

Mayo Clinic Inpatient Hyperglycemia and Diabetes Mellitus:

Management from Admission to Discharge

Participant Guide

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Mayo Clinic INPATIENT HYPERGLYCEMIA AND DIABETES MELLITUS: MANAGEMENT FROM ADMISSION TO DISCHARGE Enduring Material

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Mayo Clinic INPATIENT HYPERGLYCEMIA AND DIABETES MELLITUS: MANAGEMENT FROM ADMISSION TO DISCHARGE Enduring Material

Activity Profile

Inpatient Hyperglycemia and Diabetes Mellitus: Management from Admission to Discharge is designed as an interactive online educational activity comprised of six (6) modules. The activity begins with a brief video introduction and a review of current standards of care, followed by a review of what we currently know about the status of inpatient diabetes care. The course then progresses through a discussion about initial management steps to take at admission, ending with suggestions about discharge planning. Along the way, an overview is given on insulin management, with an opportunity to practice dosing calculations.

Modules:

- 1. Current Standards for Management of Inpatient Diabetes and Hyperglycemia
- 2. Epidemiology, Current Status of Inpatient Glycemic Control, and Clinical Inertia
- 3. Initial Triage and Approach to the Patient
- 4. Principles of Pharmacologic Management of Hospital Hyperglycemia: Understanding How to Use Insulin
- 5. Pharmacologic Management of Hospital Hyperglycemia: Practical Application of Insulin Therapy
- 6. Getting the Patient Ready for Discharge

Participation for CME credit in this activity consists of:

- Reviewing each of the six modules in sequential order and answering "knowledge check" questions throughout
- Participants are permitted up to two attempts and must score 80% or better to complete the activity for CME credit.
- Completion of evaluation

The goal of this course is to provide a high-level overview of care, rather than to delve into every management situation that might be encountered.

Participants are required to progress sequentially from the first module to the next, and not randomly from topic to topic. The modules are designed to be interactive and require participants to respond to questions at the end of each module. Participants must achieve 80% or better on the post-test assessment to successfully complete this activity.

Original Release Date: August 1, 2016, 12:01 a.m.

Credits Expire: July 31, 2018, 11:59 p.m.

Duration/Completion Time: 3 hours (0.5 hours per module)

Upon completion of registration, learners can access the activity via this website: https://ce.mayo.edu/hospital-medicine/node/19995

Prerequisites for Participation

There are no prerequisites for physicians needed prior to participation in this continuing education activity.

Customer Service / Technical Support

For **educational activity support**, contact Mayo School of Continuous Professional Development directly at telephone 480-301-4580 or email mca.cme@mayo.edu. Standard business hours are Monday – Friday, 8 a.m. – 5 p.m. (MT).

For **technical support**, contact Mayo Clinic Education Technology Center at 507-266-9087 or email etc@mayo.edu. Standard business hours are Monday – Friday, 8 a.m. – 5 p.m. (CT).

Mayo Clinic INPATIENT HYPERGLYCEMIA AND DIABETES MELLITUS: MANAGEMENT FROM ADMISSION TO DISCHARGE Enduring Material

Activity Description

Managing diabetes or hyperglycemia in the hospital setting can be challenging. Inpatients with hyperglycemia generally fall into 3 categories: persons with known diabetes, individuals with newly diagnosed diabetes, and patients who have hyperglycemia due to other causes such as stress from acute illness or due to certain medications like steroids. Regardless of the etiology of hyperglycemia, there is little doubt that uncontrolled hyperglycemia is associated with higher morbidity and mortality.

Previous excitement over the benefits of tight glucose control in the critically ill patient has since been tempered by concerns about the dangers of hypoglycemia that occurs with any attempt to tightly control glucose levels. Despite the controversies that exist regarding inpatient glucose targets, there is agreement among specialty societies that hyperglycemia in the inpatient setting cannot be ignored.

This activity is designed to provide some basic guidance about how to approach management of the patient with hyperglycemia or diabetes in the hospital setting. Our focus is the non-critically ill adult, non-obstetrical inpatient.

Learning Objectives

Upon completion of this activity, participants should be able to:

- Discuss current standards of inpatient care for the patient with hyperglycemia or diabetes.
- Review current knowledge of quality of inpatient diabetes care.
- Describe general principles of inpatient management of hyperglycemia and diabetes.
- Demonstrate how to employ insulin therapy in the hospital

Intended Audience

This activity is designed for physicians practicing in internal medicine, hospital internal medicine, family practice and general surgery. Any specialists, physician assistants, nurse practitioners, or residents who care for inpatients with hyperglycemia or diabetes may benefit from this activity.

Disclaimer

Participation in this Mayo Clinic educational activity does not indicate nor guarantee competence or proficiency in the performance of any procedures which may be discussed or taught in this activity. You should be aware that substantive developments in the medical field covered by this activity may have occurred since the date of original release.

Continuing Education Credit

Mayo Clinic College of Medicine is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

Mayo Clinic College of Medicine designates this enduring material for a maximum of 3.0 AMA PRA Category 1 CreditsTM. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

CME Activity Evaluation

The overall CME activity evaluation will be available in the course outline. The CME activity evaluation is brief and will only take a few minutes to complete. Your feedback is very important to us and will be used for planning future online educational programs.

Requesting CME Credit / Record of Attendance

To achieve successful completion of this activity, participants complete the following:

- Review each of the six modules in sequential order and answer "knowledge check" questions throughout
- Participants are permitted up to two attempts and must score 80% or better to complete the activity for CME credit.
- Complete activity evaluation

An electronic Record of Attendance (ROA) will be available in the MSCPD registration system, EthosCE. Upon conclusion of the CME activity, participants may claim credit and will receive a confirmation page reflecting the number of credits awarded for the activity and may then download the ROA. A copy of your ROA or a full transcript can be printed at any time from "My Account". The ROA can be used for requesting credits in accordance with state licensing boards, specialty societies, or other professional associations.

Faculty

Course Directors

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Faculty, Planning Committee and Provider Disclosure Summary

Inpatient Hyperglycemia and Diabetes Melli	tus:
Management from Admission to Discharge	

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Listed below are individuals with control of the content of this program who have disclosed...

Relevant financial relationship(s) with industry:

Name	Nature of Relationship	Company	
None			

No relevant financial relationship(s) with industry:

Name

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References to off-label and/or investigational usage(s) of pharmaceuticals or instruments in their presentation:

Name	Manufacturer/Provider	Product/Device	
None			

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This activity is supported in part by educational grants from the following companies in accordance with ACCME Standards:

Lilly
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Module 1 – Current Standards for Management of Inpatient Diabetes and Hyperglycemia

- 1. American Diabetes Association. Standards of Medical Care in Diabetes—2014. Diabetes Care. 2014 Jan; 37(Suppl 1):S14-S80. doi:10.2337/dc14-S014
- 2. Umpierrez GE, Hellman R, Korytkowski MT, Kosiborod M, Maynard GA, Montori VM, Seley JJ, Van den Berghe G; Endocrine Society. Management of hyperglycemia in hospitalized patients in non-critical care setting: an endocrine society clinical practice guideline. J Clin Endocrinol Metab. 2012 Jan;97(1):16-38. doi: 10.1210/jc.2011-2098.
- 3. Deedwania P, Kosiborod M, Barrett E, Ceriello A, Isley W, Mazzone T, Raskin P. (2008). Hyperglycemia and acute coronary syndrome: a scientific statement from the American Heart Association Diabetes Committee of the Council on Nutrition, Physical Activity, and Metabolism. *Circulation*. 2008;117(12):1610-1619. 10.1161/CIRCULATIONAHA.107.188629

<u>Module 2 – Epidemiology, Current Status of Inpatient Glycemic Control and Clinical Inertia</u>

- 4. Hospital Discharges with Diabetes as Any-Listed Diagnosis, United States, 1988–2009. From http://www.cdc.gov/diabetes/statistics/dmany/fig1.htm
- 5. Yang W, Dall TM, Halder P, Gallo P, Kowal SL, Hogan PF, (American Diabetes Association). Economic costs of diabetes in the U.S. in 2012. Diabetes Care. 2013;36:1033–1046.
- 6. Cook C, Elias B, Kongable G, Potter D, Shepherd K, McMahon D. Diabetes and Hyperglycemia Quality Improvement Efforts in Hospitals in the United States: Current Status, Practice Variation, and Barriers to Implementation. Endocrine Practice. 2010 Mar;16(2):219-230.
- 7. Bersoux S, Cook C, Kongable G, Shu J, Zito D. Benchmarking Glycemic Control in U.S. Hospitals. Endocrine Practice. 2014 Sep;20(9):876-883.
- 8. Cook CB, Ziemer DC, El-Kebbi I, et al. Diabetes in urban African-Americans. XVII. Improved diabetes management over five years with nurse provider-led care at a large municipal hospital. Diabetes Care. 1999;22:1494-1500.
- 9. Cook CB, Castro JC, Schmidt RE, et al. Diabetes care in hospitalized noncritically ill patients: more evidence for clinical inertia and negative therapeutic momentum. J Hosp Med. 2007;2:203–211.

- 10. Schnipper JL, Barsky EE, Shaykevich S, Fitzmaurice G, Pendergrass ML. Inpatient management of diabetes and hyperglycemia among general medicine patients at a large teaching hospital. J Hosp Med. 2006;1:145–150
- 11. Green Conaway DL, Enriquez JR, Barberena JE, Jones PG, O'Keefe JH Jr, Spertus JA. Assessment of and physician response to glycemic control in diabetic patients presenting with an acute coronary syndrome. Am Heart J. 2006;152:1022–1027.
- 12. Griffith ML, Boord JB, Eden SK, et al. Clinical inertia of discharge planning among patients with poorly controlled diabetes mellitus. J Clin Endocrinol Metab. 2012;97:2019–2026.
- 13. Apsey H, Coan K, Castro J, Jameson K, Schlinkert R, Cook C. Overcoming clinical inertia in the management of postoperative patients with diabetes. Endocrine Practice. 2014 Apr;20(4):320-328.
- 14. Mackey P, Boyle M, Walo P, Castro J, Cheng MR, Cook C. Care directed by a specialty-trained Nurse Practitioner or Physician Assistant can overcome clinical inertia in management of inpatient diabetes. Endocrine Practice. 2014 Feb;20(2):112-119.
- 15. Hermayer KL, Cawley P, Arnold P, Sutton A, Crudup J, Kozlowski L, Hushion TV, Sheakley ML, Epps JA, Weil RP, Carter RE. Impact of improvement efforts on glycemic control and hypoglycemia at a university medical center. J Hosp Med. 2009;4:331–339.
- 16. Murphy DM, Vercruysse RA, Bertucci TM, Wall MJ, Schriever AE, Nabhan FA, Barron WM, Emanuele MA. Reducing hyperglycemia hospital-wide: the basal-bolus concept. Jt Comm J Qual Patient Saf. 2009;35:216–223.
- 17. Maynard G, Lee J, Phillips G, Fink E, Renvall M. Improved inpatient use of basal insulin, reduced hypoglycemia, and improved glycemic control: effect of structured subcutaneous insulin orders and an insulin management algorithm. J. Hosp. Med. 2009;4:3–15. doi: 10.1002/jhm.391
- 18. Schnipper JL, Ndumele CD, Liang C L, Pendergrass ML. Effects of a subcutaneous insulin protocol, clinical education, and computerized order set on the quality of inpatient management of hyperglycemia: Results of a clinical trial. J Hosp Med. 2009;4:16–27. doi: 10.1002/jhm.385
- 19. Schnipper J, Liang C, Ndumele C, Pendergrass M. Effects of a computerized order set on the inpatient management of hyperglycemia: a cluster-randomized controlled trial. Endocrine Practice. 2010 Mar;16(2):209-218.
- 20. Wexler DJ, Shrader P, Burns SM, Cagliero E. Effectiveness of a computerized insulin order template in general medical inpatients with type 2 diabetes: a cluster randomized trial. Diabetes Care. 2010;33:2181–2183.

21. Donihi AC, Gibson JM, Noschese ML, et al. Effect of a targeted glycemic management program on provider response to inpatient hyperglycemia. Endocrine Practice. 2011;17:552-557. doi: http://dx.doi.org/10.4158/EP10330.OR

Module 3 – Initial Triage and Approach to the Patient

- 22. Cook CB, Wilson RD, Hovan MJ, Hull BP, Gray RJ, Apsey HA. Development of computer-based training to enhance resident physician management of inpatient diabetes. J Diabetes Sci Technol. 2009 Nov;3:1377-1387. doi:10.1177/193229680900300618
- 23. Stolker JM, Spertus JA, McGuire DK, et al. Relationship between glycosylated hemoglobin assessment and glucose therapy intensification in patients with diabetes hospitalized for acute myocardial infarction. Diabetes Care. 2012;35:991–993.
- 24. Robbins JM, Webb DA. Diagnosing diabetes and preventing rehospitalizations: the urban diabetes study. Med Care. 2006;44:292–296.
- 25. Dungan KM. The effect of diabetes on hospital readmissions. J Diabetes Sci Technol. 2012 Sep;6: 1045-1052. doi:10.1177/193229681200600508

<u>Module 4 – Principles of Pharmacologic Management of Hospital Hyperglycemia:</u> <u>Understanding How to Use Insulin</u>

- 26. Cook CB, Wilson RD, Hovan MJ, Hull BP, Gray RJ, Apsey HA. Development of computer-based training to enhance resident physician management of inpatient diabetes. J Diabetes Sci Technol. 2009 Nov;3:1377-1387. doi:10.1177/193229680900300618
- 27. Umpierrez GE, Smiley D, Zisman A, et al. Randomized study of basal-bolus insulin therapy in the inpatient management of patients with type 2 diabetes (RABBIT 2 trial). Diabetes Care. 2007;30:2181–2186.
- 28. Umpierrez GE, Smiley D, Jacobs S, 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). Diabetes Care. 2011;34:256–261.
- 29. Umpierrez GE, Smiley D, Hermayer K, et al. Randomized study comparing a basal-bolus with a basal plus correction insulin regimen for the hospital management of medical and surgical patients with type 2 diabetes: basal plus trial. Diabetes Care. 2013;36:2169–2174.

<u>Module 5 – Pharmacologic Management of Hospital Hyperglycemia: Practical Application of Insulin Therapy</u>

None

Module 6 – Getting the Patient Ready for Discharge

- 31. Cook CB, Wilson RD, Hovan MJ, Hull BP, Gray RJ, Apsey HA. Development of computer-based training to enhance resident physician management of inpatient diabetes. J Diabetes Sci Technol. 2009 Nov;3:1377-1387. doi:10.1177/193229680900300618
- 32. Wheeler K, Crawford R, McAdams D, *et al.* Inpatient to outpatient transfer of care in urban patients with diabetes: patterns and determinants of immediate postdischarge follow-up. *Archives of Internal Medicine*. 2004;**164**:447–453.
- 33. Forster AJ, Clark HD, Menard A, et al. Adverse events among medical patients after discharge from hospital. CMAJ. 2004;170:345–349.
- 34. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. Ann Intern Med. 2003;138:161–167.
- 35. Wheeler K, Crawford R, McAdams D, *et al.* Inpatient to outpatient transfer of care in urban patients with diabetes: patterns and determinants of immediate postdischarge follow-up. *Archives of Internal Medicine*. 2004;**164**:447–453.
- 36. Rhee MK, Slocum W, Ziemer DC, Culler SD, Cook CB, El-Kebbi IM, Gallina DL, Barnes C, Phillips LS. Patient adherence improves glycemic control. *Diabetes Educ.* 2005 MarApr;31(2):240–250.
- 37. Dungan KM. Symposium: the effect of diabetes on hospital readmissions. J Diabetes Sci Technol. 2012 Sep;6:1045-1052. doi:10.1177/193229681200600508
- 38. Wheeler K, Crawford R, McAdams D, Robinson R, Dunbar VG, Cook CB. Inpatient to outpatient transfer of diabetes care: perceptions of barriers to postdischarge followup in urban African American patients. Ethnicity and Disease. 2007;17:238-243.
- 39. Healy SJ, Black D, Harris C, Lorenz A, Dungan KM. Original Research Clinical Care/Education/Nutrition/Psychosocial Research: Inpatient diabetes education is associated with less frequent hospital readmission among patients with poor glycemic control. Diabetes Care. 2013 Oct;36(10):2960-2967; published ahead of print July 8, 2013, doi:10.2337/dc13-0108
- 40. Dungan K, Lyons S, Manu K, Kulkarni M, Ebrahim K, Grantier C, Harris C, Black D, Schuster D. An individualized inpatient diabetes education and hospital transition program for poorly controlled hospitalized patients with diabetes. Endocrine Practice. 2014 Dec;20(12):1265-1273.
- 41. Wexler DJ, Beauharnais CC, Regan S, Nathan DM, Cagliero E, Larkin ME. Impact of inpatient diabetes management, education, and improved discharge transition on glycemic control 12 months after discharge. Diabetes Res Clin Pract. 2012;98(2):249–56.

- 42. Leichter SB, August GL, Moore W. The business of hospital care of diabetic patients: 2. A new model for inpatient support services. Clin Diabetes. 2003 Jul;21(3):136-139. doi:10.2337/diaclin.21.3.136
- 43. Cook CB, Seifert KM, Hull BP, Hovan MJ, Charles JC, Miller-Cage V, et al. Inpatient to outpatient transfer of diabetes care: planning for an effective hospital discharge. Endocr Pract. 2009;15:263–269.