Background

Patient optimization before, during and after surgery improves outcomes and reduces length of stay and readmissions.ⁱ Modifiable attributes of patient health status such as anemia or blood sugar control can have negative consequences for recovery after surgery. Preoperatively anemic individuals have higher costs generally due to increased length of stayⁱⁱ and even mild preoperative anemia is associated with an increase in 30-day morbidityⁱⁱⁱ lower quality of recovery and higher adjusted risk of death and disability.^{iv} Some studies suggest poor A1c control preoperatively increases morbidity and mortality,^v but perioperative glucose is a stronger predictor of 30-day mortality.^{vi} Enhanced Recovery After Surgery (ERAS) protocols improve length of stay and reduce total cost of care, complications, and readmissions.^{vii} However, Washington State has variation for A1c optimization before surgery, perioperative glycemic control protocols, and perioperative anemia control.

Black patients are three to four times more likely to experience anemia perioperatively; Black, Hispanic, American Indian/Alaska Native patients more likely to experience uncontrolled diabetes/serum glucose, leading to inequitable outcomes.

Narrative Evidence Review

Glucose control intraoperatively is linked to complications such as surgical site infection, systemic infection, increased hospital length of stay, morbidity and mortality.^{viii} Screening for diabetes as a risk factor for surgery is a common, as it's known that increased HbA1c (most studies have cut off point of >8%) increases risk for infection and other complications postoperatively.^{ix} However, patients without diabetes also commonly experience hyperglycemia^x, and often experience worse outcomes than patients with diabetes, across a wide variety of surgery types.^{xi} Patients without diabetes are less likely to receive insulin perioperatively,^{xii} but a study of Washington State surgical patients showed that insulin administration is associated with lowered risk for postoperative complications like infection, re-operative interventions, interventions, and mortality. ^{xiii}

While the exact best target glucose level is unknown perioperatively, most guidelines set a range between 100-110 mg/dL and around 180 mg/dL.^{xiv} For patients with diabetes, intensive glucose control (<120mg/dL versus <160mg/dL) does not reduce infections, length of stay or all-cause mortality – however it is linked to increased hypoglycemic incidents.^{xv}

Supplemental Table 3 Hyperglycemia management in the perioperative patient

V	AACE	ACP	ADA	DC	ES	IDF	JBDS	SHM
Blood glucose goal (mg/dL)	110-140	80-180	100-180	100-200* CV surgery 90- 180* minor/moderate surgery W infusion CV	100-180 e	<140 pre- prandial <180 random	108-180*^	100-150 CV surgery 100- 180 other procedures
Treatment	-	-	Prandial as needed	surgery, basal and prandial insulin minor/moderate surgery	No carbohydrate oral fluids pre- eop	IV insulin as needed	VRIII if miss > 1 meal, miss 1 meal adjust normal meds	Basal insulin, no prandial
Capillary Blood Glucose Monitoring Frequency	4-6 h	-	2-4 h	-	-	-	Hourly during procedures	1-2 h

Note: The Australian Diabetes Society (ADS) and Joslin Diabetes Center (JDC) guidelines are omitted from this table as hyperglycemia management in the perioperative period was not discussed in these guidelines.

Abbreviations: CV, cardiovascular; IV, intravenous; VRIII, variable rate intravenous insulin infusion.

AACE = American Association of Clinical Endocrinology; ACP = American College of Physicians; ADA = American Diabetes Association; DC = Diabetes Canada; ES = Endocrine Society; IDF = International Diabetes Foundation; JBDS = Joint British Diabetes Society for Inpatient Care Group; SHM = Society of Hospital Medicine. "-" indicates topic not mentioned in guideline

https://diabetesjournals.org/care/article/48/4/655/157984/Management-of-Diabetes-and-Hyperglycemia-in-the

Primary Care

Preoperative

- When referring patient for elective procedures, as part of preoperative evaluation evaluate glycemic control for: (AAFP)
 - Patients with prediabetes or diabetes
 - Patients without diabetes but with risk factors such as:
 - >/= 45 years old
 - >/= BMI 30 kg/m2
 - Familial history of diabetes
 - Past medical history of gestational diabetes
- A preoperative risk assessment should be performed for people with diabetes who are at high risk for ischemic heart disease and those with autonomic neuropathy or renal failure. (<u>ADA 2025</u>)
 - Discuss and determine goals of medical optimization of glycemic control and anemia before surgery with patient and/or support system.
 - Decide together what thresholds would indicate a potential need to postpone referral for elective procedure.
 - For patients with diabetes, discuss setting a HbA1c goal for surgery in the preoperative period. Consider guidelines of 8% or lower, but any lowering in A1c

in the preoperative period can reduce risk of infection and other postoperative outcomes.

- If not previously done, consider prescribing continuous glucose monitor for patients with type 1 diabetes or with type 2 diabetes per most updated guidelines.
- If a patient has diabetes, consider referring to a certified diabetes education specialist and/or registered dietician/nutritionist for support with optimization. Consider referral to diabetes prevention program as applicable.
- Communicate glycemic control status and optimization plan to surgery team in referral/handoff. Plans should include:
 - Medication initiation or adjustment points for patients with HbA1c >8%
 - Follow up plan to re-check blood sugar before procedure and threshold by which to consider inpatient admission
- Identify patients for whom there is a high risk of infection^{xvi} such as advanced age, higher BMI, patients with substance use disorders and/or comorbidities.
 - Consider checking a fasting blood glucose/random blood glucose as soon as possible preoperatively to evaluate glycemic control

Postoperative

• Consider post-op day 1 follow-up appointments for patients with uncontrolled hyperglycemia undergoing ambulatory procedures.

Surgical Team

Preoperative

- At intake, identify patients with risk for intraoperative hyperglycemia including:
 - Patients with prediabetes or diabetes
 - Patients without diabetes but with risk factors such as:
 - >/= 45 years old
 - >/= BMI 30 kg/m2
 - Familial history of diabetes
 - Past medical history of gestational diabetes
- If undergoing intermediate or high-risk procedure, review latest HbA1c or order if not done within 3 months prior to surgery
- Refer to PCP/endocrinologist for support in preoperative optimization of glycemic control if HbA1c >5.7%.
 - For patients with diabetes, set a HbA1c goal any reduction in HbA1c before surgery will lower surgical risk.
- Document plan for glycemic control optimization, and communicate plan with primary care/endocrinology/other appropriate medical teams to assist in optimization.
 - If planned to have outpatient procedure and A1c >8 %, either admit for inpatient procedure or consider next day/daily clinic f/u scheduled
 - For patients with an elevated HbA1c (>5.7%), consider the following recommendations for preoperative planning:

	Surgical Risk Score					
		1	2	3	4	5
Patient	1 -			Make a	Make a	Make a
Risk Score	prediabete			plan for	plan for	plan for
	s (5.7% -			perioperati	perioperati	perioperati
	6.4%)			ve	ve	ve
				glycemic	glycemic	glycemic
				control and	control and	control and
				close	close	close
				follow up	follow up	follow up,
						consider
	2			Make a	Make a	Make a
	controlled			plan for	plan for	plan for
	diabetes			perioperati	perioperati	perioperati
	(6.5 – 7%)			ve	ve	ve

			glycemic control and close follow up, consider inpatient stay	glycemic control and close follow up	glycemic control and close follow up
3 uncontrolle d diabetes (HbA1c >7%)	Make a plan for perioperati ve glycemic control and close follow up	Make a plan for perioperati ve glycemic control and close follow up	Make a plan for perioperati ve glycemic control and close follow up, require inpatient admission	Make a plan for perioperati ve glycemic control and close follow up,	Consider delaying; Proceed only if procedure is urgent/em ergent

- Medication management for patients with diabetes before surgery.
 - Stop SGLT2 inhibitors 3-4 days before surgery per American Diabetes Association Standards
 - Hold other oral diabetes medications the morning of surgery (metformin, sulfonylureas, meglitinides, thiazolidinediones,
 - Consider holding DPP-4 inhibitors for potential to alter gastrointestinal motility.
 - Consider holding GLP-1 RAs and/or GLP-1/GIP RAs
- Prepare insulin transition plan for insulin-dependent patients with diabetes. Consider individual patient factors such as meals, activity, perioperative stress, potential use of glucocorticoids or other hyperglycemic inducing medications (<u>UpToDate</u>)
- for patients undergoing ambulatory procedures if the patient is expected to need intraoperative insulin therapy, prepare insulin transition plan
 - If a patient is unable to demonstrate good glycemic control or plan for good glycemic control, consider recommending admission for an inpatient stay.
- For patients undergoing inpatient procedures, ensure that there are day after/daily follow up plans
- If safe to do so, wait to schedule procedure until patient reaches their individualized threshold for glycemic control optimization

Day of Surgery

• Check a fasting blood sugar (FBG) within 4 hours of elective procedures for:

- o Patients with prediabetes or diabetes
- Patients without prediabetes or diabetes but with risk factors such as:
 - >/= 45 years old
 - >/= BMI 30 kg/m2
 - Familial history of diabetes
 - Past medical history of gestational diabetes
- Patients with ASA Score 2+
- Patients with surgical risk score 3+ (intermediate-very high risk)
- If fasting blood glucose is >100 mg/dL or random BG > 200mg/dL, reflexively test a HbA1c.
- Review the blood glucose management plan with the surgical team prior to procedure start.
- Do not proceed with procedure if patient has signs or symptoms of DHA/HHNS
- Intraoperatively
 - Check a blood glucose within 60 minutes of procedure start time for
 - Administer insulin per facility protocol for elevated blood sugar, regardless of diabetes status (e.g., blood glucose reading >180mg/dL)^{xvii}

	Type 2 treated with	Type 2 with oral or	Type 1 or insulin
V	diet	noninsulin injectable	treated Type 2
		meds	
Short	Check BG preop and	Monitor every 2 hours –	Generally, can continue
surger	postop	subq short or rapid	with subq insulin
у		acting insulin	
Long	Chack BD avany 1-2	Monitor overy 2 hours -	IV infusion often
LONG	Check BF every 1-2		
surger	nours intraop – give	subd short or rapid	required for
У	subq short or rapid	acting insulin	long/complex
	acting		procedures

• For patients with diabetes, consider the following xviii

- For patients with continuous glucose monitoring on during procedure, corroborate CGM readings by checking capillary blood glucose.
- For emergency surgery
 - In the critically ill, hyper- and hypoglycemia are both associated with poor clinical outcomes
 - Optimal blood glucose target is less restrictive (140-180mg/dL) rather than intensive (80-110mg/dL)

- Carefully monitor blood glucose, (e.g., every 60 minutes for patients on intravenous insulin)
- Consider using intermittent subcutaneous sliding scale insulin for BG >180mg/dL consistently and transitioning to IV insulin infusion if it continues to be uncontrolled. (<u>UpToDate</u>)

Postoperative

- For patients with intraoperative hyperglycemia:
 - Check a blood glucose within 60 minutes of last insulin dose, and continue to monitor blood glucose every 1-2 hours.
 - If an insulin infusion has been started, continue it postoperatively in patients until they resume eating. Then transition to subcutaneous insulin. Reinstate preoperative diabetes treatments once the patient is eating, unless otherwise contraindicated (<u>UpToDate</u>)
 - Ensure orders for insulin are placed when transferred to recovery units and/or other units if remaining inpatient.
- Communicate new hyperglycemia to patients' primary care provider. If the patient does not have a regular primary care provider or medical home, provide referral to establish care.
 - If patient needed insulin for new hyperglycemia in the perioperative period (day of surgery, immediately postop) consider next day post-op appointment with surgical team to assess glucose control and adjust treatment
- For emergency surgery
 - 0

Health Delivery Systems

- Protocolize hyperglycemia treatment for patients with and without diabetes in ambulatory, inpatient and critical care settings based on most updated guidelines.
 - Include recommendations for clinicians:
 - Who to screen with a random/fasting blood sugar and/or HbA1c preoperatively
 - Who to screen day of surgery by taking a fasting blood glucose
 - Intraoperative target glycemic control ranges based on surgery risk stratification and patient condition (e.g., critically ill often require less restrictive glycemic targets)
 - Postoperative workflow for patients who receive insulin intraoperatively
 - Standardized discharge recommendations for patients with new intraoperative hyperglycemia or diabetes

• Ensure equipment is available perioperatively to check a capillary blood glucose at least every 60 minutes for patients undergoing intermediate-high risk surgery

Health Plans

- Preoperative
 - Review prior authorization protocols to ensure streamlined access to CGM coverage preoperatively for patients with diabetes who meet eligibility criteria??
 - Incorporate treatment for hyperglycemia as eligibility criteria for inpatient admission for intermediate risk procedures performed in an ambulatory setting (BMCC criteria?)
 - Incentivize surgical teams to optimize HbA1c for patients with diabetes before surgery, such as through alternative payment mechanisms such as up- or downside risk payment adjustments
 - Provide care coordination support for patients with diabetes, including assistance specifically with arranging postoperative follow up appointments
- Day of Surgery
 - For all intermediate-high risk surgeries, require a blood glucose level be drawn for all patients on day of surgery
 - Provide coverage for insulin therapy regardless of diabetes diagnosis
- General
 - For members with prediabetes or diabetes, provide education on preoperative optimization

Employer

• Review benefit coverage for care coordination support for employees with diabetes

Ambulatory Surgery	Inpatient Surgery		
 Colon Procedures/Bowel Resection Spinal Laminectomy (any level(s)) Spinal Fusion (any level(s)) Total Joint Implants (Hip and Knees) Hysterectomy (with any type of abdominal incision) Hernia Repair (any approach, with or without implant) Breast Procedures (includes reduction, mastectomy, with or without implants) Orthopedic procedures with implants (cadaver tissue, pins, plates, screws, bone grafting, etc.) ANY procedure with implantation of materials such as: cardiac devices, cochlear implants, plates, screws, pins, mesh, cadaveric tissue, bone grafting, and others. Does not include: Implantation of ocular lenses, hormonal implants, tracheostomies, gastric tubes, urinary stents or other drains. 	 Any urgent or emergency surgery Any procedure for which an inpatient stay is required Ambulatory procedures in this list that are performed during an inpatient stay 		

Table X. Procedures for which it is recommended to evaluate glycemic control

UCLA Risk Stratification Before Elective Surgery

Surgical Risk Score Surgery Types	
1- Very low risk	Procedures that usually require only minimal or moderate sedation
	and have few physiologic effects
	 Eye surgery that can be performed under Monitored
	Anesthesia Care
	 Simple GI endoscopy (without stents)
	Dental procedures
2- Low risk	Procedures associated with minimal physiologic effect
	Hernia repair
	 ENT procedures without planned flap or neck dissection
	 Diagnostic cardiac catheterization
	 Interventional radiology
	 Interventional GI endoscopy

	Eve surgery that requires General Anesthesia		
	• Cystoscopy		
3- Intermediate	Procedures associated with moderate changes in hemodynamics, risk		
risk	of blood loss		
	 Intracranial and spine surgery 		
	 Gynecologic and urologic surgery 		
	 Intra-abdominal surgery without bowel resection 		
	 Intra-thoracic surgery without lung resection 		
	Cardiac catheterization procedures including electrophysiology		
	studies, ablations, AICD, pacemaker		
4- High risk	Procedures with possible significant effect on hemodynamics, blood		
	loss		
	 Colorectal surgery with bowel resection 		
	Kidney transplant		
	 Major joint replacement (shoulder, knee, and hip) 		
	 Open radical prostatectomy, cystectomy 		
	 Major oncologic general surgery or gynecologic surgery 		
	 Major oncologic head and neck surgery 		
	Spine deformity surgery		
5- Very high	Procedures with major impact on hemodynamics, fluid shifts, possible		
risk	major blood loss		
	Aortic surgery		
	Cardiac surgery		
	 Intra-thoracic procedures with lung resection 		
	 Major transplant surgery (heart, lung, liver) 		



Current State	Intermediate Steps	Ideal State	
Patients with diabetes are sometimes not identified prior to day of procedures, or are optimized but without good blood glucose control plans on day of surgery Patients without diabetes experience worse complications rates when they do experience intraoperative/postoperative hyperglycemia Patients with intraoperative hyperglycemia are not receiving close BG management in the days following surgery	 Delivery systems that perform surgeries should establish protocols to screen blood sugar and A1c in people with risk factors Delivery systems secure equipment (e.g., POC blood glucose monitors) for clinicians to execute BG optimization workflows Health plans should incorporate blood sugar management plans as an element of bundled payment models for intermediate and high-risk procedures When primary care is not previously established, surgery teams should take ownership over managing blood glucose immediately postoperatively 	 Patients have a medical home with a primary care provider that performs comprehensive preoperative evaluation before referring for elective surgery Preoperative, intraoperative and postoperative blood sugar management plans are made collaboratively with care teams and patients/family and documented in the medical record Surgical teams routinely check blood sugar perioperatively and manage with insulin/other treatment considering patients' PMH, current medications, and management plan Patients with new hyperglycemia perioperatively are established or closely followed by their PCP/medical home in the postoperative period 	

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