Texas Children's Hospital

TEXAS CHILDREN'S HOSPITAL
EVIDENCE-BASED OUTCOMES CENTER
Diabetes and Perioperative Management
Evidence Summary

Inclusion Criteria
- Patients presenting for elective surgery with acceptable metabolic control (no ketonuria, normal serum electrolytes, and HbA1c within the ideal range for the child's age).

Exclusion Criteria
- Patients requiring emergent surgery due to trauma or acute surgical conditions, such as appendicitis.

Background

Perioperative management of the pediatric patient with diabetes can be a challenge for the anesthesiologist, surgeon and other members of the surgical team. The collaborative plan must take into consideration each patient's individual diabetic regimen, glycemic control, planned surgical procedure and the anticipated postoperative course. The aim of the perioperative plan should be glycemic control, maintenance of hydration and serum electrolyte balance, and avoidance of hypoglycemia and other complications.

Critically Analyze the Evidence

The **GRADE criteria** were used to evaluate the quality of evidence presented in research articles reviewed during the development of this guideline. The table below defines how the quality of evidence is rated and how a strong versus a weak recommendation is established.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	**Type of Evidence**
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, from RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

PICO Question 1: In pediatric patients with diabetes in the perioperative setting, should home medication regimen be adjusted in preparation for fasting for the procedure?

a. Oral
b. Insulin

Recommendation(s): Consensus recommendation

- Oral
  - Metformin should be discontinued 24 hours prior to procedures with a perioperative period longer than 3 hours, for perioperative risk of hypoxemia, dehydration, and poor tissue perfusion or procedure with anticipated contrast media.
  - Oral diabetic medication should be discontinued on the day of surgery prior to procedures with a perioperative period longer than 3 hours.
- Insulin
  - Patients on long-acting insulin should take their usual morning dose of their long-acting insulin on the day of the procedure.
  - Patients on split/mix insulin (NPH/regular, 70/30, 75/25) should hold their morning dose on the day of the procedure and be administered 50% of their usual morning NPH by hospital staff upon arrival.
  - Patients on NPH should take 50% of their usual morning dose on the day of the procedure.

A review of the literature revealed no research studies on the topic of preoperative medication adjustments for diabetic patients in preparation for the operating room. Four consensus guidelines and/or review articles were found that discussed recommendations for changes to home medications. [1-4] As a result, the above recommendations were made by consensus from experts within the Endocrinology and Anesthesia departments based upon the patient's procedure length and usual medication regimen.

PICO Question 2: In pediatric patients with diabetes in the perioperative setting, what physical findings, labs or symptoms require surgical delay?

Recommendation(s): Strong recommendation with very low quality evidence for the following:

- Patients with glucose >300 mg/dL and moderate-to-large urine ketones (serum ketones >2.5) on the day of surgery should have an endocrine consult and surgery cancellation should be considered due to the risk of complications from uncontrolled diabetes.
- Hemoglobin A1C values should not be the determining factor in the decision to cancel surgery for pediatric patients with diabetes on the day of the procedure.
- During the preoperative, visit consult Endocrine for patients with most recent HgA1C >11 (must be within the past three months).

A review of the literature revealed eleven observational studies on the relationship between HbA1C and surgical complications. [5-15] All of the studies represented adult populations with many having comorbid conditions to warrant surgical procedures. [5,7-11,13-15] In a 2013 retrospective review, adult patients (n = 40,491) with uncontrolled diabetes (HgA1C ≥7.0%) undergoing total knee replacement had possible reductions in risks for deep infection (OR, 0.55; 95% CI: 0.29-1.06) and pulmonary embolism (OR 0.70; 95% CI: 0.43 - 1.13) compared with patients without diabetes, however neither finding reached significance. [5] Engoren et al. reported that in a retrospective review of 880 adult patients, 43% suffered complications. Hemoglobin A1C levels were similar in those patients with and without complications. [8] A cohort of patients (n = 68,872) retrospectively reviewed revealed that preoperative HbA1C and glucose concentrations were not associated with increased postoperative infection rates. [12] Harris et al. reported that patients with a preoperative HgA1C ≥7% had a 22% higher risk of having at least one surgical complication following total joint arthroplasty. [10] Due to indirectness of the evidence to the PICO question and inconsistency of the results in the body of literature, the recommendation was made to not consider HgA1C in the decision to cancel surgery for pediatric patients with diabetes on the day of the procedure.

PICO Question 3: In pediatric patients with diabetes in the perioperative setting, how often should blood glucose be checked to maintain optimal glycemic control?

Recommendation(s): Consensus recommendation that patients with diabetes undergoing surgery without an insulin infusion should have POC blood glucose checked upon arrival to hospital and every two hours while NPO. Patients with diabetes undergoing surgery with an insulin infusion should have POC blood glucose checked every hour.

There were no research articles found that studied the frequency of glucose checks on the maintenance of glycemic control in diabetic patients undergoing surgery. Therefore, the above recommendation was made by expert consensus considering the need to monitor glucose and the frequency in which hyperglycemic correction doses should be administered.

PICO Question 4: In pediatric patients with diabetes in the perioperative setting, what are optimal glucose targets to maintain glycemic control?

Recommendation(s): Strong recommendation with very low quality evidence that patients with diabetes undergoing surgery should have a blood glucose target of 150 mg/dL with a range from 100 to 200 mg/dL.

A review of the literature revealed one meta-analysis and one observational study comparing intensive glycemic control and liberal glycemic control during surgical procedures. Buchleitner et al. found no significant differences between the intensive glycemic control group and standard group for all-cause mortality (RR 1.19; 95% CI: 0.89 - 1.59; p = 0.24) and infectious complications (RR 0.83; 95% CI: 0.45 - 1.52; p = 0.54). The meta-analysis did find an increased risk of experiencing hypoglycemic episodes with intensive glycemic control (RR 6.92; 95% CI: 2.04 - 23.41; p = 0.002). [16] However, there was a large amount of heterogeneity between studies and no standard parameters for the intensive glycemic control groups. Glycemic control was reported to be a significant risk for wound dehiscence in a 2013 retrospective review evaluating hypo- and hyperglycemic episodes on the rate of complications in high-risk patients undergoing surgical wound closure. [7]

PICO Question 5: In pediatric patients with diabetes in the perioperative setting, should insulin pump therapy be continued, suspended or substituted for long-acting insulin?

Recommendation(s): Strong recommendation with very low quality evidence Patients on an insulin pump scheduled for procedures with a perioperative period longer than 3 hours should have their insulin pump removed by a parent or guardian immediately before transport to the operating room. An IV insulin infusion should be started within 30 minutes of discontinuing the insulin pump.

There is a paucity of research on the topic of maintenance of insulin pump therapy for diabetic patients undergoing surgical procedures. A retrospective study of 92 cases (n = 72 patients) revealed there was no significant difference in the mean blood glucose per surgical case between patients that continued on their insulin pump infusion at basal rate during the surgical procedure (163.5 ± 58.5 mg/dL; range 48-311 mg/dL), patients that were converted to an IV insulin infusion from their insulin pump (152.3 ± 28.9 mg/dL; range 103-213 mg/dL) and patients with their insulin pump suspended during the surgical procedure (188.3 ± 44.9 mg/dL; range 118-302 mg/dL; p = 0.128). The study did find that patients with their insulin pump suspended experienced more cases (84.2%) with one or more

intraoperative blood glucose measurements above 179 mg/dL than the patients who were continued on their insulin pump or converted to IV insulin infusions. The study reported that no patients experienced severe hypoglycemia (blood glucose less than 40 mg/dL). [17]

PICO Question 6: In pediatric patients with diabetes in the perioperative setting, what IV fluids are beneficial to maintain optimal glycemic control?

Recommendation(s): Consensus recommendation that patients with diabetes undergoing procedures >3 hours or requiring an IV insulin infusion during the perioperative period should be administered a 5% dextrose containing crystalloid fluid at their maintenance infusion rate.

A review of the literature revealed no studies evaluating different types of IV fluid infusions on the maintenance of glycemic control during the perioperative period. Due to lack of evidence, the above recommendation was made by consensus from experts in the Endocrinology and Anesthesia departments.

Critical Points of Evidence*

Evidence Supports

- Patients with glucose >300 mg/dL and moderate-to-large urine ketones (serum ketones >2.5) on the day of surgery should have an endocrine consult and surgery cancellation should be considered due to the risk of complications from uncontrolled diabetes. Hemoglobin A1C values should not be the determining factor in the decision to cancel surgery for pediatric patients with diabetes on the day of the procedure. During the preoperative, visit consult Endocrine for patients with most recent HgA1C >11 (must be within the past three months). [5-15] – Strong recommendation with very low quality evidence
- Patients with diabetes undergoing surgery should have a blood glucose target of 150 mg/dL with a range from 100 to 200 mg/dL. [7-16] – Strong recommendation, low quality evidence
- Patients on an insulin pump scheduled for procedures with a perioperative period longer than 3 hours should have their insulin pump removed by a parent or guardian immediately before transport to the operating room. An IV insulin infusion should be started within 30 minutes of discontinuing the insulin pump. [17] – Strong recommendation, low quality evidence

Evidence Against

- None

Evidence Lacking/Inconclusive

- For patients taking oral diabetic medications, metformin should be discontinued 24 hours prior to procedures with a perioperative period longer than 3 hours, for perioperative risk of hypoxemia, dehydration, and poor tissue perfusion or procedure with anticipated contrast media and oral diabetic medication should be discontinued on the day of surgery prior to procedures with a perioperative period longer than 3 hours. [1-4] – Consensus recommendation
- For patients taking insulin at home, patients on long-acting insulin should take their usual morning dose of their long-acting insulin on the day of the procedure and patients on split/mix insulin (NPH/regular, 70/30, 75/25) should hold their morning dose on the day of the procedure and be administered 50% of their usual morning NPH by hospital staff upon arrival. [1-4] – Consensus recommendation
- Patients with diabetes undergoing surgery without an insulin infusion should have POC blood glucose checked upon arrival to hospital and every two hours while NPO. Patients with diabetes undergoing surgery with an insulin infusion should have POC blood glucose checked every hour. – Consensus recommendation
- Patients with diabetes undergoing procedures >3 hours or requiring an IV insulin infusion during the perioperative period should be administered a 5% dextrose containing crystalloid fluid at their maintenance infusion rate. – Consensus recommendation

*NOTE: The references cited represent the entire body of evidence reviewed to make each recommendation.

Apply the Evidence

Adjusting home medication in preparation for fasting

- Metformin should be discontinued 24 hours prior to procedures with a perioperative period longer than 3 hours, for perioperative risk of hypoxemia, dehydration, and poor tissue perfusion or procedure with anticipated contrast media
- Oral diabetic medication should be discontinued on the day of surgery for procedures with a perioperative period longer than 3 hours.
- Surgery for patients requiring insulin as diabetic treatment should be scheduled first case.
- Patients on long-acting insulin should take their usual morning dose of their long-acting insulin on the day of surgery.
- Patients on split/mix insulin (NPH/regular, 70/30, 75/25) should hold their morning dose on the day of surgery and be administered 50% of their usual morning NPH by hospital staff upon arrival.
- Patients on NPH should take 50% of their usual morning dose on the day of surgery.

Physical findings, labs or symptoms that require surgical delay

- Patients with diabetes should have a preoperative evaluation, preferably in the PASS clinic, 1 – 2 weeks prior to surgical procedures to assess glycemic control, document total daily dose and correction factor, discuss preoperative medication management, and receive procedural education.
- Patients with glucose >300 mg/dL and moderate-to-large urine ketones (serum ketones >2.5) on the day of surgery should have an endocrine consult and surgery cancellation should be considered due to the risk of complications from uncontrolled diabetes.
- During the preoperative visit, consult Endocrine for patients with most recent HgA1C >11 (must be within the past three months).

Blood glucose monitoring

- Patients with diabetes undergoing surgery without an insulin infusion should have POC blood glucose checked upon arrival to hospital and every two hours while NPO.
- Patients with diabetes undergoing surgery with an insulin infusion should have POC blood glucose checked every hour.
- Blood glucose should be checked one hour after insulin pump site change.

Blood glucose target

- Patients with diabetes undergoing surgery should have a blood glucose target of 150 mg/dL with a range from 100 to 200 mg/dL.

Insulin pump therapy

- Patients on an insulin pump scheduled for surgery or procedures with a perioperative period longer than 3 hours should have their insulin pump removed by a parent or guardian immediately before transport to the operating room. An IV insulin infusion should be started within 30 minutes of discontinuing the insulin pump.
- On the day of surgery, patients on an insulin pump should omit their bolus dose unless it is needed to treat hyperglycemia above 200 mg/dL.
- Site placement of the insulin pump and patient positioning during surgery should be discussed preoperatively with the parents/guardians of patients on insulin pumps scheduled for surgical procedures.

IV fluids

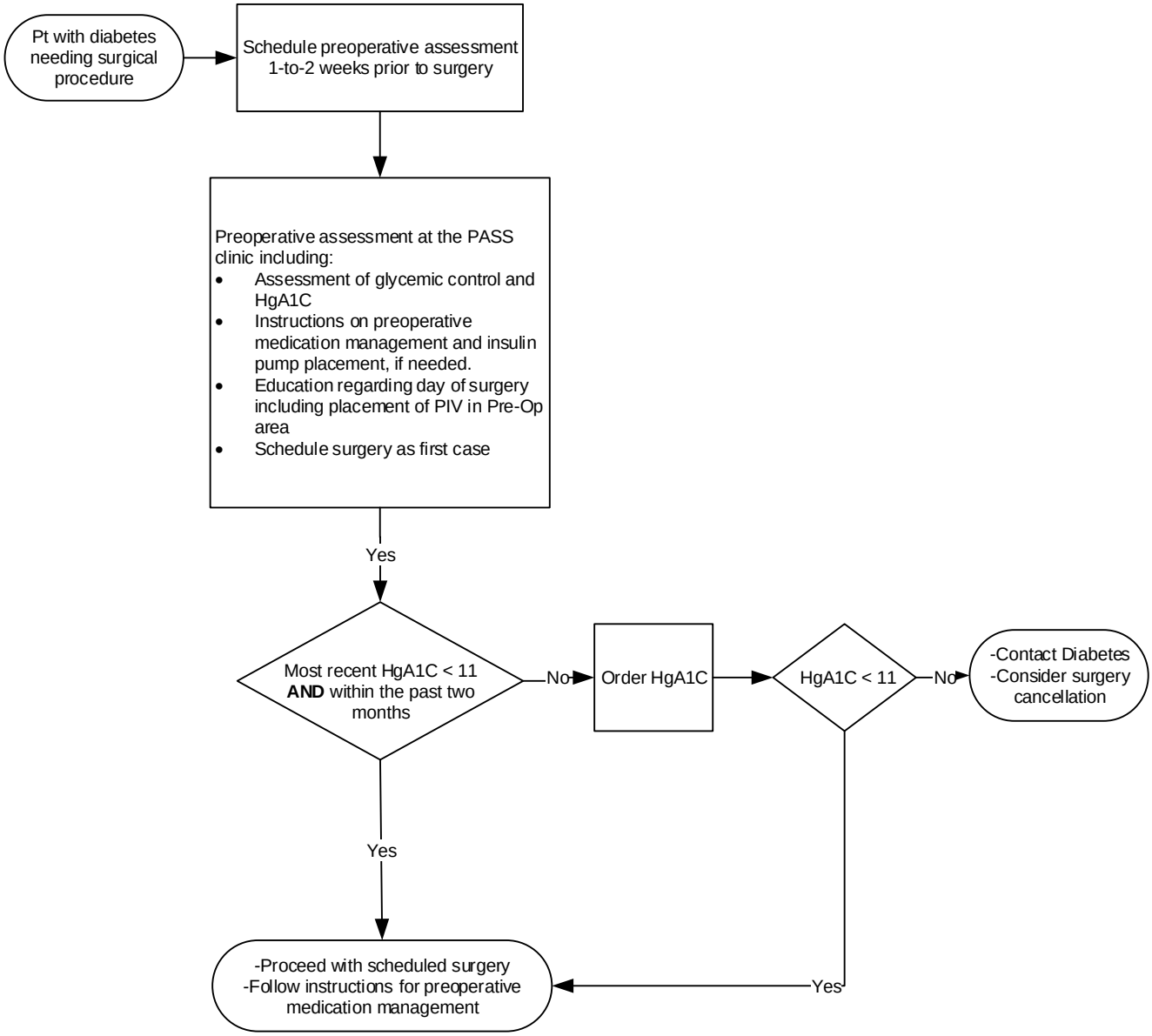
- Patients with diabetes undergoing procedures longer than 3 hours or requiring an insulin drip during the perioperative period should be administered a 5% dextrose containing crystalloid fluid at their maintenance infusion rate.

Measures

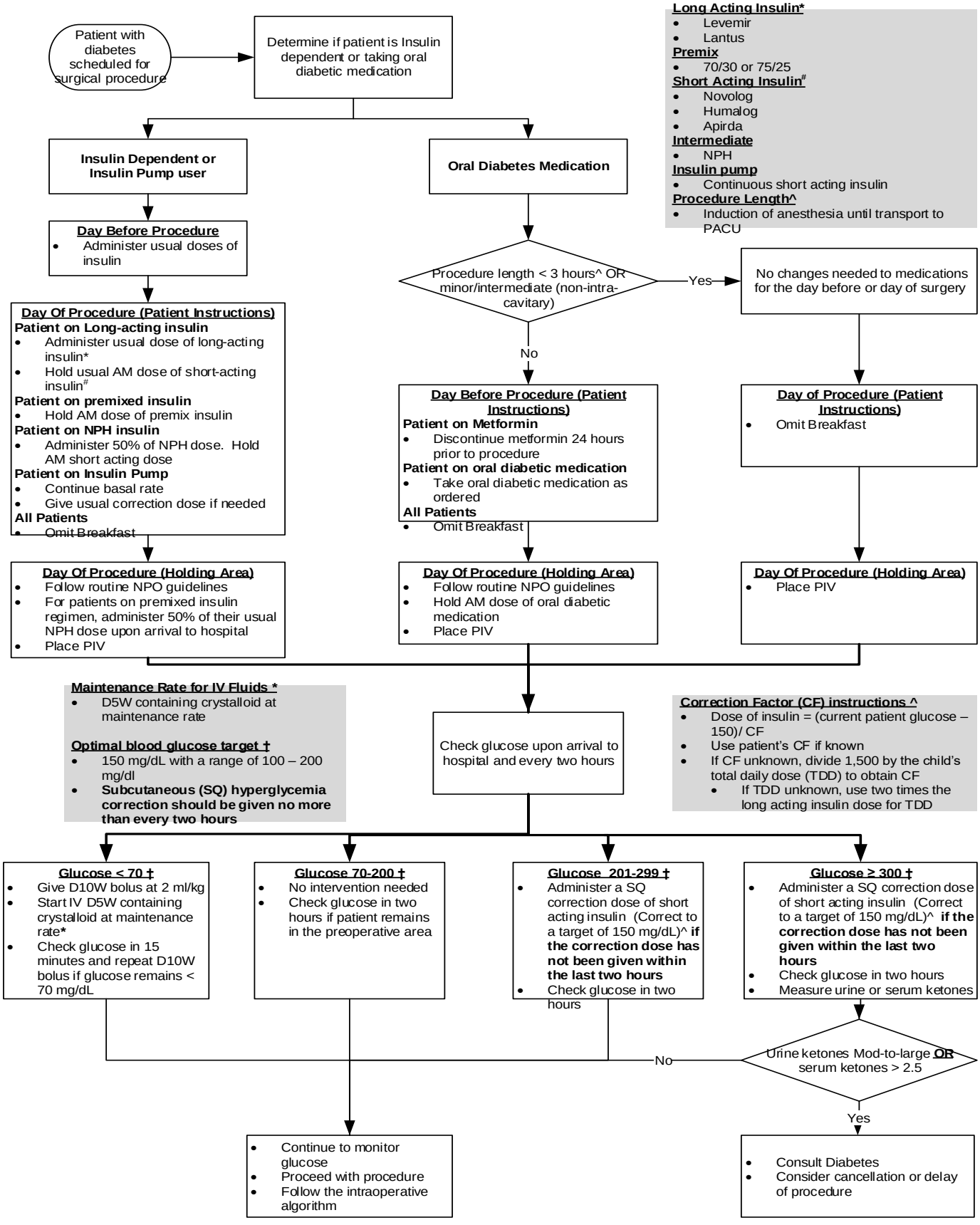
Outcome

- Percentage of patients with post-operative complications
- Percentage of patients with pre-operative visit in the PASS clinic
- Intervention within 15 minutes for hyperglycemia and hypoglycemia management
- POC blood glucose within one hour of PACU admit time
- POC blood glucose in the pre-operative area and no more than two hours prior to anesthesia start time
- POC blood glucose every hour for patients on an IV insulin infusion
- POC blood glucose every two hours for NPO patients without an IV insulin infusion

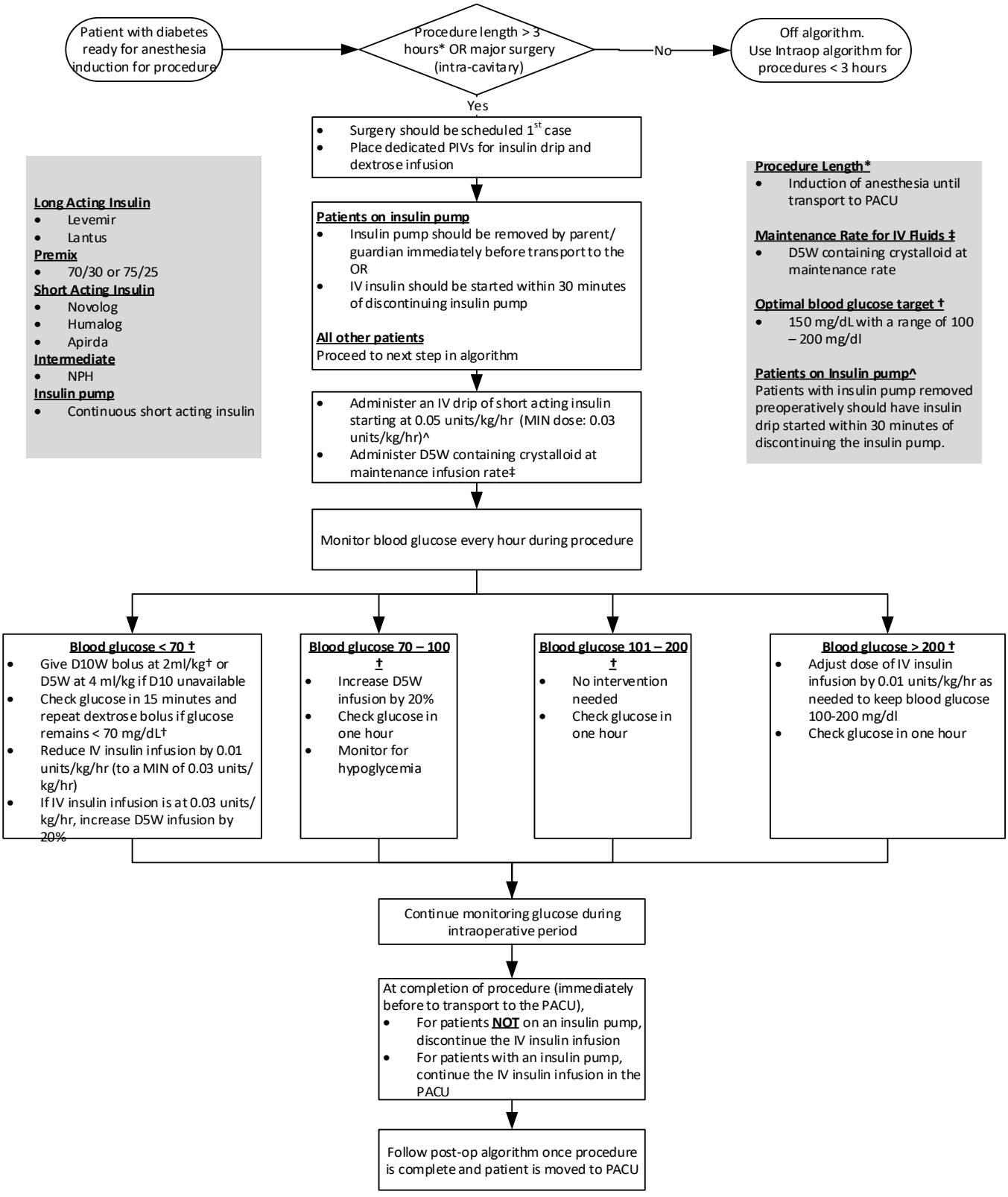
Diabetes and Perioperative Management
Preoperative Algorithm



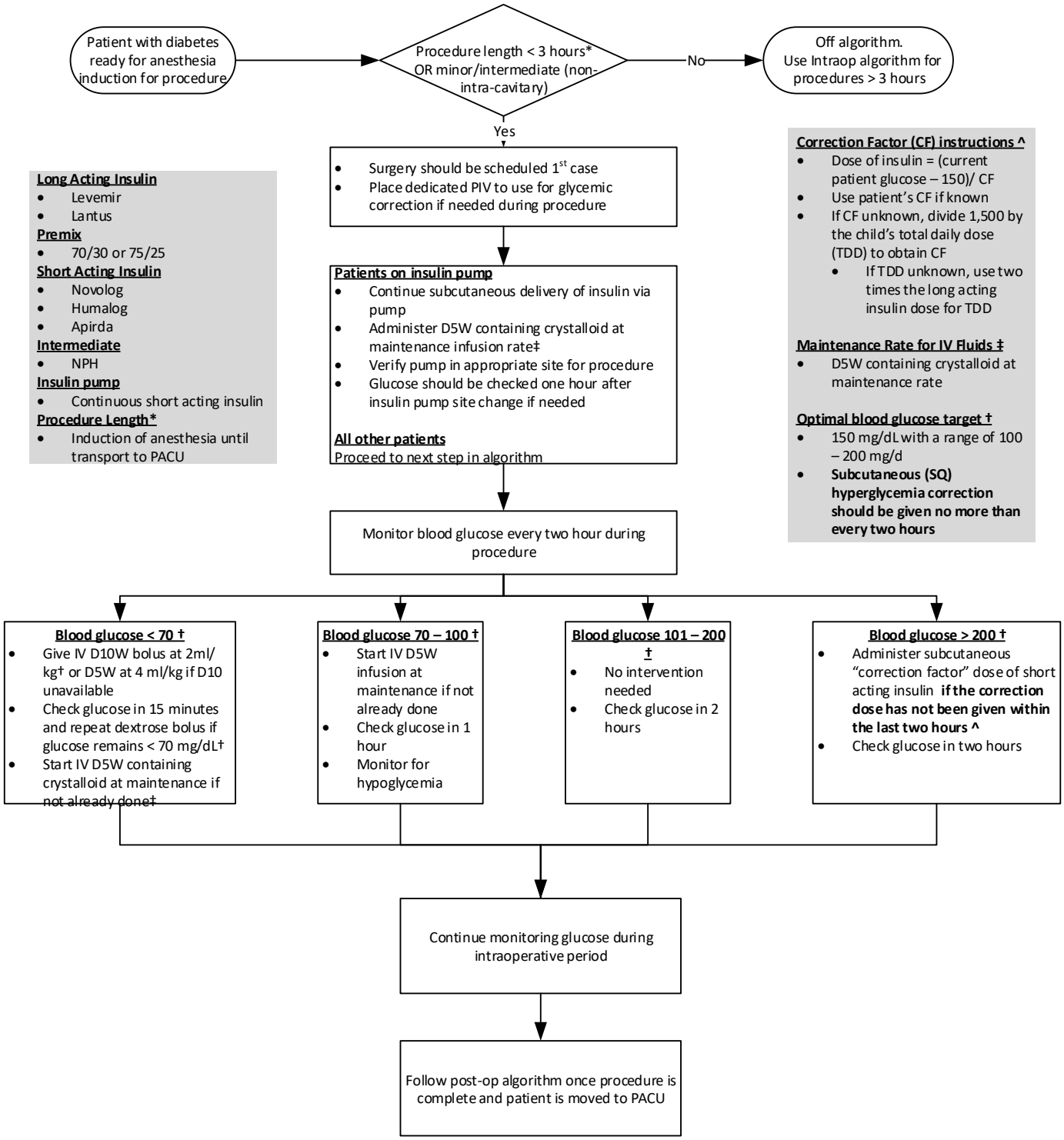
Diabetes and Perioperative Management
Preoperative Medication Management Algorithm for the Day of Surgery



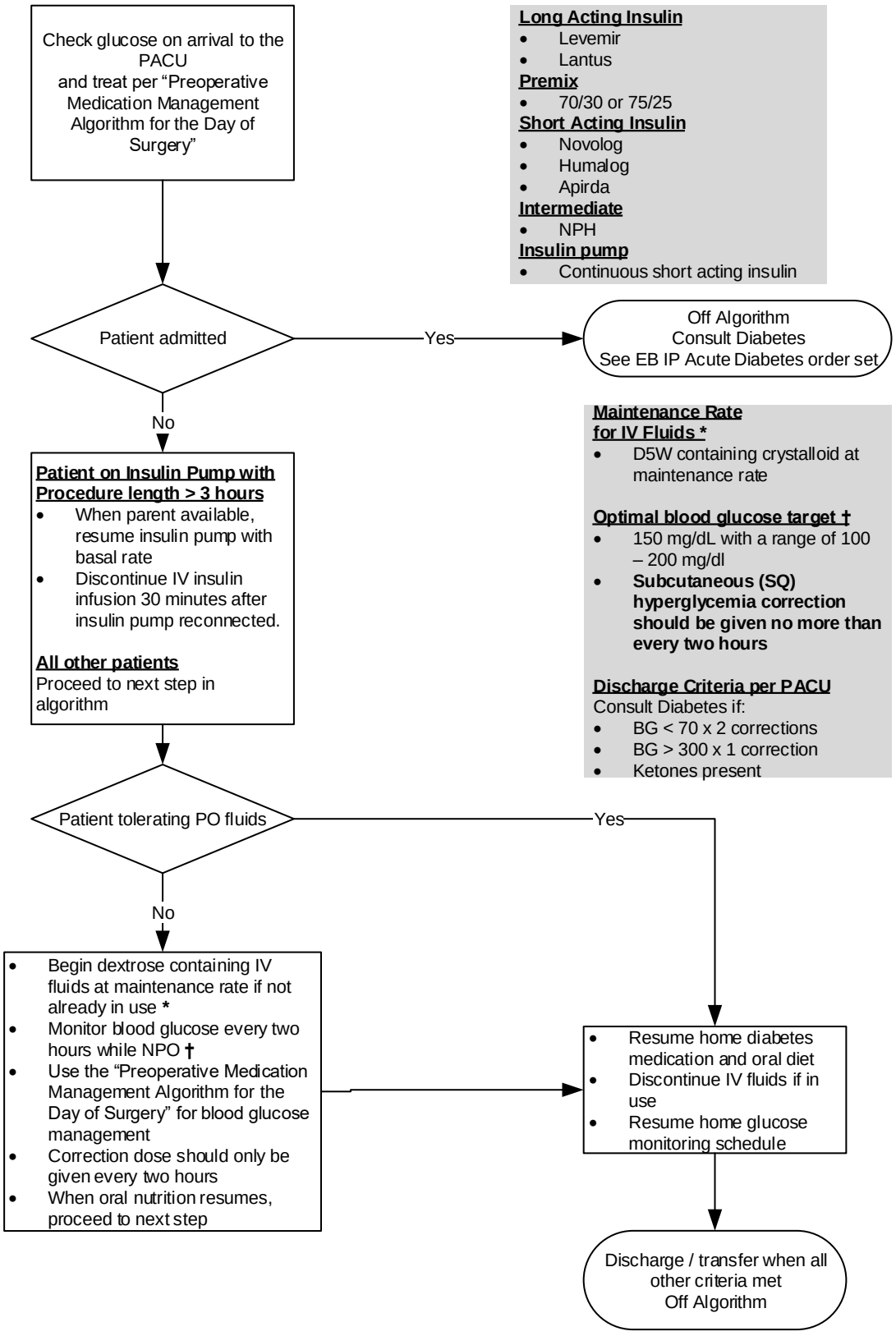
Diabetes and Perioperative Management
Intraoperative Algorithm for Procedure Length greater than 3 hours



Diabetes and Perioperative Management
Intraoperative Algorithm for Procedure Length less than 3 hours



Diabetes and Perioperative Management
Postoperative Algorithm



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Clinical Standards Preparation

This clinical standard was prepared by the Evidence-Based Outcomes Center (EBOC) team in collaboration with content experts at Texas Children's Hospital. Development of this clinical standard supports the TCH Quality and Patient Safety Program initiative to promote clinical standards and outcomes that build a culture of quality and safety within the organization.

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EBOC Team

No relevant financial or intellectual conflicts to report.

Development Process

This clinical standard was developed using the process outlined in the EBOC Manual. The literature appraisal documents the following steps:

1. Review Preparation
   - PICO questions established
   - Evidence search confirmed with content experts

2. Review of Existing External Guidelines
   - ISPAD Clinical Practice Consensus Guidelines, Joslin Diabetes Center and Joslin Clinic, Children's Hospital Boston

3. Literature Review of Relevant Evidence
   - Searched: PubMed, CINAHL, Cochrane, Medline

4. Critically Analyze the Evidence
   - 1 meta-analysis and 12 observational studies

5. Summarize the Evidence
   - Materials used in the development of the clinical standard, literature appraisal, and any order sets are maintained in a Diabetes and Perioperative Management evidence-based review manual within EBOC.

Evaluating the Quality of the Evidence

Published clinical guidelines were evaluated for this review using the **AGREE II** criteria. The summary of these guidelines are included in the literature appraisal. AGREE II criteria evaluate Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence using a 4-point Likert scale. The higher the score, the more comprehensive the guideline.
This clinical standard specifically summarizes the evidence *in support of* or *against* specific interventions and identifies where evidence is *lacking/inconclusive*. The following categories describe how research findings provide support for treatment interventions.
"Evidence Supports" provides evidence to support an intervention
"Evidence Against" provides evidence against an intervention.
"Evidence Lacking/Inconclusive" indicates there is insufficient evidence to support or refute an intervention and no conclusion can be drawn *from the evidence.*
The **GRADE** criteria were utilized to evaluate the body of evidence used to make practice recommendations. The table below defines how the quality of the evidence is rated and how a strong versus weak recommendation is established. The literature appraisal reflects the critical points of evidence.

Recommendation	
STRONG	Desirable effects clearly outweigh undesirable effects or vice versa
WEAK	Desirable effects closely balanced with undesirable effects
Quality	**Type of Evidence**
High	Consistent evidence from well-performed RCTs or exceptionally strong evidence from unbiased observational studies
Moderate	Evidence from RCTs with important limitations (e.g., inconsistent results, methodological flaws, indirect evidence, or imprecise results) or unusually strong evidence from unbiased observational studies
Low	Evidence for at least 1 critical outcome from observational studies, RCTs with serious flaws or indirect evidence
Very Low	Evidence for at least 1 critical outcome from unsystematic clinical observations or very indirect evidence

Recommendations

Practice recommendations were directed by the existing evidence and consensus amongst the content experts. Patient and family preferences were included when possible. The Content Expert Team and EBOC team remain aware of the controversies in the perioperative management of children with diabetes. When evidence is lacking, options in care are provided in the clinical standard and the accompanying order sets (if applicable).

Approval Process

Clinical standards are reviewed and approved by hospital committees as deemed appropriate for its intended use. Clinical standards are reviewed as necessary within EBOC at Texas Children's Hospital. Content Expert Teams are involved with every review and update.

Disclaimer

Practice recommendations are based upon the evidence available at the time the clinical standard was developed. Clinical standards (guidelines, summaries, or pathways) do not set out the standard of care and are not intended to be used to dictate a course of care. Each physician/practitioner should use his or her independent judgment in the management of any specific patient and is responsible, in consultation with the patient and/or the patient's family, to make the ultimate judgment regarding care.

Permission of Use

Version History

Date	Comments
Jan 2015	Originally completed
Jan 2020	Reaffirmed