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Perioperative Diabetes Management

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Discussion Topics

- Glycemic Targets in Inpatient Settings
- Oral Agents & Non-Insulin Injectables for Type 2 Diabetes
- Perioperative Guidelines
- Diabetes Technology: To Wear or Not to Wear

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I **do not** have a financial interest in commercial products or services related to the subject of this lecture.

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A Quick Diabetes Review

- Type 1 vs. Type 2 Diabetes
- Multiple Defects of Type 2 Diabetes
- Glycemic Targets in Hospital and Home

Importance of Documenting Type of Diabetes in EHR

Type 1

- Autoimmune disease
- β-cell destruction
- Little or no insulin production
- Ketosis prone

Type 2

- Insulin resistance
- Insulin deficiency
- Gut Hormone GLP-1 RA and GIP deficiency & resistance
- ↑ weight, BP & LDL common

Treatment:

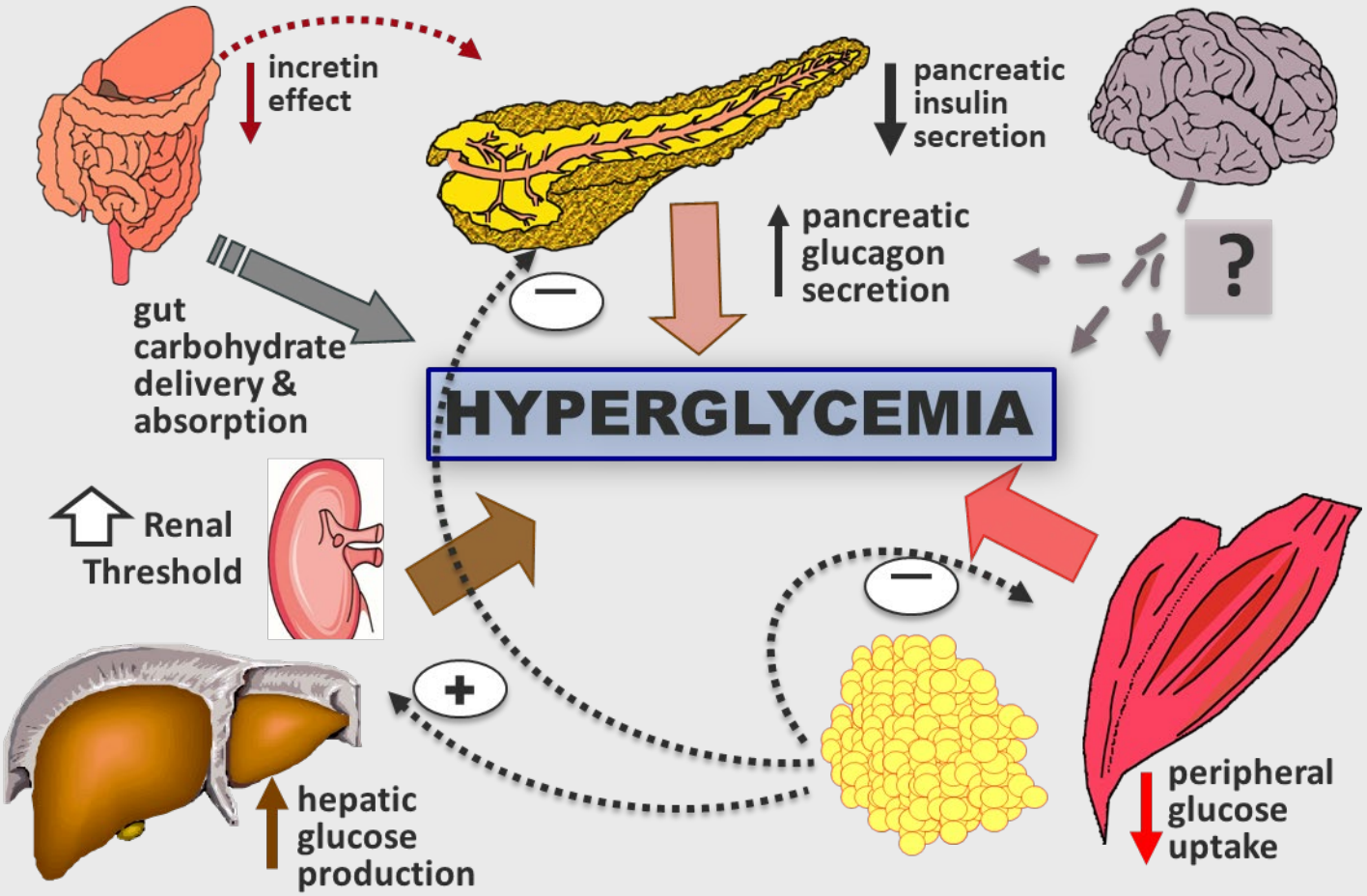
- *Lifestyle Changes*
- *Insulin Dependent*

Treatment:

- *Lifestyle Changes*
- Oral agents, GLP-1 RAs
- May *Require* insulin

American Diabetes Association. *Standards of Care in Diabetes-2022. Diabetes Care* December 2021 45 (Suppl 1):S1-264.

Multiple Defects of Type 2 Diabetes



Adapted from: Inzucchi SE, Sherwin RS in: *Cecil Medicine* 2011

NYP Inpatient Blood Glucose (BG) Targets and Hypoglycemia Categories

Location	BG Goals (mg/dL)
Non-ICU	
• Pre-Meal	100-140 if clinically *stable* **OR** 140-180 if clinically *unstable*
• Other times	140-180 for *most* patients
ICU	100-140 or 140-180 per IV protocols
HOME Pre-Meal HOME Post-Meals	80-130 80-180 1-2 hrs post meals
HYPOGLYCEMIA Categories	
Hypoglycemia Alert	BG <70 mg/dl
Clinically Significant Hypoglycemia	BG <54 mg/dl

1. American Diabetes Association. "16. Diabetes Care in the Hospital: Standards of Medical Care in Diabetes—2022." *Diabetes Care* 45 Supplement 1 (2022): S244-253...
2. Umpierrez, GE; Hellman, R; Korytkowski, M; Kosiborod, M; Maynard, G; Montori, VM, Seley, JJ; Van den Berghe, G. (2012). Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guideline. (2012). J *Clin Endocrinol Metab* 97: 16–38

Oral Agents & Non-Insulin Injectables for T2D

A review

Primary Oral Agents for Type 2 Diabetes

Insulin secretagogues

- Long-acting sulfonylureas

  glyburide, glipizide, glimepiride

- Short-acting meglitinide

  repaglinide

- Short-acting amino acid derivative

  nateglinide

Biguanides

- *metformin*

Primary Oral Agents for Type 2 Diabetes (Continued)

Thiazolidinediones

- *rosiglitazone, pioglitazone*

Alpha-Glucosidase inhibitors

- *acarbose, miglitol*

SGLT2 inhibitors

- *canagliflozin, dapagliflozin, empagliflozin, ertugliflozin*

DPP-4 inhibitors

- *alogliptin, linagliptin, saxagliptin, sitagliptin*

Oral GLP1-RA

Rybelsus® (*semaglutide*)

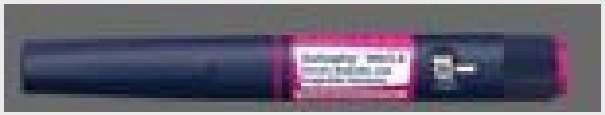
Mostly Injectable Agents for Diabetes

- **GLP-1 RA**: Byetta® (exenatide), Bydureon® (exenatide LAR), Victoza® (liraglutide), Trulicity® (dulaglutide), Adlyxin® (lixisenatide), Ozempic® (semaglutide)
- **GIP + GLP-1 RA:** Mounjaro® (tirzepatide)
- **Human Insulin**: Regular (short-acting), Isophane suspension (NPH : intermediate acting), Pre-Mix 70/30 isophane suspension
- **Basal Insulin**: Lantus® (glargine), Toujeo® (U300 glargine), Basaglar® (glargine), Semglee® (glargine), Levemir® (detemir), Tresiba® (U100/U200 degludec)
- **Rapid Acting**: Admelog® (lispro), Humalog® (U100/U200 lispro), Lyumjev® (lispro-aabc), Novolog® (aspart), Fiasp® (aspart), Apidra® (glulisine), Pre-Mix 70/30, 75/25, 50/50

Mostly Injectable Agents for Diabetes (Continued)

Combination GLP-1 RA & basal insulin

- Xultophy® (degludec & liraglutide), Soliqua® (glargine & lixisenatide)



Human Inhaled Insulin

- Afrezza®

Amylin

- Symlin® (pramlintide)

Sulfonylureas:

Glyburide (Micronase®, Diabeta®), Glipizide (Glucotrol®), Glimepiride (Amaryl®)

Mechanism	**↑ insulin secretion- *long-acting* (12-24 hrs)** - need *functioning* beta cells
Efficacy	↓ A1c 1-2%
Advantages	**No lag time** **Easy dosing** **$**
Disadvantages	**Hypos (especially glyburide)** **Weight gain** **Low durability**
Contraindications	**Caution if advanced renal/hepatic disease** Adjust dose in elderly Sulfa allergy

Short-acting Secretagogues:

Meglitinide: repaglinide (Prandin®),
Amino Acid Derivative: nateglinide (Starlix®)

Mechanism	**↑ insulin secretion- *fast-acting, short duration (onset < 10 min, peak ~ 42 min, T ½ 60 min)*** - need *functioning* beta cells **↓ PPG**
Efficacy	↓ A1c 1- 1.5%
Advantages	**Work quickly;** short half life **Can titrate** based on BG, carb content May take at end of meal for unreliable PO intake Safe at higher levels of Cr than SUs
Disadvantages	Hypos, weight gain (less than SUs) **Frequent dosing**
Contraindications	Caution if advanced renal/hepatic disease Adjust dose in elderly

Biguanides:

metformin (Glucophage®, Glumetza®, Fortamet®, Riomet®)

Mechanism	**↓ hepatic glucose production**
Efficacy	↓ A1c 1 - 2%
Advantages	↓ CV risk (UKPDS), ↓ IGT -> T2DM (DPP) **no hypos** **↓ appetite- possible weight loss** ↓ cancer risk **$ generic**
Disadvantages	**GI (nausea, diarrhea)** Lactic acidosis (very rare) B12 deficiency
Contraindications	**Impaired renal fx (eGFR <30)** excessive ETOH, CHF Hold 48 hrs post contrast studies Caution in elderly (>80 yo)

Thiazolidinediones:

pioglitazone (Actos®), rosiglitazone (Avandia®)

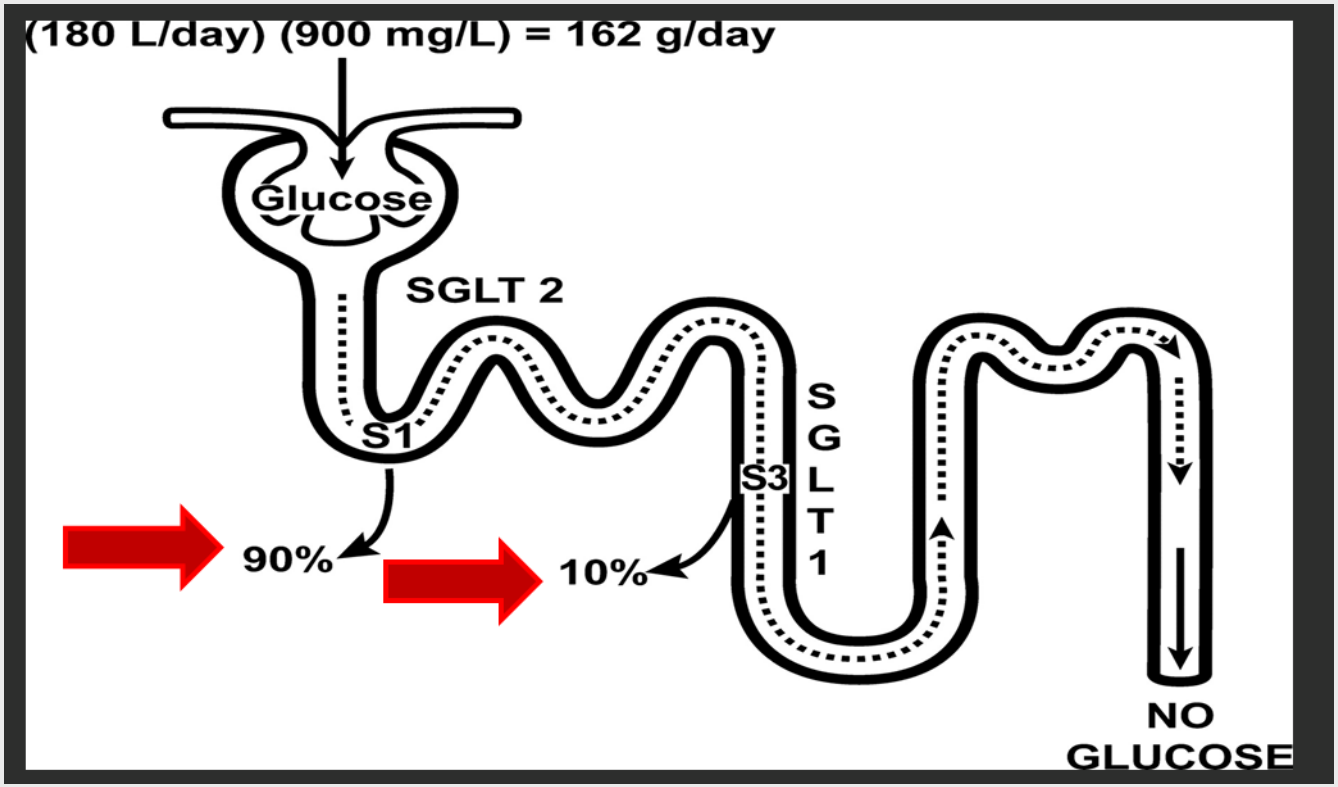
Mechanism	**↑ Insulin peripheral sensitivity in muscle and adipose tissue**
Efficacy	↓ A1c 0.8-1.0%
Advantages	**No hypos** **No renal excretion** Beneficial lipid effects; + vascular effects (pio) ↓ **insulin requirement**
Disadvantages	**Slow onset** **Weight gain** – increase in subQ fat **Fluid retention/edema**- esp w/ insulin Bladder CA risk- pio (?) Macular edema; fracture risk
Contraindications	**Black box -> may cause/exacerbate CHF**; contraindicated NYHA Class III or IV CHF

Alpha Glucosidase Inhibitors:

acarbose (Precose®), miglitol (Glyset®)

Mechanism	Delays CHO absorption in small intestine ↓ PPG
Efficacy	↓ A1c 0.5- 0.8%
Advantages	**no weight gain** **no hypos** **Non-systemic**- good CV safety
Disadvantages	**Flatulence, bloating, diarrhea** Frequent dosing- with meals **If used with insulin/secretagogue-> must treat hypos with glucose** Limited efficacy
Contraindications	Intestinal disorder Cirrhosis

Sodium-Glucose CoTransporter 2 (SGLT2)



Lowers renal threshold to increase urinary glucose excretion

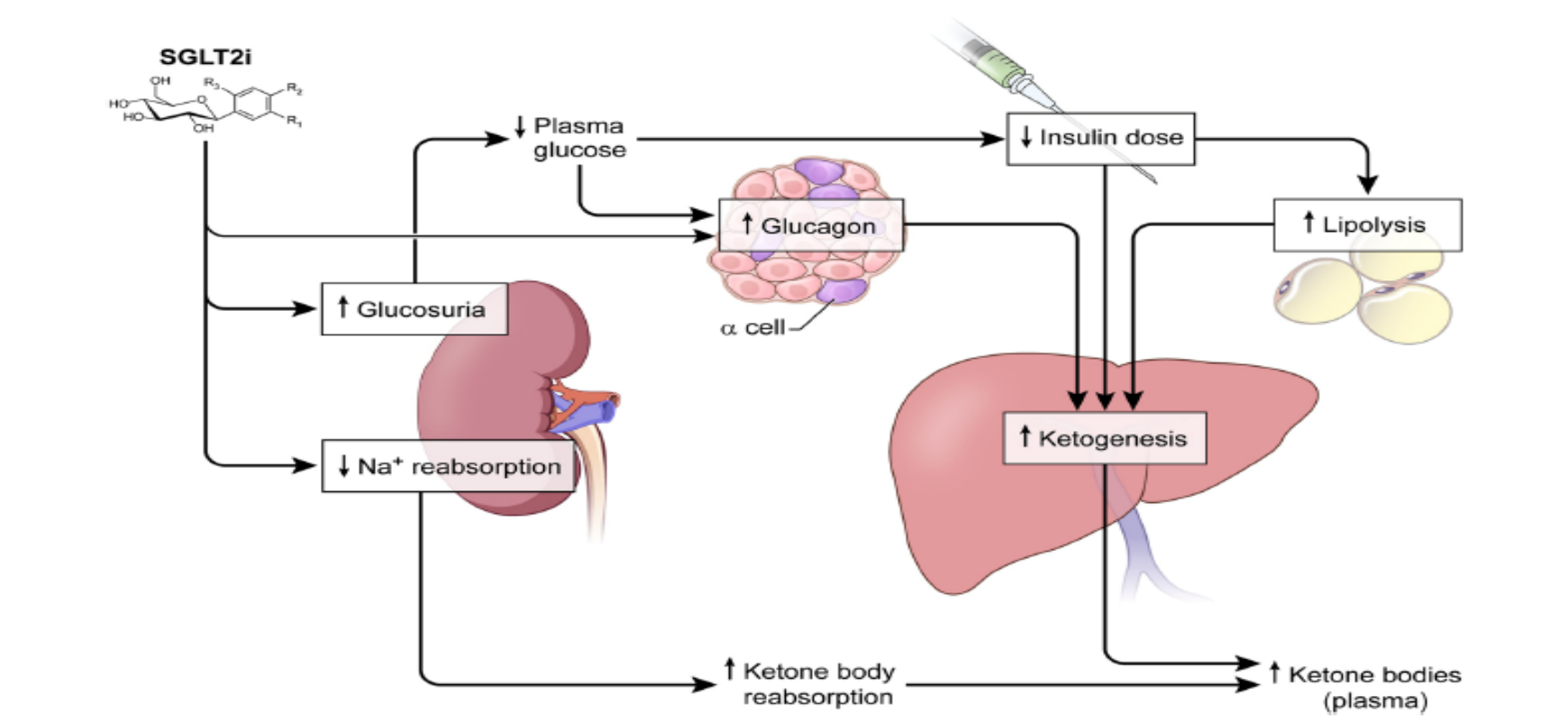
Abdul-Ghani M A et al. Endocrine Reviews 2011;32:515-531

SGLT2 Inhibitors:

CANAgliflozin (Invokana®), DAPAgliflozin (Farxiga®), EMPAgliflozin (Jardiance®), ERTUgliflozin (Steglatro®)

Mechanism	**Lowers renal threshold to increase urinary excretion of glucose**
Efficacy	↓ A1c 0.7-1 %
Advantages	**Oral, easy dosing** **Weight loss** **Possible BP lowering** **CV benefit** **Renal benefit**
Disadvantages	**UTI; genital mycotic infections** Hypotension; hyperkalemia Euglycemic DKA ? bladder CA (dapagliflozin) ? ↑ risk of lower extremity amputation (canagliflozin)
Contraindications	eGFR < 45 (dapagliflozin, ertugliflozin), eGFR < 30 (canagliflozin, empagliflozin)

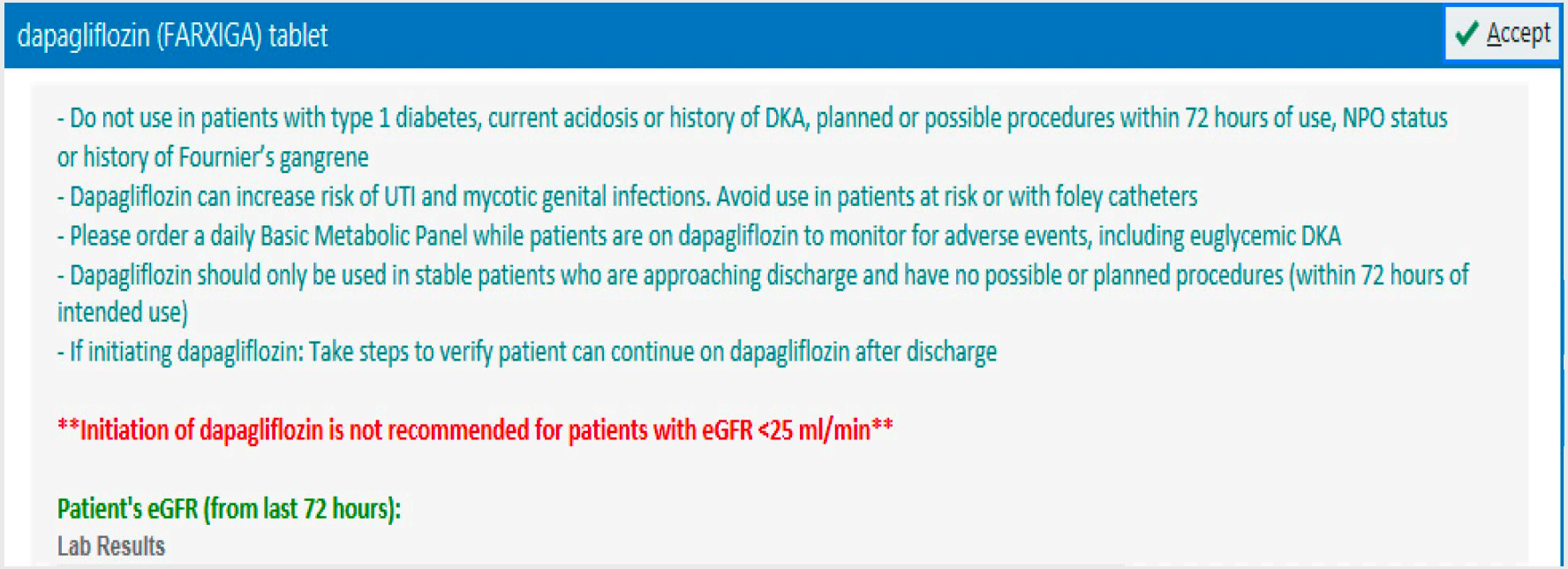
Pathogenesis of SGLT2 Inhibitor Induced DKA



Taylor et al. J Clin Endocrinol & Metabol 2015

Inpatient Use of SGLT-2 Inhibitor (dapagliflozin)

- For the treatment of CHF within 7 days of discharge



Incretin Hormones

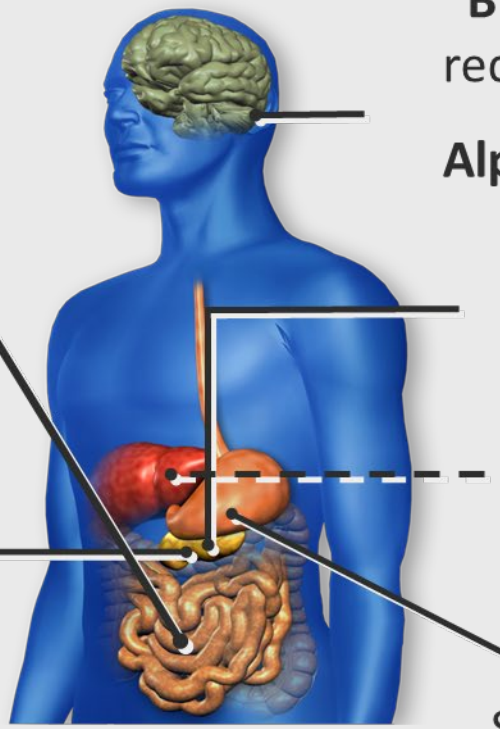
- GLP-1 and GIP are the major incretin hormones, produced and secreted by intestinal cells
- Released in response to food ingestion
- Extremely short half-life, degraded by DPP-4 enzyme
- Patients with T2D may have defects in the release or action of these hormones

Glucagon-Like Peptides

Small Intestine:
Secreted upon the ingestion of food

Brain: Promotes satiety, reduces appetite

Alpha Cells: ↓ postprandial glucagon secretion



Liver: ↓ Glucagon reduces hepatic glucose output

Beta Cells:
Enhances glucose-dependent insulin secretion

Stomach:
Slows gastric emptying

GLP-1 RA *vs.* DPP-4 Inhibitors

Add GLP-1 agonists with longer half-life:

- exenatide
- exenatide LAR weekly
- liraglutide
- dulaglutide weekly
- lixisenatide
- semaglutide weekly (SC) or daily (PO)

GIP + GLP-1 RA:

- tirzepatide weekly

Block DPP-4, the enzyme that degrades GLP-1:

- sitagliptin
- saxagliptin
- linagliptin
- alogliptin

GLP-1 Receptor Agonists:

exenatide (Byetta®), exenatide LAR (Bydureon®), liraglutide (Victoza®), dulaglutide (Trulicity®), lixisenatide (Adlyxin®), semaglutide (Ozempic®, Rybelsus®)

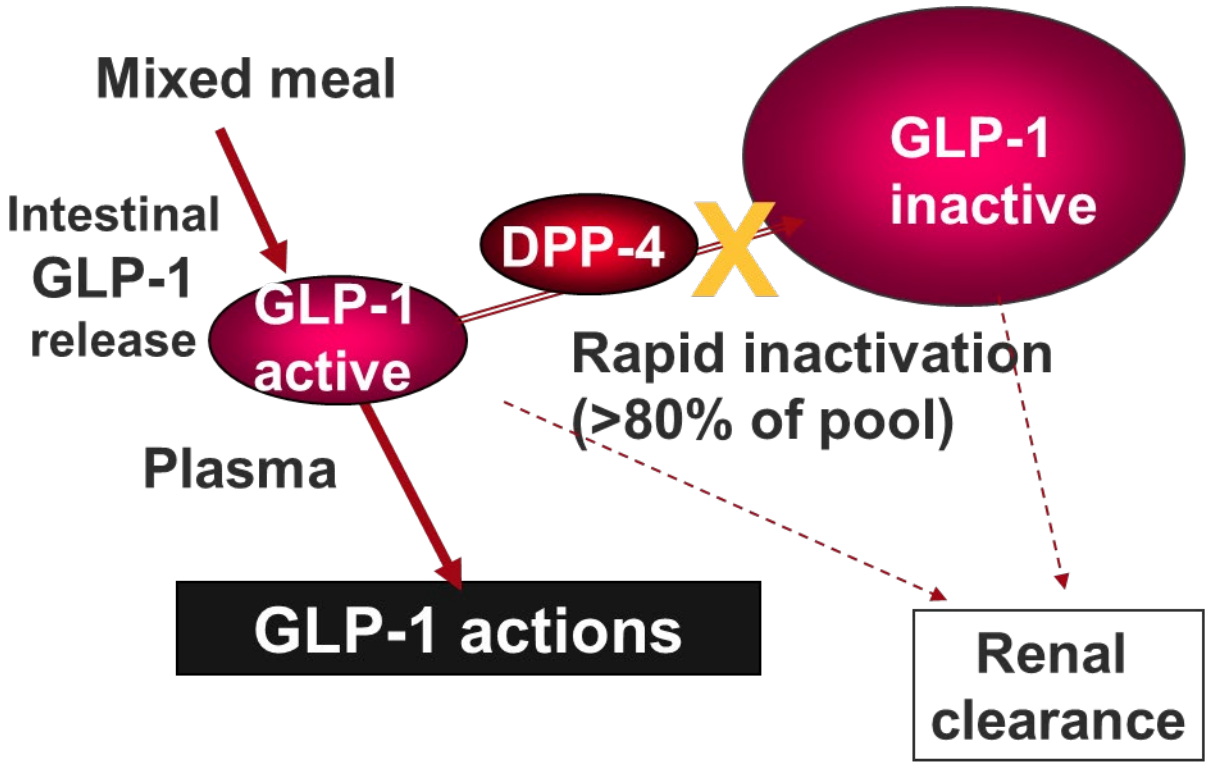
Mechanism	**Binds to the GLP-1 receptor, mimics native GLP-1** -> ↑ glucose dep insulin secretion -> ↓ glucagon secretion
Efficacy	↓ A1c 0.9-1.6%
Advantages	**Dosing, some weekly** **Appetite suppression, Weight loss** **Low risk of hypos** **CV benefit**
Disadvantages	S/E: nausea, vomiting; ↑ HR Post-marketing: pancreatitis, acute renal failure secondary to volume depletion $$$
Contraindications	eGFR<30 (exenatide), <15 (lixisenatide) Gastroparesis Black box: contraindicated with personal/family hx MTC or MEN2 (except exenatide)

GLP-1 RA

Drug	Dose	Dosing schedule	Mixing	Needles
Byetta® (exenatide)	5 mcg 10 mcg	Twice daily within 60 min of meal	No	Not included (32 g 4mm)
Bydureon® (exenatide LAR)	2 mg	Weekly	Yes	23 g, 7 mm
Trulicity® (dulaglutide)	0.75 mg 1.5 mg	Weekly	No	29 g, 5 mm Built in
Victoza® (liraglutide)	0.6, 1.2, 1.8 mg	Daily	No	Not included (32 g, 4 mm)
Adlyxin® (lixisenatide)	10 mcg 20 mcg	Daily	No	Not included (32 g, 4 mm)
Ozempic® (semaglutide)	0.25, 0.5, 1 mg	Weekly	No	Included (32 g, 4 mm)
Rybelsus® (semaglutide)	3, 7, 14 mg	Daily (take with < 4 oz water, wait 30 min before 1st food/drink/med)	Oral	N/A

DPP-4 Inhibitors

Mechanism of Action



Deacon, Carolyn F., et al. "Both subcutaneously and intravenously administered glucagon-like peptide I are rapidly degraded from the NH2-terminus in type II diabetic patients and in healthy subjects." *Diabetes* 44.9 (1995): 1126-1131.
Kieffer, Timothy James, and Joel Francis Habener. "The glucagon-like peptides." *Endocrine reviews* 20.6 (1999): 876-913.

DPP-4 Inhibitors:

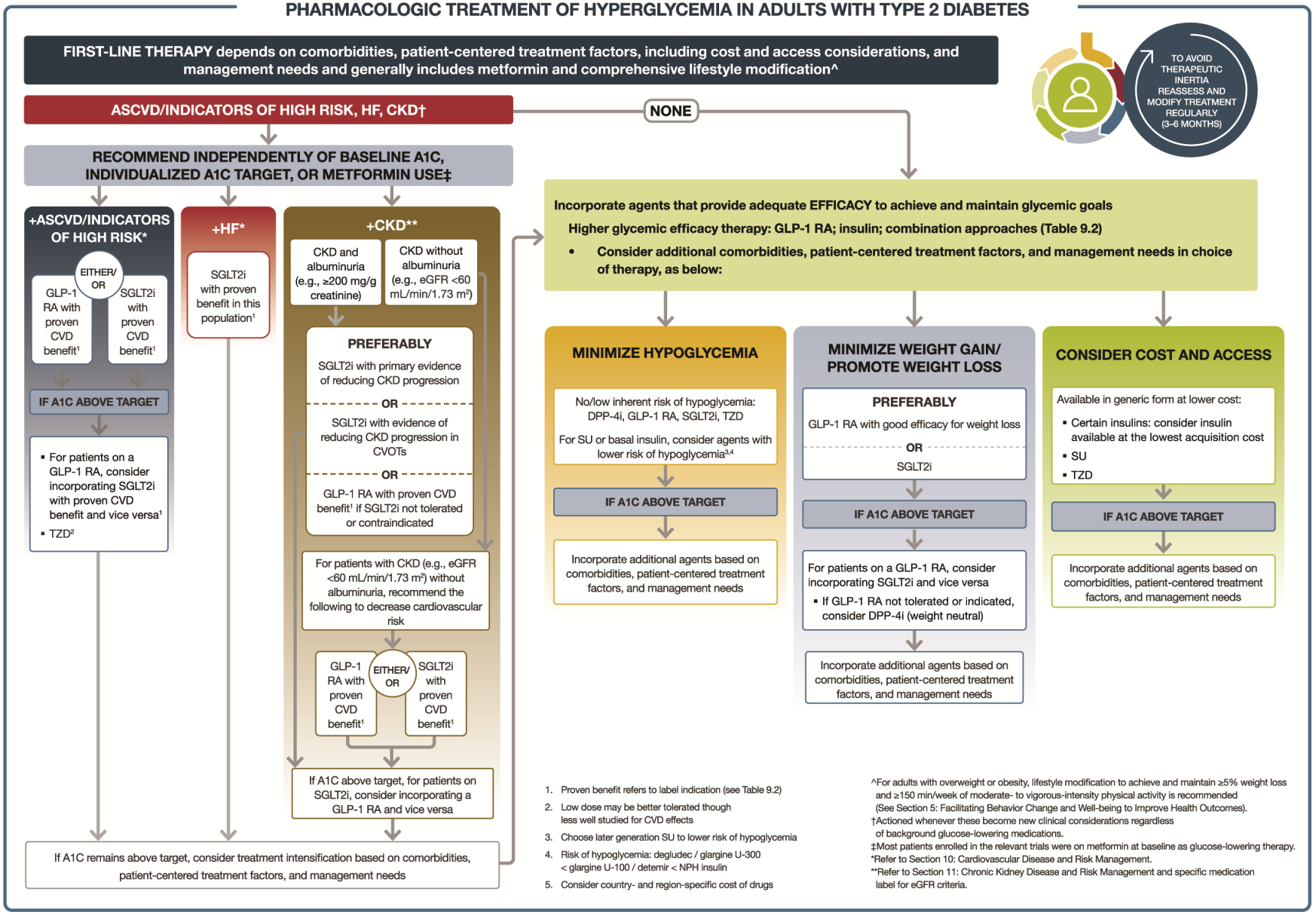
alogliptin (Nesina®), linagliptin (Tradjenta®), saxagliptin (Onglyza®), sitagliptin (Januvia®)

Mechanism	**Inhibits enzyme that deactivates GLP-1 & GIP** -> ↑ glucose dep insulin secretion -> ↓ glucagon secretion
Efficacy	↓ A1c 0.5- 0.9%
Advantages	**Oral, easy dosing, well tolerated** **Weight neutral** **No hypos** Dose reductions for renal insufficiency (except linagliptin)
Disadvantages	S/E: URI sxs, nasopharyngitis, H/A Post-marketing: pancreatitis, anaphylaxis, angioedema, Stevens-Johnson FDA -> ↑ risk CHF (saxagliptin, alogliptin) (4/2016) FDA -> severe joint pain (8/2015) $$$
Contraindications	Hypersensitivity to individual meds

DPP-4 Inhibitors

Name	Max dose	Renal dosing
Januvia® (sitagliptin)	100 mg daily	CrCl 30-49: 50 mg daily CrCl < 30: 25 mg daily
Onglyza® (saxagliptin)	5 mg daily	CrCl < 50: 2.5 mg daily
Tradjenta® (linagliptin)	5 mg daily	Same dose
Nesina® (alogliptin)	25 mg daily	CrCl 30-59: 12.5 mg daily CrCl < 30: 6.25 mg daily

Glucose-lowering Medication in Type 2 Diabetes Guidelines



Pharmacologic Approaches to Glycemic Management: *Standards of Medical Care in Diabetes - 2022. Diabetes Care* 2021;45(Suppl. 1):S125-S143

Perioperative Glycemic Management

Perioperative Glycemic Management: Scope of the Problem

CDC Estimates (Todd & Vigersky, 2021)

- Prevalence of diabetes in general surgery population 15-20%
- Prevalence of undiagnosed diabetes or pre-diabetes in general surgery population 23-60%
- Persons with diabetes (PWD) more likely to require surgery
- Increased hyperglycemia due to surgical stress & counter-regulatory hormone release
- Increased infections, length of stay, mortality

Todd, L. Alan, and Robert A. Vigersky. "Evaluating Perioperative Glycemic Control of Non-cardiac Surgical Patients with Diabetes." *Military medicine* 186.9-10 (2021): e867-e872.
https://www.ahrq.gov/hai/tools/surgery/tools/surgical-complication-prevention/glucose-control-factsheet.html

Lack of Consensus for Perioperative Glycemic Targets

Organization(s)	Glycemic Targets	Recommendation
American Association of Clinical Endocrinology (AACE)* American Diabetes Association (ADA) * Endocrine Society*	BG > 140 mg/dl is hyperglycemia BG > 180 mg/dl start insulin therapy	Targets should be reasonable, achievable and safe
Centers for Disease Control and Prevention**	BG < 200 mg/dl	
Society for Ambulatory Anesthesia*	BG < 180 mg/dl	Lack of evidence to support optimal glucose level
Society for Healthcare Epidemiology of America (SHEA) and Infectious Disease Society of America (IDSA)**	< 200 mg/dl post op days 1 & 2	Intraoperative and perioperative guidelines in cardiac surgery 18-24 hours after anesthesia end time**
European Society of Cardiology*	BG < 180 mg/dl	After major non-cardiac surgery
National Health Service (UK)*	108-180 mg/dl	

*Todd, L. Alan, and Robert A. Vigersky. "Evaluating Perioperative Glycemic Control of Non-cardiac Surgical Patients with Diabetes." *Military medicine* 186.9-10 (2021): e867-e872.

**https://www.ahrq.gov/hai/tools/surgery/tools/surgical-complication-prevention/glucose-control-factsheet.html

Relationship of A1c and Surgical Outcomes

Diabetes is a significant risk factor for surgical complications

Systematic review, N=17 studies

Table 4
Quality assessment using GRADE approach.

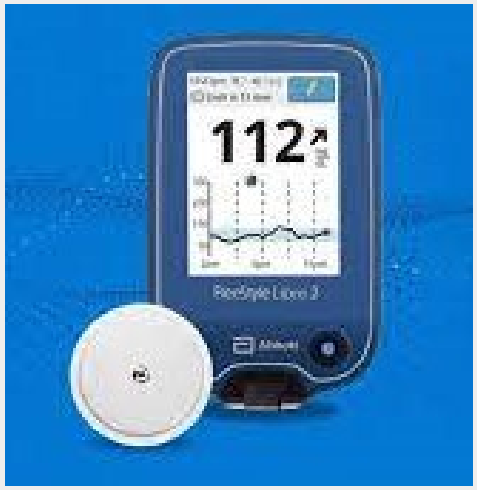
Quality assessment							Quality	Importance
No of studies	Design	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations		
Postoperative complications (assessed with: numbers reported in studies)								
17	Observational studies	Serious. Differing HbA1c cutoff levels were used in each study and definitions of each of the complications were inconsistent between studies	Serious. Differing HbA1c cutoff levels were used in each study and definitions of each of the complications were inconsistent between studies	Serious. Multiple confounders affecting the directness of the relationship between HbA1c and postoperative complications	Serious. Small population size and small event rate for each individual complication	Reporting bias. Multiple database studies, predominantly retrospective	OOO Very low	Critical
Mortality (assessed with: numbers reported in studies)								
9	Observational studies	No serious risk of bias	Serious. Differing HbA1c cutoff values for individual studies making this a highly heterogeneous group	No serious indirectness	Serious. Small population size and small event rate for each individual complication	None	OOO Very low	Important
ITU and Hospital Length of Stay (assessed with: numbers reported in studies)								
5	Observational studies	No serious risk of bias	Serious. Differing HbA1c cutoff values for individual studies making this a highly heterogeneous group	No serious indirectness	Serious. Small population size and small event rate for each individual complication	None	OOO Very low	Important
Reoperation (assessed with: numbers reported in studies)								
4	Observational studies	Serious. Small population size and small event rate for each individual complication	Serious. Differing indications and time frames for reoperation used between different papers	Serious. Time of reoperation disparate between papers making this relationship unclear	Serious. Small population size and small event rate for each individual complication	None	OOO Very low	Not important
Readmission to Hospital (assessed with: numbers reported in studies)								
1	Observational studies	Serious. Single retrospective database study only	No serious inconsistency	No serious indirectness	Serious. Single retrospective study only	Reporting bias. Single retrospective database study only	OOO Very low	Not important

Rollins, Katie E., et al. "Systematic review of the impact of HbA1c on outcomes following surgery in patients with diabetes mellitus." Clinical nutrition 35.2 (2016): 308-316.

Patient's Own Diabetes Technology in the Hospital

Medtronic MiniMed 770G with Guardian 3 CGM

Omnipod 5 (Insulet) with Dexcom G6



Abbott Freestyle Libre 2 CGM

Tandem t:slim X2 with Control IQ with Dexcom G6 CGM

Senseonics Eversense E3 CGM

Dexcom G6 CGM

Personal Diabetes Technology in the Hospital

- Patient should be able to continue to use diabetes technology e.g. insulin pumps and continuous glucose monitors (CGM) if they can demonstrate safe use and proper supervision is available (ADA SOC, 2022)
- An Endocrine/Diabetes Team consult is recommended to guide safe and appropriate management
- Patient competency must be assessed initially & throughout hospital stay to ensure safe use

BOTTOM LINE: We should make every effort to support *patient preference* to wear CGM and/or insulin pump during the hospital stay barring any safety or efficacy concerns

-American Diabetes Association Professional Practice Committee; 7. Diabetes Technology: *Standards of Medical Care in Diabetes—2022*. *Diabetes Care* 1 January 2022; 45 (Supplement_1): S97–S112. https://doi.org/10.2337/dc22-S007
-American Diabetes Association (2022). 16. Diabetes Care in the Hospital: *Standards of Medical Care in Diabetes—2022.* Diabetes Care Jan 2022, 45 (Supplement 1) S244-S253.
-Yeh, Tiffany, Michele Yeung, and Felicia A. Mendelsohn Curanaj. "Managing patients with insulin pumps and continuous glucose monitors in the hospital: to wear or not to wear." *Current diabetes reports* 21.2 (2021): 1-11.

Continuous Glucose Monitoring (CGM)
Staff Guidance

Criteria for CGM Use

- Personal CGM has not been *approved* for use to guide therapy in the hospital setting *but* can be used for the patient's own information
- Point of care blood glucose monitoring (BGM) is required for clinical decisions e.g. hypoglycemia treatment, insulin dosing and documentation in the electronic health record (EHR)
- Patient (or caregiver) must be independent with device use and bring own CGM supplies to hospital
- During current pandemic, FDA has exercised *enforcement discretion when using* hospital-owned CGMs

-American Diabetes Association Professional Practice Committee, and American Diabetes Association Professional Practice Committee:. "7. Diabetes Technology: Standards of Medical Care in Diabetes—2022." *Diabetes Care* 45.Supplement_1 (2022): S97-S112.
-Davis GM, Galindo RJ, Migdal AL, Umpierrez GE. Diabetes Technology in the inpatient setting for management of hyperglycemia. Endocrinol Metab Clin N Am. 2020;49(1):79–93.
-Galindo, Rodolfo J., et al. "Continuous glucose monitors and automated insulin dosing systems in the hospital consensus guideline." *Journal of diabetes science and technology* 14.6 (2020): 1035-1064.

Insulin Pump and CGM
Staff Guidance

Contraindications for Use of Pump and/or CGM

- altered state of consciousness (for pumps)
- suicidal ideation (for pumps)
- patient (or caregiver) unable to participate in self care
- critically ill (e.g. sepsis, trauma)
- continuous intravenous insulin infusion in OR
- undergoing procedure with prolonged sedation (for pumps)
- device placement interferes with treatment/positioning for surgery/procedures
- unable to provide insulin pump/CGM supplies on ongoing basis during hospital stay

- Galindo, Rodolfo J., et al. "Continuous glucose monitors and automated insulin dosing systems in the hospital consensus guideline." *Journal of diabetes science and technology* 14.6 (2020): 1035-1064.
- Thompson B, Leighton M, Korytkowski M et al. An Overview of Safety Issues on Use of Insulin Pumps and Continuous Glucose Monitoring Systems in the Hospital. Current diabetes reports 2018;18(10):81.

Inpatient Diabetes Technology Policy Recommendations:
Nursing Initial and Ongoing Documentation

- **Patient admitted wearing own insulin pump/CGM**
- **Assessment & location of infusion set & glucose sensor qshift & documented on EHR avatar, if available**
- **Changes in pump reservoir, infusion set, insertion site**
- **Maintain supply of hospital insulin**
- **Obtain patient-reported insulin bolus doses**
- **Episodes of hypo/hyperglycemia, pump/site problems & interruptions in insulin delivery**
- **Frequency/type/time of sensor alarms for hypo/hyperglycemia and whether POC BG verification was done & results**

Thompson B, Leighton M, Korytkowski M et al. An Overview of Safety Issues on Use of Insulin Pumps and Continuous Glucose Monitoring Systems in the Hospital. Current diabetes reports 2018;18(10):81.

Recommendations for Insulin Pump and CGM Use During Imaging, Procedures & Surgery

Table 2 Recommendations for insulin pump and CGM usage during common inpatient imaging studies and procedures [2, 25–27]

Type of imaging/procedure	Insulin pump	Dexcom G6	Medtronic Guardian	Abbott Freestyle Libre	Senseonics Eversense
X-ray Bone density Ultrasound	Cover pump by a lead apron	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Cover sensor with a lead shield, or remove if it will be directly exposed to the X-ray beam	Implantable CGM sensor itself is compatible; the transmitter must be removed prior, and can be worn after
Ultrasound	Cover pump by a lead apron	Sensor and transmitter can remain in place	Sensor and transmitter can remain in place	Sensor can remain in place	Implantable CGM sensor itself is compatible; the transmitter must be removed prior, and can be worn after
CT scan	Cover pump by a lead apron	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor; new sensor to be placed after the procedure is complete	Implantable CGM sensor itself is compatible; the transmitter must be removed prior, and can be worn after
MRI	Remove pump and infusion set; patient will need new infusion set available to resume pump	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor; new sensor to be placed after the procedure is complete	Implantable CGM sensor itself is MRI compatible; the transmitter must be removed prior, and can be worn after
PET scan	Pump needs to be off for at least Remove sensor and1 h prior to the study (no bolus insulin <4 h prior)	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor; new sensor to be placed after the procedure is complete	Implantable CGM sensor itself is MRI compatible; the transmitter must be removed prior, and can be worn after
High-frequency electrical heat (diathermy) treatment	Pump needs to be distal from surgical site; plastic infusion set may be preferred if possible	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor and transmitter; new sensor to be placed after the procedure is complete	Remove sensor; new sensor to be placed after the procedure is complete	Implantable CGM sensor itself is compatible; the transmitter may be removed prior, and can be worn after
Colonoscopy/endoscopy	Pump can remain in place and continue to run	Sensor and transmitter can remain in place	Sensor and transmitter can remain in place	Sensor can remain in place	Implantable CGM sensor itself is compatible; the transmitter may be removed prior, and can be worn after
Cardiac catheterization Pacemaker/AICD placement	Cover pump by a lead apron	Sensor and transmitter can remain in place	Sensor and transmitter can remain in place	Sensor can remain in place	Implantable CGM sensor itself is compatible; the transmitter may be removed prior, and can be worn after

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Guidance for CT and MRI Scans

Recommendations for Insulin Pump and CGM Use During Imaging, Procedures & Surgery

Table 2 Recommendations for insulin pump and CGM usage during common inpatient imaging studies and procedures [2, 25–27]

Type of imagi					
X-ray Bone density Ultrasound					st be n after
Ultrasound					st be n after
CT scan					st be n after
MRI					MRI st be n after
PET scan					st be n after
High-frequenc (diathermy)					y be n after
Colonoscopy/					y be removed prior, and can be worn after
Cardiac catheterization Pacemaker/AICD placement	Cover pump by a lead apron	Sensor and transmitter can remain in place	Sensor and transmitter can remain in place	Sensor can remain in place	Implantable CGM sensor itself is compatible; the transmitter may be removed prior, and can be worn after

CT scan — Cover pump by a lead apron

MRI — Remove pump and infusion set;patient will need new infusion set available to resume pump

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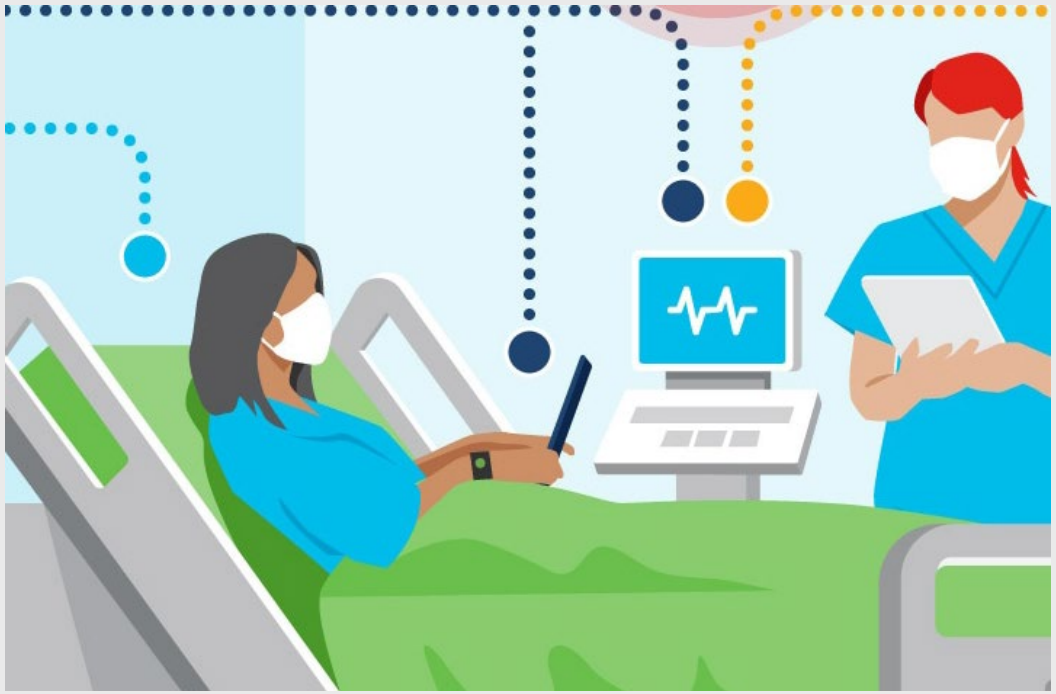
NewYork-Presbyterian/Weill Cornell Medicine Guideline:

Diabetes Medication Adjustments for Procedures and Surgery

DIABETES MEDICATION ADJUSTMENT GUIDELINES PRIOR TO PROCEDURE AND SURGERY		
Medications	**Day Before Procedure/Surgery**	**Day of Procedure/Surgery**
Oral sulfonylureas: glyburide (Micronase®), glipizide (Glucotrol®), glimepiride (Amaryl®)	Take morning and/or lunch doses only, skip evening dose	None
Sodium-Glucose Co-Transporter 2 Inhibitors (SGLT-2): canagliflozin (Invokana®), dapagliflozin (Farxiga®), empagliflozin (Jardiance®), ertugliflozin (Steglatro®)	Stop taking any medications including combinations containing SGLT-2s 3-5 days before surgery or procedure	None
All other oral agents	Take usual dose(s)	None
GLP-1 Receptor Agonists: *Injectable:* dulaglutide (Trulicity®), exenatide (Byetta®, Bydureon®), liraglutide (Victoza®), lixisenatide (Adlyxin®), semaglutide (Ozempic®) *Oral*: semaglutide (Rybelsus®)	Take usual dose(s)	None
Rapid/Short acting insulins: *Injectable*: Regular (Humulin®R, Novolin®R), lispro (Admelog®, Humalog®), lispro-aabc (Lyumjev®), aspart (Novolog®, Fiasp®), glulisine (Apidra®) *Inhaled*: Insulin human (Afrezza®)	Before meals: Take usual dose No bedtime dose	None
Insulin NPH: Humulin® N, Novolin® N	Morning dose: Take usual dose Dinner/bedtime dose: Type 1 DM: Reduce dose by 20% Type 2 DM: Reduce dose by 30%	Type 1 DM: Reduce dose by 30% Type 2 DM: Reduce dose by 50%
Long-acting basal insulin: U100 glargine (Basaglar®, Lantus®, Semglee®), U100 detemir (Levemir®), U100 glargine/lixisenatide (Soliqua®) **Longer-acting basal insulin:** U300 glargine (Toujeo®), U100 & U200 degludec (Tresiba®), U100 degludec/liraglutide (Xultophy®)	**Long-acting basal:** Morning dose: Take 100% Dinner/bedtime dose: reduce by 20% **Longer-acting basal:** Reduce AM *and/or* PM dose by 20%	Type 1 DM: Reduce dose by 20% Type 2 DM: Reduce dose by 50%
Insulin Mixtures: Humulin®70/30, Novolin®70/30, Novolog® Mix 70/30, Humalog® Mix 75/25, Humalog® Mix 50/50	Morning dose: Take 100% Type 1 DM: Reduce dinner dose by 20% Type 2 DM: Reduce dinner dose by	Type 1 DM: Reduce dose by 50% Type 2 DM: Do not take
Insulin Pumps	Ask patient to contact their diabetes care team for orders. **Endocrine consult mandatory for all inpatients.**	

Inpatient Diabetes Technology
Tele-Consults



Tele-Consults

- Cisco Jabber provides larger view of patient and any diabetes devices for assessment
- Facilitates training on BGM, CGM, insulin delivery devices e.g. pens, smart pens, pumps

Inpatient Tele-Consult Workflow

Pre-Visit

- Receive consult request in secure chat & EHR
- Text team to ask reason for consult, language spoken, review EHR
- Create group chat with MD, PA, NP, RN etc.
- Arrange time with RN to bring tele-consult cart into room along with teaching resources needed for visit

Inpatient Tele-Consult Workflow

Post-Visit

- Email handouts to RN and patient
- Ask RN to continue to practice skills: insulin injection with syringe, BGM with hospital meter
- Recommend home regimen to team

Billing Codes

- G0425- Inpatient Telehealth consult- 30 minutes face-to-face time
- G0426- Inpatient Telehealth consult- 50 minutes face-to-face time
- G0427- Inpatient Telehealth Consult- 70 minutes face-to-face time

Documentation:
Diabetes NP Consult Note Template

Diabetes NP Consult **Name** **Unit/RM** **MRN**
Preferred language: Translator? Family present?
DATE: **AGE**
Reason for Admission
Assessment:
A1c Wt BMI Creat eGFR
Past A1c:
Home DM meds, physical activity & monitoring:
Medication contraindications:
Hospital meds, meals & course:
BG and Insulin:

DATE	**BG**	__	__	__	__	**glargine**	units
lispro		__	__	__	__		
DATE	**BG**	__	__	__	__	**glargine**	units
lispro		__	__	__	__		
DATE	**BG**	__	__	__	__	**glargine**	units
lispro		__	__	__	__		

Plan:
Diabetes Self-Care Education & Evaluation:
Recommendations for Discharge Diabetes Meds, Supplies & Resources:
I spent _____ minutes minute- face-to face counseling this patient on _____ and ____ minutes consulting with the care team to develop a discharge plan.

The Future of *Virtual* Inpatient Consults

- **Support *patient's own* diabetes technology at sites without diabetes experts**
- Provide virtual consults to multiple sites within hospital system for management & education
- Serve as *remote resource* to care teams for care coordination with complex discharge plans and personalized selection of diabetes devices

Diabetes Technology Resources
For Clinicians and Patients

eMPR Monthly Prescribing Reference **for Clinicians**
Insulin Pens
Blood Glucose Meter (BGM) Comparisons
https://www.empr.com/home/clinical-charts/

For Clinicians and Persons with Diabetes (PWD)
American Diabetes Association Consumer Product Guide
BGM, CGM, Pumps, Insulin Pens
https://consumerguide.diabetes.org/

Diabetes Health
BGMs, CGMs, Insulin Pumps, Smart Insulin Pen and more…
https://www.diabeteshealth.com/charts/

American Diabetes Association.
Connected for Life

Consumer Guide Resources

- **ADA's Consumer Guide:** Information on nine categories of diabetes devices and medications
- BG Meters, CGMs, Oral Meds, Insulins & Insulin Pens, Pumps and more...
- Compare up to 4 products

https://consumerguide.diabetes.org

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