007). More than 40% of patients experiencing one hypoglycemic episode will experience a second episode during the same hospitalization (Maynard et al., 2008).

Guidelines

Guidelines to manage hypoglycemic episodes have been developed to allow nurses to intervene immediately without having to contact the physician first. Nurses who continue to use the paper-based guidelines internalize a process and no longer review the document but rather rely on memory (Rycroft-Malone, Fontenla, Seers, & Bick, 2009). In addition, these guidelines typically are housed in policy and procedure manuals; as a result, nursing utilization and documentation have been sub-optimal. In a study examining nursing adherence to practice guidelines, Anthony (2007) found nurses had poor compliance with paper-based hypoglycemia treatment guidelines. In this descriptive study, 210 retrospective medical record reviews were completed; not one record was compliant with all requirements in the practice guideline. One proposed solution to this problem is to embed guidelines within the nursing documentation section of a patient’s EHR.

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Lyerla, LeRouge, Cooke, Turpin, and Wilson (2010) developed a CDSS with an embedded protocol to improve nursing adherence to guidelines preventing ventilator-assisted pneumonia. The embedded protocol in the CDSS prompted the nurse to position the angle of the bed correctly for ventilator-dependent patients and document the angle in the clinical record. The study was completed in three phases, with 105 observations of documentation and head-of-bed angles recorded at each phase. Participants included 42 patients and 33 registered nurses. Adherence to documentation and head-of-bed elevation was measured before intervention, 1-2 months after intervention, and 4-5 months after intervention. Significant improvements were noted in protocol adherence at 1 and 5 months after implementation.

In another study, Kwok, Dinh, Dinh, and Chu (2009) evaluated the use of an asthma protocol embedded into clinical documentation. In this study, 50 patients with asthma were compared to a historical control group of 50 patients with a discharge diagnosis of asthma. The 50 patients with asthma who presented in the emergency department over a 6-month period were assessed by physicians using the Asthma Clinical Assessment Form and Electronic decision support CDSS. Following implementation of the CDSS, the medical records of the study patients were compared to a control group. A significant improvement in documentation of key clinical parameters for asthma management was noted in the study group.

Clinical Decision Support System

An interactive guideline embedded within an electronic health record is an example of a CDSS. A clinical decision support system is a computerized program utilized within the health care setting to support decision making. A nursing CDSS is used within the context of nursing to support nursing decision making. CDSS programs are based upon if-then rules that tell the computer what actions to take given certain information (Kumar, Singh, & Sanyal, 2009).

Information is accessed and stored within the knowledge base component of the CDSS. Clinical decision support systems often are used to generate alerts, reminders, or advice. Information used and generated by a CDSS should be evidence based, current, and have the ability to be updated. In this study, the diabetic educator was responsible for maintaining current evidence associated with hypoglycemia management. As the management standards changed, the diabetic educator was charged to work with programmers to ensure nurses had access to current hypoglycemia management guidelines.

Methods

Study Design and Setting

The study took place at a small community hospital in the Midwest. Approval from the hospital's institutional review board was obtained prior to study initiation. Subjects were limited to hospitalized hypoglycemic subjects over age 18. Patients who experienced blood glucose below 70 mg/dL but were receiving intravenous (IV) insulin and following the IV insulin protocol were excluded from the study as the treatment protocol was different from the hypoglycemia protocol used in this study. Using an interrupted time series design, three different samples of 150 or more medical records of patients with diabetes who had at least one incident of blood glucose below 70 mg/dL were reviewed for hypoglycemia protocol implementation and documentation. The first review was completed 6 months prior to implementing the intervention; the second review was completed 6 months following implementation; and the last review was completed 7-12 months after implementation. The intent of the final review was to determine if guideline adherence rates persisted over time.

Intervention

The purpose of this study was to develop and integrate a nursing CDSS for managing hypoglycemia within the EHR to facilitate adherence to the guideline. The CDSS involved a hypoglycemic management protocol embedded within the electronic nursing documentation section of the patient's EHR. The CDSS was activated when a blood glucose level of 70 mg/dL or lower was entered. The nurse then would be asked a series of questions, each one followed by advice in accordance with the programmed hypoglycemic management guidelines. For example, an initial question asked if the patient can swallow. If the answer was "yes," oral glucose would be included in the treatment recommendation. If the answer was "no," intravenous glucose would be listed as a recommended intervention. Additional information on the development and implementation of this CDSS is published elsewhere (Harrison & Lyerla, 2012).

Data Collection

Review of discharged electronic health records was conducted for patients who had a primary or secondary diagnosis of diabetes from February 2010 to August 2011. A data collection tool was developed and used by the researchers. Blood glucose documentation was reviewed in each record for evidence of hypoglycemia episodes (below 70 mg/dL). Episodes occurring within the intensive care unit were excluded because a different intravenous glucose protocol was utilized. All episodes and documented treatments were collected via the data collection tool.

Testing/Training

Ten nurse volunteers tested the initial CDSS prototype. Nurses were provided hypoglycemia scenarios and asked to follow the steps provided by the CDSS. A debriefing session then was held to gather feedback to guide changes regarding the sequence of questions and associated recommendations. Once the final version of the CDSS had been identified, a training manual and instructional videos were created. Manuals and videos were placed on each unit as well as uploaded to the organization's intranet.
Data Analysis

All data were entered, stored, and analyzed using SPSS v19 (Statistical Package for the Social Sciences - IBM, Armonk, NY). All subjects' identifying information was removed from the data collection tool before entering the data in a computer database. Data were collected via a chart audit tool created by the research team. Collected data included subject visit number, date and time of initial episode, recorded blood glucose value, level of consciousness, initial treatment (4 or 8 ounces of orange or apple juice, three graham crackers, 25 ml of 50% dextrose IV, 50 ml of 50% dextrose IV, or 1 mg glucagon intramuscularly), swallowing ability, IV access, initiation of IV fluids, need for follow-up blood glucose administration within 15 minutes, repeated follow-up actions if indicated, and physician notification. A compliance score was assigned to each observation for each of the data collection phases. A grace period of 5 minutes before or after the 15-minute follow-up mark was allowed. Observations were grouped into those that occurred within 1 hour of a shift change and those that did not. Chi-square statistics were used to determine significance of the intervention as well as a change of shift impact. Analysis of variance (ANOVA) was used to compare mean blood glucose values across each phase and t tests within phases. The statistical analysis concluded with a logistic regression model to control for variables found to be significant. All p values were two-tailed and were compared to a 0.05 alpha.

Results

Of the 585 hypoglycemic episodes reviewed, 284 were reviewed in phase 1, 150 were reviewed in phase 2, and 158 reviewed in phase 3. Although compliance was not as high as the researchers had hoped, the increase from 4% to 13% and then from 13% to 25% was statistically significant ($\chi^2=42.16, p<0.001$) (see Figure 1).

Only 34% ($n=68$) of the 201 hypoglycemic episodes recorded in the study occurred during a shift change. The percentage of hypoglycemic episodes occurring at shift change for phase 1 was 43%, 30% for phase 2, and only 23% for phase 3 (see Figure 2). The relationship between compliance level and shift change was not statistically significant ($\chi^2=0.005, p=0.946$).

The average blood glucose value in each of the three phases ranged from 56 to 57 mg/dl and was not statistically significant (ANOVA, $F=0.146, p=0.864$) (see Figure 3). However, across patients in phase 2, a statistically significant difference existed between blood glucose for those episodes where the protocol was followed (51 mg/dl) and those where it was not (58 mg/dl) ($t=4.85, p=0.010$).
Use of a Clinical Decision Support System to Improve Hypoglycemia Management

FIGURE 3. Blood Glucose Average and Protocol Compliance

<table>
<thead>
<tr>
<th>Blood Glucose Level (mg/dl)</th>
<th>Phase 1</th>
<th>Phase 2*</th>
<th>Phase 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td>56</td>
<td>58</td>
<td>57</td>
</tr>
<tr>
<td>58</td>
<td>54</td>
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<td>48</td>
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<tr>
<td>46</td>
<td></td>
<td>48</td>
<td></td>
</tr>
</tbody>
</table>

- No
- Yes
- Overall

* Statistically significant p < 0.05

TABLE 1. Logistic Regression Controlling for Blood Glucose

<table>
<thead>
<tr>
<th>Regression Coefficient (B)</th>
<th>S.E.</th>
<th>Odds Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1</td>
<td>Reference Category</td>
<td></td>
</tr>
<tr>
<td>Phase 2</td>
<td>0.611*</td>
<td>0.193</td>
</tr>
<tr>
<td>Phase 3</td>
<td>1.036*</td>
<td>0.177</td>
</tr>
<tr>
<td>Blood Glucose</td>
<td>-0.028*</td>
<td>0.011</td>
</tr>
<tr>
<td>Constant</td>
<td>0.250*</td>
<td>0.597</td>
</tr>
</tbody>
</table>

* Statistically significant p < 0.05

Blood glucose was controlled by its inclusion in the logistic regression analysis (see Table 1). Researchers found no greater likelihood for improved compliance as a result of different blood glucose values (0.973). The odds ratio for phase 2 indicated the protocol was almost twice as likely (OR=1.843) to be followed than in phase 1 and almost three times as likely (OR=2.818) in phase 3.

Discussion

Clinical guidelines and protocols for managing hypoglycemia are used routinely in health care practice. Nursing adherence to these guidelines has been less than optimal (Anthony, 2007; Maynard et al., 2008). The purpose of this study was to improve nursing adherence to a clinical guideline on hypoglycemia management using CDSS and to improve the ability to track compliance. In this study, a statistically significant improvement was noted before and after implementation of the hypoglycemia management CDSS; however, the improvement was not significant from a compliance standpoint (25% compliance). Nurses documenting hypoglycemia continued using the first page of the documentation tool for recording the blood glucose value and at times narratively added a treatment within an open text box. Once the page with the recorded blood glucose value was completed, however, nurses often failed to continue to the second page to complete the area in which the hypoglycemia protocol CDSS was embedded. Additionally, no statistical difference was found in compliance levels when hypoglycemic episodes occurred around shift change. However, tracking compliance after implementing the new CDSS required navigating to only one screen, where all applicable components of the hypoglycemia guideline were located. This was much improved from the previous documentation that required navigating to multiple screens to capture compliance data. Compliance in completing the training was initially a concern for researchers. However, the study site reported 97% of staff did complete the training.

During the CDSS development, nurses at the study site opted to keep the original blood glucose reporting page that included a text box for the current blood glucose value and an open text box for the nurse to add a short narrative response. The CDSS for hypoglycemia management was added as a second page or link that was consistent with other areas of nursing documentation. No alerts were built into the system to require the nurse to go beyond the first page where text boxes were located.

Current evidence-based education on the management of hypoglycemia was made available to all staff nurses prior to implementing the new CDSS (Manchester, 2008). A PowerPoint presentation about the hypoglycemia protocol, newly developed CDSS (including screen shots), and case study examples were developed, recorded, and transferred to a DVD. Copies of the DVD were distributed to all nursing units. After nurses watched the DVD, a 10-item post-test was completed using an online educational platform. Training manuals including screenshots of the CDSS also were distributed to all the nursing units. Live training sessions were not conducted at the request of nurse leaders, who already had scheduled a number of training sessions related to other changes in the clinical documentation system.
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2. Evaluations must be completed online by August 31, 2015. Upon completion of the evaluation, a certificate for 1.3 contact hours may be printed.

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Objectives

This continuing nursing educational (CNE) activity is designed for nurses and other health care professionals who are interested in a clinical decision support system to improve hypoglycemia management. After studying the information presented in this article, the nurse will be able to:

1. Discuss hypoglycemia management guidelines and clinical decision support systems (CDSS).

2. Summarize a study examining the outcome of interactive guidelines to improve nursing adherence to hypoglycemia management guidelines and improve compliance tracking.

3. Describe implications for medical-surgical nurses of a CDSS embedded within the nursing documentation section of the electronic health record.

Note: The authors, editor, and education director reported no actual or potential conflict of interest in relation to this continuing nursing education article.

CNE

Limitations

This retrospective interrupted time series design had several limitations. First, the study was conducted during the same time a number of other clinical documentation changes were occurring. This made staff education challenging as members already were involved in multiple training sessions. Additionally, although the CDSS was included as a second page to the documentation, the initial page for blood glucose value documentation remained unchanged. This may have been confusing to nurses; with no alert system in place, they could stop easily after documenting the blood glucose value, as had been done in the past. Only after the training videos were developed and distributed were the principal investigators notified that audio capabilities were limited on some of the nursing units. The study also had no control group. Finally, with one facility as the study site, results are not generalizable to other institutions.

Nursing Implications

The results of this study indicate a CDSS embedded within the nursing documentation section of the EHR can improve adherence to hypoglycemia management guidelines. However, to achieve maximum benefit, researchers must track the expected outcomes following CDSS implementation to determine if additional user training or system alterations are needed. Medical-surgical nurses routinely manage hypoglycemic events. This study demonstrated a CDSS could be used to assist nurses as they choose the most appropriate actions to take during a hypoglycemic event.

Finally, current government mandates require health care facilities to prepare reports indicating the meaningful use of their electronic health records. The Centers for Medicare & Medicaid Services established objectives for meeting the meaningful use criteria. One of the meaningful use core objectives includes the development of CDSS rules similar to those used in this study (U.S. Department of Health & Human Services, 2010). This study found a significant improvement in nursing guideline adherence following the implementation of a CDSS. Other health care facilities can use this as an exemplar in meeting this government mandate.

Conclusion

Adherence to current clinical guidelines is an important facet of quality improvement. Nurses need quick access to specific guidelines in a format that allows them to document in an accurate and efficient manner. The use of a CDSS can meet this need and also can provide a means for tracking documentation compliance easily. This study resulted in improved nursing compliance with hypoglycemia guideline documentation, although opportunity exists for continued improvement. As a result of the project, nurse leaders at the study site removed the open text box on the first page of the CDSS and added directions to proceed to the second page. Removal of the open text box may yield a higher compliance score in the future. Hypoglycemia guideline compliance now is measured and reported monthly during meetings of the site’s quality council. In the future, the timing in presenting a new CDSS will be considered so training can be completed through a live in-service with demonstration and return demonstration rather than a video format.

REFERENCES


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continued on page 263
• Tells the recipient what cannot be done.
• Has a subtle tone of blame.
• Includes words like can't, won't, unable to, which tell the recipient what the sender cannot do.
• Does not stress positive actions that would be appropriate, or positive consequences. (Bacal, 2013, p. 2)

Positive phrasing and language have the following qualities:
• Tells the recipient what can be done.
• Suggests alternatives and choices available to the recipient.
• Sounds helpful and encouraging rather than bureaucratic.
• Stresses positive actions and positive consequences that can be anticipated. (Bacal, 2013, p. 2)

Filtering SNP

In today's health care environments, the art of listening and paying attention can be lost due to distractions from many sources. Effective nurse managers have the art and skill of dealing with SNR. They can identify a legitimate signal versus noise. They know the strength of the signal in the workplace in no way indicates the importance of the message being delivered. Some employees may speak softly or rarely, but have an important message. The SNR actually may be reversed, with the noise level far exceeding the softly delivered signal. Noise may be more apparent and noticed due to its intensity and/or frequency, but that does not mean soft signals should be discounted. They may be the most significant of all. The quiet, unassuming employee needs to be heard just as much as the loud staff member. Unfortunately, unlike electrical systems, loudness and frequency do not constitute legitimacy. Understanding and appropriately filtering SNR represent both an opportunity and a fundamental skill of the successful manager. [SN]

REFERENCES


Improved Hypoglycemia Management

continued from page 254


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