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Puerto Rico Chapter

Achieving Excellence in Patient Care

Inpatient Glycemic Control

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Disclosure:

No Conflicts of Interest to Disclose

This presentation is intended for educational purposes only and does not replace independent professional judgment.

I am expressing my own views based on my reading, analysis and interpretation of the scientific information.

I am a member of SPED and a Federal Government employee
but I am **not** speaking in representation of or presenting the views of the Veterans Administration,
Puerto Rican Society of Endocrinology and Diabetes,
State or Federal Government Agency or Department, other Professional Societies, Public or Private Corporation, or Pharmaceutical Company.

Learning Objectives

- At the end of this lecture, participants will be able to:
  - Recognize the importance of evaluation and management of hyperglycemia during in-patient management
  - Identify some of the treatments associated with in-patient hyperglycemia
  - Appreciate the role of A1c determination during admission of the patient with diabetes mellitus or hyperglycemia
  - Grasp the management of in-patient hyperglycemia
  - Realize the importance for early recognition and management of hypoglycemia
  - Appreciate the need to improve the transition to the outpatient setting.

Recommend that patients without a history of diabetes with BG greater than 140 mg/dL be monitored with bedside point of care (POC) testing for at least 24 to 48 h. (1|⊕○○○)

- Hyperglycemia is present in:
  - 32 to 38% of patients in community hospitals
  - 41% of critically ill patients with acute coronary syndromes
  - 44% of patients with heart failure
  - 80% of patients after cardiac surgery

Umpierrez, GE. ***J Clin Endocrinol Metab*** 2012; 97: 16 –38.
Moghissi. ES. ***Endocrine Practice*** 2009; 15:353-369

Hyperglycemia Association with Adverse Patients Outcomes

- Hyperglycemia is associated with adverse patient outcomes, intervention to normalize glycemia has yielded inconsistent results.
  - Observational studies in CT Surgery associate 2X wound infection with hyperglycemia
    - Insulin therapy was associated with ↓ infection and ↓ cardiac-related mortality.
- Unclear if the hyperglycemia has causal effect in morbidity and mortality or it is a marker of severity of illness.
- RCTs have highlighted the risk of **severe hypoglycemia** resulting from efforts to normalize the glycemia.
  - Does hypoglycemia have a causal relationship or is just a marker of severity of illness?

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Hyperglycemia Association with Adverse Patients Outcomes

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Table 1
Summary Data of Selected Randomized Controlled Trials of Intensive Insulin Therapy in Critically Ill Patients (>200 Randomized Patients)[a]

Trial	N	Setting	Blood glucose target, mg/dL (mmol/L)		Blood glucose achieved,[b] mg/dL (mmol/L)		Primary outcome	End point rate		ARR[c]	RRR[c]	Odds ratio[c] (95% CI)
			Intensive	Conventional	Intensive	Conventional		Intensive	Conventional			
DIGAMI (33), 1995	620	CCU (AMI)	126-196 (7-10.9)	Usual care	173 (9.6)	211 (11.7)	1-year mortality	18.6%	26.1%	7.5%	29%[d]	NR
Van den Berghe et al (5), 2001	1,548	SICU	80-110 (4.4-6.1)	180-200 (10-11)	103 (5.7)	153 (8.5)	ICU mortality	4.6%	8.0%	3.4%	42%	0.58[d] (0.38-0.78)
DIGAMI 2 (34), 2005	1,253	CCU (AMI)	126-180 (7-10) (groups 1 & 2)	Usual care (group 3)	164 (9.1)	180 (10)	2-year mortality	Group 1, 23.4%; group 2, 21.2%	Group 3, 17.9%	…[e]	…[e]	NR
Van den Berghe et al (16), 2006	1,200	MICU	80-110 (4.4-6.1)	180-200 (10-11)	111 (6.2)	153 (8.5)	Hospital mortality	37.3%	40.0%	2.7%	7.0%	0.94[e] (0.84-1.06)
HI-5 (35), 2006	240	CCU (AMI) (GIK)	72-180 (4-10)	Usual care <288 (<16)	149 (8.3)	162 (9)	6-month mortality	7.9%	6.1%	−1.8%[e]	−30%[e]	NR
GluControl[f] (27), 2007	1,101	ICU	80-110 (4.4-6.1)	140-180 (7.8-10)	118 (6.5)	144 (8)	ICU mortality	16.7%	15.2%	−1.5%	−10%	1.10[e] (0.84-1.44)
Gandhi et al (36), 2007	399	Operating room	80-110 (4.4-6.1)	<200 (<11)	114 (6.3)	157 (8.7)	Composite[g]	44%	46%	2%	4.3%	1.0[e] (0.8-1.2)
VISEP (13), 2008	537[h]	ICU	80-110 (4.4-6.1)	180-200 (10-11)	112 (6.2)	151 (8.4)	28-day mortality	24.7%	26.0%	1.3%	5.0%	0.89[e,i] (0.58-1.38)
De La Rosa et al[f] (28), 2008	504	SICU MICU	80-110 (4.4-6.1)	180-200 (10-11)	117 (6.5)	148 (8.2)	28-day mortality	36.6%	32.4%	−4.2%[e]	−13%[e]	NR
NICE-SUGAR (14), 2009	6,104	ICU	81-108 (4.5-6)	≤180 (≤10)	115 (6.4)	145 (8.0)	3-month mortality	27.5%	24.9%	−2.6%	−10.6%	1.14[d] (1.02-1.28)

Recommend that in patients receiving therapies associated with hyperglycemia be monitored with bedside POC testing for at least 24 to 48 h after initiation of these therapies. (1|⨁○○○)

- Therapies associated with hyperglycemia:
  - Corticosteroids
  - Octreotide
  - Enteral nutrition (EN)
  - Parenteral nutrition (PN)
  - Quinolones: Moxifloxacin, gatifloxacin
  - Atypical antipsychotics
  - Protease inhibitors
  - NRTIs
  - Calcineurin inhibitors

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Recommend that all inpatients with known diabetes or with hyperglycemia be assessed with a HbA1C level if this has not been performed in the preceding 2–3 months. (1|⨁○○○)

- May help differentiate patients with previously undiagnosed diabetes from those with stress-induced hyperglycemia.
- Glucose and HbA1C values, together with the medical history, can be used to tailor therapy and assist in discharge planning.

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American Diabetes Association. ***Diabetes Care*** 2019; 42(Suppl 1): S173-S181

Recommend that timing of glucose measures match the patient's nutritional intake and medication regimen. (1|⨁○○○)

- Use of BG monitoring devices that have demonstrated accuracy of use in acutely ill patients.
- Monitor
  - before meals and at bedtime in patients who are eating
  - Every 4–6 h in patients who are NPO or receiving continuous enteral feeding
- Insulin should be administered using protocols that allow for predefined adjustments in the insulin dosage based on glycemic fluctuations.

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Glycemic Control in the Hospital Setting

- Food intake
  - abrupt discontinuation of meals in preparation for diagnostic studies or procedures
  - variability in appetite due to the underlying illness,
  - limitations in food selections
- Insulin-Food Intake Match
  - Poor coordination between insulin administration and meal delivery creates difficulties in predicting the efficacy of glycemic management strategies.
- Clinical stressors

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Recommend a premeal BG target < 140 mg/dL and a random BG of < 180 mg/dl for the majority of hospitalized patients with non-critical illness. (1|⨁⨁◯◯)

- Individualize your target
  - Lower targets if achievable without hypoglycemia
  - Higher targets for patients with severe comorbidities, terminally ill, or at risk of hypoglycemia.
- **Avoid hypoglycemia**
  - POC-BG 70-100mg/dL: Re-assess anti-glycemic therapy
  - POC-BG < 70mg/dL: Modify anti-glycemic therapy
- POC Capillary Blood Glucose values are subject to imprecisions
  - Accuracy of equipment
    - High or low Hgb
    - Low tissue perfusion
    - Extraneous substances
  - Inadequate sampling

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Recommend insulin therapy as the preferred method for achieving glycemic control in hospitalized patients with hyperglycemia. (1|⨁⨁○○)

- Suggest the discontinuation of oral hypoglycemic agents and initiation of insulin therapy for the majority of patients with type 2 diabetes at the time of hospital admission for an acute illness. (2|⨁○○○)
- In the critical care setting, continuous intravenous insulin infusion has been shown to be the best method for achieving glycemic targets.
- If using continuous subcutaneous insulin infusion(**CSII**), or insulin pump at home, the patient should be considered to continued with their self-management in the hospital if possible and allowed per hospital policy.

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Suggest that patients treated with insulin before admission have their insulin dose modified according to clinical status as a way of reducing the risk for hypoglycemia and hyperglycemia. (2|⨁OOO)

- Patients with diabetes treated with insulin at home should be treated with a **scheduled** sc insulin regimen in the hospital.
  - Basal or intermediate-acting insulin given once or twice a day in combination with rapid- or short-acting insulin administered before meals in patients who are eating
  - Correction insulin should be included as a component of a scheduled insulin regimen for treatment of BG values above the desired target.
- Prolonged use of sliding scale insulin (SSI) therapy should be avoided **as the sole method** for glycemic control in hyperglycemic patients with history of diabetes during hospitalization.
  - This different from correction-dose insulin scale.

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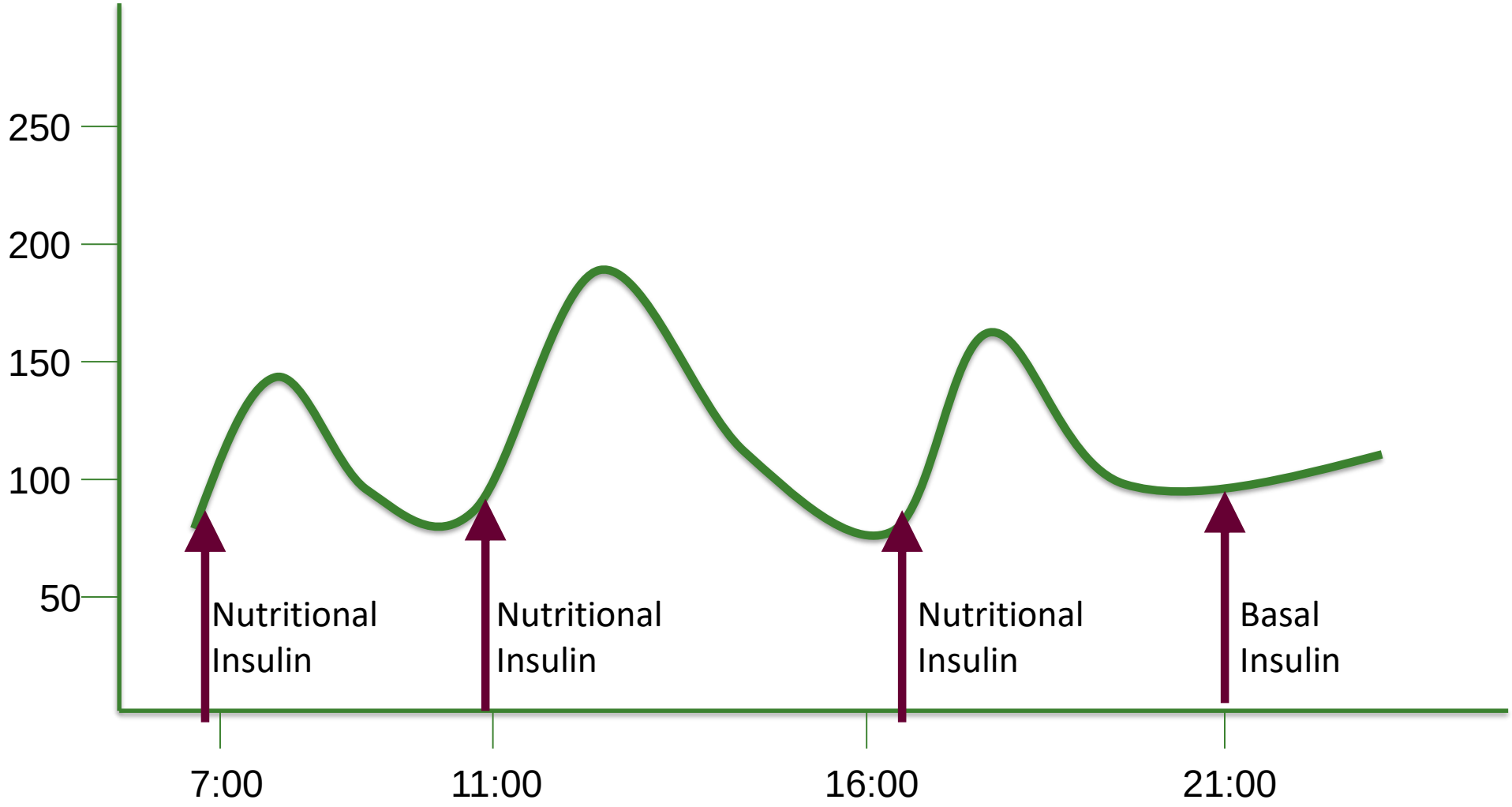
Insulin Guidelines

- The home total basal and prandial insulin dose should be reduced on admission in patients with poor nutrition intake, impaired kidney function, or with admission BG levels less than 100 mg/dL.
- Total Daily Insulin Dose (TDD)
  - ~0.2-0.3 units/kg if ≥70 years old or eGFR < 60 mL/min
  - ~0.4 units/kg and blood glucose 140-200 mg/dL
  - ~0.5 units/kg and blood glucose 201-400 mg/dL
  - 50% as basal and 50% as prandial
- NPO
  - Use 50% of the TDD as basal insulin to control gluconeogenesis
  - Corrective insulin every 4-6 hours
  - Readjust according to blood glucoses and insulin requirements

Matching Insulin with Carbohydrate Intake



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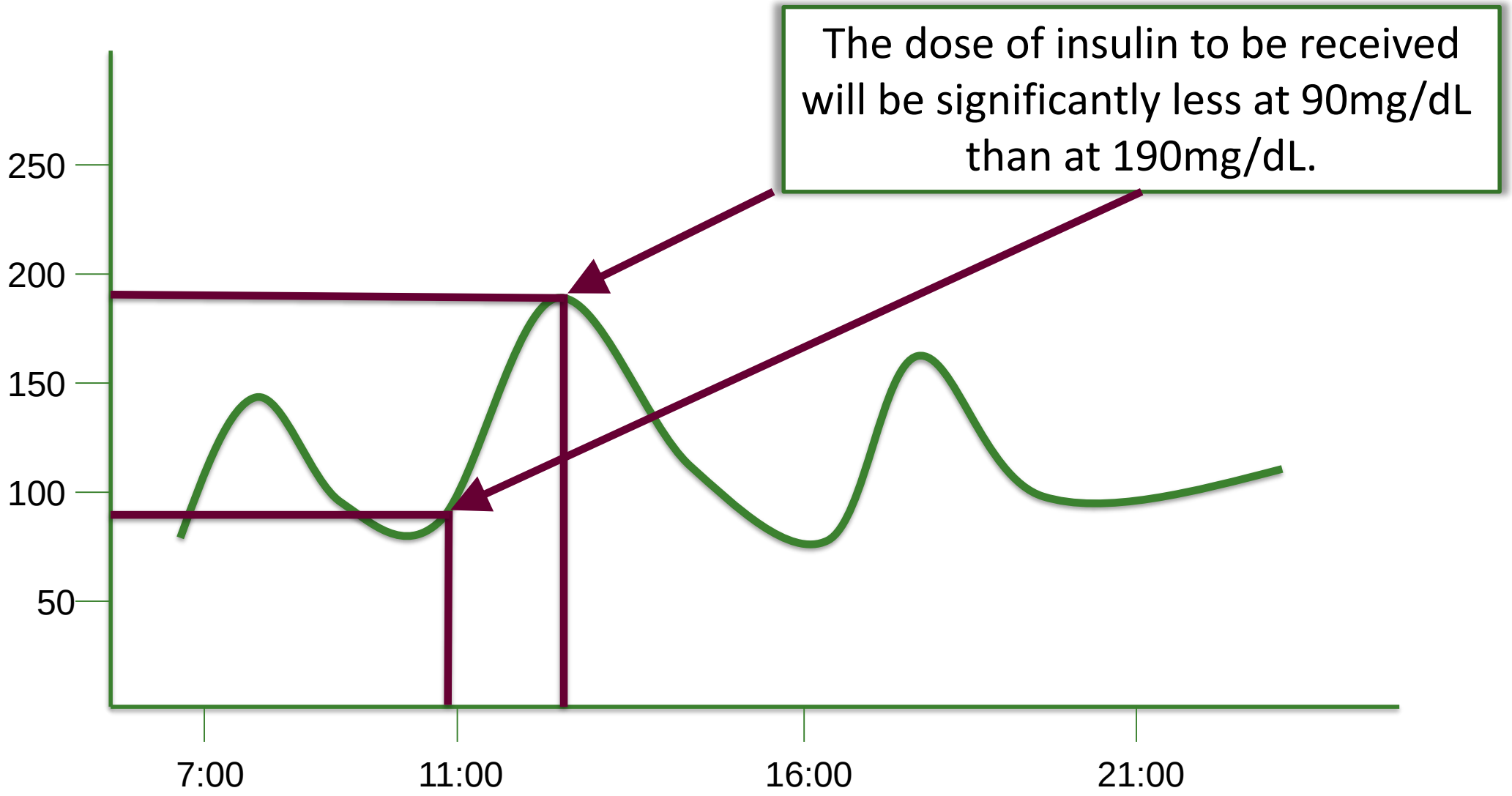
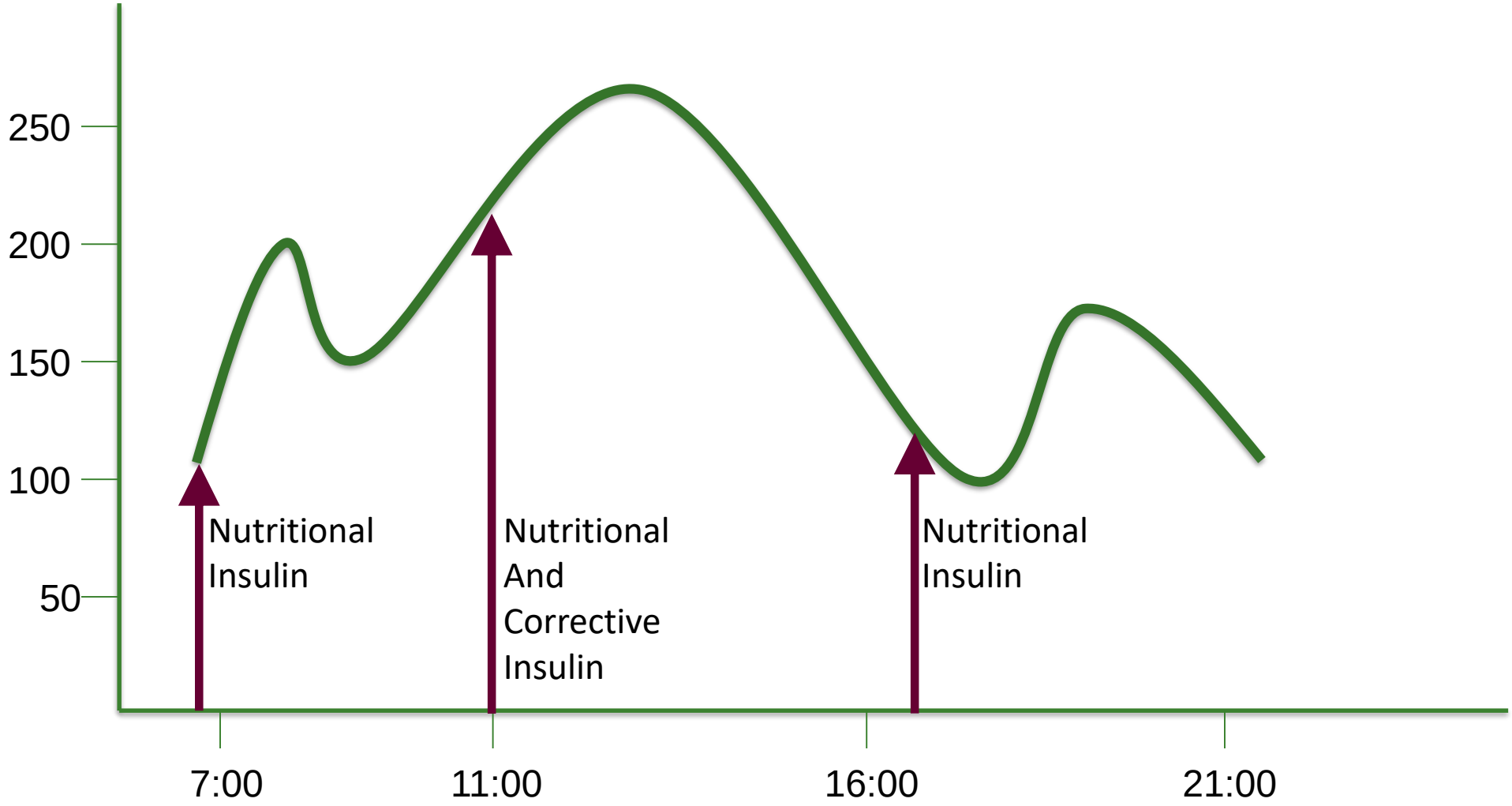
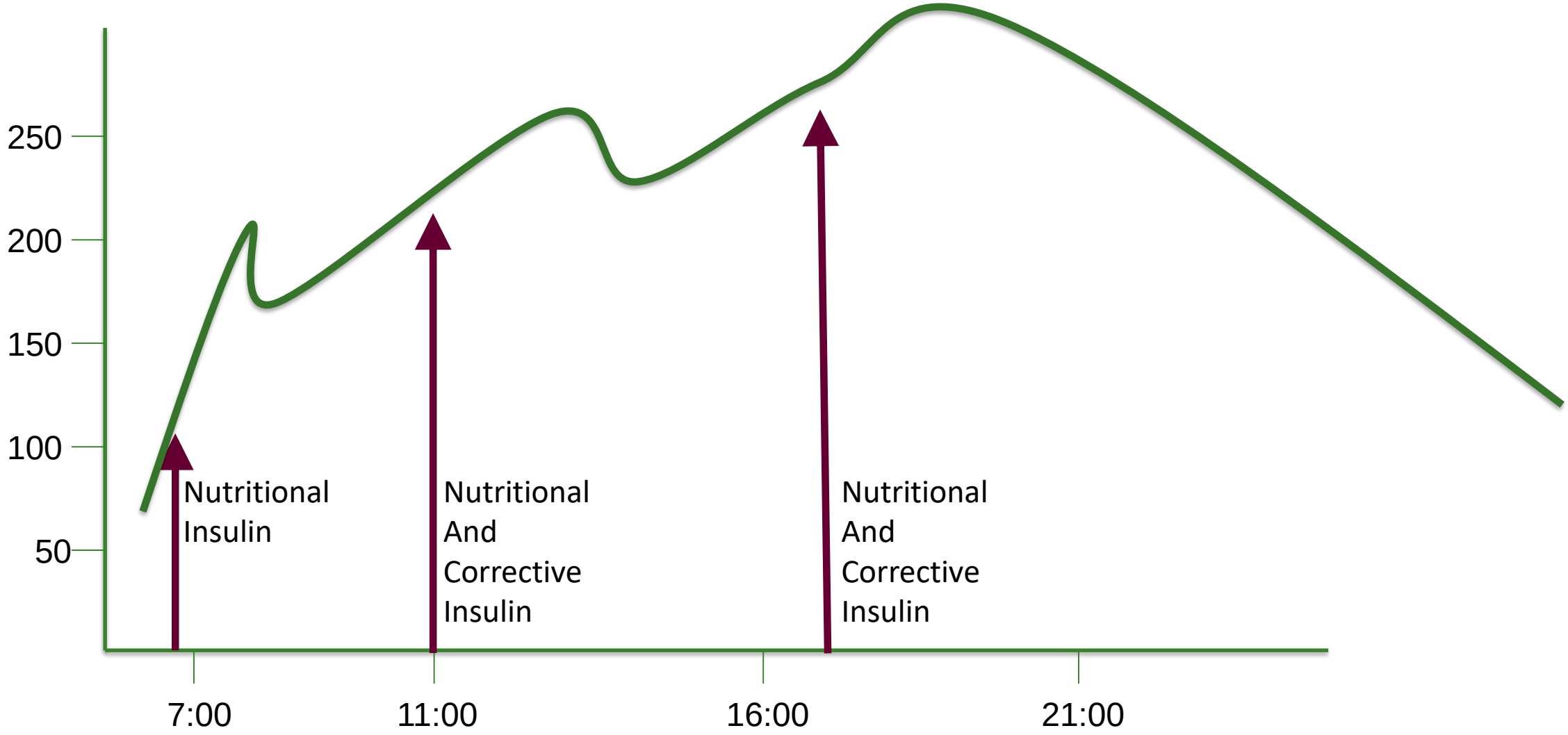


Needs More Prandial Insulin
The Basal Insulin Should be Reduced to avoid Hypoglycemia



Too Much Basal Insulin Needs Prandial Insulin



What to Do with Patient Using U-500 Concentrated Insulin at Home?

You need to check if U-500 Concentrated can be used or not.

- If NOT allowed:
  - If adequate diet intake is expected, reduce the TDD to 40-50% and administer 50% basal and 50% as pre-prandial.
    - Patient using 150 units AM, 50 units at Noon and 50 units before dinner. His TDD = 250 units
      - Basal: Glargine 50 units bedtime [40% of 250 = 100; half as basal = 50 units]
      - Prandial:

Under 80mg/dL	No Regular
80-100 mg/dL	14 units of Regular
101-140 mg/dL	16 units of Regular
141-180 mg/dL	18 units of Regular
181-220 mg/dL	20 units of Regular
221-260 mg/dL	24 units of Regular
261-200 mg/dL	28 units of Regular
Over 300 mg/dL	32 units of Regular

50 Units ÷ 3 = 16.6 ∴ 16 units

  - If NPO, administer only basal, 50 units, monitor glucose, use corrective doses, and readjust therapy.
- If allowed to use U-500, I recommend that you consult Endocrinologist.

Recognition and Management of Hypoglycemia in the Hospital Setting

- Glucose management protocols with specific directions for hypoglycemia avoidance and hypoglycemia management be implemented.
- Standardized hospital-wide, nurse-initiated hypoglycemia treatment protocol to prompt immediate therapy of any recognized hypoglycemia, defined as a **BG below 70 mg/dL**.
- The key predictors of hypoglycemic events in hospitalized patients include:
  - Older age
  - Greater illness severity (presence of septic shock, mechanical ventilation, renal failure, malignancy, and malnutrition)
  - The use of oral glucose lowering medications and insulin

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Hypoglycemia Triggering Events

- Reduction of corticosteroids
- Reduced caloric intake
  - NPO, enteral or parenteral nutrition reduced or stopped.
- Emesis
- Clinical inertia
  - Failure of the clinician to make adjustments to glycemic therapy based on daily CBG patterns
- Inappropriate timing of short or rapid acting insulin in relation to meals
- Reduced infusion rate of intravenous dextrose
- Lack of insulin adjustments with capillary blood glucose below 70mg/dL.

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Transition to Home

- Reinstitute preadmission regimen (insulin or oral and non-insulin injectable antidiabetic drugs) at discharge for patients with acceptable preadmission glycemic control and without a contraindication to their continued use.
  - Patients with elevated HbA1C require intensification of the outpatient antidiabetic regimen
- If starting insulin, initiation of insulin administration should be instituted at least one day before discharge to allow assessment of the efficacy and safety of this transition.
- Provide both written and oral instructions regarding their glycemic management regimen at the time of hospital discharge.

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Transition to Home

- An outpatient follow-up visit with the primary care provider, endocrinologist, or diabetes educator within 1 month of discharge is advised for all patients having hyperglycemia in the hospital.
  - If glycemic medications are changed or glucose control is not optimal at discharge, an earlier appointment (in 1–2 weeks) is preferred, and frequent contact may be needed to avoid hyperglycemia and hypoglycemia.
- Clear communication with outpatient providers facilitates safe transitions to outpatient care.

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Special Situations

Transition from IV Continuous Insulin Infusion (CII) to SC Insulin Therapy

- Administer scheduled SC insulin therapy at least 1–4 h before discontinuation of CII.
  - In patients without a history of DM who have hyperglycemia requiring more than 2 Units/h.
    - The initial dose and distribution of sc insulin at the time of transition can be determined by extrapolating the iv insulin requirement over the preceding 6 to 8 h to a 24-h period.
      - Ex: CII at 2.3 units/hr over the last 6 hours ∴~55 units/day
        - 60 to 80% as basal will be 30 to 40 units. The rest should be provided as prandial if eating.
  - Daily adjustment of the insulin regimen after discontinuation of CII.

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Patients Receiving Continuous Enteral Nutrition

- Scheduled insulin therapy be initiated in patients with and without known diabetes who have hyperglycemia, defined as BG greater than 140 mg/dL, and who demonstrate a persistent requirement (*i.e*. >12 to 24 h) for correction insulin.

- Challenges:
  - Unanticipated dislodgement of feeding tubes
  - Temporary discontinuation of nutrition due to nausea, for medication administration (*e.g.* T_4, phenytoin), or for diagnostic testing
  - Cycling with oral intake in patients with an inconsistent appetite, cycled feeding, or intermittent enteral nutrition

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Use of Glucocorticoids

- Insulin therapy be initiated for patients with persistent hyperglycemia while receiving glucocorticoid therapy.
- The starting insulin dose and timing of insulin administration should be individualized depending on severity of hyperglycemia and duration and dosage of steroid therapy.
- Continuous Insulin Infusion is an alternative to sc insulin therapy for patients with severe and persistent elevations in BG despite use of scheduled basal bolus sc insulin.
- Adjustment of insulin doses is required when the glucocorticoid dose is changed.
- For prednisone at AM consider using NPH. For longer acting or glucocorticoids around the clock consider longer acting basal insulin.

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Summary/Conclusions

- Check glucose on admission
- In patient with hx of diabetes mellitus or glucose 140mg/dL or above check A1c
- Control in-patient hyperglycemia with insulin
  - At ICU use insulin drip
  - Outside of ICU
    - Basal insulin
    - Nutritional insulin
    - Corrective insulin
- At discharge, readjust out-patient management if A1c was above goal
- Hand-over the patient to the outpatient provider following the patient.