Body System: Emergency-Urgent Care

Session Topic: Hyperglycemic Emergency

Educational Format		Faculty Expertise Required
REQUIRED	Interactive Lecture	Expertise in the field of study. Experience teaching in the field of study is desired. Preferred experience with audience response systems (ARS). Utilizing polling questions and engaging the learners in Q&A during the final 15 minutes of the session are required.
OPTIONAL	Problem-Based Learning (PBL)	Expertise teaching highly interactive, small group learning environments. Case-based, with experience developing and teaching case scenarios for simulation labs preferred. Other workshop-oriented designs may be accommodated. A typical PBL room is set for 50-100 participants, with 7-8 each per round table. Please describe your interest and plan for teaching a PBL on your proposal form.

Professional Practice Gap	Learning Objective(s) that will close the gap and meet the need	Outcome Being Measured
• Knowledge and practice gaps differentiating hyperglycemia from diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state(HHS). • Diagnosis is challenging, in that patients with DKA and patients with HHS often both present with symptoms of hyperglycemia. • There are no large-scale studies to determine optimal management of DKA and HHS	1. Differentiate hyperglycemia from diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state(HHS). 2. List the evaluation for a patient with hyperglycemia. 3. Describe the treatment for DKA and HHS. 4. Describe the differences in the treatment of DKA in adults and in patients less than 20-years of age. 5. Identify the differences between mild, moderate and severe DKA.	Learners will submit written commitment to change statements on the session evaluation, indicating how they plan to implement presented practice recommendations.

ACGME Core Competencies Addressed (select all that apply)

X	Medical Knowledge		Patient Care
	Interpersonal and Communication Skills		Practice-Based Learning and Improvement
	Professionalism		Systems-Based Practice

Faculty Instructional Goals

Faculty play a vital role in assisting the AAFP to achieve its mission by providing high-quality, innovative education for physicians, residents and medical students that will encompass the art, science, evidence and socio-economics of family medicine and to support the pursuit of lifelong learning. By achieving the instructional goals provided, faculty will facilitate the application of new knowledge and skills gained by learners to practice, so that they may optimize care provided to their patients.

- Provide up to 3 evidence-based recommended practice changes that can be immediately implemented, at the conclusion of the session; including SORT taxonomy & reference citations
- Facilitate learner engagement during the session
- Address related practice barriers to foster optimal patient management
- Provide recommended journal resources and tools, during the session, from the American Family Physician (AFP), Family Practice Management (FPM), and Familydoctor.org patient resources; those listed in the References section below are a good place to start
    - Visit http://www.aafp.org/journals for additional resources
    - Visit http://familydoctor.org for patient education and resources
- Provide recommendations for differentiating hyperglycemia from diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state(HHS).
- Provide recommendations for the evaluation for a patient with hyperglycemia
- Provide recommendations for prescribing individualized treatment for DKA and HHS
- Provide recommendations for taking into account the differences in the treatment of DKA in adults and in patients less than 20-years of age.
- Provide recommendations for identifying the differences between mild, moderate and severe DKA

*Note – the scope of this topic is to include diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS).

Needs Assessment

Hyperosmolar hyperglycemic state (HHS) is a relatively common, life-threatening endocrine emergency that is reported in all age groups, but it most frequently affects older patients with type 2 diabetes.[1] Diabetic ketoacidosis (DKA) continues to have high rates of morbidity and mortality despite advances in the treatment of diabetes mellitus. In a study of 4,807 episodes of DKA, 14 percent occurred in persons older than 70 years, 23 percent in persons 51 to 70 years of age, 27 percent in persons 30 to 50 years of age, and 36 percent in persons younger than 30 years.[2] DKA is the most common cause of death in children and adolescents with type 1 diabetes and accounts for half of all deaths in diabetic patients younger than 24 years of age. In adult subjects with DKA, the overall mortality is <1%; however, a mortality rate >5% has been reported in the elderly and in patients with concomitant life-threatening illnesses.[3]

Practice Gaps

The number of hospital discharges with diabetic ketoacidosis (DKA) as the first-listed diagnosis increased from about 80,000 discharges in 1988 to about 140,000 in 2009.[4] Recent data from an American Family Physician (AAFP) CME Needs Assessment Survey indicate that family physicians have a statistically meaningful and significant gap in knowledge and skill necessary to provide optimal management of diabetes complications; however, medical skill ratings for diabetes and pregnancy, thyroid disease and pregnancy, and diabetic ketoacidosis exceeded mean relevance ratings.[5] More specifically, CME outcomes data from 2013 AAFP Scientific Assembly: *Diabetes-Advanced,* and 2014 and 2015 AAFP FMX (formerly Assembly): *Diabetes Complications: Recognition, Prevention, and Treatment* sessions indicate that many family

physicians have knowledge gaps with regard to underdiagnoses/misdiagnoses latent autoimmune diabetes of adults (LADA); application of current guidelines for vaccines for diabetic patients; evidence-based recommendations for pharmacologic management of co-morbid conditions; and application of guidelines for screening and diagnosis of diabetic complications.[6-8]

Patients with DKA and patients with HHS often both present with symptoms of hyperglycemia.[9] Another challenge that physicians face, is that there are no large-scale studies to determine optimal management of DKA and HHS.[10] Additionally, some recent reports suggest atypical antipsychotic medications play a significant role in the development of fatal cases of DKA.[11] Family physicians who care for patients with HIV infection should be aware that hyperglycemia is an antiretroviral-associated metabolic condition.[12]

In terms of hospital management, it has been reported that 11% of medication errors result from insulin misadministration, and insulin has been identified as one of several medications that deserve high alert status.[13] Hypoglycemia may also result from drug-dispensing errors, including mistaken administration of hypoglycemic agents to nondiabetic patients. Racial disparities exist with regard to diabetic complications. Blacks, for example, have a higher prevalence of hyperglycemia (42.3% vs. 36.7%); however, the cause for health disparities is unknown.[14] Although, several factors may account for the racial difference in hospital complications, including worse glycemic control before and during hospitalization and a higher number of comorbidities such as hypertension and CKD in Blacks compared to Whites.[14] Individualized goals for diabetes care should be considered, especially as recent studies suggest that pursuing the same glycemic goal across all racial groups could actually lead to persistent undertreatment of hyperglycemia.[15]

Physicians may improve their care of patients with a hyperglycemic emergency by engaging in continuing medical education that provides practical integration of current evidence-based guidelines and recommendations into their standards of care, including, but not limited to the following:[1,2,12]

- Venous pH may be measured as an alternative to arterial pH in persons with DKA who are hemodynamically stable and without respiratory failure.
- Serum ketone level should be used in the diagnosis and management of DKA.
- Subcutaneous insulin can be used for treatment of uncomplicated DKA.
- Bicarbonate therapy has not been shown to improve outcomes in persons with DKA, but is recommended by consensus guidelines for persons with a pH less than 6.9.
- Clinicians should consider switching antiretroviral combinations to more lipid- and/or glucose-neutral regimens if specific agents are suspected of causing or worsening significant hyperlipidemia or hyperglycemia.
- Fluid and electrolyte replacement should be initiated based on the recommendations in the ADA algorithm.
- Once fluids have been started, continuous insulin therapy can be initiated.
- Phosphate replacement should be considered only if hypophosphatemia is severe (less than 1.0 mg per dL) or if respiratory depression, anemia, and cardiac dysfunction are comorbidities.
- Patients should be assessed carefully and treated for underlying causes of hyperosmolar hyperglycemic state.

- Physicians should work with the patient, family, and caregivers to help prevent future occurrences.

These recommendations are provided only as assistance for physicians making clinical decisions regarding the care of their patients. As such, they cannot substitute for the individual judgment brought to each clinical situation by the patient's family physician. As with all clinical reference resources, they reflect the best understanding of the science of medicine at the time of publication, but they should be used with the clear understanding that continued research may result in new knowledge and recommendations. These recommendations are only one element in the complex process of improving the health of America. To be effective, the recommendations must be implemented. As such, physicians require continuing medical education to assist them with making decisions about specific clinical considerations.

Resources: Evidence-Based Practice Recommendations/Guidelines/Performance Measures

- Diabetic Ketoacidosis: Evaluation and Treatment[2]
- Hyperosmolar Hyperglycemic State[1]
- ADA: Hyperglycemic Crises in Adult Patients With Diabetes[3]
- Familydoctor.org – Diabetic Ketoacidosis (patient education)[16]

References

1. Stoner GD. Hyperosmolar hyperglycemic state. *American family physician.* 2005;71(9):1723-1730.
2. Westerberg DP. Diabetic ketoacidosis: evaluation and treatment. *American family physician.* 2013;87(5):337-346.
3. Kitabchi AE, Umpierrez GE, Miles JM, Fisher JN. Hyperglycemic Crises in Adult Patients With Diabetes. *Diabetes care.* 2009;32(7):1335-1343.
4. Centers for Disease Control and Prevention. Diabetes Data & Trends: Diabetes Complications. 2013;
5. AAFP. 2012 CME Needs Assessment: Clinical Topics. American Academy of Family Physicians; 2012.
6. American Academy of Family Physicians (AAFP). 2013 AAFP Scientific Assembly: CME Outcomes Report. Leawood KS: AAFP; 2013.
7. American Academy of Family Physicians (AAFP). AAFP Assembly CME Outcomes Report. Leawood KS: AAFP; 2014.
8. American Academy of Family Physicians (AAFP). AAFP FMX CME Outcomes Report. Leawood KS: AAFP; 2015.
9. Corwell B, Knight B, Olivieri L, Willis GC. Current diagnosis and treatment of hyperglycemic emergencies. *Emergency medicine clinics of North America.* 2014;32(2):437-452.

10. Dhatariya KK, Vellanki P. Treatment of Diabetic Ketoacidosis (DKA)/Hyperglycemic Hyperosmolar State (HHS): Novel Advances in the Management of Hyperglycemic Crises (UK Versus USA). *Current diabetes reports.* 2017;17(5):33.
11. Maletkovic J, Drexler A. Diabetic ketoacidosis and hyperglycemic hyperosmolar state. *Endocrinology and metabolism clinics of North America.* 2013;42(4):677-695.
12. Chu C, Pollock LC, Selwyn PA. HIV-Associated Complications: A Systems-Based Approach. *American family physician.* 2017;96(3):161-169.
13. Clement S, Braithwaite SS, Magee MF, et al. Management of Diabetes and Hyperglycemia in Hospitals. *Diabetes care.* 2004;27(2):553-591.
14. Fayfman M, Vellanki P, Alexopoulos A-S, et al. Report on Racial Disparities in Hospitalized Patients with Hyperglycemia and Diabetes. *The Journal of clinical endocrinology and metabolism.* 2016;101(3):1144-1150.
15. Laiteerapong N, Fairchild PC, Chou C-H, Chin MH, Huang ES. Revisiting Disparities in Quality of Care Among US Adults With Diabetes in the Era of Individualized Care, NHANES 2007–2010. *Medical care.* 2015;53(1):25-31.
16. FamilyDoctor.org. Diabetic Ketoacidosis. 2017;

