

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Presented as a Live Webinar
Wednesday, March 19, 2014
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Planned and conducted by ASHP Advantage

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Webinar Information

How do I register?

Go to <http://www.ashpadvantagemedia.com/hyperglycemia/webinar.php> and click on the **Register** button. After you submit your information, you will be e-mailed computer and audio information.

What is a live webinar?

A live webinar brings the presentation to you – at your work place, in your home, through a staff in-service program. You listen to the speaker presentation in “real time” as you watch the slides on the screen. You will have the opportunity to ask the speaker questions at the end of the program. Please join the conference at least 5 minutes before the scheduled start time for important announcements.

How do I process my Continuing Education (CE) credit?

Continuing pharmacy education for this activity will be processed on ASHP’s new eLearning system and reported directly to CPE Monitor. After completion of the live webinar, you will process your CPE and print your statement of credit online at <http://elearning.ashp.org/my-activities>. To process your CPE, you will need the enrollment code that will be announced at the end of the webinar.

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What if I would like to arrange for my colleagues to participate in this webinar as a group?

One person serving as the group coordinator should register for the webinar. That group coordinator will receive an e-mail confirmation with instructions for joining the webinar. A few minutes before the webinar begins, the group coordinator should launch the webinar link. Once the webinar has been activated, the coordinator will have the option to open the audio via VoIP (Voice Over IP) on the webinar toolbar or use a touch tone phone with the provided dial-in information. At the conclusion of the activity, the group coordinator will complete a brief online evaluation and report the number of participants at that site. Each participant will process his or her individual continuing education statement online.

What do I need in order to participate in the webinar?

1. Computer with internet access and basic system requirements. When you register, the webinar system will assess your system to ensure compatibility.
2. Telephone to dial the toll-free number and listen to the presentation (if you choose not to use Voice Over IP [VoIP] via your computer).

Webinar System Requirements

Be sure to view the webinar [system requirements](#) for Windows, Mac, iOS, and Android prior to the activity.

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Activity Faculty

Kevin W. Box, Pharm.D.

Senior Clinical Pharmacist
UC San Diego Health System
San Diego, California

Kevin W. Box, Pharm.D., is Senior Clinical Pharmacist at UC San Diego Health System in San Diego, California. His primary practice is in the surgical critical care unit specializing in trauma, neurosurgery, and transplantation. He is an advocate for optimizing pharmaceutical care in the intensive care unit (ICU), and he routinely serves as a preceptor for Doctor of Pharmacy students and pharmacy residents in the institution's postgraduate year 1 and postgraduate year 2 programs.

Dr. Box received his Doctor of Pharmacy degree from the University of the Pacific in Stockton, California.

At UC San Diego Health System, Dr. Box plays an important role in initiatives to develop and implement guidelines aimed at improving patient care. He is a member of the critical care committee, glycemic control task force, and performance improvement team for the surgical intensive care unit. Other recent committee involvement addressed continuous infusion titration, glucometer selection, and protocol for spontaneous awakening of patients in the ICU.

In addition to his responsibilities at UC San Diego Health System, Dr. Box serves as Associate Clinical Professor (non-salary) at University of California, San Diego (UCSD) Skaggs School of Pharmacy and Pharmaceutical Sciences, where he co-chairs an elective course on critical care medicine in addition to lecturing on selected topics in required courses. He also is Assistant Clinical Professor at University of California, San Francisco (UCSF) School of Pharmacy (non-salary). Dr. Box has been recognized as preceptor of the year by both of these institutions.

Dr. Box was a recipient of the 2008 Hospital Pharmacist-Hospitalist Collaboration Grant from the American Society of Health-Systems Pharmacists (ASHP) Foundation for his work on transitioning from insulin infusions to subcutaneous insulin using a transition protocol, a study subsequently published in *Journal of Hospital Medicine*. He has also co-authored peer-reviewed articles on topics related to prophylaxis of venous thromboembolism in trauma patients and glycemic control in the burn intensive care unit. He is a member of the Society of Critical Care Medicine and California Society of Health-System Pharmacists. Twice he served on the evaluation panel for the ASHP Foundation Pharmacy Resident Practice-Based Research Grant.

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Paul M. Szumita, Pharm.D., BCPS

Clinical Pharmacy Practice Manager
Director, Critical Care Pharmacy Residency
Brigham and Women's Hospital
Boston, Massachusetts

Paul M. Szumita, Pharm.D, BCPS, is Clinical Pharmacy Practice Manager at Brigham and Women's Hospital (BWH) in Boston, Massachusetts. He also is Director of the postgraduate year 2 critical care pharmacy residency.

Dr. Szumita earned a Doctor of Pharmacy degree at Northeastern University in Boston, and he is a board-certified pharmacotherapy specialist.

At BWH, Dr. Szumita has helped develop and is responsible for managing clinical programs aimed at optimizing pharmacotherapy and improving patient outcomes. As a former Clinical Specialist and current practicing clinical pharmacist in critical care, he has an active role in bedside education, clinical research, and guideline development and implementation with a focus on glucose management, pain management for critically ill patients, agitation and delirium, hemodynamics in shock states, and inpatient glycemic management. He is co-chair of the hospital's diabetes committee.

Dr. Szumita is an Adjunct Assistant Professor of Pharmacy at three colleges and helps coordinate 15 clinical rotations, training more than 100 students each year. He serves on several committees focused on improving clinical practice at the local and national level and has over 25 peer-reviewed publications.

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

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The faculty-planner listed below reports relationships pertinent to this activity:

- Curtis L. Triplitt, Pharm.D., CDE has served on the speakers bureau for Boehringer Ingelheim, Inc., Bristol-Myers Squibb, Gilead, and Janssen Pharmaceuticals, Inc. and has been a consultant for BD.

The following faculty and planners report no relationships pertinent to this activity:

- Kevin W. Box, Pharm.D.
- Paul M. Szumita, Pharm.D., BCPS
- Carla J. Brink, M.S., B.S.Pharm.
- Susan R. Dombrowski, M.S., B.S.Pharm.

ASHP staff has no relevant financial relationships to disclose.

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Activity Overview

In this activity, the faculty will provide health-system pharmacists with practical approaches for improving the management of hyperglycemia using case vignettes representing different populations of hospitalized patients. Suggestions for overcoming barriers will also be presented.

The content for this activity is based on questions raised by participants in a recent educational symposium on this topic. Time for questions and answers from the webinar audience will be provided at the end of the presentation.

Learning Objectives

At the conclusion of this application-based educational activity, participants should be able to

- Recommend approaches for managing hyperglycemia in different populations of hospitalized patients.
- Outline a plan for overcoming barriers to inpatient glucose management.

Continuing Education Accreditation



The American Society of Health-System Pharmacists is accredited by the Accreditation Council for Pharmacy Education as a provider of continuing pharmacy education. This activity provides 1.0 hour (0.1 CEU) of continuing pharmacy education credit (ACPE activity #0204-0000- 14-474-L01-P).

Participants will process CE credit online at <http://elearning.ashp.org/my-activities>, with the option of printing a CE certificate. CPE credit will be reported directly to CPE Monitor.

Complete instructions for processing CE can be found on the last page of this handout.

Additional Educational Opportunities on this Topic

- **On-demand activity**, “Managing Hyperglycemia in Inpatients: Ensuring Success” based on proceedings of a live symposium on December 9, 2013 (2 hour CPE)
 - Note: individuals who claim CPE credit for a live activity are ineligible to claim credit for the web-based activity)
- Informational **podcasts** featuring faculty interviews on the topic
- **e-Newsletters** featuring updates on emerging information, as well as tips for ensuring the success of efforts to improve the management of hyperglycemia in inpatients

www.ashpadvantage.com/hyperglycemia

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Learning Objectives

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Case Vignette 1



An 82 y/o woman is admitted for community-acquired pneumonia and altered mental status

- History of hypertension and T2DM, otherwise healthy
- A1c last month was 6.2% on metformin 500 mg twice daily
- Blood glucose at time of admission 170 mg/dL
- Weighs 55 kg

What medications for diabetes would you start at the time of admission?

- Continue metformin at outpatient dose
- Increase metformin to 1000 mg twice daily
- Withhold metformin, start lispro correction scale qAC and qHS; add basal glargine if consistently hyperglycemic
- Withhold metformin, start glargine 20 units/day + lispro 7 units qAC

Which patients should be treated with basal/bolus insulin?

Immediately at the time of admission

- All patients with type 1 diabetes
- Patients with type 2 diabetes if...
 - Known to require insulin
 - Known to be poorly controlled despite treatment with high doses of oral agents
 - Known to require high doses of oral agents that will be held in the hospital

During hospitalization

- Any patient with blood glucose levels consistently above the target range

See enlargement, p. 17

Estimate the Amount of Insulin the Patient Would Need Over One Day, If Getting Adequate Nutrition = Total Daily Dose (TDD)

- For patients already treated with insulin, consider the patient's **preadmission** subcutaneous regimen and glycemic control on that regimen
- Weight-based estimate
 - TDD = 0.4 units X weight in kg
 - Adjust down to 0.3 units X weight in kg for those with hypoglycemia risk factors
 - Including kidney failure, type 1 diabetes (especially if lean), frail/low body weight/malnourished elderly, or insulin naïve patients
 - Adjust up to 0.5-0.6 units (or more) X weight in kg for those with hyperglycemia risk factors
 - Including obesity and high-dose glucocorticoid treatment

Umplierrez GE et al. *J Clin Endocrinol Metab.* 2012; 97:16-38.

Barriers to Success

- Patient preference
- Physician preference
 - Limited knowledge
 - Lack of confidence
 - Discomfort with insulin
- Poor communication

Case Vignette 2



A 28 y/o man with T1DM is admitted with a displaced tib/fib fracture after a motor vehicle accident

- Blood glucose 110-200 mg/dL on outpatient regimen of glargine 10 units qHS, lispro 3 units qAC, + correction scale lispro qAC and qHS
- Nurse pages you because blood glucose at 9 pm is 88 mg/dL, and he is NPO at midnight for surgery tomorrow

What should you do with his insulin regimen?

- a. Give glargine 10 units as scheduled & small bedtime snack
- b. Withhold glargine, start regular correction scale every 6 hr; resume glargine after OR
- c. Give 50% of scheduled glargine (5 units), change to lispro 2 units every 6 hr while NPO
- d. Discontinue glargine/lispro & convert to equivalent dose of regular while NPO (start regular 5 units every 6 hr at midnight)

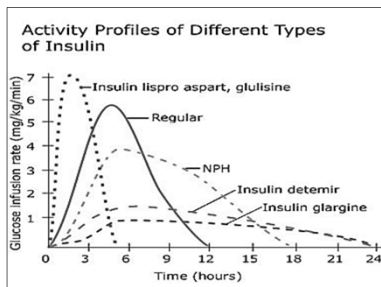
See enlargement, p. 17

Basal Insulin

- Long-acting, non-peaking insulin is preferred as it provides continuous insulin action, even when the patient is fasting
- Purpose: suppress glucose and ketone production
- Required in ALL patients with type 1 diabetes
- Most patients with type 2 diabetes will require basal insulin in the hospital
- Is approximately 50% of the total daily dose of insulin (TDD)

Umpierrez GE et al. *J Clin Endocrinol Metab.* 2012; 97:16-38.

Types of Insulin



Diabetes Education Online: Diabetes Education Center at the University of California, San Francisco. Types of insulin. URL in ref list. Used with permission.

See enlargement, p. 18

Appropriate Bedtime Snacks for Patients Who Are Hypoglycemic

- Snacks are available for those who need them or upon request
 - Bedtime blood glucose <80 mg/dL: simple carb (juice, glucose tablet, D50W) combined with complex carb (carb + protein) for sustained source of carbs
 - Bedtime blood glucose 80-100 mg/dL: complex carb
 - Any patient with diabetes who requests snack
- Examples of appropriate complex carb (15 g carb + protein) snacks
 - Half sandwich
 - Cottage cheese and fruit
 - Crackers and peanut butter

Barriers to Success

- Physician knowledge
- Nurse knowledge
- Lack of standardized protocol

Case Vignette 3



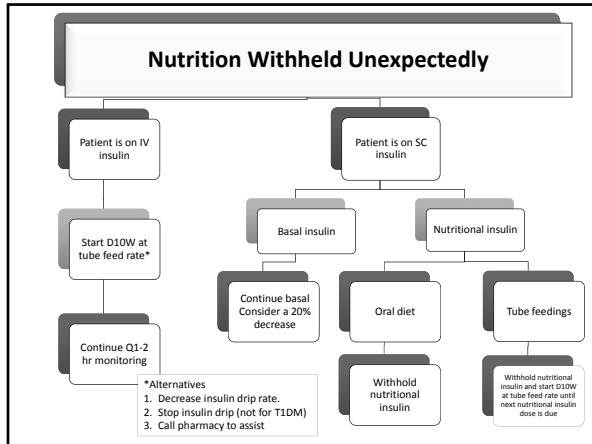
A 58 y/o man with T2DM is intubated in the burn ICU after being injured in electrical fire. He is receiving feedings at 70 mL/hr through a flexible, small diameter feeding tube.

- Blood glucose has been well controlled on regimen of glargine 40 units qHS and regular insulin 10 units every 6 hr
- At 1 AM the patient pulls out his feeding tube and nurses are having great difficulty reinserting it. He was last given his regular insulin at midnight.

What is the first thing that should be done?

- a. Continue insulin as scheduled, page you again if tube not replaced in next 4 hr
- b. Start D10W 70 mL/hr as substitute for nutritional carbohydrates from interrupted tube feedings
- c. Withhold the next dose of glargine and regular insulin
- d. Administer glucagon to prevent hypoglycemia

See enlargement, p. 18



See enlargement, p. 19

Case Vignette 4



A 79 y/o man with hypertension, T2DM is admitted for aortic valve replacement

- Blood glucose well controlled as outpatient on metformin 1000 mg twice daily and glipizide 5 mg twice daily; no hypoglycemia (A1c 6.8%)

Postop course is complicated by pneumonia, and he remains in ICU for 3 days on an insulin drip

- Slowly improves, is transitioned to glargine/lispro regimen
- By day 8 is ready for discharge; blood glucose has been well controlled on glargine 25 units qHS and lispro 7 units qAC

What diabetes regimen should you prescribe on discharge to ensure good blood glucose control at home?

- Resume outpatient regimen of metformin and glipizide
- Discontinue outpatient regimen, continue inpatient insulin regimen
- Resume outpatient regimen, continue glargine 25 units qHS
- Restart metformin, add lispro correction scale qAC prn glucose > 150 mg/dL

See enlargement, p. 19

Transition Guide from Inpatient to Outpatient Regimen

A1c <7% And no significant hypoglycemia	A1c 7-10%*	A1c >10%*
Return to same regimen as prior to admission (oral agents and/or insulin)	Restart outpatient oral agents, optimize oral agents, consider adding basal insulin once daily at 50% inpatient dose	Restart outpatient oral agents, optimize oral agents, add basal insulin once daily at 75% inpatient dose Alternative: stop oral agents and start 70/30 or basal/bolus at same inpatient dose
*Ensure compliance with home regimen, maximize lifestyle changes, optimize oral agents, and add insulin according to finances, adherence, and lifestyle on individual basis		

Adapted with permission from algorithm by Umpierrez G. Emory University School of Medicine, 2011.

See enlargement, p. 20

Transition from Inpatient to Outpatient

Transition to home regimen	Other considerations
<ul style="list-style-type: none"> Ensure compliance with home regimen Maximize lifestyle Optimize oral agents Consider adding basal insulin Consider adding nutritional insulin Rarely need correctional insulin Consider endocrine consultation while inpatient 	<ul style="list-style-type: none"> Compliance Cost Lifestyle (e.g., meal pattern, work, travel) Contraindications Risk of hypoglycemia Adverse effects

Issues and Special Populations

Guidelines from Professional Organizations on ICU Blood Glucose (BG) Goal

Year	Organization	Patient Population	BG Treatment Threshold (mg/dL)	BG Target (mg/dL)	BG Hypoglycemia Definition (mg/dL)	Updated since NICE-SUGAR, 2009
2009	American Association of Clinical Endocrinologists and American Diabetes Association	ICU	180	140-180	<70	Yes
2013	Surviving Sepsis Campaign	ICU	180	<180	Not stated	Yes
2009	Institute for Healthcare Improvement	ICU	180	<180	<40	Yes
2012	American College of Critical Care Medicine (ACCM)	ICU	150	<150 (Trauma) <180 (Stroke+)	<70	Yes
2014	American College of Physicians	ICU	Not stated	140-200	Not stated	Yes
2008	American Heart Association	ICU with ACS	180	90-140	Not stated	No

Kavanagh BP et al. *N Engl J Med*. 2010; 363:2540-6.
 Qaseem A et al. *Ann Intern Med*. 2011; 154:260-7.
 Dellinger R et al. *Crit Care Med*. 2013; 41:580-637.
 Jacobi J. *Crit Care Med*. 2012; 40:3251-76.
 Finfer S et al. *N Engl J Med*. 2009; 360:1283-97.
 Qaseem A. *Am J Med Qual*. 2014; 29:95-8.

See enlargement, p. 20

What is your opinion on the goal glucose in critical care setting?



- a. Guidelines have it right on the money
- b. Would like goal glucose higher than current guideline
- c. Would like goal glucose lower than current guideline
- d. Would like another large RCT to put controversy to bed

Case: ICU Patient

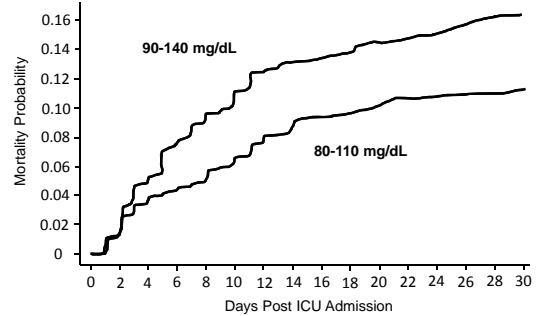
- 55-year-old man admitted to cardiac surgery ICU post valve replacement
- No history of diabetes
- Not eating meals yet
- Glucose 185 mg/dL on admission from the OR

ICU patient, cardiac surgery, no DM

Ignoring the national guidelines – what would be **your goal** glucose in this patient?

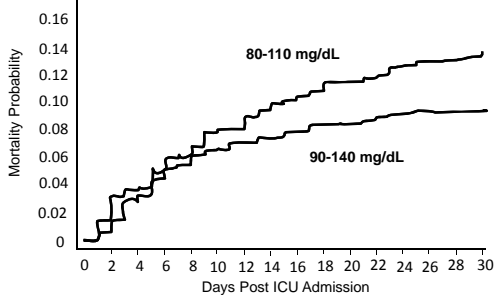
- a. Less than 180 mg/dL
- b. Less than 150 mg/dL
- c. 80-110 mg/dL
- d. Other?

Target Blood Glucose: Patients Without Diabetes



Lanspa MJ et al. *Chest*. 2013; 143:1226-34 (adapted).

Target Blood Glucose: Patients With Diabetes



Lanspa MJ et al. *Chest*. 2013; 143:1226-34 (adapted).

In your opinion what is the most important barrier to glucose management in the ICU?



- a. Inadequate insulin protocol
- b. No consensus on the goal level
- c. Lack of compliance
- d. Acceptance of hyperglycemia to avoid risk of hypoglycemia

Barriers to Inpatient Glucose Management

- Health care system and workers
- No consensus regarding goals
- No published "how to"
- No standardized approach to testing and treatment
- Inadequate insulin drip protocol
- Lack of compliance
- Fear of hypoglycemia
- Culture
- Inaccuracy of point-of-care testing
- Lack of education
- Poor communication
- Lack of health care resources

Anger KE et al. *Pharmacotherapy*. 2006; 26:214-28.

In your opinion are all IV insulin protocols essentially equal?

- Yes
- No
- Not sure

The "Fixed" Protocol

Blood Glucose (mg/dL)	Action
< 50	<ul style="list-style-type: none"> • Stop insulin; give 25 mL of 50% dextrose; recheck BG in 30 minutes • When BG >75 mg/dL, restart with rate 50% of previous rate
50 – 75	<ul style="list-style-type: none"> • Stop insulin; if previous BG >100 mg/dL, then give 25 mL of 50% dextrose; recheck BG in 30 minutes • When BG >75 mg/dL, restart with rate 50% of previous rate
76 –100	<ul style="list-style-type: none"> • If <10 mg/dL lower than last test, decrease rate by 0.5 units/hr • If >10 mg/dL lower than last test, decrease rate by 50% • If ≥ last test result, maintain same rate
101 – 150	• Same rate
151 – 200	<ul style="list-style-type: none"> • If 20 mg/dL lower than previous test, same rate • If higher than previous test, increase by 0.5 units/hr
> 200	<ul style="list-style-type: none"> • If ≥30 mg/dL lower than last test, use same rate • If <30 mg/dL lower than last test (OR if higher than last test), increase rate by 1 unit/hr

Furnary AP et al. *Endocr Pract*. 2004; 10(Suppl 2):21-33.

See enlargement, p. 21

Multiplication Factor Concept

$$\begin{aligned} &\text{CURRENT RATE} \\ &\quad \times \\ &\text{ADJUSTMENT FACTOR} \\ &\text{(this factor based on rate of change in} \\ &\quad \text{BBG over time)} \\ &= \\ &\text{NEW RATE} \end{aligned}$$

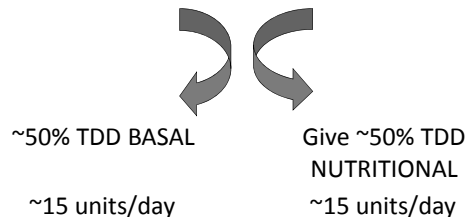
BBG = bedside blood glucose

Optimizing Care of the Inpatient with Hyperglycemia Is Challenging!

- Inpatient situations are unstable
- No single algorithm is suitable for all patients
- Many scenarios require increased monitoring and possible adjustments in insulin dose

Estimating Initial Insulin Regimen

Estimate total daily dose (TDD)
 $0.5 \text{ units/kg/day} \times 60 \text{ kg} = 30 \text{ units/day}$



Insulin Needs in Special Patient Populations

- NPO patients
- Patients receiving high dose steroids
- Patients receiving continuous enteral tube feeds
- Patients on cycled enteral tube feeds
- Patients on different home regimens
- Patients on insulin drip and eating meals
- Patients to transition from IV to SC insulin

Case: 65 y/o woman - NPO

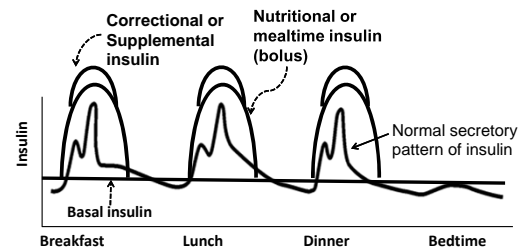
- 80 kg, no history of diabetes
- NPO
- Admitted to general surgery ward
 - Intra-abdominal abscess
- First glucose value = 201 mg/dL

How should this patient's glucose be managed in-house?

80-kg, NPO, BG 201

1. BBG frequency
 - Every 6 hr
2. TDD insulin ($\sim 0.5-0.7$ units/kg/day)
 - $80 \text{ kg} \times 0.5 \text{ units/kg/day} = 40 \text{ units/day}$
3. Basal ($\sim 50\%$ TDD)
 - NPH 10 units q12hr or long-acting insulin 20 units HS
4. Nutritional (prandial) ($\sim 50\%$ TDD)
 - 0
5. Correctional ($<40_{\text{mg/dL}}$, $40-80_{\text{mg/dL}}$, $>80_{\text{mg/dL}}$)
 - Medium dose algorithm, rapid-acting insulin q6hr

Maintaining Physiologic Insulin Delivery in the Hospital: Basal Bolus



Hirsch IB. Insulin analogues. *N Engl J Med.* 2005; 352:174–83. EL4, review.

Case: 70 y/o with T2DM - Steroid

- Home regimen
 - Metformin 1000 mg twice daily
 - Admitted with exacerbation of COPD
 - Starting methylprednisolone 40 mg IV q8hr
 - Eating meals
 - 100 kg
 - Lab blood glucose 250 mg/dL, SCr 1.0 mg/dL
- How should this patient's diabetes be managed while in house?

COPD = chronic obstructive pulmonary disease

When starting a basal bolus insulin regimen for a patient with steroid-induced hyperglycemia, what percent of TDD should come from basal component?



- 40%
- 50%
- 60%
- Not sure

Hyperglycemia and Steroids

- Common complication of glucocorticoid therapy
 - Prevalence 20-50% among patients without prior history of diabetes
- Results from
 - Increases in hepatic glucose production
 - Impairment of glucose uptake in peripheral tissues
- Contributes to **increases in postprandial glucose**
- Predictors
 - Total glucocorticoid dose
 - Duration of glucocorticoid therapy
 - Increasing age

Umpierrez GE et al. *J Clin Endocrinol Metab.* 2012; 97:16-38.
 Clore JN et al. *Endocr Pract.* 2009; 15:469-74.

100 kg, eating meals, BG 250

1. BBG frequency
 - qAC and qHS
2. TDD insulin (~0.5-0.7 units/kg/day)
 - 100 kg X 0.7 units/kg/day = 70 units/day
3. Basal (~40% TDD)
 - NPH 14 unit q12hr or long-acting 28 units qHS
4. Nutritional (prandial) (~60% TDD)
 - Rapid-acting 14 units qAC
5. Correctional (<40_{mg/dL}, 40-80_{mg/dL}, >80_{mg/dL})
 - Medium dose algorithm, rapid-acting qAC

Case: 70 y/o with T2DM – High Home Insulin Requirement

- Home regimen
 - Long-acting insulin 80 units qHS, metformin 1000 mg twice daily
- Admitted with exacerbation of congestive heart failure
- Eating discrete meals
- 90 kg
- Lab blood glucose 250 mg/dL, SCr 1.0 mg/dL

90 kg, high home requirement - eating meals

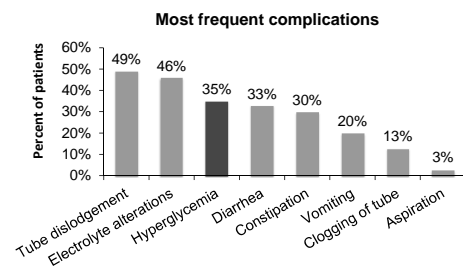
1. BBG frequency
 - qAC and qHS
2. TDD insulin (~0.5-0.7 units/kg/day) vs. home
 - 90 kg X 0.5 units/kg/day = 45 units/day vs. 80 units/day home
3. Basal (~50% TDD)
 - Long-acting insulin 40 units qHS
4. Nutritional (prandial) (~50% TDD)
 - Rapid-acting insulin 14 units qAC
5. Correctional (<40_{mg/dL}, 40-80_{mg/dL}, >80_{mg/dL})
 - Medium dose algorithm, rapid-acting qAC

Case: 67 y/o with T2DM – Continuous Tube Feedings

- Home regimen: diet and exercise
- Continuous tube feedings
- 60 kg
- Lab blood glucose 190 mg/dL
- Repeat Point of Care glucose 195 mg/dL

Complications of Enteral Nutrition

Prospective and observational study in 64 patients (mean age 76.2 yr) receiving EN on internal medicine inpatient unit

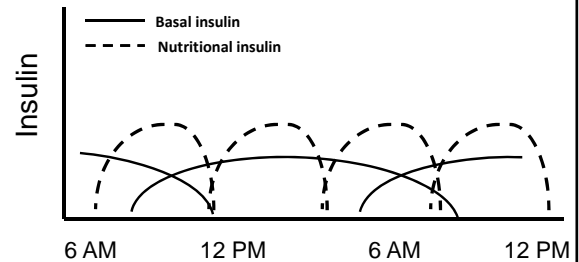


Pancorbo-Hidalgo PL et al. *J Clin Nurs.* 2001; 10:482-90.

T2DM, tube feedings, 60 kg

1. BBG frequency
 - Every 6 hr
2. TDD insulin ($\sim 0.5-0.7$ units/kg/day)
 - $60 \text{ kg} \times 0.5 \text{ units/kg/day} = 30 \text{ units/day}$
3. Basal ($\sim 40\%$ TDD)
 - 12 units long-acting insulin q24hr
4. Nutritional (prandial) ($\sim 60\%$ TDD)
 - 5 units regular insulin q6hr
5. Correctional ($<40_{\text{mg/dL}}$, $40-80_{\text{mg/dL}}$, $>80_{\text{mg/dL}}$)
 - Low dose algorithm, regular q6hr

Insulin Requirement During Continuous Dextrose, TPN, or Enteral Feedings



Case: Cycled tube feedings, no previous diabetes

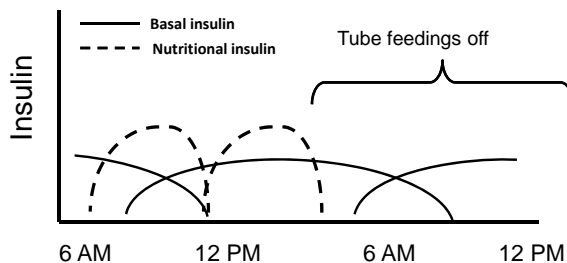
- Previously NPO with FPG 90 mg/dL
- Tube feeding on 12 hours, off 12 hours
- 70 kg
- FPG (laboratory) 250 mg/dL while feedings run

FPG = fasting plasma glucose

70 kg, tube feedings

1. BBG frequency
 - Every 6 hr
2. TDD insulin ($\sim 0.5-0.7$ units/kg/day)
 - $70 \text{ kg} \times 0.5 \text{ units/kg/day} = 35 \text{ units/day}$
3. Basal ($\sim 40\%$ TDD)
 - NPH 7 units twice daily or 14 units long-acting q24hr
4. Nutritional ($\sim 60\%$ TDD – but only when on feedings)
 - Regular 5 units q6hr X2 per day, starting at start of 12-hr cycle feed
5. Correctional ($<40_{\text{mg/dL}}$, $40-80_{\text{mg/dL}}$, $>80_{\text{mg/dL}}$)
 - Low dose algorithm, regular SC q6hr

Insulin Requirement During Cycled Dextrose, TPN, or Enteral Feedings



Glycemic Management of the Patient Receiving Enteral Nutrition

- Continuous enteral nutrition (EN)
 - Basal: 40-50% of TDD as long- or intermediate-acting insulin given once or twice a day
 - Short-acting insulin 50-60% of TDD given every 6 hr
- Cycled enteral nutrition
 - Intermediate-acting insulin given together with a rapid- or short-acting insulin with start of tube feeding
 - Rapid- or short-acting insulin administered every 4-6 hr for duration of EN administration
 - Correctional insulin given for BG above goal range
- Bolus enteral nutrition
 - Rapid-acting or short-acting insulin given prior to each bolus feeding

Umpierrez GE et al. *J Clin Endocrinol Metab.* 2012; 97:16-38.

Case: ICU patient, eating meals while on IV insulin

- 55-year-old man admitted to cardiac surgery ICU post valve replacement
- No history of diabetes
- Now postoperative day 2; ready to start eating meals
- Glucose is 150 mg/dL on average of 3 units/hr of IV regular insulin over the past 6 hours

ICU Patient; on IV drip; eating meals

1. BBG frequency
 - Every 1 hr (or per protocol)
2. Basal (from IV drip protocol)
 - Per protocol – current dose 3 units/hr
3. Nutritional (prandial) (~ unit/hr dose)
 - Rapid-acting insulin 3 units SC before meal (or equal to that hour's IV insulin rate)
4. Correctional (<40_{mg/dL}, 40-80_{mg/dL}, >80_{mg/dL})
 - Covered by the drip

Case: Transition from IV to SC Insulin

- 68 y/o man admitted for exacerbation of COPD
- 80 kg
- ICU day 4: patient is extubated
- No history of diabetes
- Continuous tube feedings
- Glucose is 150 mg/dL on IV regular insulin 3 units/hr

Transition from IV to SC insulin, continuous tube feedings on 3 units/hr

1. BBG frequency
 - Every 6 hr
2. Estimated TDD
 - 3 units/hr X 24 hr/day X 0.6 ish ~ 44 units/day
3. Basal Insulin (~40% TDD)
 - Long-acting insulin 17 units q24hr
4. Nutritional insulin (~60% TDD)
 - 7 units regular insulin q6hr
5. Correctional (<40_{mg/dL}, 40-80_{mg/dL}, >80_{mg/dL})
 - Medium dose algorithm, regular insulin q6hr

Umpierrez GE et al. *J Clin Endocrinol Metab.* 2012; 97:16-38.
Rocchio MA et al. *Diabetes Metab Syndr Obes.* 2013; 6:389-92.

Approach to Hyperglycemia in Hospitalized Patients

1. Inpatient situations are unstable
2. Change from home to inpatient regimen
3. No single algorithm suitable for all patients
4. Daily adjustment of insulin regimen
5. Reassess medications when planning for discharge → change back to appropriate outpatient (home) regimen

Have a Discharge Plan Tailored to Patient!

- Diabetes and insulin education, survival skills: START EARLY and repeat
- Follow up and community resources
- Covered by insurance
- Patient and family can understand
- Reconcile medications
- Language, health literacy, and cultural barriers
- Use A1c
- Insulin requirement may decrease post discharge

Conclusion

- Insulin protocols for managing hyperglycemia needed in wide variety of inpatient populations
- Pharmacists can play important role in protocol development and glycemic control
 - Obtain buy-in from key opinion leaders
 - Facilitate transition from inpatient to outpatient setting
- Additional research needed to identify optimal approach to providing glycemic control with insulin in inpatient setting

Case Vignette 1



An 82 y/o woman is admitted for community-acquired pneumonia and altered mental status

- History of hypertension and T2DM, otherwise healthy
- A1c last month was 6.2% on metformin 500 mg twice daily
- Blood glucose at time of admission 170 mg/dL
- Weighs 55 kg

What medications for diabetes would you start at the time of admission?

- a. Continue metformin at outpatient dose
- b. Increase metformin to 1000 mg twice daily
- c. Withhold metformin, start lispro correction scale qAC and qHS; add basal glargine if consistently hyperglycemic
- d. Withhold metformin, start glargine 20 units/day + lispro 7 units qAC

Case Vignette 2



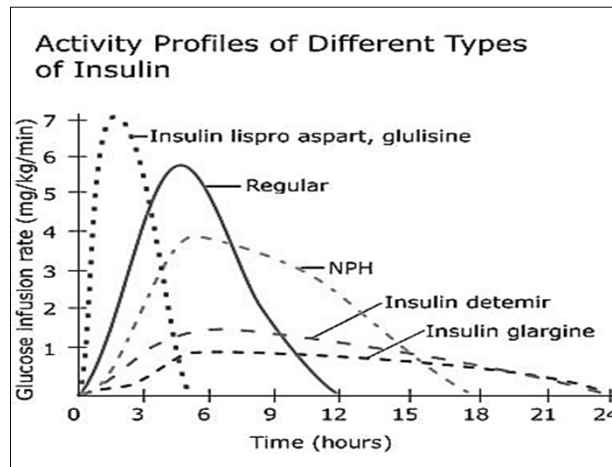
A 28 y/o man with T1DM is admitted with a displaced tib/fib fracture after a motor vehicle accident

- Blood glucose 110-200 mg/dL on outpatient regimen of glargine 10 units qHS, lispro 3 units qAC, + correction scale lispro qAC and qHS
- Nurse pages you because blood glucose at 9 pm is 88 mg/dL, and he is NPO at midnight for surgery tomorrow

What should you do with his insulin regimen?

- a. Give glargine 10 units as scheduled & small bedtime snack
- b. Withhold glargine, start regular correction scale every 6 hr; resume glargine after OR
- c. Give 50% of scheduled glargine (5 units), change to lispro 2 units every 6 hr while NPO
- d. Discontinue glargine/lispro & convert to equivalent dose of regular while NPO (start regular 5 units every 6 hr at midnight)

Types of Insulin



Diabetes Education Online: Diabetes Education Center at the University of California, San Francisco. Types of insulin. URL in ref list. Used with permission.

Case Vignette 3

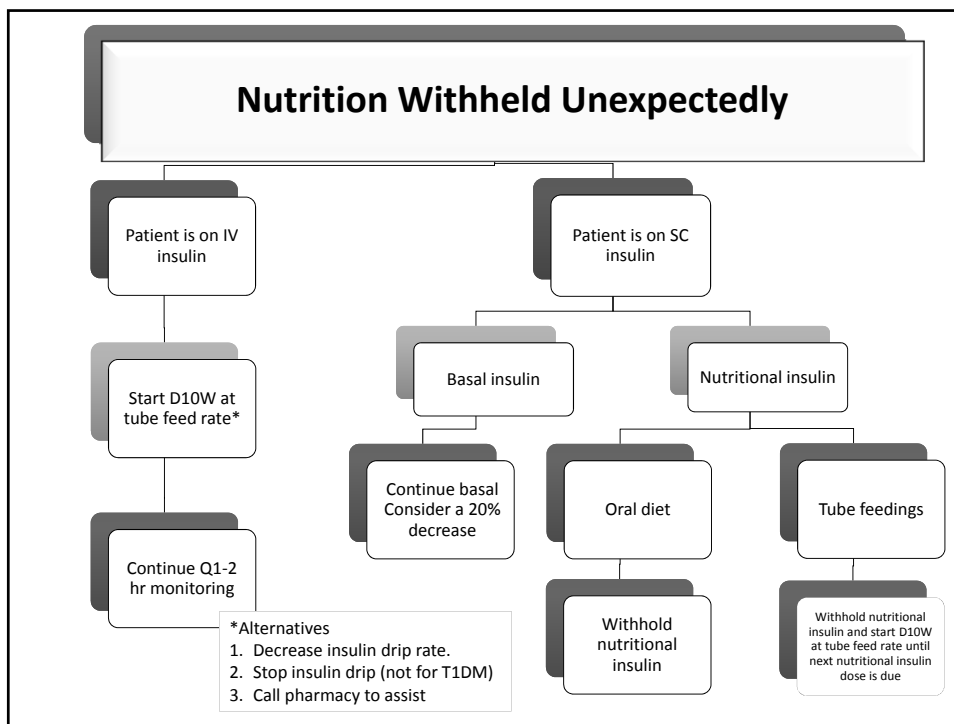


A 58 y/o man with T2DM is intubated in the burn ICU after being injured in electrical fire. He is receiving feedings at 70 mL/hr through a flexible, small diameter feeding tube.

- Blood glucose has been well controlled on regimen of glargine 40 units qHS and regular insulin 10 units every 6 hr
- At 1 AM the patient pulls out his feeding tube and nurses are having great difficulty reinserting it. He was last given his regular insulin at midnight.

What is the first thing that should be done?

- a. Continue insulin as scheduled, page you again if tube not replaced in next 4 hr
- b. Start D10W 70 mL/hr as substitute for nutritional carbohydrates from interrupted tube feedings
- c. Withhold the next dose of glargine and regular insulin
- d. Administer glucagon to prevent hypoglycemia



Case Vignette 4



A 79 y/o man with hypertension, T2DM is admitted for aortic valve replacement

- Blood glucose well controlled as outpatient on metformin 1000 mg twice daily and glipizide 5 mg twice daily; no hypoglycemia (A1c 6.8%)
- Postop course is complicated by pneumonia, and he remains in ICU for 3 days on an insulin drip
- Slowly improves, is transitioned to glargine/lispro regimen
- By day 8 is ready for discharge; blood glucose has been well controlled on glargine 25 units qHS and lispro 7 units qAC

What diabetes regimen should you prescribe on discharge to ensure good blood glucose control at home?

- Resume outpatient regimen of metformin and glipizide
- Discontinue outpatient regimen, continue inpatient insulin regimen
- Resume outpatient regimen, continue glargine 25 units qHS
- Restart metformin, add lispro correction scale qAC prn glucose > 150 mg/dL

Transition Guide from Inpatient to Outpatient Regimen

A1c <7% And no significant hypoglycemia	A1c 7-10%*	A1c >10%*
Return to same regimen as prior to admission (oral agents and/or insulin)	Restart outpatient oral agents, optimize oral agents, consider adding basal insulin once daily at 50% inpatient dose	Restart outpatient oral agents, optimize oral agents, add basal insulin once daily at 75% inpatient dose Alternative: stop oral agents and start 70/30 or basal/bolus at same inpatient dose
*Ensure compliance with home regimen, maximize lifestyle changes, optimize oral agents, and add insulin according to finances, adherence, and lifestyle on individual basis		

Adapted with permission from algorithm by Umpierrez G. Emory University School of Medicine, 2011.

Guidelines from Professional Organizations on ICU Blood Glucose (BG) Goal

Year	Organization	Patient Population	BG Treatment Threshold (mg/dL)	BG Target (mg/dL)	BG Hypoglycemia Definition (mg/dL)	Updated since NICE-SUGAR, 2009
2009	American Association of Clinical Endocrinologists and American Diabetes Association	ICU	180	140–180	<70	Yes
2013	Surviving Sepsis Campaign	ICU	180	<180	Not stated	Yes
2009	Institute for Healthcare Improvement	ICU	180	<180	<40	Yes
2012	American College of Critical Care Medicine (ACCM)	ICU	150	<150 (Trauma) <180 (Stroke+)	<70	Yes
2014	American College of Physicians	ICU	Not stated	140–200	Not stated	Yes
2008	American Heart Association	ICU with ACS	180	90–140	Not stated	No

Kavanagh BP et al. *N Engl J Med.* 2010; 363:2540-6.
Qaseem A et al. *Ann Intern Med.* 2011; 154:260-7.
Dellinger R et al. *Crit Care Med.* 2013; 41:580-637.

Jacobi J. *Crit Care Med.* 2012; 40:3251-76.
Finfer S et al. *N Engl J Med.* 2009; 360:1283-97.
Qaseem A. *Am J Med Qual.* 2014; 29:95-8.

The "Fixed" Protocol

Blood Glucose (mg/dL)	Action
< 50	<ul style="list-style-type: none"> • Stop insulin; give 25 mL of 50% dextrose; recheck BG in 30 minutes • When BG >75 mg/dL, restart with rate 50% of previous rate
50 – 75	<ul style="list-style-type: none"> • Stop insulin; if previous BG >100 mg/dL, then give 25 mL of 50% dextrose; recheck BG in 30 minutes • When BG >75 mg/dL, restart with rate 50% of previous rate
76 –100	<ul style="list-style-type: none"> • If <10 mg/dL lower than last test, decrease rate by 0.5 units/hr • If >10 mg/dL lower than last test, decrease rate by 50% • If ≥ last test result, maintain same rate
101 – 150	<ul style="list-style-type: none"> • Same rate
151 – 200	<ul style="list-style-type: none"> • If 20 mg/dL lower than previous test, same rate • If higher than previous test, increase by 0.5 units/hr
> 200	<ul style="list-style-type: none"> • If ≥30 mg/dL lower than last test, use same rate • If <30 mg/dL lower than last test (OR if higher than last test), increase rate by 1 unit/hr

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Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

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14. Rocchio MA, Belisle CD, Greenwood BC et al. Evaluation of the maximum beyond-use-date stability of regular human insulin extemporaneously prepared in 0.9% sodium chloride in a polyvinyl chloride bag. *Diabetes Metab Syndr Obes*. 2013; 6:389-92.
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Online Source of Guidelines, Protocols, and Quality Improvement Tools

1. Society of Hospital Medicine. Glycemic control resource room. <http://www.hospitalmedicine.org/resourceroomredesign/glycemiccontrol.cfm> (accessed 2013 Oct 31).

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Other Useful Resources

1. Ahmann AJ, Maynard G. Designing and implementing insulin infusion protocols and order sets. *J Hosp Med.* 2008; 3(suppl 5):42 -54.
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Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

Self-assessment Questions

1. An 82-year-old woman is admitted to the hospital for community-acquired pneumonia and altered mental status. She has a history of hypertension and type 2 diabetes but is otherwise healthy. She takes metformin 500 mg twice daily, and her A1c last month was 6.2%. Her blood glucose at time of admission 170 mg/dL. She weighs 55 kg. What medications for diabetes would you start at the time of admission?
 - a. Continue metformin at outpatient dose.
 - b. Increase metformin to 1000 mg twice daily.
 - c. Withhold metformin, start insulin lispro correction scale before each meal and at bedtime; add basal insulin glargine if consistently hyperglycemic.
 - d. Withhold metformin, start basal insulin glargine 20 units/day plus insulin lispro 7 units before each meal.
2. A 58 year-old man with type 2 diabetes is intubated in the burn intensive care unit after being injured in an electrical fire. He is receiving feedings at 70 mL/hr through a flexible, small diameter feeding tube. His blood glucose has been well controlled on a regimen of insulin glargine 40 units at bedtime and regular insulin 10 units every 6 hours. At 1 AM the patient pulls out his feeding tube, and nurses are having great difficulty reinserting it. He was last given his regular insulin at midnight. What is the first thing that should be done?
 - a. Continue insulin as scheduled, page you again if tube not replaced in next 4 hours.
 - b. Start D10W 70 mL/hr as substitute for nutritional carbohydrates from interrupted tube feedings.
 - c. Withhold the next dose of glargine and regular insulin.
 - d. Administer glucagon to prevent hypoglycemia.
3. In regard to target blood glucose levels in the critical care setting, recent literature suggests
 - a. Patients without diabetes may benefit from a lower goal compared with patients with diabetes.
 - b. Patients with diabetes may benefit from a lower goal compared with patients without diabetes.
 - c. Patients with and without diabetes should have the same goal.
4. All of the following would be effective approaches for improving the management of inpatient hyperglycemia EXCEPT
 - a. Provide ongoing education for nurses and physicians on preventing and managing hypoglycemia.
 - b. Develop a standardized algorithm or protocol for managing hyperglycemia that can be used for all patients.
 - c. Develop a transition plan for patients before discharge that addresses patient preferences and their need for education.
 - d. Engage an interdisciplinary glycemic control team that has the support of key opinion leaders in the hospital.

Answers


1. c
2. b
3. a
4. b

Ask the Experts: Real-world Approaches for Managing Hyperglycemia in Hospitalized Patients

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