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VARIATION IN INSULIN ADMINISTRATION

Impact of Audit and Feedback on Timing Variation in the Point of Care Glucose Collection-Insulin Administration Workflow: A Quality Improvement Study

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Abstract

BACKGROUND: Multiple roles contribute to the point of care glucose collection and insulin administration workflow. Diabetes care associations and safety advocates provide recommendations since the time-action profile of prandial insulin requires knowledge and performance to deliver insulin safely.

PROBLEM: Variation of practice in relation to the time that point of care glucose was collected and meal and insulin administration assessments were completed failed to meet parameters.

PURPOSE: A quality improvement project aimed to test the effect audit and feedback has on rapid acting insulin administration and point of care glucose collection practice at meals.

METHOD: Audit and feedback, a knowledge transfer-behavior change intervention, was tested to determine its effectiveness as a technique to translate evidence to practice. Audit and feedback cycles informed nurses of the goals, performance measures, and gaps to improve practice. A pre-test post-test study design was used. Point of care glucose and rapid acting insulin data was retrospectively audited from electronic medical records of a medical-surgical unit.

RESULTS: Post-intervention performance measures indicated the intervention was not effective. Variation persisted after the intervention. While the frequency of outcomes measures did not improve, the quality improvement process revealed information to inform clinical improvements for future quality improvement.

CONCLUSION: Audit and feedback as an intervention for knowledge transfer and behavior change remains a questionable intervention for translating evidence to practice. More evidence is needed of when and how audit and feedback will be most effective must be understood.

Keywords: audit and feedback, guideline, diabetes, glucose, prandial insulin

Impact of Audit and Feedback on Timing Variation in the Point of Care Glucose Collection-Insulin Administration Workflow: A Quality Improvement Study

Introduction

Problem

The staggering prevalence, cost burden, and potential harms attributed with inpatient diabetes (DM) require effective healthcare delivery systems to manage complexities of this population. The genesis of this project originated from priorities set in 2019 by a community hospital. The hospital's analysis of DM practice revealed opportunities for quality improvement (QI) among a burgeoned DM inpatient population. The analysis indicated that recommendations for DM inpatient care (American Diabetes Association [ADA], 2020; Institute for Safe Medication Practices [ISMP], 2017a; Umpierrez et al., 2012), specific to timely insulin administration with point of care glucose (POCG) collection and appetite assessment, were not consistently met. It appears to be that at the root of the problem has been a lack of organizational culture of inter-professional teamwork and communication, multidisciplinary knowledge gaps, and a strategy to standardize DM practice for non-critical care inpatients.

In 2019, the hospital for this QI project noted that the POCG collection at meals varied from the evidence based (EB) guidelines (ADA, 2020; Umpierrez et al., 2012) and insulin practice recommendations (ISMP, 2017a; Slattery et al., 2018). The POCG collection to rapid acting insulin (RAI) administration practice was moderately improved after the workflow was redesigned. However, variation of practice, in relation to the time that POCG was collected and meal and insulin administration assessments were completed, failed to meet EB practice parameters. Given the burgeoning DM prevalence in hospitals and complexities in DM care and insulin medication regimens, it was essential to address remediable practice gaps when EB

practice was available. The workflows of timing the POCG collection with meal intake and insulin administration will likely vary without a shared understanding of EB recommendations and mechanisms to evaluate DM practice.

All insulins are among nationally high-risk medications (ISMP, 2017b). Since insulin was also the medication associated with the most medication events at the study location in 2018 and 2019, it was especially relevant to focus on improvements in insulin safety practice. The project tested the EB intervention of audit and feedback (AF) for nurses to implement EB recommendations (ADA, 2019; ISMP, 2017a; Slattery et al., 2018; Umperriez et al., 2012) and improve DM practice on a medical-surgical unit. Appendix A provides recommendations associated with the aspect of the clinical practice guideline (CPG) of this QI project.

Available Knowledge

CPG began as systematically developed statements to assist in decisions about appropriate health care for specific clinical circumstances (Institute of Medicine, 1992). Approaches by Maynard et al. (2015) and Milligan et al. (2015) were derived from a larger DM improvement initiative and gap in knowledge, practice and processes. Maynard et al. (2015) and Milligan et al. (2015) reported that DM practices did not conform to standards and CPG were foundational to DM management in the hospital. CPGs have intended to reduce practice variations, advance translation of research into practice, and improve healthcare quality and safety. The EB recommendation statements within a CPG strengthen their trustworthiness (Graham et al., 2011) to adapt to them in practice.

It is widely reported that insulin doses are poorly coordinated with glucose monitoring in the hospital (Alwan et al., 2017; Freeland, et. al, 2011; ISMP, 2017a; Maynard et al., 2015; Milligan et al., 2015; Ryan & Swift, 2014; Szalc & Nicolas, 2018). Behind the recommendations

is the need “that each institution establish a uniform method of collecting and evaluating POCG testing data and insulin use information as a means of monitoring the safety and efficacy of the glucose control program” (Umperriez et al., 2012, p. 32). To guide glycemic management and RAI dosing researchers recommend acting on a POCG result within 60 minutes of collection (Umperriez, 2012) and within 15 minutes of meals (Slattery, 2017). A variety of factors need to be addressed to translate the POCG recommendation of the CPG into practice.

Variation

The notion that practice variation is abundant and unwanted in healthcare delivery is certain. Efforts to avert variation in practice are necessary and form the basis for local QI. Variability of the timing of POCG collection, meal delivery, or insulin administration practice can lead to harmful outcomes for patients (ISMP, 2017a). Interventions to reduce variation from best practice for a targeted process can improve care. Standardization is a key to success in reducing variation and improving outcomes (Ferguson, 2017; ISMP, 2017a).

Workflow

Managing the DM population in the hospital is especially complex given the interwoven, dynamic and interdependent systems involving multiple care givers. Without structure and process to manage inpatient DM care can be fragmented, task-based, and lacking a collaborative approach. Improvements to DM management in the hospital include standardization, coordination, and communication (Maynard et al., 2015; Milligan et al., 2015; Milligan & Zellmer, 2015). The rising prevalence of DM and complexities in DM care today suggests that more intensive nursing care and monitoring are needed. However, acute care units may not be equipped or kept pace with the necessary adjustments in practice to contend with these issues (Freeland et al., 2011).

Coordination of POCG monitoring, meal delivery, and insulin administration workflows in the hospital has been widely recommended (ISMP, 2017a; Maynard et al., 2015; Milligan et al., 2015; Milligan & Zellmar, 2015; Umperriez, et al., 2012). A lack of coordination of the POCG to RAI administration workflow was explicitly documented as a common barrier to optimal care (Umperriez et al., 2012). Harrison et al. (2013) discovered that workflows that include interactivity, such as electronic alerts, reminders, and/or advice embedded within nursing documentation, facilitate compliance with recommended guidelines. QI activities aimed at improved insulin workflows have achieved coordination and standardization (Bernaldez-Ngugi et al., poster presentation, n.d.; Milligan et al., 2015; Maynard, et al., 2015; Milligan & Zellmar, 2015). Meal tray arrival, POCG collection, and awareness of the meal start time require coordination to align insulin administration. Coordination is problematic regardless of a hospitals' use of standard mealtime or "room-service" delivery method (Maynard et al., 2015).

Insulin Safety

Insulin is recommended for managing most DM patients in the hospital (ADA, 2020; Umperriez et al., 2012). Management generally includes converting DM patients from their prehospital oral agents to subcutaneous regimens. The agents used in the hospital regimen include a combination of basal, nutrition, and correction insulin. Pharmacodynamics and contexts that influence insulin's effect are complex. The complexities help explain insulin's continued classification as a high alert medication by the Institute for Safe Medication Practices (2017b). Insulin's potential harm is severe, margin for error is small, and time to recover is short (Mathioudakis et al., 2015). Clinicians must attend to decision-making and priority setting when planning insulin administration.

RAI analogues are often a part of the medication regimen during hospitalization (ADA,

2020; Umperriez et al., 2012). Key factors for the optimal control of blood sugar and to prevent harm are the dose and timing of RAI (Slattery et al., 2018). Many practice environments have not achieved insulin timing recommendations (ISMP, 2017a; Slattery et al., 2018; Umperriez et al., 2012). Timing of insulin with the interdependent processes of meal delivery and POCG collection requires coordination of the roles that complete these processes.

Knowledge

DM researchers cite pervasive multidisciplinary knowledge deficits among multiple healthcare professionals despite EB recommendations (Engvall et al., 2014; Harrison et al., 2013; Maynard et al., 2015). Engvall et al. (2014) supported education and protocol standardization to address failure to comply with EB recommendations.

The method of identifying causative factors, performing proactive surveillance, and using interdisciplinary data-driven approaches yielded improvements at multiple locations in a mid-west healthcare system (Milligan et al., 2015). Milligan (Milligan & Zellmar, 2015) considered their use of continuous dissemination of improvement as vital for clinicians to learn and standardize throughout a change process.

Not uncommon in organizations is that clinicians are unaware of evidence as well as practice data that informs improved clinical practice (National Patient Safety Foundation [NPSF], 2015). Practice data at the project location had been inadequately collected and presented to clinicians to inform their practice. Clinicians improve and spread best practice when shown their performance (NPSF, 2015). Making data visible to drive improvement is recommended (Health Research & Educational Trust, 2017). Transparency of process measures and benchmarks will inform clinicians of their practice. Information serves as knowledge and potential motivation to influence clinicians to change practice.

Rationale

This project was underpinned by EB recommendations (ADA, 2020; ISMP, 2017a; Slattery et al., 2018; Umperriez et al., 2012) and an EB intervention (Flottorp et al., 2010; Ivers et al., 2012; Tuti et al., 2017). AF has been indicated as a strategy to improve practice (Ivers et al., 2012; Tuti et al., 2017). In an earlier systematic review Jamtedt et al. (2006, Abstract) defined AF as “any summary of clinical performance of health care over a specified period of time (p.19)”. More recently Ivers et al. (2012) defined an AF intervention as “clinical performance feedback (p.5)”.

While it seems intuitive that health professionals would be prompted to modify their clinical practice if they were provided with feedback that was inconsistent with their peers or accepted guidelines, research suggested that may not always occur (Flottorp et al., 2010). Flottorp et al. (2010) advised that AF allowed healthcare professionals to assess and adjust performance. Ivers et al. (2012) suggested AF allowed professionals to meet professional standards. AF facilitated important small to moderate improvements in professional practice to support clinical behavior change (Ivers et al., 2012).

Conceptualizing AF within a theoretical framework offers a way forward for AF to be a reliable QI approach (Foy, et al. 2005, Tuti et al., 2017). For years researchers examined AF as a QI strategy to improve professional practice (Flottorp et al., 2010; Foy et al., 2005; Ivers et al., 2012). Problems with coordination of meal delivery, POCG collection, and insulin administration were reported in a California medical center (Maynard et al., 2015). Maynard et al. (2015) used AF to reinforce a unified process. Standardization was improved.

Translating EB recommendations into nursing practice requires that leaders are fundamentally prepared to lead change. While not all change leads to improvement, all

successful improvements require change with an equal emphasis on the critical aspect of working with stakeholders throughout any change process (Langley et al., 2009). While QI approaches are sometimes fragmented, a change agent can manage complex dynamics within the system especially when a disciplined methodology is applied, and key stakeholders are engaged in the change and work redesign. Clinicians gain understanding and motivation to change when they are invited to contribute to QI that impacts their workflow.

The use of AF for this project was based on the belief that healthcare professionals are prompted to modify their practice when given performance feedback showing that their clinical practice is inconsistent with a desirable target (Ivers et al., 2012). The project leader was aware of nurses' interest to receive personalized feedback about their clinical performance. As providers are thought to be inherently motivated, but are unaware of suboptimal performance, there is a lack of intention to modify their practice until feedback is provided (Ivers et al., 2012).

The IOWA Model of Evidenced-Based Practice to Promote Quality Care (Titler, et al., 2001) provided a lens to explain the problem and guiding framework to test and select strategies to promote the EB practice recommendation and intervention. The model recognized areas Titler and Everett (2001) described as necessary for innovation adoption. Areas for adoption include characteristics of the guideline, users of the guideline, methods of communicating the guideline, and the social system in which it is adopted. The gap between EB recommendations and application to improve care is linked with poor outcomes (Titler, 2018). Translation science tests implementation interventions in an effort to improve uptake and use of evidence toward improvement (Titler, 2014). The EB practice model (Titler, et al., 2001) that underpinned this project is provided in Appendix B.

The popularity of AF in QI has been studied relative to both its effectiveness to improve healthcare practice and the characteristics that lead to greater impact (Ivers et al., 2012). Ivers et al. (2012) suggested that in addition to the design of the AF intervention, the characteristics of context and recipients may influence the effectiveness in behavior change and improvement. Foy et al. (2005, pp.4-6) suggested “AF appeared to work better for DM” and that with or without other interventions AF was more effective than doing nothing (Maynard et al., 2015). In Maynard et al. (2012) a standardized process improvement of meal tray delivery, POCG testing (POCG), and insulin administration was reinforced by AF.

Specific Aim

The QI project focused on staffs’ knowledge of their own clinical practice relative to the EB recommendations for reducing practice variation in the workflow of POCG collection and RAI administration administered at meals. The question was will AF compared to current practice reduce nursing practice variation in timing RAI administration to POCG collection at meals on the inpatient unit.

QI cycles conducted at the study location in 2019 improved communication among nurses, nutrition aides, and nursing assistants involved in their respective roles of RAI administration, meal delivery, and pre-meal POCG testing. The QI work conducted in 2019 that improved the workflow provided structure for further improvement. The purpose of QI was to test the effectiveness of AF in the adherence of nurses to professional standards in RAI administration timing with POCG collection at meals. Outcomes of the project were increased compliance with established guidelines (ADA, 2020; ISMP, 2017a; Slattery et al., 2018; Umperriez et al., 2012) by improving the frequency of RAI administration within 30 minutes and not exceeding 60 minutes from the POCG collection.

Method

Context

The study was carried out on a hospital's medical-surgical unit in New Hampshire. The average daily census of the unit was 27 and ranged from 18 to 35. With an average of 22 percent of the study unit's inpatients prescribed insulin, DM was a common diagnosis among the unit's population. POCG collection and RAI administration protocols were carried out daily on an average of six inpatients on the study unit. The study was focused solely on the POCG collection and RAI administration workflow at the breakfast meal where the staffing model was generally one nurse to five patients.

Breakfast time was determined as the first meal of the day from 0700 and before 1100. All breakfast period times of POCG collection and RAI documentation were recorded on a data collection tool. The study criteria excluded DM patients that did not receive meals by the dietary service, were nil per os (NPO) using a continuous glucose monitoring device or insulin pump.

Cost-Benefit Analysis

The spiraling global and local burden of DM has a vast impact on individuals and societal institutions faced with managing DM. The most significant component of medical care expenditures is hospital inpatient care (ADA, 2018). QI efforts that can demonstrate positive benefits toward burgeoning costs are appropriate.

Resources for the project were approved by the hospital. The most significant costs were salary expenses. The project leader extracted and interpreted data over 56 days. While the project leader's time was volunteered the hours were captured to examine costs. A weekly salary expense estimated two nursing leaders' time to provide nurses with feedback. The project leader estimated the nurses' time to engage with the feedback. Important resources to the overall QI project were the internal consultants on the project team. Consultants included a quality analyst,

certified diabetes educator, and clinical informatics nurse. The consultants’ contribution to the QI project team provided expertise that expedited the project leader’s navigation within the electronic medical record and enhanced Excel reports. The non-salary expenses, primarily print material, were nominal in comparison. Estimated expenses of this QI are presented in Table 1.

Table 1
Estimated Cost of Quality Improvement Project

Expense		Expense Total
Salary		8,750
	Project Leader	6,160
	Practice Leadership	540
	Consultants	720
	Study Unit Nurses	1,330
Non-Salary	Print Materials	100
Estimated Total Cost of Quality Improvement Project		8,850

The majority of DM care is covered by government insurers (ADA, 2018). Annually, the national cost burden of DM is in the hundreds of billions of dollars (ADA, 2018). Preventing complications and managing costs tied to DM diagnostic related group (DRG) payments are essential to an organization’s sustainability.

An average of 22 percent of patients on the unit had a DM diagnosis during the project. The average DRG Medicare rate at the study location among the most common DM codes was estimated at \$8,099/day. The average length of stay at the study location for a DM patient is 4.4 days with the daily rate at \$1,841/day. An additional cost or extension to the average length of stay breaks into the fixed DRG payment and adds a loss. An example of the impact of the DRG payment on one patient’s inpatient DM care is outlined in Table 2.

Table 2*Examining Financial Impact: Diabetes Diagnostic Related Group (DRG)*

Expense	DRG Payment Impact
Avoid loss of one day on extended stay	1,841
Realize gain of one less day of length of stay	8,099
Avoid loss of one 30-day readmit	8,099

Intervention

AF was a single approach with two integrated phases. The intervention intended to address what Flottorp et al. (2010) suggested, that is, AF allows healthcare professionals to assess and adjust their performance. The project leader operationalized the intervention with characteristics that were known to have an impact on its effectiveness (Ivers et al., 2012). The effectiveness of an AF intervention was tied to the current practice state that nurses were not performing to standards of the POCG collection to the meal and insulin administration workflow. The presence of clearly targeted measures, 60 minutes to a clinical practice guideline and 30 minutes to best practice, were chosen for assessing the impact of AF. AF cycles included characteristics of repetitiveness and both verbal and written feedback.

Audit comprised the uniform method that Ivers et al. (2012) addressed for collecting and evaluating POCG testing data and insulin use information and an aspect of the clinical practice guideline recommended (Umperriez et al., 2012). Feedback provided the approach to bring awareness of suboptimal performance to the staff and that addressed nurses' ability to accurately self-assess when practice was inconsistent with peers or accepted guideline (Ivers et al., 2012).

Audit

To inform nurses of their clinical practice relative to recommendations, the initial phase

involved gathering time data from insulin reports generated from the electronic medical record (EMR). A daily insulin report allowed the project leader to identify all inpatients that were prescribed RAI. The POCG collection and RAI times were recorded to the EMR by automation during the workflow. The project leader accessed the EMR to collect the data. The POCG collection time and value was wirelessly downloaded to the EMR from a POCG collection device as licensed nursing assistants completed the bedside workflow. A timestamp was recorded when nurses completed the barcode administration workflow.

The audit informed the feedback phase of the intervention throughout the study period and later for the process to determine the sample. The audit data included patients' dates and location of care. Diet orders were confirmed. Nurses' names and timestamps associated with all RAI documentation were gathered from the medication record during audit. The time and value of POCG that was collected prior to breakfast was captured in the course of audit. Lastly, diet was audited. The audit data collection tool is provided in Appendix C.

Audit data for studying the timing of POCG collection and RAI administration was calculated, recorded, and maintained in Excel spreadsheets. The audited data was organized, labeled, and filtered by date over eight weeks. The baseline audit contained three weeks of daily practice data. The post-intervention audit contained five weeks of practice data for comparison.

Feedback

Providing feedback provides an opportunity for healthcare professionals to assess and adjust their performance (Flottorp et al., 2010) and encourages compliance with professional standards (Ivers et al., 2012). Providers are thought to be inherently motivated, but because they are unaware of suboptimal performance there is a lack of intention to modify their practice until they are given feedback (Ivers et al., 2012).

The feedback phase of the intervention provided information of the POCG and RAI times the project leader had audited from medical records. The clinical performance data the project leader audited was used to create a weekly clinical summary. The weekly summary was illustrated by daily bar charts. The summary was feedback for the unit's staff to view RAI administration practice. Regardless of whether the RAI workflow resulted in an administered dose, all audited POCG to RAI time measures were included in each feedback cycle.

A structured approach, situation, background, assessment, and recommendation (SBAR) was used to announce the project to the inpatient unit's nurses and nursing assistants. The SBAR included links to the EB recommendations and information for the project. The SBAR was sent by email from the project leader at the launch of the project and in the week following the first feedback cycle. The SBAR communication is provided in Appendix D.

Conveyance of the feedback involved displaying the clinical summaries by multiple methods: poster, binder, and postcards to the nursing unit staff. The feedback presented a view of nurses' performance in relation to a 30- and 60-minute benchmark and in comparison to the other nurses' POCG and RAI times. Feedback occurred five times: baseline and time periods one, two, three, and four. The methods used to convey the summaries to the unit's nurses are illustrated in Appendix E.

In preparation for implementation of feedback to the staff the project leader prepared a set of slides. The slides described the goal, listed EB statements, and illustrated the nurses' audited baseline and post-intervention compliance with measures in bar charts. The bar charts informed nurses of their performance relative to the clinical practice guideline benchmark. A poster was created with the slides and displayed at the nurses' station on the department communication board. The slides were organized in a binder and the bar charts were reproduced as postcards.

The binder and postcards were positioned where nurses huddled for change of shift and morning rounds. An example of the feedback that was displayed is illustrated in Appendix F.

The engagement of the supervisor and project leader in the AF intervention supported the impact AF would have on improvement of practice (Ivers et al., 2012). The Clinical Leader (CL) assisted the project leader to verify that nurses received the EB statements and their individual practice times a minimum of once after the feedback was displayed. Several methods provided confirmation that the nurses received the feedback. The methods included their email read-receipts and replies to email. Nurses provided their initials with the date on a roster that was maintained by the CL. Face to face interactions occurred between the nurse and the CL or project leader. The earliest date was used by the project leader if more than one verification date was recorded.

Study of the Intervention

AF informed the unit's nurses of their current clinical performance relative to the 60-minute guideline and 30-minute best practice. The project leader displayed the clinical performance after each AF cycle subsequent to the three-week baseline assessment period. A pre-test post-test design was chosen to assess the impact of the AF intervention. AF intended to inform nurses of their insulin administration practice with POCG collection at meals. The time measures that represented the clinical performance results were derived from the 60-minute clinical practice guideline and 30-minute best practice benchmarks. Pre- and post-intervention measures were compared at the conclusion of the project.

Clinical nurses were consulted prior to the project implementation to evaluate the method of displaying the clinical performance. Bar charts were recommended. Thirty and 60-minute benchmark lines were emphasized and labeled to convey the goals and demonstrate practice to

the goal after they would be displayed. Comparing baseline measures to post-intervention measures after the best practice information was made available to the nurses, allowed the project leader to determine if the project aim and outcomes were met.

Measures

The clinical performance measures indicated when the timing of POCG to RAI best practice or clinical practice guideline was achieved. The outcome measures to evaluate the project's aim included:

1. Time from breakfast POCG collection to RAI dose administered.
2. Percent of breakfast POCG measurement to RAI dose administered within 60 minutes.
3. Percent of breakfast POCG measurement to RAI dose administered within 30 minutes.
4. Percent of breakfast POCG measurement to RAI dose administered beyond 60 minutes.

Analysis

The project leader monitored nurses that received the intervention while identifying errors and missing data. Pivot tables created in Excel assisted the analysis of the pre-intervention and post-intervention data. The pivot tables filtered, grouped, and summed the data to analyze the frequency distribution and spread.

Descriptive statistics were used to analyze the data. Since the dates nurses received the audited data as feedback varied, time measures were grouped as baseline and post-intervention datasets for each nurse. The analysis evaluated the frequency that nurses' practice met and exceeded EB recommended benchmarks at baseline and post intervention.

Ethical Considerations

The project was approved by the UNH Nursing Quality Review Committee, facility department's director and the Chief Nursing Officer. The project was considered QI and

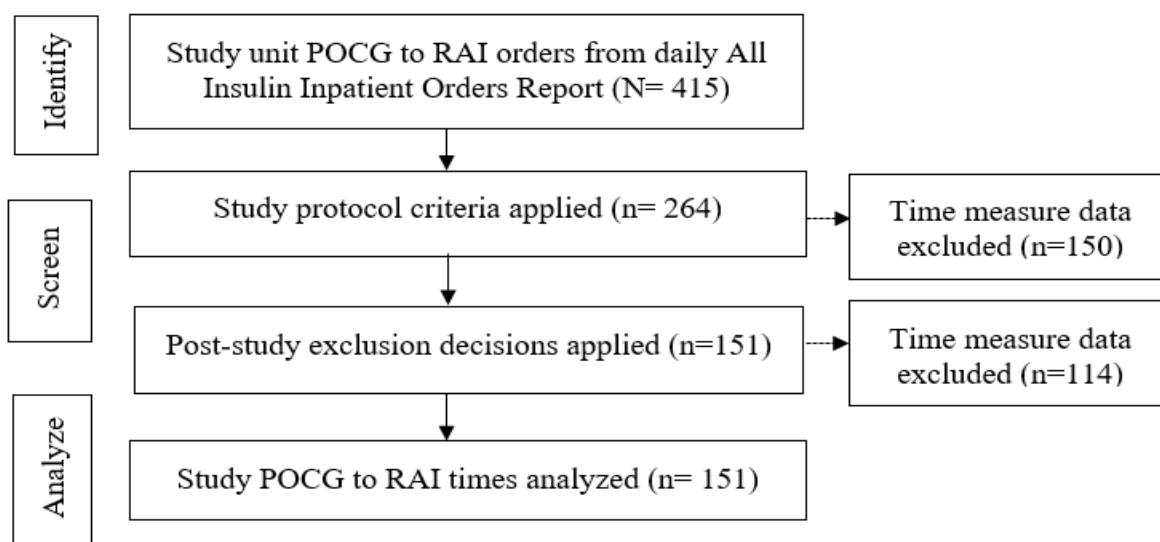
therefore exempt from IRB review. All data was collected and maintained in accordance with privacy, security and hospital policy.

Results

The project began in late August 2020 and continued until mid-October 2020. A total of 415 POCG to RAI time measures among 56 nurses were collected and coded over eight weeks. Data screening resulted in 264 POCG to RAI time measures excluded as the measures did not meet the protocol criteria. One hundred fourteen POCG to RAI time measures were excluded by the project leader. Of the 114 measures, 8 were excluded due to a missing POCG time or RAI documentation in the electronic medical record. The remaining 106 of the 114 excluded measures were rejected because the project leader identified that the nurse associated with the measure had not met the minimum number of measures (n=5) across the study period. The sample was comprised of 151 POCG collections and RAI administration time measures among 13 nurses. The application of exclusion criteria to arrive at the sample is illustrated in Figure 1.

Figure 1

Flow Diagram Applying Exclusion Criteria to Sample



Note. POCG-point of care glucose, RAI-rapid acting insulin

Further analysis of the 264 POCG to RAI time measures excluded was grouped into two categories: patient influenced or nurse presented. Of the 264 excluded measures, 129 data elements had a patient factor and 135 data elements had a nurse factor. The details of the factors that lead to exclusion are outlined in Table 3.

Table 3

Factors for Exclusion of POCG to RAI Data from Analysis

Category	Reason POCG to RAI Measure Excluded from Sample (n)
Patient Factor n=129	
	No breakfast meal service- NPO or enteral feed (18)
	RAI not administered- POCG parameter not met (102)
	RAI not administered- refused (7)
	RAI not administered- off unit (2)
Nurse Factor n=135	
	RAI not administered- medication error (5)
	Nurse did not acknowledge receipt of intervention (16)
	Missing POCG or RAI time* (8)
	Nurse did not meet minimum of five administrations * (106)

*Post study coded as exclude

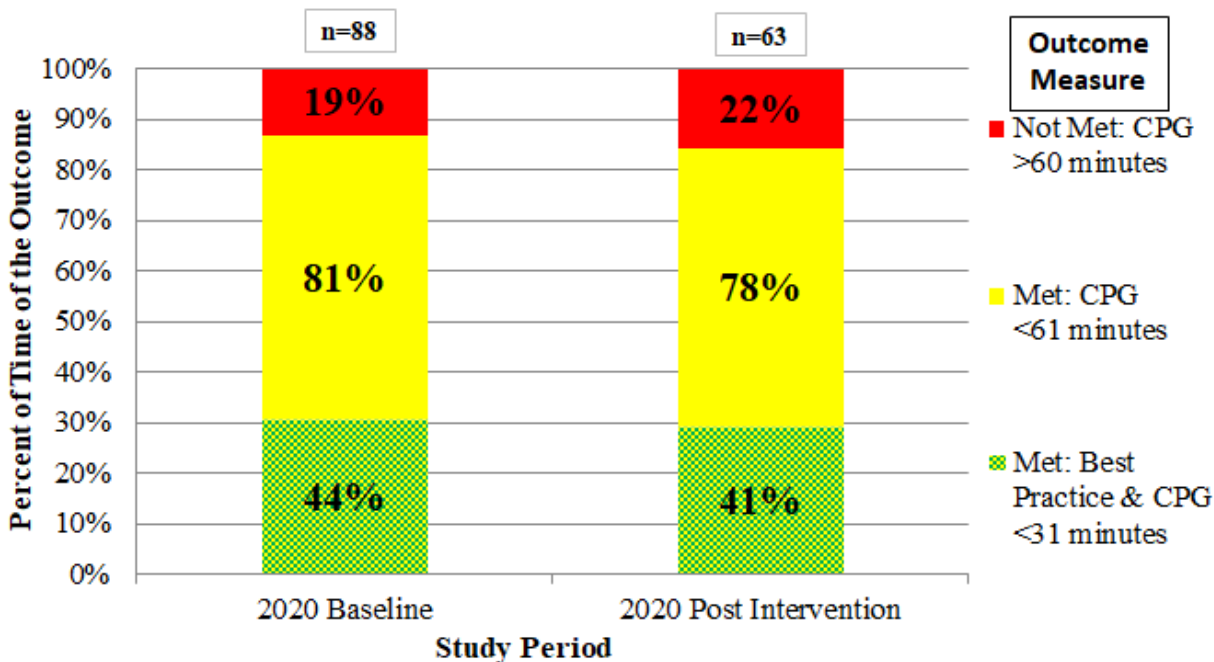
The final analysis of the 13 nurses’ baseline datasets provided 88 breakfast POCG collection to RAI administration times for evaluation. The 88 baseline measures were ranked as ‘most timely’ at zero minutes to ‘least timely’ at 119 minutes, a range of 119 minutes. Sixty-three breakfast POCG to RAI measures were among the 13 nurses’ datasets evaluated from 4 feedback cycles

occurring post intervention. The 63 post-intervention measures were ranked as ‘most timely’ at zero minutes to ‘least timely’ at 122 minutes, a range of 122 minutes.

Seventy-one of the 88 (81%) baseline measures met the 60-minute CPG. Thirty-one of the 70 (44%) baseline measures that met the CPG also met the 30- minute best practice recommendation. Forty-nine of the 63 (78%) breakfast POCG collection to RAI measures met the 60-minute CPG throughout the feedback cycles. During the intervention feedback cycles, 20 of 49 (41%) measures that met the CPG also met the 30-minute best practice recommendation. The frequency of time the outcome measures were met is illustrated in Figure 2.

Figure 2

Frequency Outcome Measures Met by Period among the Thirteen Nurses



At the individual practice level, 11 of the 13 nurses’ datasets had at least one baseline measure that surpassed 60 minutes. Of the two nurses that did not surpass the CPG among their baseline measures, neither nurse achieved best practice among their measures. One nurse had all breakfast POCG to RAI measures greater than 60 minutes. Compared to the baseline measurements,

8 of the 13 nurses achieved the CPG within 60 minutes after the intervention. One of 13 nurses achieved all best practice measures after the intervention. None of the nurses’ datasets had all breakfast POCG to RAI measures greater than 60 minutes. The individual datasets achieving the outcome measures are presented in Table 4.

Table 4

Individual Datasets that Achieved Outcome Measure by Time Period

Outcome	n=13	n=13
Measure (Minutes)	Baseline	Post Intervention
Met CPG (≤ 60)	2	5
Met Best Practice & CPG (≤ 30)	0	1
CPG Not Met (> 60)	1	0

Note. CPG-Clinical Practice Guideline

The intervention of AF exposed several QI learnings during the study. The learnings and actions taken are summarized in Appendix G.

Discussion

Summary

The question for this project was if an AF intervention compared to current practice would result in reduced nursing practice variation in the timing of RAI administration to POCG collection at meals on the inpatient unit. The findings from this study suggest that the AF intervention was insufficient to impact variation in timing POCG collection to RAI administration to the 30- and 60-minute aims. Variation remains among nurses that coordinated RAI dosing with POCG collection at breakfast prior and subsequent to the intervention.

The model of EB practice guiding the implementation of the intervention supported the process of translation of evidence into practice. Theories are not as limited as models since theory explains what influences implementation outcomes. While the EB practice model that guided this project may have been an appropriate framework for implementation it may have been limiting to address facets of activating behavior. A methodology that recognized change and behavioral theory may have yielded new findings for what is associated with the effectiveness of AF to improve practice.

The recommendation to test EB practice change before widespread implementation (Titler, Kleiber et al., 2001) was fitting given that AF differs in terms of recipients, formats, resources, frequency, duration, and content (Flottorp et al., 2010). A key principle for EB practice change is that elements perceived by users, such as ease of use, are neither a stable nor sure determinant of adoption (Titler, 2014). The busy atmosphere of inpatient units at the breakfast meal has been attributed as a factor when timely delivery of insulin with glucose monitoring is not accomplished (Freeland et al., 2011). The ease to synchronize timing of POCG and RAI among roles and workflows may remain a barrier for widespread adoption of guidelines in practice regardless of knowledge transfer.

AF did not change nurses' adherence to the standards with RAI administration and POCG collection timing at the breakfast meal. Still in the course of data collection the process of AF yielded corollary benefits that represented clinical importance to improve the quality of DM practice at the study location and strength of the project. While individual and group level findings did not change nurses' adherence to the standards, the QI project had a clinically meaningful impact related to gaps in DM practice. The information recorded in Appendix G explicated the clinical importance of AF and future consideration for AF as an ongoing feature of

QI, especially AF combined with other interventions (Ivers et. al.2012). The information directed real-time remediation to clinicians, potentially averted DM complications, and presented recommendations for further QI. However, the benefits of AF need to be weighed given the uncertainty, cost, and resources required for AF in ongoing QI work.

Interpretation

At the individual level after the intervention a small improvement in timing of the POCG collection to RAI was observed. The individuals that demonstrated improvement after the intervention included one of the two nurses that achieved the CPG consistently at baseline and four others that had not achieved the CPG consistently until after the intervention. While chance may have contributed to this individual level finding, the comparison of the same nurses at baseline and post intervention supports that the intervention may have accounted for this small though meaningful change. Based on leader-member exchange theory, the nature of the dyadic relationship between nursing leader and individual staff may have played a role (Regts, Mollenman, & Van de Brake, 2019). Ivers et al. (2012) posed that the effect of AF may be associated with the perception of the colleague delivering feedback as an opinion leader. It is not clear if the importance of the staff-leader relationship influenced individual nurses' practice when receiving communications related to their practice.

Nurses' individual baseline performance of POCG to RAI administration consistently included measures that exceeded the 60-minute benchmark. One nurse's measures all exceeded 60 minutes prior to the intervention. Post-intervention collective measures improved. The majority of measures either met the CPG or achieved the best practice parameter. None of the 13 nurses met the 30-minute benchmark across all their measures prior to the intervention, yet one nurse's time measurements were all within 30 minutes after. The decrease of "CPG Not Met"

and increase of “CPG Met” and “Exceedingly Met CPG” that resulted at an individual level was small. Ivers et al. (2012) indicated that characteristics of individual nurses contribute to the direction and degree of change associated with AF. It is plausible that AF was personally more relevant to individual nurses. Individual nurses may have been motivated to modify their practice.

At the group level more of the 151 POCG collections to RAI administration time measures exceeded the 60-minute CPG recommendation after the intervention. However, the results do not support that the AF intervention was effective at improving the frequency toward the best practice benchmark of 30 minutes. The increase of “CPG Not Met” and decrease of both “CPG Met” and “Exceedingly Met CPG” after the intervention reflects an undesirable negative trend at the group level. This finding would contradict what some researchers have suggested; that AF has shown success in DM contexts (Foy, et al. 2005). Ivers et al (2012) suggest that the perception of the importance of the behavior and the complexity of DM practice play a role in the effectiveness of feedback changing behavior. The contrary finding may remain uncertain without an understanding of the organization’s culture for EB practice.

Management of the DM patient in the hospital is complex and nurses perceive barriers to timely insulin administration. Alwan et al. (2017) surveyed nurses on their perceptions related to personal frequency, determinants, and potential solutions of accurate and timely dosing of prandial insulin. The surveying concluded low confidence that nurses could achieve timely insulin administration, though it is not clear if nurses attributed this to complexity, importance or another contextual factor.

The 4-week period after the baseline audit was insufficient to address contextual barriers to enable the uptake a group requires to change practice. Implementation of the intervention was

impacted by circumstances present after COVID-19 prevention measures were introduced in the hospital. Three inpatient nurses reported to the project leader that they do not prioritize insulin administration every time. The three nurses described a burden of more than one DM patient in their assignment and many medications scheduled at the breakfast meal. Medication administration, irrespective of time, was coordinated when other interventions required them to enter a patient room, especially after COVID-19. Nurses' perception of the importance of insulin administration when faced with competing priorities impacted variation in practice. Future study should determine what may anchor nurses to this decision making in their practice.

A confounding variable may have influenced the outcomes. Nursing assistant and nutrition aide communications to each other and nurses were important to time POCG collection and subsequent RAI administration. The project leader observed that POCG measurement was collected earlier than expected during this time period. Standard mealtimes are generally at or near 0800 daily with POCG generally collected after 0730 in 2019. A trend was noted by time period three that post-intervention POCG collection was being collected before 0730. The increase number of POCG collections occurring closer to change of shift, that is, before 0730 may have reflected an uncoordinated workflow or spurious finding. Alternatively, the effect of the early POCG collection may have had a direct impact on the results.

AF provided a greater improvement when initial compliance was low (Ivers, et al., 2012). Despite low compliance with the best practice parameter, the findings did not represent the potential other researchers have suggested (Foy, et al., 2005; Ivers et al., 2012). Alwan et al. (2017) reported 28% of their subjects had met the 60-minute POCG collection to insulin administration. Freeland et al. (2011) reported 16% of POCG collections were within 30 minutes. In comparison the relative degree of compliance with the clinical practice guideline and

best practice was respectively higher at the study location, both at baseline (81% and 44%) and post-intervention (78% and 41%). The need to operationally define “low” compliance would allow for improved comparisons across studies in future research.

The project introduced questions of what contextual factors interacted with the intervention. Structural and process-oriented factors may have included daily census, staff assignment, patients’ choices, workflow communications, and medication policy and systems. It remains unclear as to all the factors which influence nurses’ decision making to time prandial insulin doses with the POCG collection. It is reasonable to expect that nurses will adjust their practice when it is not consistent with evidence. Clarity is needed as to the intrinsic needs that change behavior (Tuti, et al., 2017). Future studies should determine what anchors nurses to a practice when insulin’s mechanism of action relies on a dynamic approach. Furthermore, future studies must offer sufficient detail of the application of AF to replicate the intervention.

Limitations

Limitations of this QI project include that this unit’s workflows and resources may not be representative of practice or priorities in other units or other organizations. While the EB practice model that guided this project may have been an appropriate framework for implementation it may have been limiting to address facets of activating behavior. A methodological approach that recognized change and behavioral theory may have yielded new findings for what is associated with the effectiveness of AF to improve practice.

While other factors may have been limitations in this project, the most limiting were the study design, delivery methods, measurement, and analysis. The EB practice model that guided this study supported a test methodology prior to widespread rollout, yet, the length of audit cycles impacted the number of nurses and administrations that ultimately determined eligibility

in the sample. While the project leader carefully considered all nurses from the inpatient unit for the sample, the sample size limited statistical analysis. An interrupted time series design for comparison may have controlled for threats that a single comparison had to validity.

Times recorded electronically to the medication administration record rather than by direct observation of practice may be considered a limitation. While it was apparent that real-time documentation of insulin was delayed when a dose was not indicated, the project leader determined that the automated medication documentation that populates the medication administration record was sufficiently accurate when RAI was administered.

Finally, a key methodological limitation was inadequate information was gathered from the staff, especially nurses, to validate the results. The project leader included in the weekly feedback that the early POCG may negatively impact the results. Still, direct observation and surveying questions may have provided additional data to evaluate AF in the current QI cycle, explain the results, and plan future rapid cycle improvements.

Conclusion

DM management workflows in the hospital are complex with interdependent systems among multiple care givers at play. AF has been commonly used as a QI intervention to improve professional practice. While AF may be a useful intervention when operationalized in the right context and optimally designed and delivered it was not sufficient to change practice in the selected environment when nurses were given performance feedback. AF as an intervention for knowledge transfer and behavior change remains a questionable intervention for translating evidence to practice. More evidence of when and how AF will and perhaps more importantly will not be effective must be understood. Understanding factors and solutions that contribute to nurses exceeding clinical practice recommendations are needed.

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<https://doi.org/10.1210/jc.2011-2098>

Appendix A

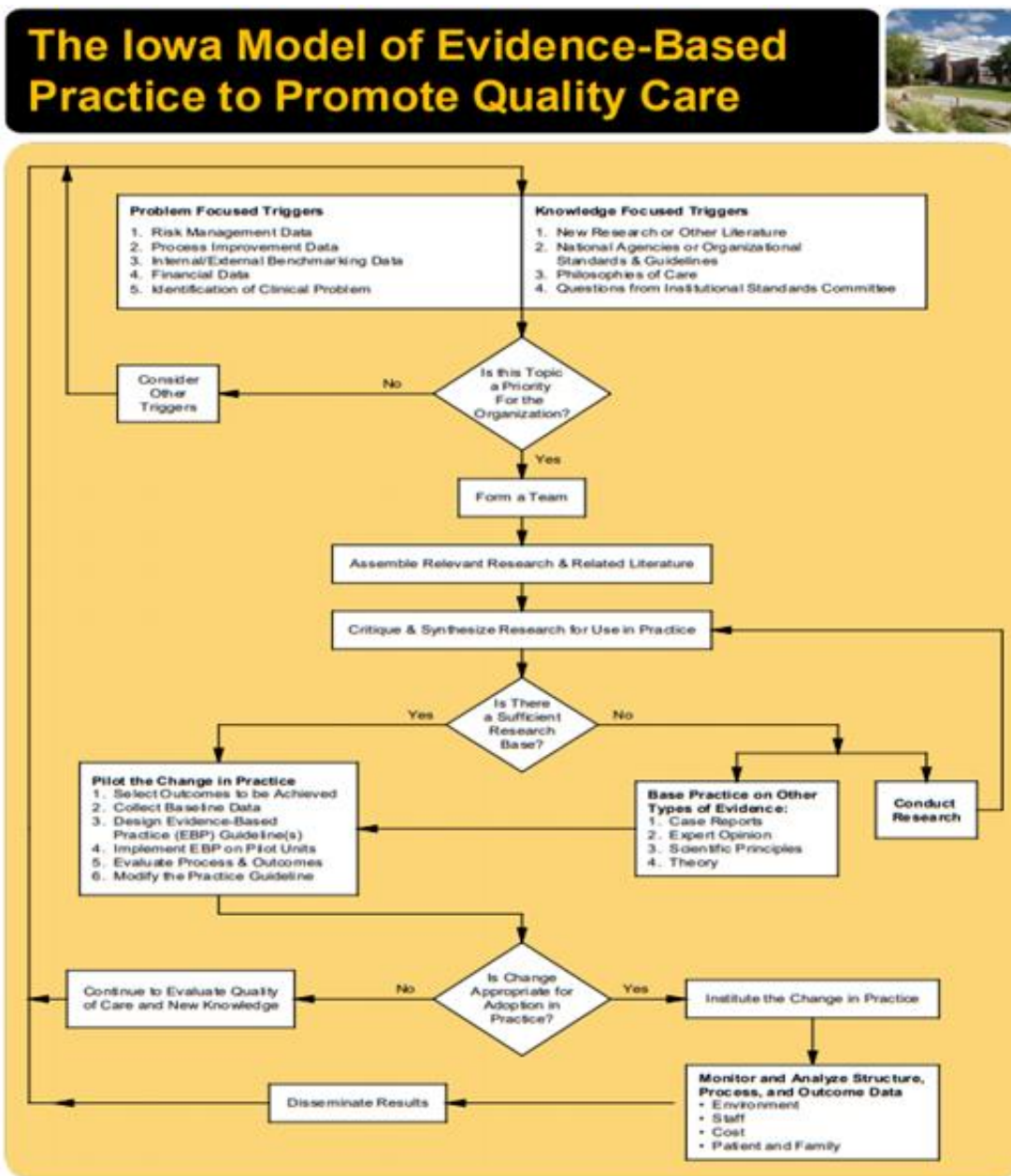
Recommendation Statements

Statement	Category	Author
Recommend that timing of glucose measures match the nutritional intake and medication regimen	Clinical Practice Guideline	Umperriez et. al, 2012, p. 31
Premeal POCG testing should be obtained as close to the time of the meal tray delivery as possible and no longer than one hour before meals	Clinical Practice Guideline	Umperriez et. al, 2012, p. 31
Insulin injections should align with meals. In such instances, POCG testing should be performed immediately before meals	Standard	ADA, 2020, p. S196
Organizations should develop a coordinated process to ensure timely blood glucose checks and administration of NUTRITIONAL INSULIN in conjunction with meal delivery	Guideline	ISMP, 2017a, p. 18
Administer RAI analogues 15-20 minutes before mealtime to try to synchronize the blood glucose and insulin peaks	Review of Literature	Slattery, et al., 2018, p. 314

Note. POC-point of care

Appendix B

Evidenced-Based Practice Model



Titler, M.G., C., Steelman, V.J., Rakel, B. A., Budreau, G., Everett, L.Q., Buckwalter, K.C., Tripp-Raimer, T., & Goode C. (2001). The Iowa Model Of Evidence-Based Practice to Promote Quality Care. *Critical Care Nursing Clinics of North America*, 13(4), 497-509.

Note. The Iowa Model of Evidence-Based Practice to Promote Quality Care. Reprinted with permission from Titler, M.G.

Appendix C



Chart Audit Data Collection Tool

Pilot Unit							
Patient identifier							
Date							
Inclusion criteria met (Y/N)							
Time breakfast POCG collected							
Breakfast POCG result							
Time breakfast meal insulin administered							
Nurse administering breakfast meal insulin							
Time breakfast correction insulin administered							
Nurse administering breakfast correction insulin							
Timeframe b/t POCG and insulin administration							
<30 minutes (Y/N)							
30-60 minutes (Y/N)							
>60 minutes (Y/N)							
Notes							

Appendix D

SBAR Communication

Date: September 16, 2020
Re: Quality Improvement Project

<p>Situation</p>	<p>Evidence-based (EB) Diabetes recommendations (clinical practice guidelines, standards) are available for further translation to current policy and practice. An EBP quality improvement (QI) project is planned on the Thomson Unit.</p>	
<p>Background</p>		<p>Diabetes improvement initiatives carried out most recently across inpatient services focused on standardized practice with tools and education. Each QI project provided an opportunity to advance and evaluate improvement in practice.</p>
<p>Assessment</p>	<p>Over the next 4-8 weeks, specific time data that is routinely recorded in eDH (BREAKFAST associated collection of Point of Care Glucose (POCG) and administration of Rapid Acting Insulin (RAI) administration times) will be collected daily, measured to best practice and policy benchmarks and shared to the nursing staff.</p>	
<p>Recommendations</p>		<p>THOMPSON UNIT and FLOAT POOL DAYSHIFT NURSES: Please review the material that relate to this QI project.</p> <p>The specific EB recommendations for this project, related statements from the current Cheshire inpatient Nursing Procedure, and the weekly time data from eDH can be reviewed by any of these 3 means:</p> <ul style="list-style-type: none"> ● Email communication with attachment ● Binder on Thompson Unit ● Poster on Thompson Unit <p>Questions: Please call or email Paula Hudon (x2612)</p>
<p style="text-align: center;">References</p> <p>American Diabetes Association (2020). Diabetes care in the hospital: Standards of medical care in diabetes-2020. <i>Diabetes care</i> (43(6)), S193-202. https://doi.org/10.2337/dc20-S015</p> <p>Institute for Safe Medication Practices (2017a). ISMP guidelines for optimizing safe subcutaneous insulin use in adults. Retrieved July 11, 2020 from https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP138-Insulin%20Guideline-051517-2-WEB.pdf.</p> <p>Slattery, D., Amiel, S. A., & Choudhary, P., (2018). Optimal prandial timing of bolus insulin in diabetes management: A review. <i>Diabetes Medicine</i>, 35(3). https://doi.org/10.1111/dme.13525</p> <p>Umpierrez, G. E., Hellman, R., Kovacs, M. T., Kitabchi, M., Maynard, G. A., Montori, V.M., Seley, J. J. & Van den Bergh, G., (2012). Management of hyperglycemia in hospitalized patients in non-critical care setting: An Endocrine Society clinical practice guideline. <i>Journal of Clinical Endocrinology and Metabolism</i>, 97(1), 16-38. https://doi.org/10.1210/jc.2011-2098</p>		

Appendix E

Audit and Feedback Intervention Methods

PPT Slide deck here (tile view)

Poster

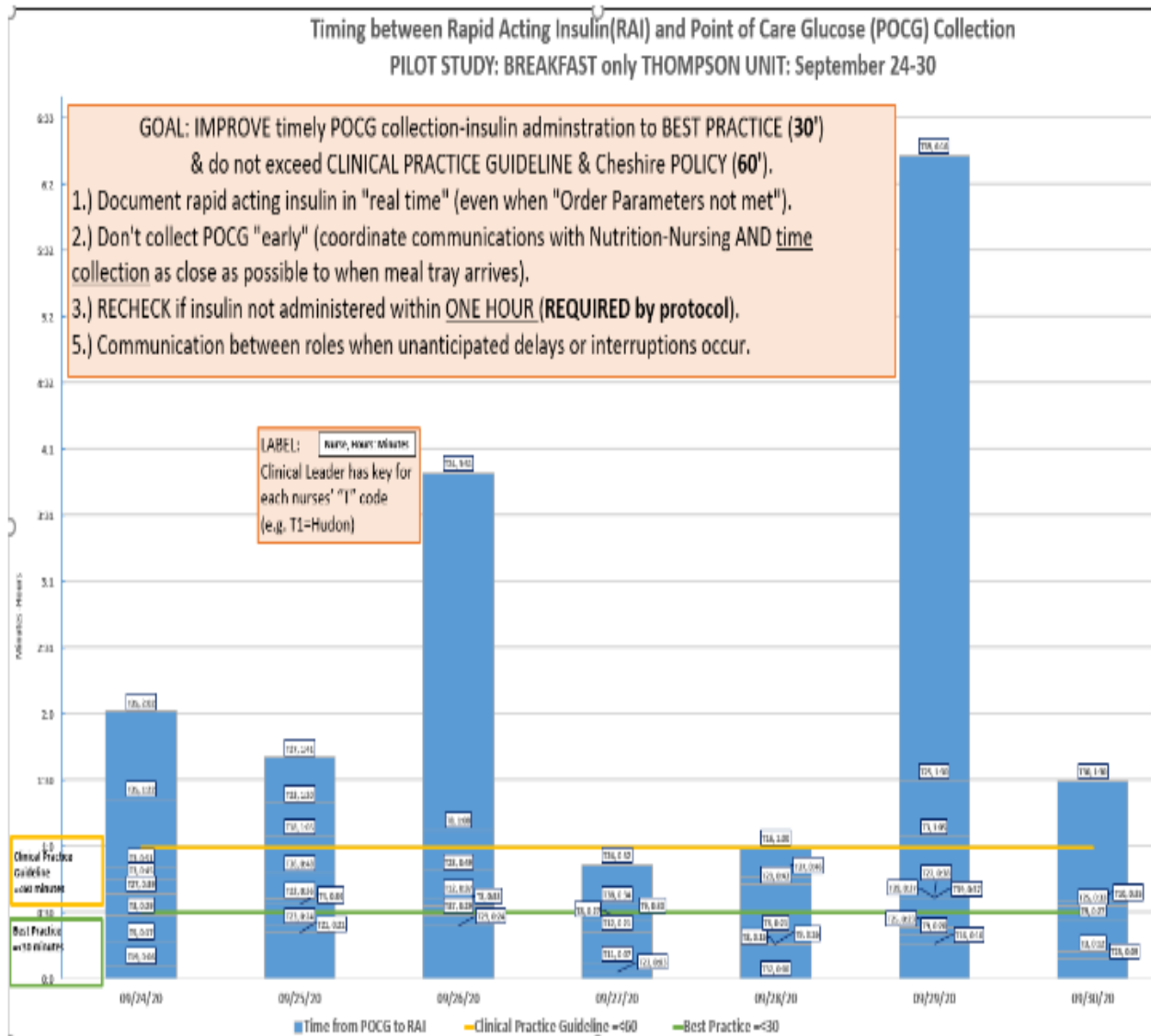


Binder

Nursing Station Postcards

Appendix F

Example of Bar Chart in the Feedback Methods



Appendix G

Quality Improvement Learnings and Actions Revealed While Conducting Chart Reviews

Opportunity for Improvement	Action Taken
Procedures/Workflow	
Documentation delay trend/non-administration not in real-time	Report to Clinical Leader (CL)
Early Point of Care Glucose (POCG) collection resulting in repeats	Feedback to CL/Department
Rapid Acting Insulin (RAI) protocol not followed	
Insulin dose stacking	
Wrong correction dose	Feedback to CL/nurse/O-Report
Indicated omission	Feedback to CL/nurse/O-Report
Held meal-associated dose	Feedback to CL/nurse/O-Report
System failures	
Random POCG results quarantined in Lab system software	Convened stakeholders
Unapproved electronic alert activated to medication record	Convened stakeholders
POCG and RAI order set alignment/standardization	
Limitations of clinical reports	Future QI
Clinical practice guideline gaps	
Sole sliding scale RAI ordering practice by provider	Report to Chair Hospitalists
Lab blood sugar used by nurse	Feedback to CL/nurse/O-Report

Note. O-Report: Occurrence Report