

E01: Hypoglycemia and Hyperglycemia

Sheena Osborne

Updated: December 19, 2023

Reviewed: September 29, 2023

Introduction

Diabetes mellitus (DM) is a common disease affecting the endocrine system. DM can be classified into Type 1, Type 2, and gestational diabetes. These diseases produce complications that are commonly encountered in the out-of-hospital environment, including hypoglycemia, hyperglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state (HHS). Disruptions in blood glucose levels are the hallmark of all diabetic emergencies. A typical blood glucose (BG) level is 4.0–7.0 mmol/L and may be slightly higher after meals. A blood glucose measurement < 4.0 mmol/L is considered hypoglycemia and should be corrected.

The goals of care include early recognition of abnormal blood glucose levels, followed by the immediate correction of hypoglycemia. Paramedics and EMRs/FRs should investigate the underlying cause of hypoglycemia and treat concurrent illnesses. Patients with hyperglycemia, diabetic ketoacidosis, or HHS require immediate conveyance and supportive care, often including fluid replacement.

Essentials

- Early recognition of abnormal BG levels and identification of underlying pathologies.
- Hypoglycemic patients who are able to swallow and follow commands should be given oral glucose preferentially.
- Hypoglycemic patients who are unable to follow commands should receive intravenous dextrose or intramuscular glucagon.
- Hyperglycemic patients, and those with suspected diabetic ketoacidosis or HHS, should be conveyed urgently and evaluated for possible fluid replacement.

Additional Treatment Information

- Diabetic emergencies often involve an alteration in a patient's level of consciousness. Ensure the airway is patent and manage as required.
- Patients experiencing an episode of hypoglycemia who are able to follow directions can be encouraged to eat long-acting carbohydrates (e.g., a sandwich or fruit) when available. This provides a more sustained correction of blood glucose and may be preferred over other interventions, provided paramedics or EMRs/FRs do not suspect any other underlying problems (such as infection).
- Blood glucose levels should be retested to measure the effectiveness of treatment and to confirm adequate reversal of hypoglycemia.
- During IV administration of dextrose solutions, ensure IV is patent as extravasation causes tissue necrosis.
- Fluid therapy may be necessary during diabetic emergencies. Assess for signs of dehydration and provide IV fluid if required. Patients in hyperglycemic states often become dehydrated; diabetic ketoacidosis and HHS can cause profound hypotension.
- Paramedics and EMRs/FRs must consider other causes of altered levels of consciousness, particularly in those patients whose blood glucose levels have been corrected but remain obtunded.

Referral Information

Adult patients who experience an explained hypoglycemic episode that is fully resolved may wish to decline conveyance. Patients who elect to not be conveyed must:

- Not have a concurrent acute illness
- Not have suffered a drug overdose, nor consumed excessive alcohol
- Not be taking oral hypoglycemic medications
- Not have experienced another hypoglycemic episode requiring treatment within the past 24 hours
- Not have any abnormal vital signs, including blood pressure and decreased Glasgow Coma Scale

- Not be febrile
- Have fully recovered from their hypoglycemic episode with a return to normal mentation; post-recovery blood glucose shall be ≥ 4.0 mmol/L
- Be attended to by a responsible adult who will stay with the patient for at least 4 hours
- Have completed the appropriate waivers and demonstrated, to the paramedic or EMR's satisfaction, that they understand the recommendations for follow-up care

General Information

- Causes of hypoglycemia (< 4.0 mmol/L) include: missed meals; an overdose of insulin or oral hypoglycemic agent; recent changes in medications; higher than normal amounts of physical activity; underlying illness (particularly infections); alcohol consumption; or other physiological stressors.
- Signs and symptoms of hyperglycemia include: thirst and polydipsia; polyphagia; polyuria; blurred vision; dehydration; and nausea.
- Common causes of hyperglycemia include: infection; medication changes or mismanagement; changes in diet; increased emotional stress; or a reduction in physical activity. Hyperglycemia is sometimes the initial finding prior to a diagnosis of diabetes.
- DKA is a life-threatening emergency primarily affecting Type 1 diabetics. It may represent a first-time presentation of diabetes; 25% of patients who present with DKA have no prior diagnosis of diabetes.
 - It is typically the result of an insulin deficiency and a surge in counter-regulatory hormones and can be triggered by a variety of causes. DKA results in hyperglycemia, ketosis from fatty acid breakdown, dehydration, metabolic acidosis, and electrolyte disturbances. Patients commonly present with altered levels of consciousness, nausea and vomiting, an elevated blood glucose level, abdominal pain, and a 'fruity' or ketone odor on their breath.
 - The increase in ketone body production causes a metabolic acidosis, which in turn drives compensatory hyperventilation (Kussmaul's respirations). This ventilatory rate is intended to lower PaCO_2 and counteract the decrease in pH.
- HHS, formerly known as hyperosmolar hyperglycemic nonketotic coma, is similar to DKA, though it is more common in Type 2 diabetics. Patients experience an extreme elevation in blood glucose and significant dehydration, but do not experience the same acidosis and ketosis as would be seen in DKA.
- Gestational diabetes has a similar pathogenesis as Type 2 diabetes and is the cause of glucose intolerance in pregnancy. It can be managed in the same way as diabetes mellitus and affects approximately 7% of pregnancies.

Interventions

First Responder

- Position patient in lateral position if unconscious
- Evaluate for stroke signs and symptoms
- Assess and maintain airway patency
 - → [B01: Airway Management](#)
- Provide supplemental oxygen therapy as required
 - → [A07: Oxygen Administration](#)
- Correct suspected hypoglycemia
 - For patients with sufficient mentation to maintain an airway, apply glucose gel to oral mucosa
 - [Oral 40% Glucose Gel](#)
 - For patients with insufficient mentation or an unprotected airway
 - [Glucagon](#)

Emergency Medical Responder – All FR interventions, plus:

- Provide supplemental oxygen therapy in patients with clinical signs of hypoxemia or to maintain $\text{SpO}_2 \geq 94\%$
 - → [A07: Oxygen Administration](#)
- Correct suspected hypoglycemia

- For patients with sufficient mentation to maintain an airway, apply glucose gel to oral mucosa
 - [Oral 40% Glucose Gel](#)
- ☐ **Requires completion of EMRscope expansion education:**
 - [Glucagon](#)
- Provide safe and expeditious conveyance
- Consider intercept with additional resources

Primary Care Paramedic – All FR and EMR interventions, plus:

- Obtain vascular access
 - → [D03: Vascular Access](#)
- Correct confirmed hypoglycemia:
 - [10% dextrose in water](#) (D10W) IV: 10 to 25 g (100-250 mL)
 - [Glucagon](#) if unable to obtain IV access
- Correct hypotension; target systolic blood pressure of 90 mmHg

Advanced Care Paramedic – All FR, EMR, and PCP interventions, plus:

- If suspected DKA/HHS:
 - Obtain and interpret 12-lead ECG
 - → [PR16: 12-Lead ECG](#)
- Perform continuous cardiac monitoring en route to hospital; electrolyte disturbances may produce arrhythmias
- Exercise caution in DKA when performing advanced airway procedures: tachypnea is the main compensatory mechanism to control acidosis; if intubation is required, select a higher than normal ventilatory rate (use patient's intrinsic rate as a guide)

Community Paramedic (CP) Interventions

[CPG CP4.7: Diabetic Follow-up](#)

Critical Care Paramedic – All FR, EMR, PCP, and ACP interventions, plus:

- Pediatric DKA/HHS follow BC Children's Hospital protocol
- Hypoglycemia
 - Consider [Thiamine](#)
- DKA/HHS
 1. Replace fluid loss
 - Shock isotonic fluid as quickly as possible.
 - Hypovolemic without shock 15-20ml/kg/hr
 - Euvolemic infused slower guided by clinical assessment.
 - Corrected sodium less than 135 mEq/L continue saline 250-500ml/hr approximately.
 - Normal or elevated corrected sodium switch to one-half saline at 250-500 ml/hr
 2. [Potassium](#) correction
 - Potassium less than 3.3 mEq/L start KCL 20-40 mEq/hr
 - Potassium between 3.3-5.3 mEq/L KCL 20-30 mEq to maintain the range of 4-5 mEq/L.
 - Potassium greater than 5.3 mEq/L then delay potassium replacement.
 3. Insulin infusion
 - Delay insulin if potassium is less than 3.3 mEq/L.
 - Insulin R IV bolus 0.1U/kg followed by 0.1U/kg/hr
 - If glucose is not decreasing after 1 hour and there is no inline filter or extravasation. The insulin infusion may be doubled.
 - When serum glucose approaches 11.1 mmol/L in DKA or 13.9-16.7 in HHS switch saline to D5W and decrease the insulin to 0.02-0.05U/kg/hr. Do not allow the serum glucose to fall below 11.1 in DKA or 13.9-16.7 in HHS.

4. [Bicarbonate](#)

- [Call ETP prior to Bicarbonate initiation](#)
- Not routinely given
- pH less than or equal to 6.9 give 100 mEq of sodium bicarbonate. If potassium is less than 5.3 mEq/L add 20 mEq KCL.

5. Phosphate

- [Call ETP prior to Phosphate initiation](#)
- Should not routinely be replaced.
- If severe hypophosphatemia occurs as defined by 0.32 mmol/L potassium or sodium phosphate 20-30 mEq can be added to 1L of saline.

Evidence Based Practice

Hypoglycemia

Supportive

- [D10](#)
- [D50W](#)
- [Glucagon](#)
- [Option to treat and release](#)
- [Point of Care Blood Glucose Monitoring](#)

Neutral

- [Oral Glucose](#)
- [Thiamine](#)

Against

Hyperglycemia

Supportive

Neutral

- [Fluid Bolus](#)

Against

References

1. Alberta Health Services. AHS Medical Control Protocols. 2020. [\[Link\]](#)
2. Ambulance Victoria. Clinical Practice Guidelines: Ambulance and MICA Paramedics. 2018. [\[Link\]](#)
3. American Diabetes Association. Gestational diabetes mellitus. 2004. [\[Link\]](#)
4. Marx JA, et al., editors. Rosen's emergency medicine: Concepts and clinical practice. 8th edition. 2014.
5. Norris TL, et al. Porth's pathophysiology: Concepts of altered health states. 10th edition. 2019.
6. Pasquel FJ, et al. Hyperosmolar hyperglycemic state: A historic review of the clinical presentation, diagnosis, and treatment. 2014. [\[Link\]](#)
7. Tintinalli JE, et al. Tintinalli's emergency medicine: A comprehensive study guide. 9th edition. 2019.
8. Hirsch IB, et al. Diabetic ketoacidosis and hyperosmolar hyperglycemic state in adults: Treatment. 2020.

Practice Updates

- 2023-09-29: added glucagon to FR and EMR interventions

