

How Do I Manage Diabetes in the Hospitalized Patient?

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Disclosures

- ▶ No relevant commercial relationships to disclose.

Objectives

At the conclusion of this session, participants should be able to:

- ▶ Identify the key elements that influence a blood sugar management plan for a hospitalized patient
- ▶ Describe how to develop blood sugar goals for hospitalized patients
- ▶ Design an appropriate diabetes management plan for a hospitalized patient

Outline

- ▶ Pre-Test Case Questions
- ▶ Evidence for glycemic control
- ▶ Challenges of glycemic control
- ▶ Tools for glycemic control
- ▶ How to develop glycemic management plans
- ▶ Post-Test Case Questions
- ▶ Take-Home points

Pre-test Mr. D

Mr. D is a 50 year old male admitted to the hospital with chest pain. He has orders for a cardiology consultation.

He has Type 2 DM. HbA1C 7.8%. His medications include metformin 1000mg BID and 70/30 insulin 45 units q AM and 30 q pm. Initial labs show: eGFR of 64 and serum glucose of 254.



Which of the following factors is it most important to consider when designing your diabetic management plan for this patient?

- A. symptoms
- B. dietary status
- C. volume status
- D. renal function
- E. hepatic function

Pre-test: Ms. R



Ms. R is a 68 year old woman admitted with pneumonia. She has type 2 diabetes with a HbA1C 8.5%. Home medications: metformin 1,000mg BID and glyburide 5mg daily. Initial labs show: eGFR 45, Serum glucose 195

According to current guidelines, which of the following would be the safest and most efficacious way to control Ms. R's hyperglycemia?

- A. Continue her home dose of metformin and glyburide
- B. Stop the metformin but continue the glyburide
- C. Stop her home medications and start an SGLT-2i
- D. Stop her home medications and start a sliding scale insulin
- E. Stop her home medications and start on a basal-bolus insulin regimen.

Why is inpatient
glycemic control
important?

Improve
patient
outcomes

Shorten
hospital stays

Reduce
readmissions

1

2

3

Renal
function

Diet
changes

Clinical
status

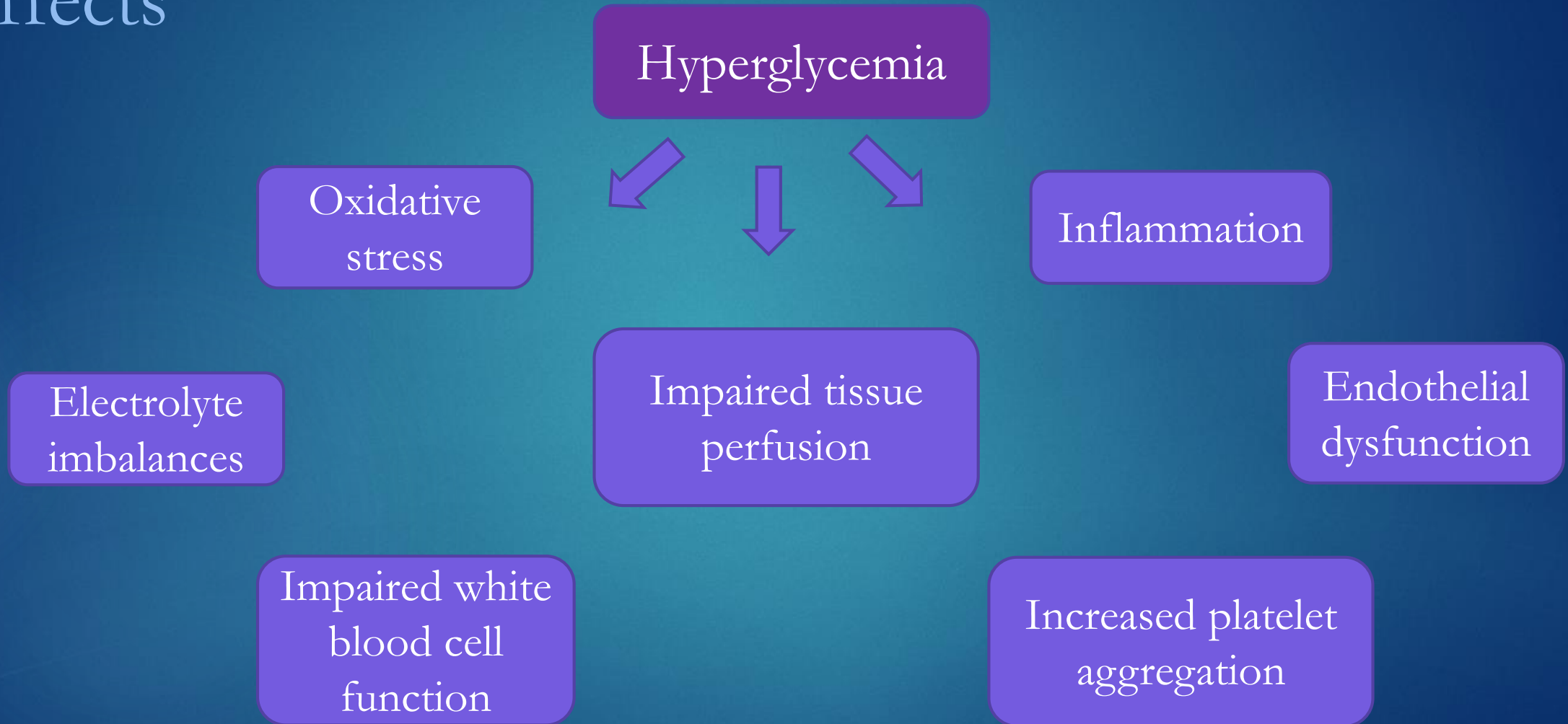
Challenges

Procedures

Physiologic
stress

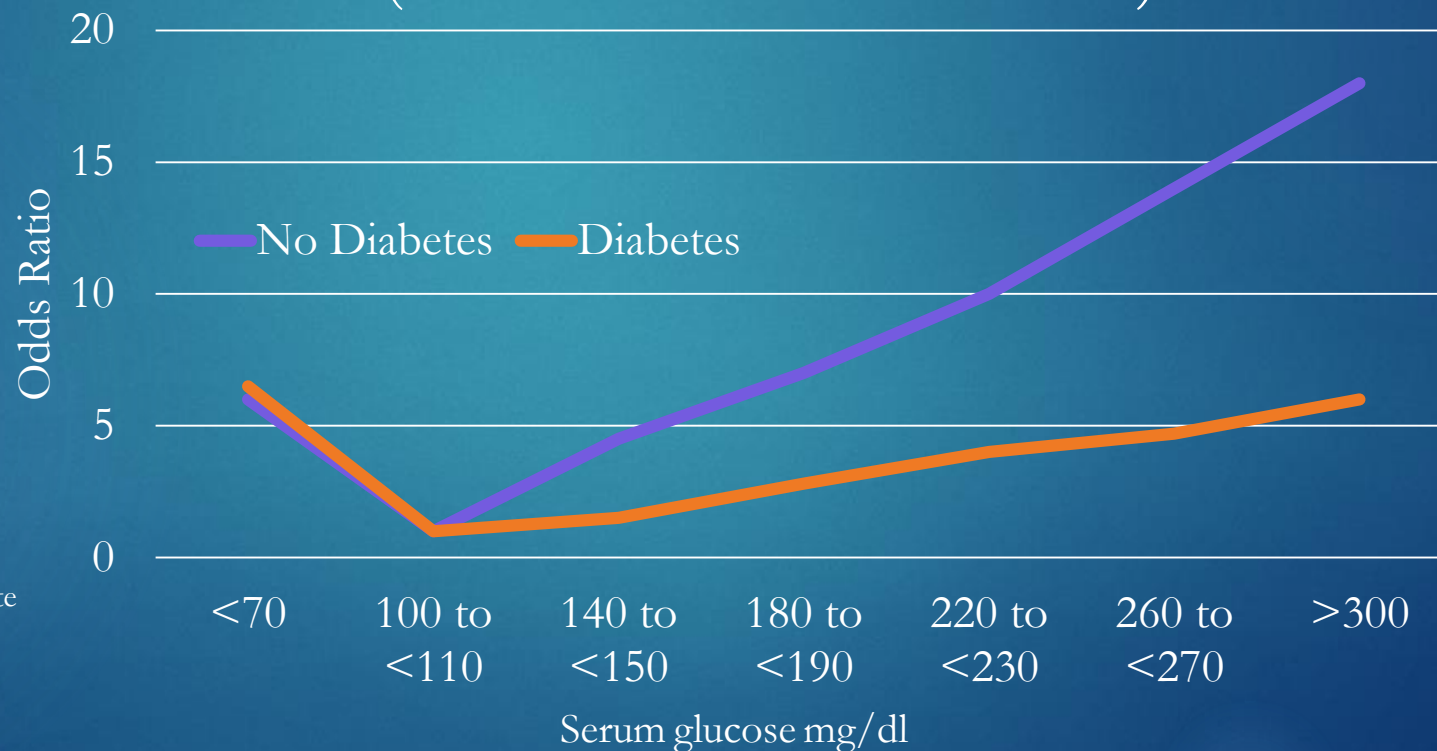
Steroids

Hyperglycemia effects



Hyperglycemia and Mortality After Acute Myocardial Infarction

Association Between Mean BG and In-Hospital Mortality for Patients with AMI
(Reference Mean: 100 to <110)



Adapted from: Kosiborod M, et al.
Glucometrics in patients hospitalized with acute myocardial infarction: defining the optimal outcomes-based measure of risk. *Circulation*. 2008 Feb 26;117(8):1018-27.

Overarching Goals of Glycemic Control in the Hospital

1. Reduce hypo- and hyperglycemia
2. Reduce adverse effects related to glycemic management
3. Provide a smooth transition to outpatient management upon discharge

Roadmap

Assess our individual patient

Individualize glycemic goals

Assess the safety of available agents given likely clinical course

Monitor and follow up with frequent modification of therapy/goal as needed

Provide patient with a plan for smooth transition to outpatient care

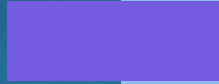
Step 1

Step 2

Step 3

Step 4

Step 5



Step 1: Assess your individual patient

What is their baseline glycemic control?

What is their home regimen?

What are their capabilities for self-management?



Step 2: Individualize glycemic goals

What has the patient been hospitalized for and how does this affect their blood sugar goals?

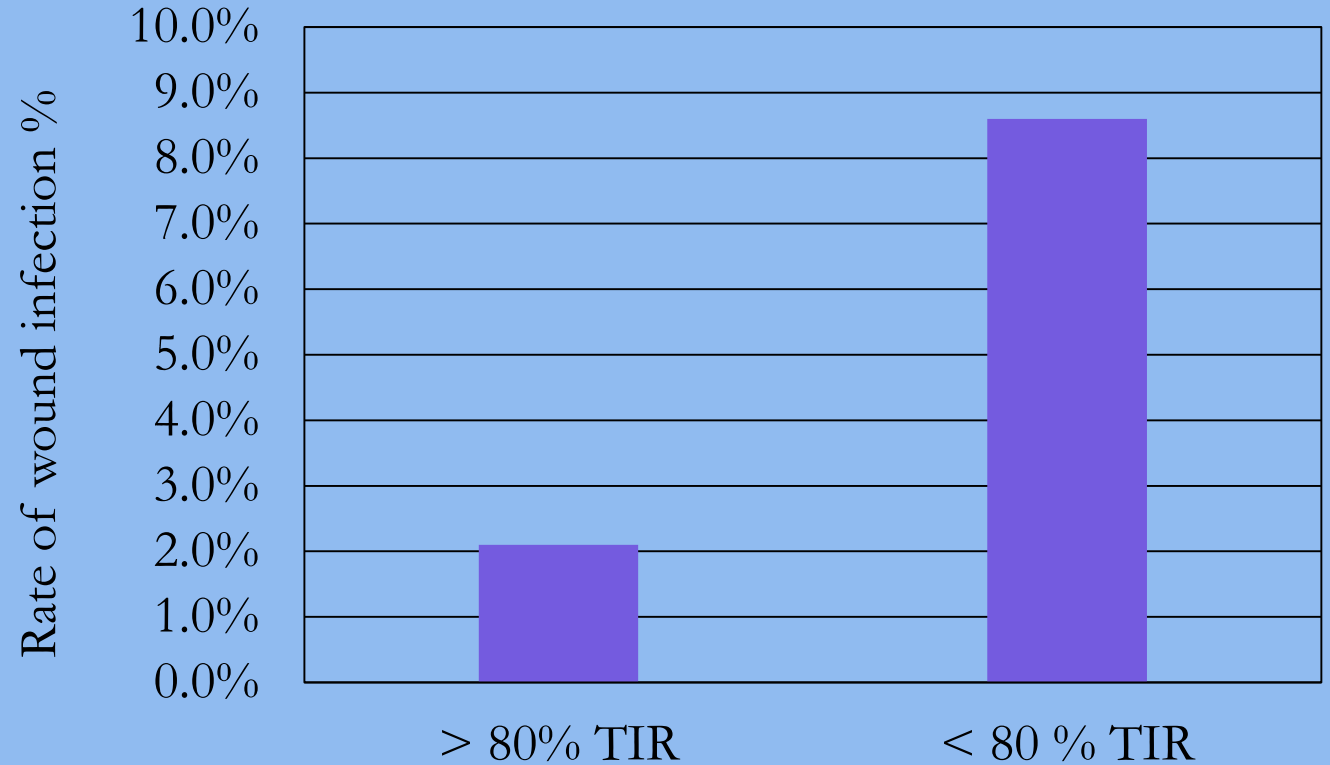
What are the risks of hypoglycemia for this patient?

What about hyperglycemia?

What comorbidities does this patient have and what risks are associated with these?

Postoperative Glycemic Control in Cardiac Patients

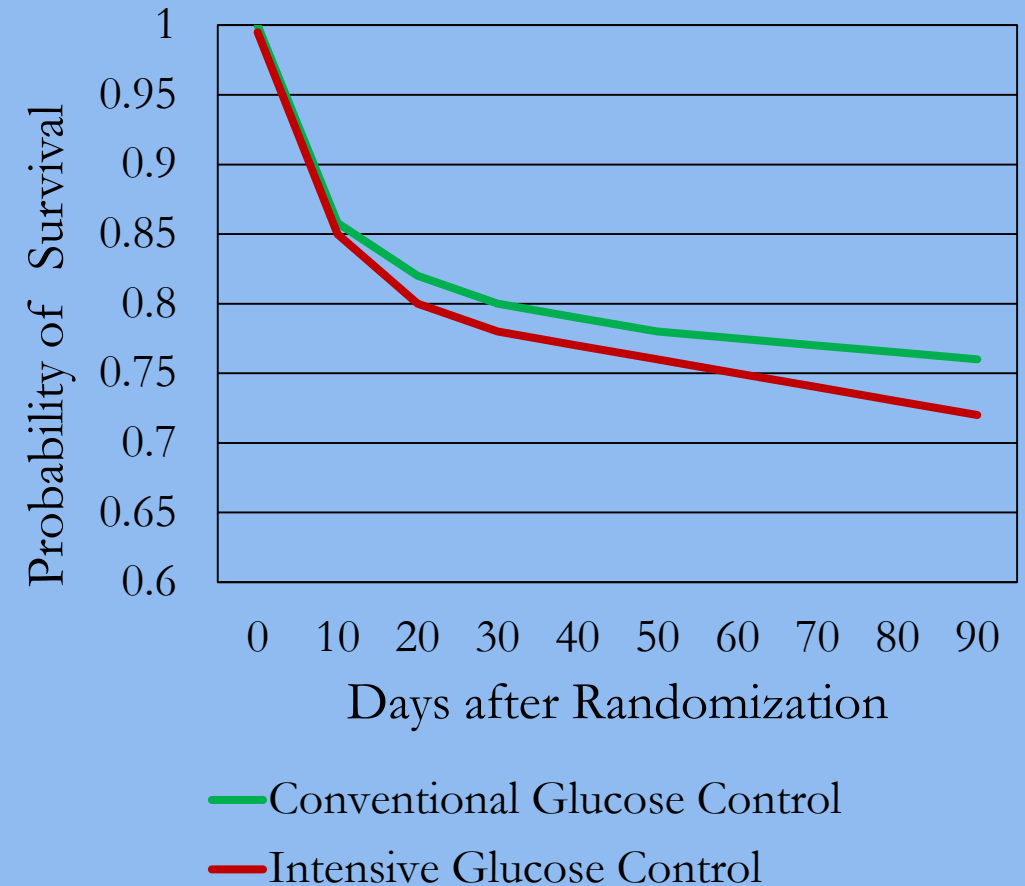
Rate of wound infection: The impact of time in range (TIR) glucose control (106mg/dl to 146mg/dl)



Adapted from: Omar, A.S., Salama, A., Allam, M. *et al.* Association of time in blood glucose range with outcomes following cardiac surgery. *BMC Anesthesiol* **15**, 14 (2015).

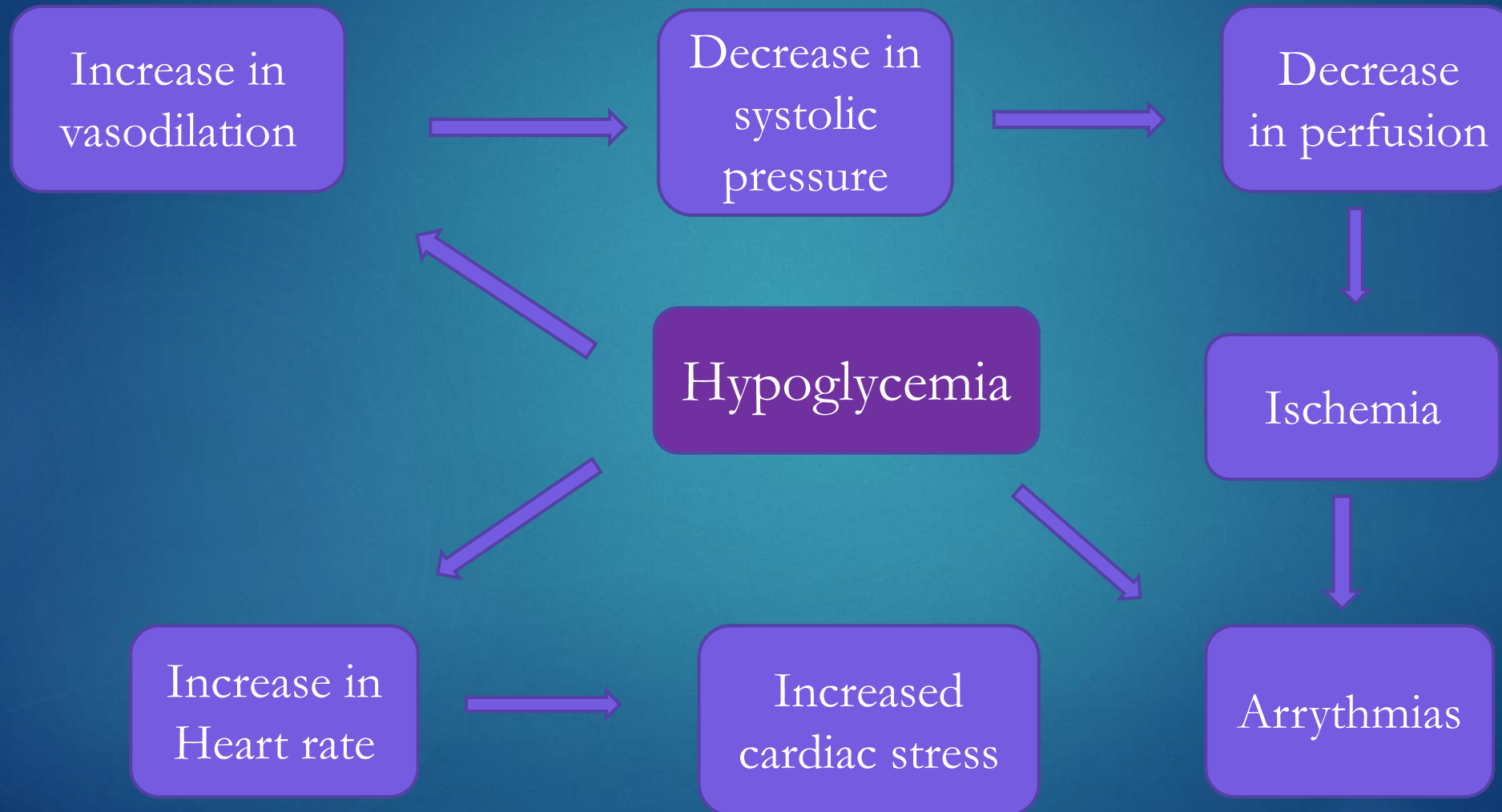
NICE-SUGAR

Probability of Survival with Intensive vs. Conventional Glucose Control



Adapted from Griesdale, et al. Intensive insulin therapy and mortality among critically ill patients.. NEJM 2009, Vol. 360 No. 13

Risks of hypoglycemia



Glycemic Goals in Hospital Setting†

GENERAL GOAL	MORE STRINGENT GOAL*
140-180mg/dl	110-140mg/dl

*may be used if this goal can be achieved without hypoglycemia

† Per the American Diabetes Association, *Diabetes Care in the Hospital: Standards of Medical Care in Diabetes - 2020*



SAFETY

Step 3: Assess the safety of available agents given likely clinical course

What is their renal function?

What is their po status?

What comorbidities do they have?

Choice of Therapy in the Hospital

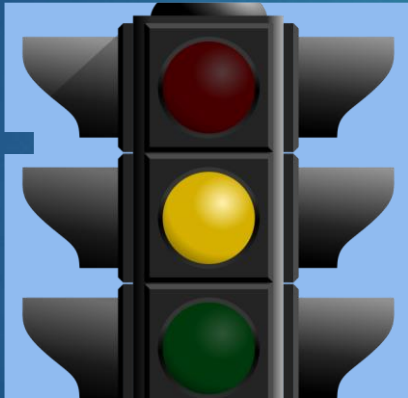
Insulin therapy is preferred

Why not use oral medications or non-insulin injectable therapies?



Many contraindications to their use

Indications to Hold Oral Antihyperglycemics and Injectable Non-insulin Therapies



Metformin:

- ▶ eGFR <60
- ▶ IV contrast
- ▶ Congestive heart failure
- ▶ Liver disease

Sulfonylurea:

- ▶ Acute kidney injury or chronic kidney disease
- ▶ NPO

Pioglitazone:

- ▶ Lower extremity edema
- ▶ Congestive heart failure

DPP-4

- ▶ Pancreatitis
- ▶ Other

GLP-1

- ▶ Nausea, vomiting
- ▶ Pancreatitis

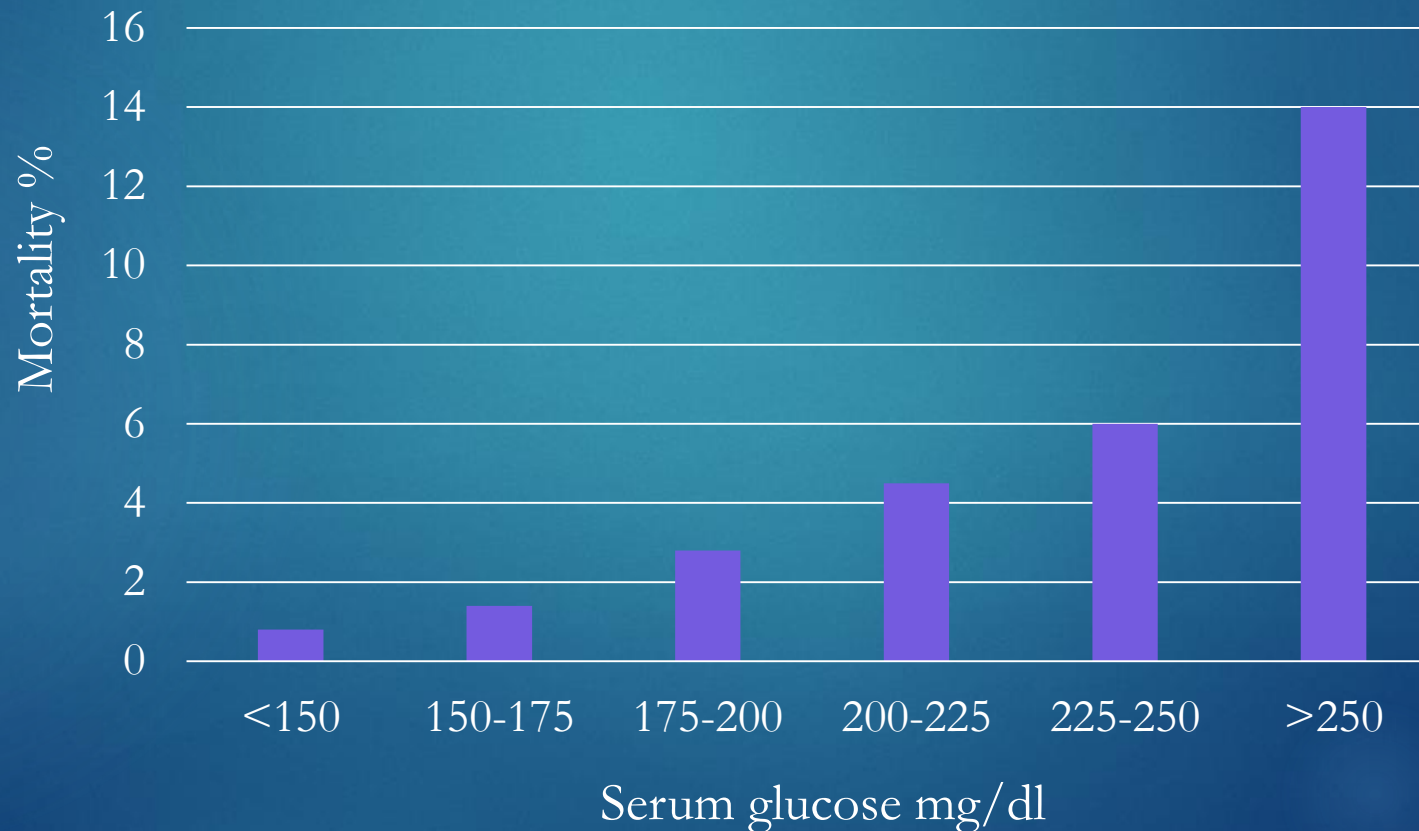
Critically Ill Patients

Consider continuous intravenous insulin infusion for persistent hyperglycemia



Portland Project

Relationship between blood glucose levels and post operative mortality in CABG patients (%)

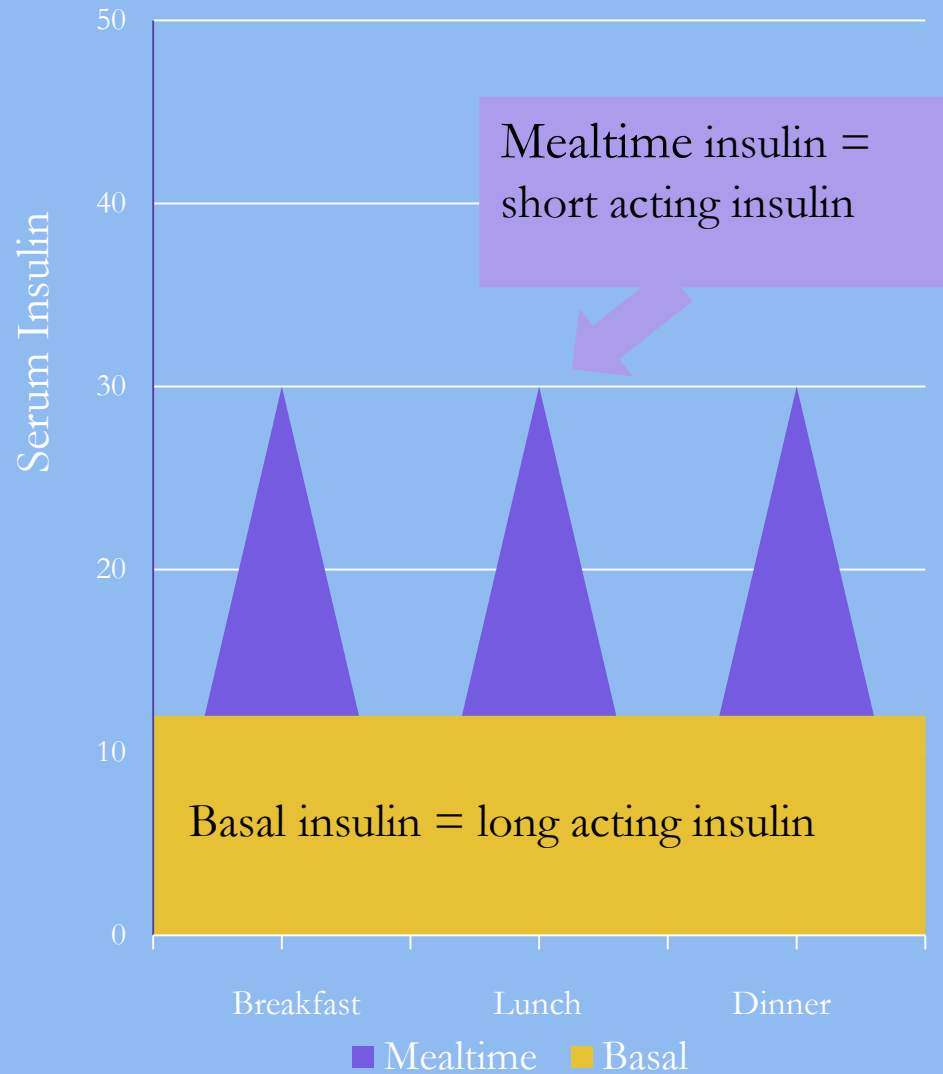




What About Stable Patients?



Insulin Secretion

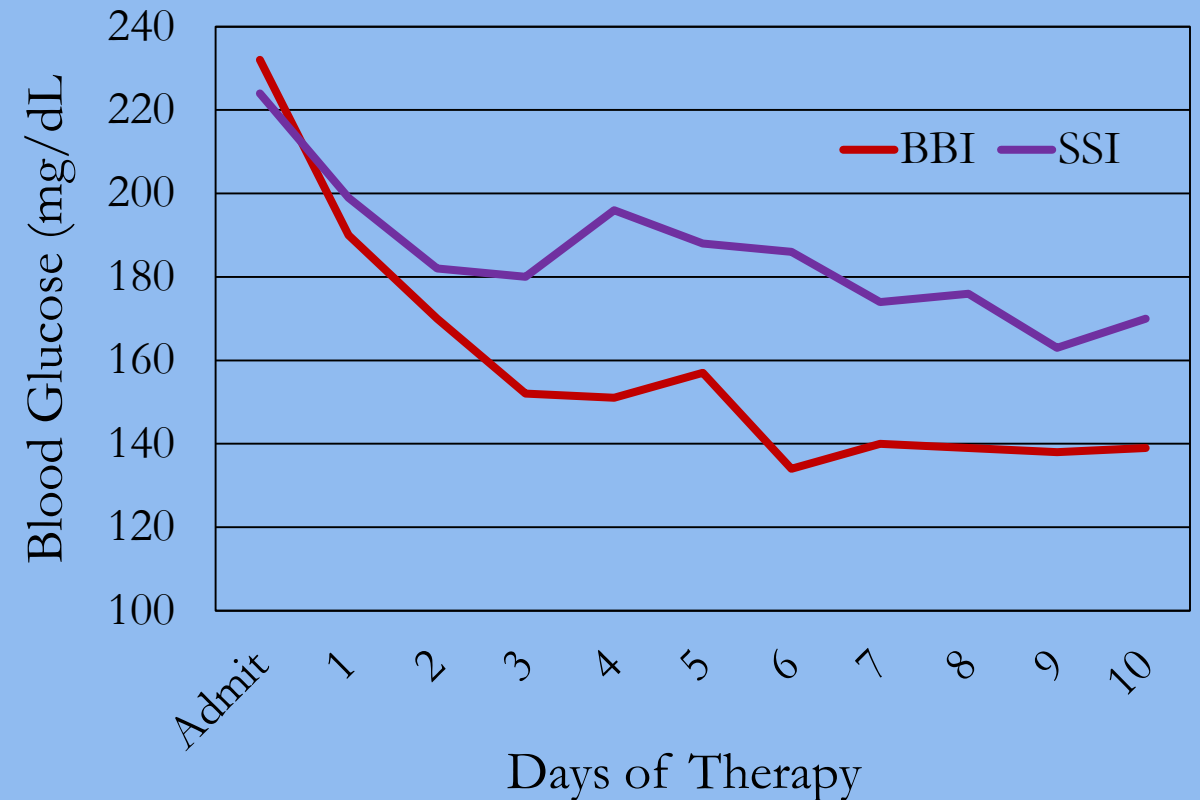


What Type of Insulin Should We Use?

- ▶ Long acting (basal)
- ▶ Short acting (correctional sliding scale, premeal, or continuous IV)
- ▶ Combination of long and short (basal insulin plus mealtime bolus insulin +/- correctional insulin)

Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients with Type 2 Diabetes (Rabbit 2 Trial)

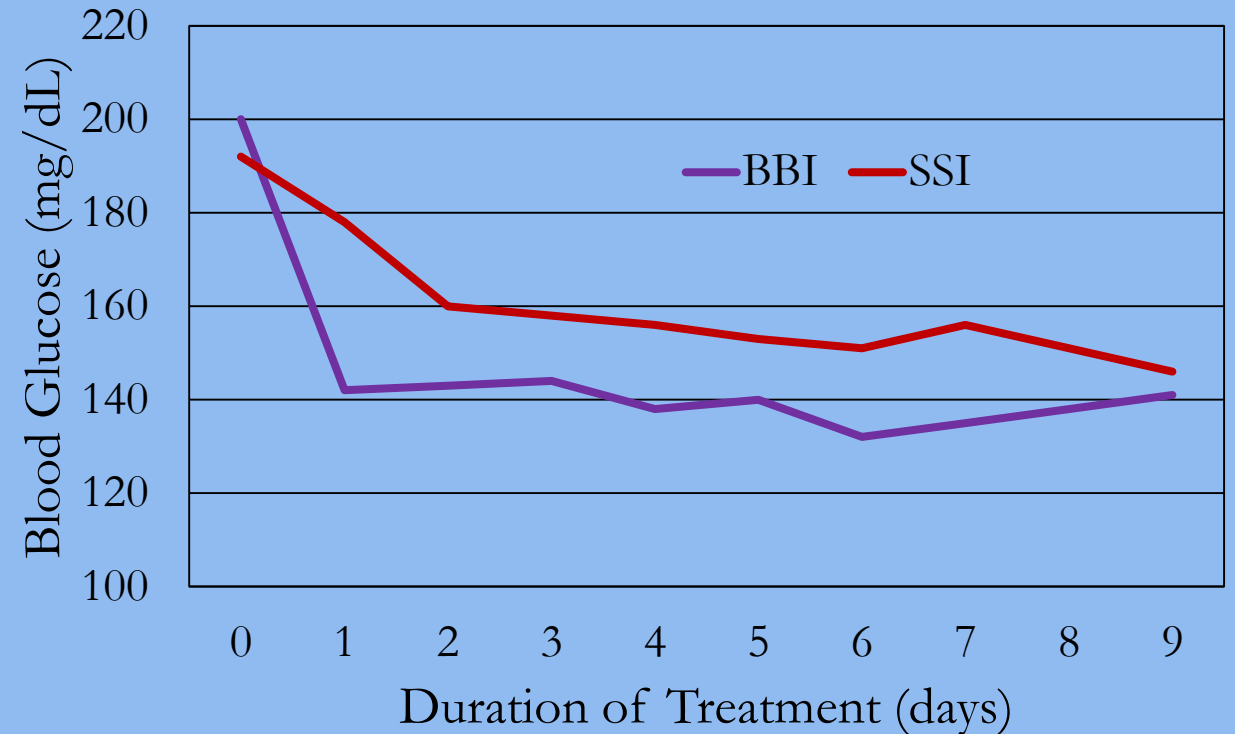
Basal-bolus insulin versus SSI in hospitalized non-critically ill patients with type 2 diabetes



Adapted from: Umpierrez, G. et. al. Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes (RABBIT 2 Trial). 2007. Diabetes Care, Vol 30, p. 2181-2186

Rabbit 2 Surgery

Basal-bolus insulin versus SSI in hospitalized non-critically post surgical patients with type 2 diabetes



Adapted from Umpierrez, G. et al. Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes Undergoing General Surgery (RABBIT 2 Surgery). 2011; Diabetes Care, Vol. 34, p. 256-261.

Practical Benefits Observed in Rabbit 2 Surgery Trial

Hospital complications and outcomes

Complications	All	SSI	Basal-bolus insulin	P value
Wound infections	14	11	3	0.050
Pneumonia	3	3	0	0.247
Acute respiratory failure	6	5	1	0.213
Bacteremia	3	2	1	0.999
Number of patients with complications	35	26	9	0.003
Mortality	2	1	1	NS

Adapted from Umpierrez, G. et al. Randomized Study of Basal-Bolus Insulin Therapy in the Inpatient Management of Patients With Type 2 Diabetes Undergoing General Surgery (RABBIT 2 Surgery). 2011; Diabetes Care, Vol. 34, p. 256-261.

Why Would Basal Bolus Therapy Be More Effective Than “Sliding Scale”?

Sliding scale as sole coverage

- ▶ Lacks basal coverage
- ▶ Reactive, not proactive
- ▶ Non-physiologic dosing raises risk of wide swings in glucose

VS

Basal bolus therapy with basal insulin and mealtime insulin

- ▶ Provides insulin coverage for hepatic glucose production
- ▶ Provides anticipatory insulin for expected sugar release from carbohydrate digestion
- ▶ Correctional scale insulin allows for adjustments in insulin therapy as needed
- ▶ Overall achieves more stable glycemic control overall

Case Report

Mr. D

50 year old male with chest pain

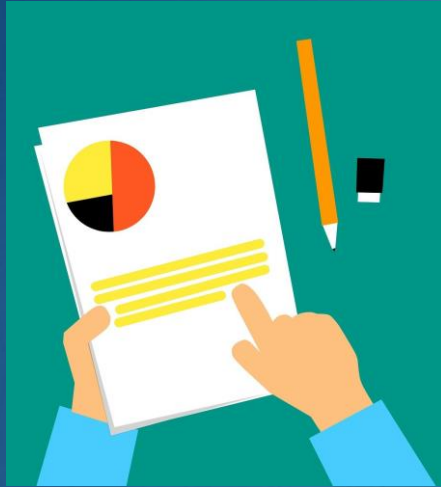
Type 2 DM. HbA1C 7.8%.

His medications include
metformin 1000mg BID and
70/30 insulin 45 units q AM, 30 q pm

Initial labs show eGFR of 64

Serum glucose of 254

Case Report



- Admission orders from the ER:
 - Diabetic diet
 - D/C metformin
 - Sliding scale insulin ac & hs
 - BG > 200 5 units regular
 - BG > 300 10 units regular
 - BG > 400 15 units regular
 - Cardiac Cath scheduled, NPO

Case Report

Glucose flow sheet

Day	Breakfast	Lunch	Supper	HS
1			254 (5R)	320 (10R)
2	440			



IV Insulin drip started

Case Report

IV insulin results

Hour	Glucose	Hour	Glucose
1	440 mg/dl	9	140 mg/dl
2	375 mg/dl		stop drip & start SSI
3	382 mg/dl	10	160mg/dl
4	320 mg/dl	11	200 mg/dl (5R)
5	220 mg/dl	12	260 (5R)
6	190 mg/dl		
7	176 mg/dl		
8	154 mg/dl		

Case Report

Resume 70/30 insulin: 35 units q AM, 20 units q PM

Day	Breakfast	Lunch	Supper	HS
1			260 (5R)	150
2	170 (35 units)	35		

NPO

20 u
70/30

Patients Already on Insulin at Baseline

For patients already on insulin including patients with type 1 diabetes, reassess their current insulin needs before continuing their home doses without modification

- ▶ At home is your patient:
 - ▶ Over-basalized?
 - ▶ Adherent to their medication regimen?
 - ▶ Consuming excess carbohydrates?

Starting Insulin in a Patient with Type 2 Diabetes*

Calculate Total Daily Dose (TDD) of insulin

- ▶ Approximately 50% of this should be basal insulin and 50% mealtime insulin
- ▶ A correctional sliding scale that reflects the patient's level of insulin sensitivity (low dose, medium dose, high dose)

*The Endocrine Society 2012 Management of Hyperglycemia in Hospitalized Patients in Non-Critical Care Setting: An Endocrine Society Clinical Practice Guideline

Type of insulin	Age \geq 70 or GFR $<$ 60ml/min	Age \leq 70 and GFR \geq 60ml/min and BG 140-200mg/dl	Age \leq 70 and GFR \geq 60ml/min and BG 201-400mg/dl
Total daily dose (TDD) of insulin	0.2 – 0.3 U/kg	0.4 U/kg	0.5 U/kg
Basal	50% of the TDD	50% of the TDD	50% of the TDD
Mealtime insulin	50% of the TDD	50% of the TDD	50% of the TDD

What if My Patient is NPO for Surgery?

- ▶ The ADA recommends giving between 50%- 80% of the usual basal insulin
- ▶ With corrective insulin q 4-6 hours as needed

What About Enteral Feeding?

- ▶ Consider scheduled short acting insulin q 4-6 hours
- ▶ Consider adding hold parameters
 - ▶ Hold if tube feeds are held
 - ▶ If BG <120, give 1/2 scheduled dose
 - ▶ If BG <100, do not give

When Should We Consider Oral Antihyperglycemics or Non-insulin Injectables?



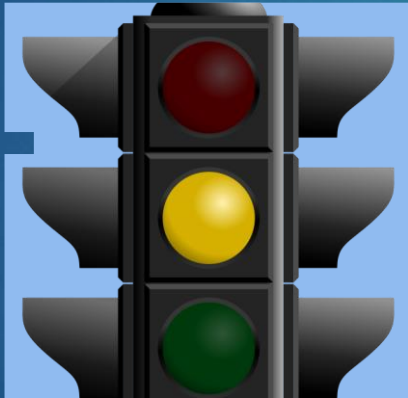
Consider if:

- Stable patient
- Eating well
- Not on steroids
- No acute renal injury
- No planned contrast
- No plans for NPO status or surgery

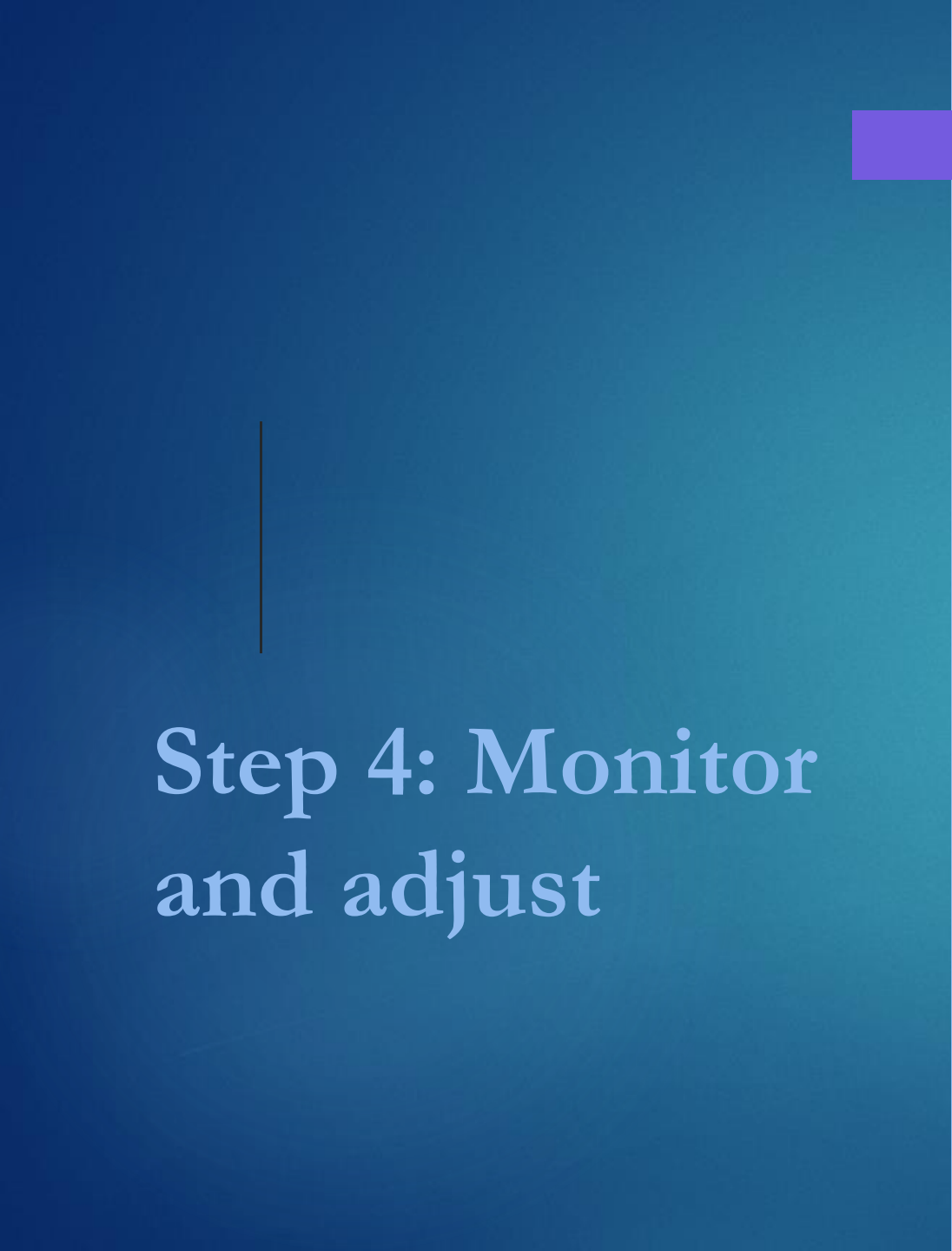
Which Oral Therapies
or Non-insulin
Injectables Can Be
Used?

- ▶ Metformin
- ▶ Sulfonylureas
- ▶ DPP-4 inhibitors
- ▶ GLP-1 agonists

Indications to Hold Oral Antihyperglycemics and Injectable Non-insulin Therapies



- ▶ Metformin:
 - ▶ eGFR <60
 - ▶ IV contrast
 - ▶ CHF
 - ▶ Liver disease
- Sulfonylurea:
 - ▶ Acute kidney injury or chronic kidney disease
 - ▶ NPO
- Pioglitazone:
 - ▶ Lower extremity edema
 - ▶ CHF
- DPP-4
 - ▶ Pancreatitis
 - ▶ Other
- GLP-1
 - ▶ Nausea, vomiting
 - ▶ Pancreatitis



Step 4: Monitor and adjust

Is our glycemic goal for this patient still appropriate, or does it need to be modified?

Is this patient responding to therapy as I would have expected, and if not, why not?

Is there a trend toward improved insulin sensitivity? Towards hypoglycemia?

Common Triggering Events for Hypoglycemia

Interruption
of TPN

New NPO
status

Interruption of
enteral feedings

Declining
renal function

Changing insulin
sensitivity

Interruption of
intravenous dextrose

Transportation off
floor causing meal
delay

How to Avoid Hypoglycemia



Reassess therapy when blood sugar falls below 100

Example: patient on basal insulin has BG <100 in the morning, decrease basal insulin dose

Avoiding Hyperglycemia

Reassess therapy if blood sugar is consistently above goal

Example: Patient requires multiple doses of correctional insulin during the day while on a diet – are they snacking or do they need more mealtime coverage?



PLAN

Step 5: Provide
patient with a plan
for smooth
transition to
outpatient care

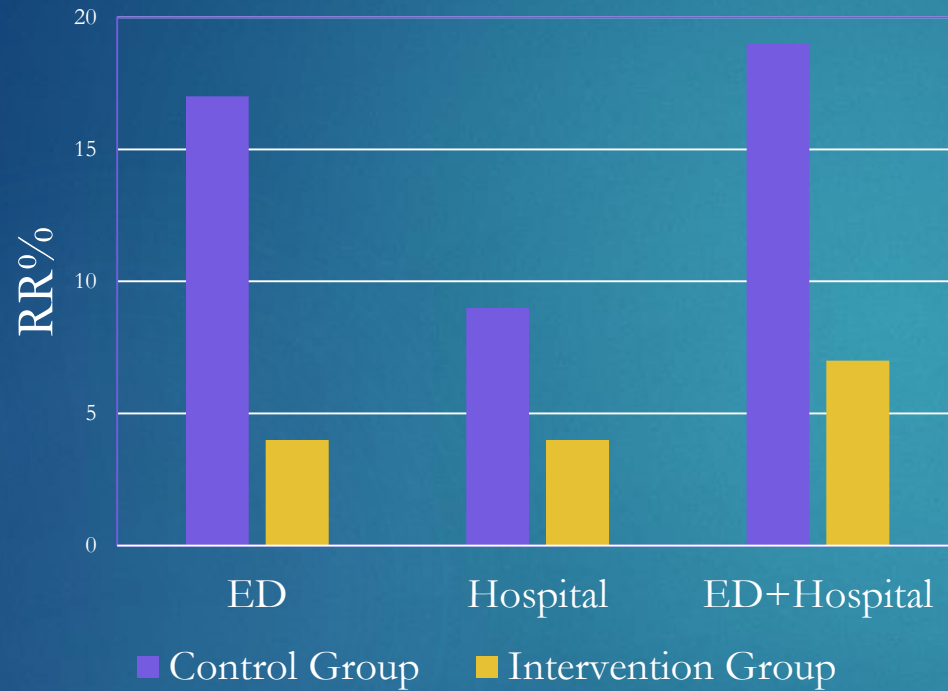
What is the patient's capabilities for self-monitoring and self-care?

What are their outpatient glycemic goals?

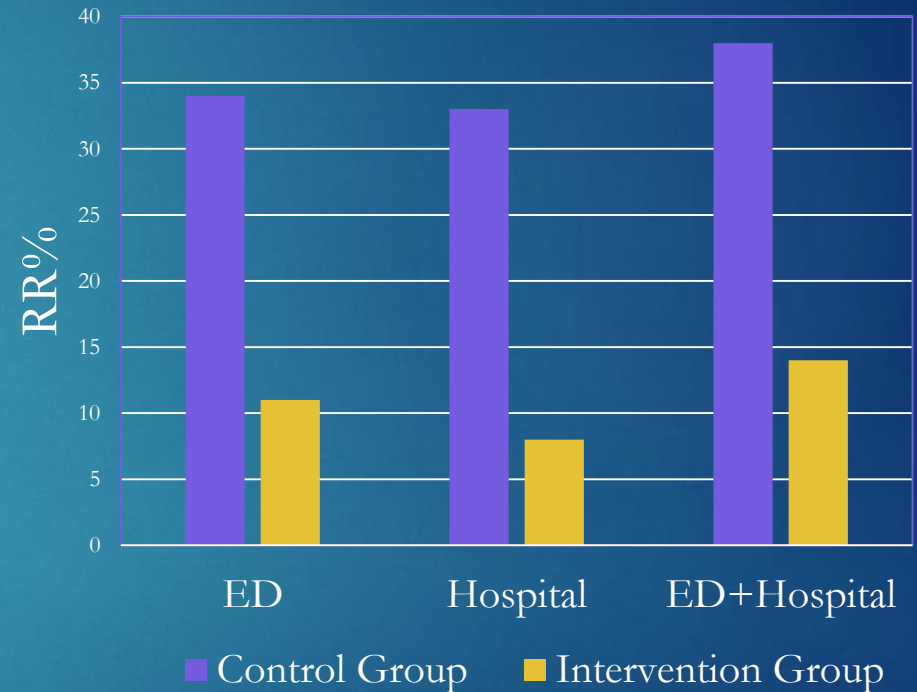
What resources or support are already in place for this individual as an outpatient and what needs to be arranged?

Outpatient plan

30 Day Readmission Rate



365 Day Readmission Rate



Adapted from: Bhalodkar, et al. The Effects of a Comprehensive Multidisciplinary Outpatient Diabetes Program on Hospital Readmission Rates in Patients with Diabetes. 2020, Endocrine Practice: Official Journal of the American College of Endocrinology and the American Association of Clinical Endocrinologists vol. 26.

- ▶ Diabetes educator
- ▶ Social Work
- ▶ Primary care

Post-test: Ms. R



Ms. R is a 68 year old woman admitted with suspected pneumonia.

She has type 2 diabetes with a HbA1C 8.5%. Home medications: metformin 1,000mg BID and glyburide 5mg daily. Initial labs show: eGFR 45, Serum glucose 195

According to current guidelines, which of the following would be the safest and most efficacious way to control Ms. R's hyperglycemia:

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Starting insulin in a patient with type 2 diabetes*

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- ▶ A correctional sliding scale that reflects the patient's level of insulin sensitivity (low dose, medium dose, high dose)

*The Endocrine Society 2012 Management of Hyperglycemia in Hospitalized Patients

$$\text{TDD} = 0.3 \text{u/kg} \times 100 \text{ kg} = 30 \text{ units}$$

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Mr. D Post-test

Mr. D is a 50 year old male admitted to the hospital with chest pain.

He has orders for a cardiology consultation.

He has Type 2 DM. HbA1C 7.8%.

His medications include metformin 1000mg BID and

70/30 insulin 45 units q AM and 30 q pm.

Initial labs show: eGFR of 64 and serum glucose of 254



Which of the following factors is it most important to consider when designing your diabetic management plan for this patient?

- A. symptoms
- B. dietary status
- C. volume status
- D. renal function
- E. hepatic function

Key points

- Persistent hyperglycemia is not benign, it increases our patients' risk of complications and mortality
- Individualize the glycemic goals for your patient, based on their expected clinical course and comorbidities
- Anticipate daily changes in your patient's clinical course and adjust medication doses accordingly to avoid hypoglycemia

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