### Table 1. Perioperative / Periprocedure Management of Hyperglycemia and Hypoglycemia

<table>
<thead>
<tr>
<th>BG* Levels</th>
<th>Initial BG Check</th>
<th>Ongoing Management</th>
</tr>
</thead>
</table>
| BG < 45 mg/dl | • Confirm most recent diabetes medication / insulin dose and time taken.  
                • Insert IV of 0.9% normal saline.  
                • Give 50 ml (1 amp) D50.  
                • Notify Anesthesia.  
| | • Re-check every 15 min and treat accordingly until BG is ≥ 80 mg/dl.  
                • Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. |
| BG 45-59 mg/dl | • Confirm most recent diabetes medication / insulin dose and time taken.  
                • Insert IV of 0.9% normal saline.  
                • Give 25 ml (½ amp) D50 (12.5 g).  
                • Notify Anesthesia.  
| | • Re-check every 15 min and treat accordingly until BG is ≥ 80 mg/dl.  
                • Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. |
| BG 60-79 mg/dl | • Confirm most recent diabetes medication / insulin dose and time taken.  
                • Insert IV of 0.9% normal saline.  
                • Give 15 ml D50 (7.5 g).  
                • Notify Anesthesia.  
| | • Re-check every 15 min and treat accordingly until BG is ≥ 80 mg/dl.  
                • Once BG > 80 mg/dl, re-check in 30 min and resume hourly glucose monitoring and management according to glucose values on this table. |
| BG 80-139 mg/dl | • Confirm most recent diabetes medication / insulin dose and time taken.  
                • Monitor.  
| | • Re-check in 1 hour. |
| BG 140-180 mg/dl GOAL | • Confirm most recent diabetes medication / insulin dose and time taken.  
                • Monitor.  
| | • Re-check in 1 hour. |
| BG > 180 mg/dl | • If anticipated procedure time > 3 hrs., consider insulin drip**.  
                • If anticipated procedure time < 3 hrs., confirm most recent diabetes medication / insulin dose and time taken.  
                • If diabetes medication / insulin dose taken within last 2 hrs., monitor patient, re-check BG in 1 hr.  
                • If no diabetes medication / insulin dose given for > 2 hrs., order and give lispro or aspart SQ based on the chart below.  
| | • Re-check BG in 1 hr.  
                • If 2 doses given in previous 5 hrs. and BG > 200 mg/dl, start IV insulin drip.  
                • DO NOT re-dose supplemental insulin more frequently than Q2H. |

* **Blood Glucose**
  - 180-200
  - 201-250
  - 251-300
  - 301-349
  - > 350

* **Dose of Lispro Insulin**
  - Type 1 DM or Insulin-Naïve Patients
  - Type 2 DM Patients

<table>
<thead>
<tr>
<th>Blood Glucose</th>
<th>Type 1 DM or Insulin-Naïve Patients</th>
<th>Type 2 DM Patients</th>
</tr>
</thead>
<tbody>
<tr>
<td>180-200</td>
<td>1 unit</td>
<td>2 units</td>
</tr>
<tr>
<td>201-250</td>
<td>2 units</td>
<td>4 units</td>
</tr>
<tr>
<td>251-300</td>
<td>3 units</td>
<td>6 units</td>
</tr>
<tr>
<td>301-349</td>
<td>4 units</td>
<td>8 units</td>
</tr>
<tr>
<td>&gt; 350</td>
<td>If BG &gt;350 mg/dl, notify Anesthesia and surgeon. Consider delaying case. Start IV insulin drip**</td>
<td></td>
</tr>
</tbody>
</table>

* BG = blood glucose

**Start insulin drip according to hospital guidelines. See OSUWMC Continuous Subcutaneous Insulin Infusion (CSII) Pumps and Continuous Glucose Monitors (CGM) guideline.
Preoperative/Preprocedure Phase

General Considerations

- Prior to Scheduling Procedure / Surgery
  - Morning procedures are preferred.
  - Check HbA1C (i.e., for intermediate / high-risk surgery) if patient is known or suspected to have diabetes, and if not available within the last 30 days.
  - If poor glycemic control (HbA1C > 9%):
    - Patient to contact referring physician for medication adjustment.
    - Consider postponing non-emergent surgery/procedure until medication adjustments are made.

- Hypoglycemia Assessment
  - Frequency, severity, hypoglycemia unawareness, or fasting hypoglycemia.
  - History of renal or liver disease.

Preoperative/Preprocedure Diabetes Medication Adjustment

- Note: This guideline is intended for use in patients whose glucose is well controlled.
- Adjust medications based on:
  - Diabetes type
  - Glycemic control
  - Duration of procedure
  - Time of day
- When appropriate, provide patient with medication management handout.

Oral Medications

- Metformin: Instruct patients to hold all metformin-containing products the day of surgery.
- Hold all other oral or non-insulin injectable diabetes medications the morning of the procedure.

Insulin

- Rapidly Acting Insulin (lispro, aspart, glulisine)
  - Hold the morning of procedure unless patient uses correction dosing in the fasting state.

- Short-Acting Insulin (Regular)
  - Hold the morning of procedure unless patient uses correction dosing in the fasting state.

- Basal Insulin (NPH, glargine, detemir)
  - Patients with type 1 and type 2 diabetes may require dose reduction prior to surgery.
  - The dose reduction depends upon glucose control prior to surgery and the total daily insulin dose (basal + prandial) before surgery (approximately 50% or less of the total daily dose is truly basal insulin).
  - Do not withhold basal insulin in patients with type 1 diabetes.

- Regular Insulin (U500)
  - Instructions per the patient’s endocrinologist.
  - See Regular Insulin U-500 Policy by OSUWMC Pharmacy.

NPH and Lente

- For a.m. procedure, reduce evening dose by 20% and morning-of dose by 50%.
- For p.m. procedure, reduce morning-of dose by 50%.

Glargine (U100, U300), Detemir, Degludec (U100, U200)

- For once-a-day basal insulin, reduce the morning-of or the evening-before dose by 20-50%.
- Patients with type 2 diabetes will need larger dose reductions (50%), particularly if basal insulin accounts for more than 50% of the total daily insulin dose.
- Patients with type 1 diabetes typically only need to reduce the dose by ≤ 20%.

Split-Mixed Insulin (70/30, 75/25, 50/50)

- Reduce evening dose prior to procedure by 20%, and reduce morning-of dose by 50%.

Pump Basal Insulin

- Consider 20% reduction to basal rates to begin at midnight prior to procedure.

Table 2. Preparation and Pharmacokinetics of Insulin

<table>
<thead>
<tr>
<th>Preparation</th>
<th>Action Onset</th>
<th>Peak</th>
<th>Action Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bolus Insulin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regular q.a.c.</td>
<td>30 min.</td>
<td>2-4 hr.</td>
<td>6-10 hr.</td>
</tr>
<tr>
<td>Aspart q.a.c.</td>
<td>5-15 min.</td>
<td>1-2 hr.</td>
<td>4-6 hr.</td>
</tr>
<tr>
<td>Glulisine q.a.c.</td>
<td>5-15 min.</td>
<td>1-2 hr.</td>
<td>4-6 hr.</td>
</tr>
<tr>
<td>Lispro q.a.c.</td>
<td>5-15 min.</td>
<td>1-2 hr.</td>
<td>4-6 hr.</td>
</tr>
<tr>
<td>Basal Insulin</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NPH daily or bid</td>
<td>1-2 hr.</td>
<td>4-8 hr.</td>
<td>10-20 hr.</td>
</tr>
<tr>
<td>Detemir daily or bid</td>
<td>3-4 hr.</td>
<td>Nearly flat</td>
<td>Approx. 24 hr.</td>
</tr>
<tr>
<td>Glargine daily</td>
<td>3-4 hr.</td>
<td>Nearly flat</td>
<td>Approx. 24 hr.</td>
</tr>
<tr>
<td>Glargine U300</td>
<td>6 hr.</td>
<td>Nearly flat</td>
<td>24-30 hr.</td>
</tr>
<tr>
<td>Degludec U100/U200</td>
<td>1 hr.</td>
<td>Nearly flat</td>
<td>24-30 hr.</td>
</tr>
</tbody>
</table>

| Other |              |      |                 |
| 70/30, 75/25, 50/50 bid | 5-15 min. | 1-2 hr. | 10-20 hr. |

Intraoperative/Intraprocedure Phase

Glucose Target

- Intraoperative / intraprocedure target:
  - 140-180 mg/dl.
- Refer to Table 1.
Glucose Monitoring
• Patients with diabetes:
  o Check blood glucose upon arrival to the ASU/Preoperative/Preprocedure holding area.
  o Blood glucose checks should be performed hourly while in ASU/Preoperative/Preprocedure area, and intraoperatively.
    ▪ For patients undergoing monitored anesthesia care, frequency of monitoring will be determined by the attending anesthesiologist. However, if preoperative BG <70, glucose should be monitored hourly.
  o If blood glucose if out of acceptable range, follow Table 1 regarding hypoglycemic/ hyperglycemic management.

• Patients without known diabetes:
  o Consider checking if:
    ▪ Body mass index ≥ 27 kg/m².
    ▪ First-degree relative with diabetes.
    ▪ High-risk ethnic population (African American, Hispanic, Native American, Asian).
    ▪ Delivered a baby weighing > 9 lb or gestational diabetes.
    ▪ Hypertension.
    ▪ HDL cholesterol ≤ 35 mg/dl and/or triglycerides 250 mg/dl.
    ▪ If blood glucose is >180 mg/dl, follow the recommendations for monitoring in patients with diabetes.

Continuous Subcutaneous Insulin Pump (CSII)
• CSIs may be continued for procedures lasting < 3 hours, at discretion of person performing procedure.
• Reduce basal rates by 20%, starting at midnight.
  o Basal adjustments should be discussed with pump prescriber prior to procedure.
• If CSII discontinued for more than 1 hour, coverage with supplemental insulin MUST be provided.
• If CSII will be discontinued for > 3 hours, start IV insulin infusion per Continuous Subcutaneous Insulin Infusion (CSII) Pumps and Continuous Glucose Monitors (CGM) Policy.
• The catheter should be in a site that will not interfere with the surgical field.

IV Insulin Infusion– Indications
• Procedures > 3 hours.
• Poor glycemic control:
  o HbA1C > 9%.
  o BG > 300 mg/dl.
  o BG > 200 mg/dl refractory to supplemental insulin.

Postoperative/Postprocedure Phase
• Check blood glucose immediately upon arrival to PACU/Postprocedure holding area and hourly thereafter while blood glucose within the acceptable range.
• If blood glucose is not within the acceptable range, follow Table 1 on page 1 for blood glucose correction.
• If patient is to be discharged to home, check blood glucose readings prior to leaving the hospital.
• If patient arrives to the PACU on insulin drip and will be admitted to the floor service, continue the insulin drip when discharged to the floor (following guidelines for insulin infusion):
  o Type 1 DM and DKA.
  o Type 2 DM.
  o DM in Pregnancy.
  o DM in Non-Pregnant Adults.

Outpatient Procedures
Oral Medication
• Diabetes medications may be resumed once the patient is eating.
• Metformin: If there are no contraindications and renal function is normal, resume medications containing metformin 2 days after any IV contrast dye load.
  o If no contrast dye is used perioperatively, medications containing metformin may be resumed without delay.
  o Please see FDA statement on use of metformin in patients with reduced kidney function.
• If glycemic control has been suboptimal, close follow-up with primary physician is recommended for healing and prevention of infection.

Insulin
• Resume intermediate-acting or long-acting insulin as previously scheduled.
• May need additional units of rapidly acting or short-acting insulin between completion of procedure and next regularly scheduled insulin.
  o Consider using sliding scale.
• For insulin pumps, resume usual basal rates and bolusing schedule once able to eat/drink.
• Check blood glucose frequently during the first 24 hours post-procedure or same-day surgery.

Inpatient Procedures
Glucose Targets
• Target for hospitalized patients is 140-180 mg/dl.
• For special populations such as post-operative cardiothoracic and neurosurgical patients, targets may be lower as determined by the managing medical team.
Glucose Monitoring

- Hourly for IV insulin infusion.
- **ICU patients:**
  - On admission.
  - Then Q1h X 4.
  - Then Q3-4h.
- **Non-ICU patients:**
  - Q6h for NPO patients.
  - Before meals if eating and at bedtime.
  - More frequently if recent hypoglycemia (within 24 hours).

Inpatient Medication Adjustments

**Insulin**

- Continue insulin infusion for 24 to 48 hours or until off inotropic agents / extubated.
- Basal long-acting insulin is required following discontinuation of insulin drip if the patient has type 1 diabetes or requires > 1 unit of insulin/hr.
  - Basal long-acting insulin should be initiated at least 2 hours prior to discontinuation of the insulin drip.
- Avoid sliding scale insulin regular monotherapy in most patients unless they:
  - Are NPO.
  - Are well-controlled.
  - Do not require basal insulin prior to surgery.

**Other Medications**

- Patients may resume home diabetes medications at discharge provided they are eating, stable, and close to discharge.
  - Patients should not resume home diabetes medications at discharge if glycemic control has been suboptimal or other contraindications exist.

To Speak to a Diabetes Specialist

- Pager # 7592, # 5234 for OSUWMC, 8 a.m.-5 p.m.
- Pager # 1821, # 2516 for OSU East, 8 a.m.-5 p.m.
- WebXchange for Attending on Diabetes Consults, 5 p.m.-8 a.m.

References

- Glucophage prescribing instructions

Quality Measures

- Patients with a current HbA1c (within 30 days).
- Accu-Checks performed before and after surgery as well as approximately hourly if case > 1 hour.
  - Monitored anesthesia care cases will be excluded.
- Procedures with two or more glucose measures > 250 mg/dl.

Guideline Authors

- Kathleen Dungan, MD
- Claire Murphy, PharmD
- Sheila Mapes, CNP
- Lindsey Karnes, CNP
- Sheila Chucta, CNS
- Kathleen Wyne, MD
- Elizabeth Buschur, MD
- Erica Stein, MD

Guideline Approved


Disclaimer: Clinical practice guidelines and algorithms at The Ohio State University Wexner Medical Center (OSUWMC) are standards that are intended to provide general guidance to clinicians. Patient choice and clinician judgment must remain central to the selection of diagnostic tests and therapy. OSUWMC’s guidelines and algorithms are reviewed periodically for consistency with new evidence; however, new developments may not be represented.

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