PERIOPERATIVE GLUCOSE MANAGEMENT IN ORTHOPEDIC SURGERY

by

Ann Rose Madden

Under Supervision of

Veronica Y. Amos, PhD, CRNA, PHCNS-BC

Second Reader

Rebecca Wiseman, PhD, RN

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Abstract

Background: There is a definitive correlation between perioperative hyperglycemia and negative outcomes in orthopedic surgeries. Vigilant treatment of hyperglycemia (>180 mg/dL) will prevent negative outcomes such as joint failure, infection and pseudarthrosis.
Local Problem: A Clinical Practice Guideline (CPG) focusing on the management of perioperative hyperglycemia for patients undergoing orthopedic surgery was created for a community hospital in Southern Maryland.
Interventions: Data was collected using the following instruments: Practitioner Feedback Questionnaire (PFQ) and the Appraisal of Guidelines Research and Evaluation II Tool (AGREE II). The acceptance and usability of the clinical practice guideline (CPG) was evaluated through these instruments.
Results: The dissemination and collection of the practitioner feedback survey resulted in a 100% response (N=16). The literature search was complete and relevant and the recommendations of the CPG were clear and suitable for the intended patient population. 90% of the clinician's scores suggested they would feel comfortable utilizing the care model suggested in the CPG. Clinical expertise and demographic variables influenced the responses in the PFQ and Agree II tool.
Conclusions: Overall the data collected demonstrated widespread acceptance and approval of this clinical practice guideline.

Perioperative Glucose Management

Overview

Diabetes is a public health problem that is quickly approaching epidemic proportions. In 2015, 30.3 million Americans had diabetes and that number continues to rise today (American Diabetes Association, 2018). As the number of individuals diagnosed with diabetes continues to increase so will the need to manage and treat patients in the surgical setting. It is estimated that 15-20% of the surgical population in the United States has diabetes (Morrison, O'Donnell, Ren & Henker, 2014). A hyperglycemic state, typically defined as a blood glucose level greater than 180 mg/dL, places patients at risk for negative post-operative events regardless of diabetes diagnosis. In orthopedic surgery, the negative events that occur from poorly managed blood glucose include impaired wound healing, hardware or implant failure, increased risk of surgical site infections and pseudarthrosis (Wukich, 2015). These adverse events ultimately increase a patient's length of stay and total hospital costs. Negative outcomes translate to a greater need for tighter glucose management in the surgical setting. Anesthesia staff at a community hospital in Southern Maryland identified that there was no existing guideline for managing preoperative hyperglycemia. An intervention that addressed the needs of this institution was the creation of a clinical practice guideline (CPG). This guideline governed the identification, treatment and monitoring of hyperglycemia in the perioperative period (See Appendix A).

The diagnosis of diabetes does not correlate with postoperative complications instead it is poor glycemic control that correlates with postoperative complications (Stryker et al., 2013). Vigilant glucose management in the perioperative setting directly correlated with positive patient outcomes, which further validated the need to create a clinical practice guideline for a community hospital in Southern Maryland.

The preoperative area is the first opportunity for an anesthesia provider to asses a patient's glycemic control; by implementing a CPG, practitioners had a resource to appropriately manage a patient's preoperative glucose. In the preoperative setting a blood glucose of 70mg/dL or greater than 140 mg/dL warrants monitoring and treatment (Morrison et al., 2014). Focusing the CPG to treat a blood glucose matching the aforementioned criteria likely decreased the risk of adverse postoperative outcomes. Research has shown that length of stay, renal insufficiency, mortality and patient outcomes have improved with greater glycemic control, when following a glucose management guideline (Morrison et al., 2014).

The purpose of this project was to decrease post-operative complications associated with elevated blood glucose levels in diabetic patients. A short-term goal for this project was to develop a sustainable clinical practice guideline for a community hospital in Southern Maryland. It was anticipated that this institution would adopt this CPG and utilize it to improve patient health outcomes. A long term goal of this project was to use this CPG within the next two years leading to improvement in blood glucose management and a decrease in negative post operative outcomes associated with poorly managed blood glucose.

Theoretical Framework

The theoretical framework that was used to develop this clinical practice guideline was the FADE quality improvement model developed by the Organizational Dynamics Institute (2005). The framework of the quality improvement FADE model is a cyclical model that consists of four broad steps: focus, analyze, develop, execute/evaluate (Wiseman & Kaprielian, 2005). The implementation of each step of the model began with the focus. The focus was identification of the problem, which was the lack of standardized glucose management. Once the focus was defined sequential flow was developed and each step of the model came together to

create a successful quality improvement project. After determining the focus of the CPG analysis of the focus commenced. The analysis consisted of a literature review of current research regarding perioperative glucose management. The literature review focused on perioperative hyperglycemia in diabetic patients and the associated negative post-operative outcomes.

The third step in the FADE model is development. In order to develop a quality improvement practice guideline data needed to be collected. The information collected relates to the current incidence of post operative complications associated with hyperglycemia, current practice protocols utilized to reduce elevated preoperative glucose, and new practice guidelines/solutions that were being tested to reduce hyperglycemic incidences (i.e. the administration of subcutaneous preoperative insulin or initiation of an intravenous preoperative insulin infusion). Based on the collected data the next step was to develop a plan of action to improve patient health outcomes. The development phase of this quality improvement model includes three subcategories: implementation, communication and measuring/monitoring (Wiseman & Kaprielian, 2005). The implementation began by developing a CPG to meet the needs of the anesthesia department at a community hospital in Southern Maryland. Communication with the key stakeholders of the project was necessary for successful development of a guideline specifically suited for their medical institution. Monitoring was done through a practitioner feedback questionnaire, which was completed by the anesthesia department at this facility.

The final step in the FADE model was to execute the plan of action and continually evaluate/monitor the results. The execution was done through presenting the CPG to the anesthesia providers at the community hospital. Evaluation of the CPG was done through a practitioner feedback questionnaire (PFQ) and the Appraisal of Guidelines Research and

Evaluation tool (AGREE II tool) from the anesthesia providers. The Agree II tool assesses quality and reporting of practice guidelines. There were monthly meetings with the key stakeholders regarding implementation of the CPG in order to monitor the usefulness of the guideline and make corrections as necessary in order to increase the likelihood of implementation of the CPG.

The lack of a perioperative glucose management guideline at this community hospital was the foundation for this project. In order to decrease the risk of adverse outcomes, this institution considered the utilization of a standardized blood glucose management guideline. The creation of a CPG provided definition for blood glucose monitoring frequency as well as thresholds for treatment. After successful implementation of the CPG it is hoped that postoperative patient outcomes would improve.

Literature Review

The focus of this literature review is to highlight the importance of preoperative glucose management in patients undergoing elective outpatient surgery. The review will highlight the negative post-operative events that could occur from poorly managed blood glucose. Several retrospective chart reviews and meta analyses will outline the drawbacks and benefits of preoperative glucose management. The details of the research trials regarding treatment of elevated preoperative blood glucose will be discussed. Information regarding the purpose, setting, methods and results of retrospective chart review and meta-analysis will be provided as well as highlighting the key strengths and limitations. The conclusion of this review will include a summary of the advantages and disadvantages of implementation of preoperative blood glucose management and its effectiveness in decreasing negative postoperative outcomes.

Kotagal et al. (2015) performed a retrospective chart review performed to determine the correlation between glucose level and surgical outcome. A total of 140,836 charts were reviewed, and 19,258 charts met the study's criteria, which consisted of patients undergoing general surgery, vascular surgery and spine operations between 2010-2012 in 53 Washington State hospitals. Exclusion criteria consisted of patients who did not receive a preoperative blood glucose measurement. There was no statistically significant difference for adverse events in patients with diabetes mellitus with a blood glucose of >180mg/dL (OR=0.8; 95% CI 0.6-1.0). However there was a statistically significant difference in non-diabetic patients who had hyperglycemia compared to those patients with normal blood glucose. The non-diabetic patients with hyperglycemia had a higher likelihood of experiencing an adverse surgical event ($p < .001$). As the glucose level increased in non-diabetic patients, so did the risk of an adverse event. These results indicate that hyperglycemia in both diabetic and non-diabetic patients can be detrimental to postoperative outcomes. One limitation of this study is the retrospective study design and the limited data set. Non-diabetic patients do not routinely undergo blood glucose monitoring so gathering concise, clear conclusions about the increased risk of negative post-operative events is difficult. The strengths of this study were the large sample size, a standard data set for collection, and the use of a standard definition for hyperglycemia. This study demonstrated a significant need to monitor blood glucose in both diabetic and non-diabetic patients in order to prevent adverse events.

A meta analysis completed by Sathya, Davis, Taveira, Whitlach and Wu (2013), analyzed the relationship among varying levels of glycemic control and it's influence on negative outcomes such as surgical site infections, stroke and death. Three levels of glycemic control were identified: liberal, moderate and strict control. Liberal control was defined as a blood glucose

>200 mg/dL, moderate control in the range of 150-200mg/dL, and strict control was 90-150 mg/dL. The glucose levels and the frequency of negative post surgical outcomes were analyzed in six different studies that contained 2,432 cases. When compared to liberal glycemic control, the lowest incidence of post-operative mortality and stroke was experienced with moderate glycemic control (OR=0.48, 95% CI 0.24-0.76). There was no noted benefit with strict glycemic control and the prevention of surgical site infections. The findings of this study indicate that glycemic control has its benefits in the prevention of adverse surgical events, however further studies are needed to determine the most effective level of control. The strength of this study was the randomized research collection, and its heterogeneity. A limitation of this meta analysis was a small sample size, of the 754 studies only six qualified. The majority of the studies were excluded because of lack of control groups and lack of specific outcome data.

A similar meta analysis by De Vries et al. (2017), reviewed the benefits of conventional glycemic control versus intense glycemic control and its relationship to negative post operative events. Conventional glycemic control was defined as “less strict glucose control with higher blood glucose levels” (Devries et al. 2017). Intense control was defined as “more strict glucose control with lower blood glucose levels” (Devries et al. 2017). A total of 15 randomized control trials were analyzed; there were a total of 2,816 participants. The participants were divided into two groups, 1,442 participants were placed in the intense control group, and 1,394 in the conventional group. There was a statistically significant amount of surgical site infections in the intense glycemic control group compared to the conventional group (p <.001). There was also a higher incidence of hypoglycemia in the intense control group but no correlations were found with the likelihood of experiencing an adverse event such as stroke or death. The large sample size and similarities in demographics between the two groups were major strengths of the study.

One major limitation to the study is that the meta analysis involved a large number of patients undergoing major surgery that required postoperative ICU stay, which poses a threat to validity in the study results to the general population. Another limitation was the lack of baseline information (i.e. medication history, lab results) and intraoperative details (i.e. blood loss) that may have influenced the adverse surgical outcomes.

A retrospective chart review from 2004-2011 by Stryker et al., (2013) was completed to determine the relationship between post operative blood glucose levels, preoperative hemoglobin A1c and their relationship with wound complications such as infection in elective joint arthroplasty. A total of 30 charts were reviewed and compared to a 1:1 control group with the following inclusion criteria: sex, age, procedure, antibiotic cement, surgical approach and tourniquet use. The charts were monitored for 30 days to assess for development of signs and symptoms of infection and compared and analyzed against the control group. An increased glucose level of >200mg/dL or a preoperative HgbA1c of >6.7% following an elective joint arthroplasty increased the risk of wound complications. In conclusion, failure to manage blood glucose pre and post operatively can contribute to the development of wound complications. The study design with creation of a control group that included comparable age, gender and the aforementioned inclusion criteria is a major strength of this study. The small sample size, the narrow 30-day data collection period, and limiting the research to one specific surgery type were limitations to the study.

Although there is a lack of evidence regarding the appropriate level of glucose control to prevent negative post-operative outcomes the overall literature supports the foundation of this project. Preoperative blood glucose management in patients with diabetes leads to the prevention of negative post-operative outcomes. Outcomes such as a decreased length of stay, reduction in

morbidity and mortality, and decreased incidences of renal insufficiency have all improved with greater glycemic control.

Plan For Implementation

The purpose of this project was to create a clinical practice guideline (CPG) for a community hospital in Maryland. This CPG was a tool for the anesthesia department to utilize when managing preoperative glucose in patients undergoing outpatient elective surgery. There were three phases of CPG guideline development. Phase I started with recruitment of stakeholders within the community hospital in Maryland and a University of Maryland School of Nursing nurse anesthesia program faculty member with a terminal degree. Once the stakeholders were identified the purpose and goals of the CPG were developed. A timeline was created in order to execute successful development of a CPG in a timely fashion. An initial draft of the CPG was delivered to stakeholders for them to review, utilizing the Appraisal of Guidelines for Research and Evaluation II (Agree II) tool. After recommendations and areas of improvement were identified the development team transitioned into Phase II. This consisted of revising the CPG before it was presented to the anesthesia department to gain support and acceptance of the CPG. Once revisions were made the Chief Anesthesiologist accepted the CPG before transitioning to Phase III. In this final phase of implementation, the final draft of the CPG was presented to the anesthesia department at the community hospital in Maryland. A practitioner feedback questionnaire (PFQ) (Appendix B) was distributed to anesthesia staff that was in attendance for the presentation of the CPG.

Design, Setting, Sample

Descriptive and correlative statistics were used to analyze the data in this CPG. The AGREE II tool was the gold standard for guideline evaluation. It was used to analyze the clinical

practice guideline for perioperative glucose management. The AGREE next Steps Consortium developed the AGREE II tool in 2009. This evaluation tool utilizes construct validity to assess the quality of a CPG. It contains 23 items within six distinct domains (scope and purpose, stakeholder involvement, rigor of development, clarity of presentation, applicability and editorial independence) and a final section for overall assessment of a CPG (Brouwers, et al., 2010). Each item within the domain is graded on a seven point Likert scale, ranging from "strongly agree" to "strongly disagree." The item is then scored and the results for each domain correlate to the quality of the CPG (AGREE Next Steps Consortium, 2009). The results from the AGREE II tool were totaled from each domain for the committee members who rated the CPG. The obtained score was subtracted from the minimum possible score and then divided by the difference of the maximum possible score minus the minimum possible score. This equation was utilized to create a percentage. The percentage was used to determine the quality of the CPG. A quality score is developed for each of the six domains, the domain scores are independent and should not be aggregated into a single quality score. Scores >70% are indicative of high quality domains. (AGREE Next Steps Consortium, 2009).

A practitioner feedback questionnaire (PFQ) (Appendix B) was also utilized during the project to measure the potential users' attitudes regarding the CPG. This evaluation tool is a valid and reliable tool used specifically for the people who will adopt and utilize the CPG. The PFQ had 23 questions that required an answer utilizing a three point Likert scale ranging from "strongly agree" to "strongly disagree." The PFQ was delivered to the appropriate committee members via paper and pencil after the CPG was presented to committee members.

Data Analysis

The quantitative data from the Agree II tool was collected and entered into a Microsoft Excel document. The qualitative data within the comments section of each domain in the Agree II tool were analyzed and entered into a Microsoft Word document. Data from the PFQ was collected by taking the mean of each question and dividing it by the total number of questions; that number was then multiplied by 100 to obtain a percentage. Once this information was gathered it was entered into a univariate frequency table in a Microsoft Excel document. The results from the PFQ and Agree II tool were analyzed and discussed with the stakeholders. The focus of this discussion was to find areas of improvement and to make revisions to the CPG to increase the usefulness of the guideline for their institution.

Protection of Human Subjects

In order to protect human rights, no identifiers were collected with the AGREE II Tool and PFQ. All anesthesia team members were encouraged to participate in this project, but participation was voluntary, no one was forced or coerced to participate. The feedback from the PFQ and Agree II tool were stored in a locked cabinet in the anesthesia office. Electronic data used for the development of this CPG was stored on a password-protected computer. Request for approval of this project was submitted to the University of Maryland, Baltimore Institutional Review Board (IRB) for a Non-Human Subjects Research (NHSR) determination.

Results

Out of the three expert panel members that received the AGREE II tool, two members completed the instrument for the first draft of the CPG. The scores reported and analyzed reflect the quality of the CPG. The domain scores ranged from 59-100%. The calculated scores for each domain from highest to lowest were as follows: Domain 6 –editorial dependence 100%, Domain

4-clarity of presentation 86%, Domain 5 applicability 83%, Domain 1- scope and purpose 81%, Domain 2- stakeholder invovment-75% and Domain 3-rigor of development 59%.

The dissemination and collection of the practitioner feedback survey resulted in a 100% response (N=16) (Appendix D). All of the end-users in attendance of the presentation of the CPG submitted the PFQ. Of the 16 providers that completed the PFQ survey, 25% (n=4) were anesthesiologists (MDA) and 75% (n=12) were certified registered nurse anesthetists (CNRA). The average years of clinical practice for the anesthesia providers was 8.7 years. The end users (100%) answered that they agreed the rationale for developing the guideline was clear and there was a need for a guideline on this topic. Another strongly scored subject (80%) was the literature search being complete and relevant and the recommendations of the CPG were clear and suitable for the intended patient population. 90% of the clinician's scores suggested they would feel comfortable utilizing the care model suggested in the CPG. Although there were several areas that the respondents scored highly on, a few of the lower scoring categories included: implementing of the CPG was too expensive, technically challenging, or too detailed for individual patients.

Discussion

A few changes were made to the initial draft CPG in order to accommodate the end users of the intended institution. The initial draft included guidelines for both intravenous and subcutaneous insulin administration. After speaking with the key stakeholders and gathering opinions from the members of the anesthesia department it was decided that due to the complexity involved in both routes of administration, the usability would be more accepted with one guideline that focused on one route of administration. It was decided that the project

members would proceed with a CPG solely focused on subcutaneous insulin administration, instead of including both subcutaneous and intravenous insulin administration.

The other changes made to the initial CPG stemmed from discussions with the expert panel and anesthesia team members. The majority of team members favored the inclusion of patients who required an adjusted insulin dosing (i.e. insulin dependent, non insulin dependent, oral hyperglycemic agents) as well as appropriate timeframes for reevaluating treated blood glucose levels. The aforementioned criteria was researched, analyzed and added to the final CPG.

The lack of current guidance on perioperative glycemic management at this institution propelled the development of this CPG. Major stakeholders of this project were the chief anesthesiologist and chief certified registered nurse anesthetist. These stakeholders had a vested interest in better serving their patient population through evidence based research and practice changes. Throughout the creation of the CPG there were many discussions with the facilitators about tailoring the CPG to meet the needs of the institution. One barrier was the disagreement between anesthesia staff regarding the ideal dose of subcutaneous insulin administration for each blood glucose category. After discussions with the key stakeholders and a review of recent literature and similar successful evidence based practice guidelines the decision was made to use a set insulin dose for each blood glucose category. Another potential barrier was the concern of lack of autonomy regarding insulin administration in the perioperative area. The target institution for which this CPG was created has a collaborative relationship between anesthesiologists and nurse anesthetists and both practitioners are viewed as autonomous providers. Therefore, the decision to manage perioperative hyperglycemia is the responsibility of either the anesthesiologist or the CRNA. Following the presentation of the final CPG along with

explanation of the utilization of the guideline including proper insulin dosing, the anesthesia providers felt more comfortable accepting responsibility of managing perioperative hyperglycemia.

Evidence from the PFQ and AGREE II tool results demonstrate widespread usability and acceptance of the CPG. According to the results, the reviewers recommend implementation of the guideline without any changes. Four of the six domains scored over 80%, which is indicative of a high quality, usable guideline. Anesthesia staff concluded if the CPG was approved, they would incorporate it into their practice.

Recent organizational changes within the facility have halted the implementation of the CPG. The anesthesia group was independently contracted with the facility for which the CPG was created. After development and presentation of the CPG the independent anesthesia group became part of a large medical system. As a result of this organizational change, system-wide guidelines and institutional policies were adopted; therefore this CPG that was created specifically for this institution will most likely not be implemented.

It is unknown if a perioperative management guideline exists within this large medical group, however the information presented and detailed in the CPG could serve as a resource tool for the development of a similar institutionally accepted guideline. It is hoped that this CPG will be utilized as a reference tool in providing better management of perioperative hyperglycemia and in turn providing better surgical outcomes for the patients at the community hospital in Maryland. The CPG was developed with focus on bariatric, cardiac and orthopedic surgeries but future use of this CPG may include adaptation for all surgical specialties along with possible implementation in larger nationally recognized medical systems.

Conclusion

Providing glycemic control through insulin administration during orthopedic surgery has significant benefits on surgical outcomes. A clinical practice guideline was successfully developed and disseminated at a community hospital in Maryland. Successful development of the clinical practice guideline began with expert panel evaluation followed by approval from key stakeholders and appraisal by the intended institution and its end users. This clinical practice guideline could provide a framework and reference for anesthesia providers in the management of perioperative hyperglycemia. There was currently no guideline for preoperative blood glucose management at this facility and the anesthesia department expressed a need for a preoperative glucose management CPG, therefore it was solely developed for use in this particular institution.

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Table 1: Evidence Review Table

Author, year	Study objective/intervention or exposures compared	Design	Sample (N)	Outcomes studied (how measured)	Results
Kotagal et al., (2015)	To explore preoperative blood glucose levels in numerous surgical procedures and study the relationship between the glucose level and surgical outcome	Retrospective review of patient charts	Patients undergoing bariatric, vascular and spine surgery were reviewed (N=140,836) Of all charts reviewed (N=19258) met the criteria or perioperative blood glucose testing.	A compilation of adverse events such as cardiac, non-cardiac and death related events.	Patients with Dia a blood glucose l demonstrated no likelihood of an a (95% CI = 0.58–1 the reference grou Non-diabetic pati hyperglycemia sh higher probability = 2.4 (95% CI, 1. mg/dL; and OR = for BG >=180 mg The extent of hyp likelihood of an a with a dose-respo increased so did t event among non patients, but not I
Sathya, B., Davis, R., Taveira, T., Whitlatch, H., & Wu, W. (2013)	The causational relationship of varying levels (conventional, moderate, intense) of glycemic control on surgical site infections and adverse events including stroke and death.	A meta analysis was done with 6 different studies.	N=2432, 6 studies were examined	The prevalence of adverse events including surgical site infections, stroke, and mortality were recorded	The lowest incide mortality (OR = (and stroke (OR = was experienced control when con control. Strict and control did not de for prevention of (OR=0.94, 95% C
De Vries, F. E., Gans, S. L., Solomkin, J. S., Allegranzi, B., Egger, M., Dellinger, E. P., & Boermeester, M. A. (2017)	Intense glycemic control (more strict control with lower blood glucose levels) vs. conventional methods (less strict control with increased glucose levels) and its relationship with surgical site infections	A meta-analysis of 15 randomized control trials	Study participants N=2816 Intense control group n= 1442 Conventional control group n=1394	The occurrence of adverse events such as stroke and death and the prevalence of surgical site infections.	The intense glyce fewer surgical sit compared to the c group. (OR 0.43, 95% CI 0.29- .64 There was a high hypoglycemia in (OR 5.55, 95% C increase the risk death (OR 0.74, 9 stroke (OR 1.37,
Stryker, L., Abdel, M., Morrey, B., Morey, M., Morrow, M., Kor, D., (2013)	Patient records were evaluated to study the correlation between levels of postoperative blood glucose and preoperative hemoglobin A1C and its relationship with risk for wound complications	A retrospective chart review was done from 2004 through 2011	N=30 A control group (1:1) was created with the following inclusion criteria: sex, age, procedure, surgical approach, antibiotic cement use and tourniquet use.	Documentation was recorded for 30 days if there was a complication from a wound infection	There was an incr complications fol arthroplasty if the blood glucose lev preoperative Hgb Failure to manage post operatively infections.

Rating System for Hierarchy of Evidence

Level of the Evidence	Type of the Evidence
I (1)	Evidence from systematic review, meta-analysis of randomized controlled trails (RCTs), or practice-guidelines based on systematic review of RCTs.

II (2)	Evidence obtained from well-designed RCT
III (3)	Evidence obtained from well-designed controlled trials without randomization
IV (4)	Evidence from well-designed case-control and cohort studies
V (5)	Evidence from systematic reviews of descriptive and qualitative studies
VI (6)	Evidence from a single descriptive or qualitative study
VII (7)	Evidence from the opinion of authorities and/or reports of expert committees

Melnyk, B.M. & Fineout-Overholt, E. (2014). *Evidence-based practice in nursing & healthcare: A guide to best practice* (3rd ed.). New York: Lippincott, Williams & Wilkins.

Rating Scale for Quality of Evidence

A: High – consistent results with sufficient sample, adequate control, and definitive conclusions; consistent recommendations based on extensive literature review that includes thoughtful reference to scientific literature

B: Good – reasonably consistent results; sufficient sample, some control, with fairly definitive conclusions; reasonably consistent recommendations based on fairly comprehensive literature review that includes some reference to scientific evidence

C: Low/major flaw – Little evidence with inconsistent results; insufficient sample size; conclusions cannot be drawn

Newhouse, R.P. (2006). Examining the support for evidence-based nursing practice. *Journal of Nursing Administration, 36*(7-8), 337-40.

Appendix A: Perioperative Glucose Management Clinical Practice Guideline (CPG)

- Determine if this is emergency or elective surgery
    - Obtain time and dose of last insulin or oral hypoglycemic medications
    - Check preoperative glucose
    - Check glucose hourly and give insulin if glucose >180 mg/dl
        - If surgery is an emergency, anticipated surgical time >4 hours, anticipated large hemodynamic changes (i.e. large volume/temperature shifts), pt is critically ill and/or poorly controlled blood glucose (BG) at home, then administer insulin gtt intravenous. If the patient does not meet this criteria then administer subcutaneous

Subcutaneous Insulin Administration Protocol

Blood Glucose (mg/dl)	Insulin Sensitive* Age > 70 yr, GFR <45 ml/min, No History of Diabetes	Patients who regularly inject Insulin	Insulin Resistant* BMI >35 kg/m2, Home TDD Insulin > 80 U, Steroids >20 mg Prednisone Daily
141-180	0 units	2 units	3 units
181-220	2 units	3 units	4 units
221-260	3 units	4 units	5 units
261-300	4 units	6 units	8 units
301-350	5 units	8 units	10 units
351-400	6 units	10 units	12 units
>400	8 units	12 units	14 units
* If the patient falls into more than one insulin treatment group, choose the category with the lowest correctional dose to minimize the risk of hypoglycemia. BMI = body mass index; GFR = glomerular filtration rate; TDD = total daily dose			

Reference: Duggan, E. W., Carlson, K., & Umpierrez, G. E. (2017). Perioperative Hyperglycemia Management: An Update. Anesthesiology, 126(3), 547-560. doi:10.1097/ALN.0000000000001515

Appendix B: Practitioner Feedback Questionnaire

Practitioner Feedback Questionnaire

1. Are you responsible for the care of patients for whom this draft guideline report is relevant? This may include the referral, diagnosis, treatment, or follow-up of patients.	Yes ☐	No ☐	Unsure ☐

If you answered "*No*" or "*Unsure*", there is no need to answer or return this questionnaire. If you answered "*Yes*", please answer the questions below and return to **[enter expected destination of surveys]**.

	Strongly agree	Neither agree or disagree	Strongly disagree
2. The rationale for developing a guideline is clear.	☐	☐	☐
3. There is a need for a guideline on this topic.	☐	☐	☐
4. The literature search is relevant and complete (e.g., no key evidence was missed nor any included that should not have been) in this draft guideline.	☐	☐	☐
5. I agree with the methodology used to summarize the evidence included in this draft guideline.	☐	☐	☐
6. The results of the evidence described in this draft guideline are interpreted according to my understanding of the evidence.	☐	☐	☐
7. The draft recommendations in this report are clear.	☐	☐	☐
8. I agree with the draft recommendations as stated.	☐	☐	☐
9. The draft recommendations are suitable for the patients for whom they are intended.	☐	☐	☐
10. The draft recommendations are too rigid to apply to individual patients.	☐	☐	☐
11. When applied, the draft recommendations will produce more benefits for patients than harms.	☐	☐	☐
12. The draft guideline presents options that will be acceptable to patients.	☐	☐	☐
13. To apply the draft recommendations will require reorganization of services/care in my practice setting.	☐	☐	☐
14. To apply the draft guideline recommendations will be technically challenging.	☐	☐	☐
15. The draft guideline recommendations are too expensive to apply.	☐	☐	☐
16. The draft guideline recommendations are likely to be supported by a majority of my colleagues.	☐	☐	☐
17. If I follow the draft guideline recommendations, the expected effects on patient outcomes will be obvious.	☐	☐	☐
18. The draft guideline recommendations reflect a more effective approach for improving patient outcomes than is current usual practice. (If they are the same as current practice, please tick NA). *NA* ☐	☐	☐	☐
19. When applied, the draft guideline recommendations will result in better use of resources than current usual practice. (If they are the same as current practice, please tick NA). *NA* ☐	☐	☐	☐
20. I would feel comfortable if my patients received the care recommended in the draft guideline.	☐	☐	☐
21. This draft guideline should be approved as a practice guideline.	☐	☐	☐
22. If this draft guideline were to be approved as a practice guideline, I would use it in my own practice.	☐	☐	☐
23. If this draft guideline were to be approved as a practice guideline, I would apply the recommendations to my patients.	☐	☐	☐

Adapted from: Brouwers, M.C., Graham, I.D., Hanna, S.E., Cameron, D.A., & Browman, G.P. (2004). Clinicians' assessments of practice guidelines in oncology: The CAPGO survey**.** *International Journal of Technology Assessment in Health Care, 20*(4), 421-6.

Appendix C- Agree II Results

Domain 1	Domain 2	Domain 3	Domain 4	Domain 5	Domain 6	OA 1	OA 2
81%	75%	59%	86%	83%	100%	100%	Yes - 2, No - 0

Domain 1: Scope and Purpose		
	Appraiser 1	Appraiser 2
Item 1	7	4
Item 2	7	5
Item 3	7	5

Domain 2: Stakeholder Involvement		
	Appraiser 1	Appraiser 2
Item 4	4	7
Item 5	4	6
Item 6	7	5

Domain 3: Rigour of Development		
	Appraiser 1	Appraiser 2
Item 7	4	5
Item 8	4	5
Item 9	6	5
Item 10	6	5
Item 11	6	4
Item 12	5	6
Item 13	1	4
Item 14	2	5

Domain 4: Clarity of Presentation		
	Appraiser 1	Appraiser 2
Item 15	7	5
Item 16	6	5
Item 17	7	7

Domain 5: Applicability		
	Appraiser 1	Appraiser 2
Item 18	6	5
Item 19	6	5
Item 20	6	7
Item 21	6	7

Domain 6: Editorial independence		
	Appraiser 1	Appraiser 2
Item 22	7	7
Item 23	N/A	7

Overall Guideline Assessment		
	Appraiser 1	Appraiser 2
OA1	7	7

Appendix D
Practitioner Feedback Results N=16

Question	Agree (n=)	% of total	Neither Agree nor Disagree (n=)	% of total	Disagree (n=)	% of total
Q2	16	100.0%	0	0.0%	0	0.0%
Q3	16	100.0%	0	0.0%	0	0.0%
Q4	14	87.5%	0	0.0%	2	12.5%
Q5	14	87.5%	0	0.0%	2	12.5%
Q6	13	81.3%	0	0.0%	3	18.8%
Q7	13	81.3%	0	0.0%	3	18.8%
Q8	12	75.0%	0	0.0%	4	25.0%
Q9	14	87.5%	0	0.0%	2	12.5%
Q10	7	43.8%	4	25.0%	5	31.3%
Q11	13	81.3%	0	0.0%	3	18.8%
Q12	15	93.8%	0	0.0%	1	6.3%
Q13	9	56.3%	2	12.5%	5	31.3%
Q14	6	37.5%	6	37.5%	4	25.0%
Q15	4	25.0%	7	43.8%	5	31.3%
Q16	14	87.5%	0	0.0%	2	12.5%
Q17	11	68.8%	0	0.0%	5	31.3%
Q18	15	93.8%	0	0.0%	1	6.3%
Q19	14	87.5%	0	0.0%	2	12.5%
Q20	15	93.8%	0	0.0%	1	6.3%
Q21	14	87.5%	0	0.0%	2	12.5%
Q22	16	100.0%	0	0.0%	0	0.0%

Demographic Data

	CRNA	**MD**
Provider Type	N=12 (75%)	N=4 (25%)

	Mean	**Median**	**Mode**
Clinical Years of Experience	3.9	8.75	4