REUE | Special Article

Management of hypoglycemia in prehospital care by Emergency Medical Technicians

Manejo de la hipoglucemia en atención prehospitalaria por técnicos en emergencias sanitarias

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Introduction

In Spain, diabetes mellitus (DM) affected nearly 6 million people in 2019, representing 13.8% of the adult population.[1]

Among patients presenting to hospital emergency departments, the prevalence of DM rises to 30–40% of all patients treated.[2] In the prehospital emergency services, the figures reach 6 million patients treated per year.

Hypoglycemia is a complication of DM considered a time-dependent emergency that can endanger the patient's life. The American Diabetes Association (ADA) defines it according to Whipple's Triad, meaning: low blood glucose—understood as venous glucose < 60 mg/dL or capillary glucose < 70 mg/dL—together with compatible symptoms (adrenergic and/or neuroglycopenic) that resolve after glucose administration.[3]

Persistent hypoglycemia can cause brain damage or even death, making rapid correction essential. Because the onset of symptoms is nonspecific, medical attention may be delayed; therefore, the first healthcare provider attending the patient must be able to detect and treat the condition.

This situation highlights the need to create a protocol for Emergency Medical Technicians (EMTs) that improves their clinical practice, incorporating this skill into their training curriculum.

Characteristics of prehospital care

The category of EMT has been officially recognized since 2007 by royal decree (R.D. 1397/2007, October 29),[4] which states: "The quality of health care during urgent or scheduled transport must guarantee the effectiveness of interventions, requiring professionals capable of recognizing patient needs in order to increase survival, reduce secondary complications, and prevent sequelae." (RD 1397/2007, Chapter II, Article 8).

The decree establishes, among other functions detailed in Chapter II, Article 5, the following responsibilities (points b, c, d, p, and q):

– Apply basic life support techniques—ventilatory and circulatory—in situations of compromise, and initial basic care in other emergency situations.

– Assist in victim triage in all types of emergencies and disasters, under supervision and following instructions from the responsible health care professional.

– Assist medical and nursing staff in the provision of advanced life support in emergency situations.

– Resolve problems and make individual decisions following established rules and procedures within the scope of their competence.

– Participate in teamwork, respecting hierarchy in work instructions.

Chapter III, Article 9 of the decree outlines the general objectives, including:

– List signs of severity and relate them to action criteria and protocols for victim classification.

– Recognize signs of vital compromise, relating deviations in external signs from normal parameters, to determine the patient's condition.

– Apply cardiopulmonary resuscitation maneuvers and initial healthcare techniques, connecting symptoms with maneuvers and techniques to stabilize the patient.

– Identify advanced life-support equipment and medication, relating them to necessary protocols to assist medical and nursing staff.

In Chapter III, Article 10, the training program specifies health care in emergency situations. These activities are considered a complementary service to ensure complete healthcare. Therefore, EMTs must possess specialized training to guarantee rapid, effective, and high-quality care.

The Order ESD/3391/2008, November 3, establishes the curriculum for EMT intermediate-level vocational training. Among its contents are administration of emergency medications and their routes of administration, as well as identification of drugs and fluids used in emergency situations.[5] This supports the

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Table 1. Symptoms of hypoglycemia

Adrenergic symptoms (caused by increased autonomic nervous system activity): anxiety, intense hunger, cold sweating, tremor, weakness, palpitations, and nausea. These are symptoms the patient can easily recognize and are considered warning symptoms.
Neuroglycopenic symptoms (caused by reduced central nervous system activity): irritability and/or behavioral changes, blurred vision, headache, transient aphasia, lack of coordination, confusion, stupor, and coma. These symptoms appear after adrenergic symptoms and indicate an inadequate supply of glucose to the brain. They are much more severe and may be life-threatening.

Table 2. Classification of hypoglycemia

Mild: Presence of adrenergic symptoms. The patient can treat it independently by ingesting fast-absorbing carbohydrates.
Moderate: Presence of both adrenergic and neuroglycopenic symptoms. There is neurological impairment, but the patient remains alert and is still able to self-treat.
Severe: A second person is required to reverse the hypoglycemia, either by administering oral glucose, nasal or subcutaneous glucagon, or IV glucose. Nocturnal unrecognized hypoglycemia is also considered severe; it occurs during nighttime sleep. It should be suspected if the patient experiences nightmares, restlessness, morning headache, and/or elevated fasting glucose.

role of EMT in identifying and treating severe hypoglycemia, including capillary blood glucose measurement and administration of treatment to correct the hypoglycemic episode—always under medical supervision from the coordination center and following protocol.

Epidemiology of hypoglycemia

The prevalence of hypoglycemia in patients with T2DM on insulin is estimated at 19.3 events/patient-year (95% CI, 19.1–19.6) for any type of hypoglycemia, 3.7 events/patient-year (95% CI, 3.6–3.8) for nocturnal hypoglycemia, and 2.5 events/patient-year (95% CI, 2.4–2.5) for severe hypoglycemia. Hypoglycemia is more common in patients older than 75 years, and its frequency is directly proportional to the duration of DM and to the duration of insulin treatment.[6]

Causes of hypoglycemia

Approximately 90% of hypoglycemia episodes are due to exogenous causes. Most are related to insulin therapy—especially rapid-acting or intermediate-acting insulin—or medications such as oral antidiabetic drugs (particularly sulfonylureas or glinides) or drugs such as pentamidine, quinine, salicylates, and sulfonamides.

Other causes include decreased, delayed, or missed meals in patients with carbohydrate metabolism disorders; situations associated with increased glucose consumption; increased physical activity without adjusting the insulin regimen; insulin administration errors (overdose or wrong type of insulin); poor injection technique; and excessive alcohol intake (due to inhibition of gluconeogenesis), both in patients with and without diabetes.

The remaining 10% are due to systemic diseases such as acute hepatic necrosis, septic shock, congestive heart failure, chronic renal failure, severe cachexia limiting glucose stores, liver disease, certain toxins, and endocrine–metabolic disorders such as insulinoma, hypopituitarism, adrenal insufficiency, deficiencies in counter-regulatory hormones, or non–beta-cell tumors such as hepatoma or rhabdomyosarcoma.

Hypoglycemia presents with a wide range of symptoms, beginning with mild manifestations and worsening as serum glucose levels drop (Table 1).

Depending on how the episode is resolved, hypoglycemia may be classified as mild, moderate, or severe (Table 2).

Pathophysiology of hypoglycemia

The body reacts to falling serum glucose levels through a stepwise response: first by inhibiting pancreatic insulin secretion, then by increasing hepatic glucagon production, and finally by activating the release of catecholamines, which stimulate the secretion of newly formed glucose. When hypoglycemia becomes frequent, the sympathetic–adrenergic response progressively decreases, leading to unrecognized hypoglycemia and eventually severe hypoglycemia.[7]

Capillary blood glucose measurement

Capillary blood glucose measurement provides valuable information and should be performed in all urgent-care evaluations, making it a routine vital sign in all patients with DM. It should also be performed in cases of neurological alterations, hyperventilation (including panic attacks), and alcohol intoxication, regardless of whether the patient has a prior diagnosis of diabetes.

To obtain a reliable capillary glucose measurement, all procedural steps must be properly followed:[8]

– Check that the glucometer is functioning correctly, verify the expiration date of test strips, and confirm that strip coding (if applicable) matches the meter.

– Select the puncture site—preferably the lateral side of the fingertip; avoid deformed or scarred areas. In infants or newborns, the heel (previously warmed) is preferred.

– Wash hands with soap and water, rinse, and dry thoroughly. Do not use alcohol.

– Turn on the meter and insert the test strip.

– Promote blood flow by keeping the hand downward.

– Puncture the outer side of the fingertip with a lancet and collect the drop of blood onto the reactive area of the strip (capillary absorption).

– Wait for the device to process the sample and record the result.

Some patients with DM use continuous interstitial glucose monitoring systems (CGM). These devices partially reduce the need for capillary glucose testing because they provide real-time interstitial glucose readings via a subcutaneous sensor. Data are collected by passing the receiver or smartphone (with the appropriate app) over the sensor. However, in hypoglycemia, a capillary glucose measurement must always be performed due to the physiological delay between interstitial and capillary values and to rule out sensor malfunction.[9]

Table 3. Ten-Point guide for managing hypoglycemia in prehospital care for emergency medical technicians in basic life support ambulances

Capillary blood glucose should be measured in all patients with diabetes mellitus who present one or more of the following symptoms: nausea, pallor, irritability, behavioral changes, tremors, hunger, palpitations, double or blurred vision, headache, dizziness, and weakness. It should also be measured—regardless of whether the patient has diabetes—in all patients with neurological impairment, hyperventilation (including anxiety attacks), decreased level of consciousness, and alcohol intoxication.
1. Perform an A-B-C-D-E assessment, including the search for alert signs such as bracelets or pendants indicating medications, diseases, or allergies, as well as the presence of continuous glucose monitoring systems or insulin pumps.
2. When possible, obtain a medical history including: current symptoms and their duration; allergies; past medical history including diabetes type (if applicable); major surgeries; usual medications; and most recent intake of food, alcohol, and/or drugs.
3. Record vital signs (respiratory rate, oxygen saturation, heart rate, blood pressure, temperature, and capillary blood glucose). Hypoglycemia is present when glucose is < 70 mg/dL.
4. In unconscious patients or those with a decreased level of consciousness, place the patient in the lateral safety position.
5. Administer O_2 if SpO_2 < 90% to achieve adequate oxygenation (> 94%).
6. Notify the coordination center: request ALS or follow medical instructions for transport to the appropriate health care facility.

Patient WITH ability to swallow:	Patient WITHOUT ability to swallow:
Apply the Rule of 15: administer 15 g of oral glucose (2 sugar packets dissolved in water, or 15 g of liquid glucose solution).	Do not give food or liquids. Administer glucagon following medical instruction: – Nasal (1 spray dose of 3 mg). – IM/SC in the arm or thigh (1 mg lyophilized vial; requires reconstitution). When consciousness is regained and swallowing is possible, administer 15 g of oral glucose.

7. If the patient uses a continuous subcutaneous insulin infusion pump, it should be recommended to stop the pump.
8. Repeat capillary blood glucose measurement after 15 minutes. If hypoglycemia persists (result < 70 mg/dL), notify the coordination center again and follow medical instructions for a second intervention or repeat the previous treatment steps.
9. As an Emergency Medical Technician you CANNOT medically discharge the patient. Continue monitoring until ALS arrives or transport the patient—according to medical telephone instruction—to an appropriate hospital for medical evaluation.
10. Document all actions performed by the Emergency Medical Technician on the BLS ambulance medical report and hand it over during patient transfer to ALS or hospital triage.

BLS: Basic Life Support; ALS: Advanced Life Support; IM: intramuscular; SC: subcutaneous.

Treatment of hypoglycemia

Hypoglycemia is a time-dependent emergency that requires rapid treatment. Its diagnosis and management are proposed in Table 3.

Initial treatment should focus on restoring adequate glucose levels while preventing recurrent hypoglycemia. Whenever possible, the underlying cause should be identified, as it influences treatment, transport decisions, and the need for hospital admission. Hypoglycemia caused by overdose of oral antidiabetic medications may recur until the drug is fully cleared, which may take up to 72 hours, depending on drug type and dosage.

The route of choice for treating hypoglycemia in patients who are fully conscious and can tolerate oral intake is the oral route. In cases of mild hypoglycemia (patients without cognitive impairment), the Rule of 15 is applied, which consists of administering 15 g of oral glucose—that is, two sugar packets of 7–8 g each (or the equivalent amount to reach 15 g, in smaller packets) dissolved in water—and repeating capillary blood glucose measurement after 15 minutes. If hypoglycemia persists, repeat intake and perform a new measurement 15 minutes later. Foods containing approximately 15 g of fast-absorbing glucose include: 175 mL of juice or soft drink, 15 mL (one tablespoon) of honey, one glass of milk, one piece of fruit, or three refined-flour cookies.

Table 4. Technique for administering glucagon: place the patient in the lateral safety position to prevent aspiration, since glucagon administration frequently causes nausea and vomiting

Injectable glucagon administration
1. Remove the plastic cap from the vial and the syringe needle.
2. Mix the solute with the diluent and shake until the powder is completely dissolved.
3. Inject into the thigh, arm, or buttock without pinching the skin.
4. It is not necessary to angle the needle, as the effect of injectable glucagon is similar via intramuscular or subcutaneous routes.
5. Measure capillary blood glucose after 15 minutes.
6. If consciousness is regained, give slow-absorbing carbohydrates to prevent another hypoglycemic episode.
Nasal glucagon administration
1. Remove the protective seal.
2. Hold the single-dose device between your fingers and thumb. It contains only one dose of glucagon and cannot be reused.
3. Gently insert the tip of the single-dose device into one nostril until the fingers touch the outside of the nose.
4. Press the plunger fully. The dose has been administered when the green line is no longer visible.
5. If consciousness is regained, give slow-absorbing carbohydrates to prevent another hypoglycemic episode.

In cases of severe hypoglycemia with reduced level of consciousness or inability to tolerate oral intake, the route of choice is IV glucose solutions.[10]

In prehospital care, when venous access is not possible, the recommendation is to administer a vial of glucagon, either intramuscularly (IM), subcutaneously (SC), or using the newer nasal formulation (Table 4).

The increase in serum glucose after glucagon administration is due to the stimulation of glycogenolysis (breakdown of glycogen into glucose), which leads to a transient rise in circulating glucose levels within a few minutes.

The classic IM or SC glucagon formulation consists of 2 separate containers: one containing the solute (lyophilized powder) and the other containing the diluent. Once reconstituted, glucagon is not stable over time, so the solution must be administered immediately or discarded. The unopened vial must be kept refrigerated. The IM or SC glucagon dose is 1 mg. The patient usually responds within 10 minutes. If the patient does not respond, the injection may be repeated; if there is still no response after the second dose, IV glucose should be administered.[11]

For nasal glucagon, the dose is 3 mg. It is administered into a single nostril and is passively absorbed

through the nasal mucosa.[12] If the patient does not respond, IV glucose solutions must be administered.

In both cases, glucagon administration may cause nausea and vomiting, so the patient should be placed in the lateral safety position to protect the airway until consciousness is regained.

Once consciousness has returned, the patient should first be given fast-absorbing carbohydrates (honey, sugar, fruit juice, sweets, bread) to replenish hepatic glycogen, followed by slow-absorbing carbohydrates to prevent recurrence of hypoglycemia. Examples of slow-absorbing carbohydrates include bread, whole grains, legumes, vegetables, and certain red fruits such as strawberries or cherries.

If the patient uses a continuous subcutaneous insulin infusion pump, it is recommended to suspend the pump until the hypoglycemia has been corrected according to the previously described recommendations. Once the episode is resolved and depending on any necessary adjustments to definitive treatment, insulin infusion may be restarted.

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