The Review Of
DIABETIC
STUDIES OPEN ACCESS

Managing Diabetic Patients In The Prehospital Setting By Paramedics

Rami Ayed Talaq Alsolami [1], Fahad Hassan Baabdullah [2], Mohammad Matar Alharbi [3], Haidar Hamad Al yami [4], Saif Hamad Alyami [5], Abdulelah Mohammed Aljarari [6], Emad Abdullah Allhyani [7], Fouad Hamdan Alfarsi [8], Omran Ammar Alzanbaqi [9], Abdullah Mohammed ALnamy [10]

1. *Paramedic, Red Crescent, Kingdom of Saudi Arabia. r4314226@gmail.com*
2. *Paramedic, Red Crescent, Kingdom of Saudi Arabia. Fahadh35@hotmail.com*
3. *Paramedic, Red Crescent, Kingdom of Saudi Arabia. mmohammadd.1@hotmail.com*
4. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. Srca07826@srca.org.sa.*
5. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. saif.h1112@hotmail.com*
6. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. Aljrari@srca.org.sa*
7. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. allahyiny@gmail.com*
8. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. falfarsi@srca.org.sa*
9. *Emergency Medical Technician, Red Crescent, Kingdom of Saudi Arabia. srca09702@srca.org.sa*
10. *Paramedic, Red Crescent, Kingdom of Saudi Arabia. srca11140@srca.org.sa*

ABSTRACT

Diabetes mellitus is a chronic metabolic condition associated with significant morbidity and mortality, with acute complications such as hypoglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state (HHS) contributing to a substantial proportion of prehospital emergency calls worldwide. Paramedics, often the first point of medical contact, play a critical role in the recognition, assessment, and management of these emergencies. This review explores the epidemiology of diabetic emergencies, the physiological underpinnings relevant to prehospital interventions, and the impact of timely paramedic management on patient outcomes. Key strategies discussed include rapid glucose administration for hypoglycemia, supportive care and fluid resuscitation for hyperglycemic crises, and the importance of structured protocols in guiding clinical decision-making. The review further highlights variations in scope of practice across regions, challenges in non-transport decisions, and innovations such as telemedicine, point-of-care testing, and artificial intelligence integration in ambulance services. Training, simulation, and community paramedicine initiatives are emphasized as crucial for enhancing care quality and reducing healthcare burden. Effective prehospital diabetes management by paramedics is essential in mitigating complications, optimizing patient outcomes, and improving system-wide efficiency.

Keywords: Diabetes mellitus; hypoglycemia; diabetic ketoacidosis (DKA); hyperosmolar hyperglycemic state (HHS); prehospital care; paramedics; emergency medical services (EMS); treat-and-release protocols; community paramedicine; telemedicine; point-of-care testing.

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by either insufficient insulin production or ineffective insulin use, leading to hyperglycemia and long-term damage to multiple organ systems. The global burden of diabetes has escalated sharply over recent decades. According to the International Diabetes Federation's 2025 report, over 11% of the adult population worldwide, approximately 1 in 9 adults aged 20-79, is living with diabetes, with prevalence rates expected to continue

rising sharply, especially in low- and middle-income countries (LMICs) where treatment coverage remains suboptimal. This increasing prevalence places an ever-growing strain on healthcare systems globally (Benoit et al., 2018).

Epidemiological data reveal that acute diabetic complications such as severe hypoglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state (HHS) contribute substantially to morbidity and emergency medical service (EMS) utilization worldwide. In the United States alone, diabetes-related EMS activations constituted approximately 2.3% of all EMS calls in 2015, with more than 230,000 hours of EMS service dedicated to diabetic emergencies. Such emergencies frequently lead to urgent hospital transports, highlighting the critical role EMS teams play in initial patient management. Globally, the impact of diabetes-related acute crises is considerable due to the high prevalence of diabetes and often delayed or inadequate outpatient glucose control (Russo et al., 2023).

Paramedics serve as the first point of medical contact in the prehospital setting for many patients experiencing acute diabetic crises. Their role encompasses timely recognition, assessment, and initiation of appropriate treatment protocols for conditions like hypoglycemia and hyperglycemic emergencies. Effective prehospital care can significantly influence outcomes by preventing complications, reducing hospital admission rates, and improving patient prognosis. Training paramedics in standardized diabetes emergency protocols has been shown to improve care quality and reduce mortality, particularly in hypoglycemic patients treated at the scene without transport (Benoit et al., 2018).

Timely identification and management of diabetic emergencies in the prehospital setting are critical given the potential for rapid deterioration. Hypoglycemia, the most common diabetic emergency, requires immediate glucose administration; conversely, hyperglycemic crises such as DKA demand supportive care like fluid resuscitation and oxygen until hospital admission can be arranged. Delays or lack of recognition can result in severe morbidity, including neurological impairments, organ failure, and death. Prehospital intervention thus represents an essential opportunity to reduce poor diabetic emergency outcomes (Turan, Yurtseven, Basa, Gökşen, Saz, et al., 2020a).

The objective of this review is to comprehensively examine the management of diabetic patients in the prehospital context by paramedics. It aims to describe the global and regional burden of diabetes and its acute complications, analyze the impact on EMS systems, elucidate the crucial role of paramedics as first responders in acute diabetic crises, and emphasize the importance of timely recognition and effective intervention before hospital arrival. By synthesizing current evidence and guidelines, this review seeks to inform improvements in paramedic training, protocols, and resource allocation to optimize prehospital diabetic care and patient outcomes.

Pathophysiology and Clinical Considerations in Diabetes

Overview of Diabetes Mellitus

Diabetes mellitus (DM) is a group of metabolic disorders characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both. The main types relevant to clinical practice include:

- **Type 1 Diabetes Mellitus (T1DM)**: An autoimmune destruction of pancreatic beta cells leading to absolute insulin deficiency. It often presents in childhood or adolescence but can occur at any age (Banday et al., 2020).
- **Type 2 Diabetes Mellitus (T2DM)**: A heterogeneous disorder characterized by insulin resistance combined with an inadequate compensatory insulin secretory response. It is typically associated with obesity and older age but is increasingly seen in younger populations (Banday et al., 2020).

- **Gestational Diabetes Mellitus (GDM)**: Hyperglycemia first recognized during pregnancy, which can have implications for both mother and fetus (Banday et al., 2020).
- **Other causes**: Include genetic defects of beta-cell function, diseases of the pancreas, and drug-induced diabetes (e.g., steroids) (Banday et al., 2020).

Pathophysiologically, T2DM involves peripheral insulin resistance, elevated hepatic glucose production, and an imbalance in glucagon secretion, leading to sustained hyperglycemia. Chronic hyperglycemia causes nonenzymatic glycation of proteins and lipids, contributing to microvascular and macrovascular complications like retinopathy, nephropathy, and cardiovascular disease (Sapra & Bhandari, 2023).

Acute Diabetic Emergencies Relevant to Prehospital Care

1. **Hypoglycemia**
   Hypoglycemia is a critical and common emergency in diabetic patients, defined by abnormally low plasma glucose levels, often below 70 mg/dL. It results from excessive insulin administration, missed meals, or increased physical activity. Clinical manifestations are driven by sympathetic nervous system activation (sweating, tremors, palpitations) and neuroglycopenia (confusion, seizures, loss of consciousness). Left untreated, hypoglycemia can progress to seizures, coma, and even death (Priambodo et al., 2024a).

2. **Diabetic Ketoacidosis (DKA)**

   DKA is an acute, severe complication primarily of T1DM, characterized by hyperglycemia (>250 mg/dL), ketoacidosis (due to increased ketone bodies causing metabolic acidosis), and dehydration. It results from absolute or relative insulin deficiency, leading to lipolysis and ketogenesis. Clinically, patients present with polyuria, polydipsia, abdominal pain, vomiting, Kussmaul respiration, altered mental status, and potential coma. Early recognition and management including fluid resuscitation, insulin therapy, and electrolyte replacement are essential to reduce morbidity and mortality (Fayfman et al., 2017).

3. **Hyperosmolar Hyperglycemic State (HHS)**

   HHS, more common in T2DM and the elderly, is marked by profound hyperglycemia (often >600 mg/dL), hyperosmolarity, and severe dehydration without significant ketoacidosis. It may present with altered sensorium or coma. Due to extreme volume depletion and electrolyte imbalance, it has a higher mortality rate compared to DKA. Prehospital recognition is crucial to initiate timely fluid replacement and rapid transport for definitive care (Adeyinka & Kondamudi, 2023).

Associated Conditions

Diabetic emergencies may be accompanied by secondary complications such as seizures (especially in severe hypoglycemia), cardiovascular events (eg, myocardial infarction triggered by metabolic stress), and coma (from severe hypoglycemia, DKA, or HHS). The possibility of these complications requires vigilance during prehospital assessment and management (Strachan, 2007).

Physiological Changes and Their Influence on Prehospital Interventions

During hypoglycemia, counterregulatory mechanisms activate the autonomic nervous system, leading to increased heart rate, cardiac output, and regional blood flow to vital organs including the brain. These responses produce warning symptoms but also demand paramedics to act swiftly to reverse low glucose levels to prevent neurological damage (Strachan, 2007).

In hyperglycemia (DKA or HHS), profound dehydration results from osmotic diuresis due to glucosuria, reducing intravascular volume and potentially causing hypotension and shock. Metabolic acidosis in DKA also affects myocardial contractility and systemic vascular resistance. These

physiological changes necessitate rapid fluid resuscitation and careful monitoring during prehospital care to stabilize circulation and prevent progression to irreversible organ damage (Adeyinka & Kondamudi, 2023).

Importance of Time-Sensitive Interventions in Prehospital Care

Effective prehospital management hinges on quick recognition and treatment initiation. For hypoglycemia, prompt administration of glucose (oral or intravenous) prevents progression to seizures and coma. In DKA and HHS, early fluid resuscitation and rapid transport to definitive care reduce complications and mortality. Delays in treatment can worsen metabolic derangements and increase the risk of adverse outcomes. Paramedics' familiarity with diabetic emergencies significantly improves patient prognosis.

Epidemiology and Prehospital Burden

Incidence of Diabetic Emergencies Encountered by Paramedics

Diabetic emergencies represent a substantial proportion of calls attended by Emergency Medical Services (EMS). These emergencies most commonly present as hypoglycemia or hyperglycemia, with diabetic ketoacidosis (DKA) and hyperosmolar hyperglycemic state (HHS) comprising severe hyperglycemic emergencies. Studies from Ambulance Victoria, Australia, report over 41,000 diabetic emergency calls during a seven-year period, where hypoglycemia accounted for roughly 70% of cases and hyperglycemia the remaining 30%. Similarly, other research estimates the incidence of EMS calls for hypoglycemia at around 108 per 10,000 people with diabetes annually. Diabetic emergencies often affect older adults predominantly, with a median age around 59 to 63 years in multiple cohorts, and a slight male predominance noted (Villani et al., 2018).

The high frequency of these calls reflects diabetes prevalence and the risk of acute metabolic decompensation, often precipitated by infection, medication errors, or treatment nonadherence. In urban and regional areas, diabetic emergencies show variable patterns influenced by population density and socioeconomic factors, contributing to localized peaks in EMS demand (Myers et al., 2022a).

Hospital Admission Rates from EMS Calls Related to Diabetes

Hospital conveyance following EMS attendance varies based on the nature of the diabetic emergency. Conveyance rates are generally higher in hyperglycemic emergencies compared to hypoglycemia. A Northern Ireland study observed hospital conveyance in 63% of diabetes-related ambulance calls, with conveyance more likely during working hours and when initiated by health professionals. A Scottish study further supports higher hospital transport rates in hyperglycemic patients (49.8%) versus hypoglycemic patients (39.3%), noting that paramedic treatment at the scene is associated with lower conveyance. Another study highlights that patients experiencing diabetic ketoacidosis (DKA) transported by EMS have increased admissions to Pediatric Intensive Care Units (PICU) compared to non-EMS transported patients, emphasizing the severity of cases EMS attends (van Woerden et al., 2021).

Hospitalization consumes significant healthcare resources and correlates strongly with emergency severity, underlying comorbidities, and timely prehospital care interventions.

Impact of Diabetes Emergencies on EMS Workload (Hypoglycemia vs Hyperglycemia)

Diabetes emergencies exert a notable burden on EMS systems, contributing a significant portion of total call volumes and resource utilization. For instance, diabetic emergencies comprised approximately 8% of cases in a South African resuscitation area study, with DKA representing nearly half these cases. Hypoglycemia remains the most common diabetic emergency encountered prehospital, requiring immediate glucose correction and monitoring (Lotter et al., 2021).

Comparative analysis reveals that hypoglycemic emergencies often result in fewer hospital transports and are more frequently managed on scene by paramedics, which can reduce system strain. Conversely, hyperglycemic emergencies, especially DKA and HHS, often necessitate hospital conveyance and extended EMS intervention times, increasing system workload. In some studies, a substantial proportion of calls involving hyperglycemia led to patient refusal of transport, suggesting a complex dynamic around EMS workload and patient compliance. These variations underscore the differential impact of hypo- and hyperglycemic episodes on EMS operational demands (Farhat, Alinier, et al., 2023a).

Mortality and Morbidity Outcomes Associated with Delayed or Inadequate Prehospital Care

Delayed or inadequate prehospital care in diabetic emergencies significantly influences morbidity and mortality outcomes. Timely paramedic intervention can reduce progression to severe metabolic disturbances and prevent complications such as cerebral edema in children with DKA. Mortality rates in diabetic patients experiencing hyperglycemic crises are associated with delays in EMS response or transportation to definitive care, with 7-day mortality rates reported at approximately 14% and 30-day mortality at 25% in cohorts with elevated prehospital blood glucose (Turan, Yurtseven, Basa, Gökşen, & Ulaş Saz, 2020b).

Studies also show that patients transported after hypoglycemic events have roughly half the recurrence rate of severe hypoglycemia requiring emergency attention within 30 days compared to those treated and left on scene, reinforcing the importance of hospital evaluation in some cases. Additionally, longer EMS delay times correlate with increased mortality in severe emergencies such as myocardial infarction and could analogously worsen outcomes in critical diabetic emergencies (Myers et al., 2022b).

Overall, effective prehospital management by paramedics plays a crucial role in reducing EMS burden, improving patient outcomes, and decreasing hospital admissions and mortality related to diabetic emergencies. Educational interventions aimed at paramedics to recognize and treat these emergencies efficiently can further optimize care delivery.

Role of Paramedics in Diabetes Management in the Prehospital Setting

Paramedics play a critical role in the management of diabetic patients in the prehospital environment, which includes initial assessment, diagnosis, treatment, and education aimed at preventing life-threatening complications and subsequent hospitalizations. Their advanced training supports interventions for both acute diabetic emergencies and ongoing chronic disease management, often in settings with limited information and resources.

Scope of Practice Variations Across Countries/Regions

The scope of practice for paramedics in diabetes management varies depending on the country or region. For example, in some North American and European systems, advanced paramedics or community paramedics receive specialized training to manage low-acuity diabetic conditions, including on-scene treatment and diabetes education, reducing unnecessary hospital conveyance. In contrast, other regions may limit paramedics to basic glucose testing and emergency stabilization before transport. Differences also exist in permitted interventions such as intravenous access or medication administration, reflecting diverse regulatory frameworks and EMS system designs (Kasper et al., 2022a).

Decision-Making Responsibilities in Non-Hospital Environments

Paramedics are required to make rapid, critical decisions based on clinical findings, patient history, and available diagnostic tools. Their decision-making encompasses whether to treat on-scene or transport, considering patient safety, capacity, and risks of treatment refusal. They must also manage situations with incomplete information while using validated assessment protocols, applying clinical judgment for

diabetic emergencies such as hypoglycemia or hyperglycemia, while also considering differential diagnoses like stroke or intoxication in patients with altered mental status (Farhat, Aifa, et al., 2023).

Initial Patient Assessment

Primary Survey: Paramedics begin with the primary survey focusing on Airway, Breathing, and Circulation (ABCs), ensuring the patient's airway is patent, breathing is adequate, and circulation is stable. This rapid assessment guides immediate life-saving interventions where necessary (Clawson et al., 2014).

Secondary Survey: This includes a detailed neurological exam assessing mental status using tools such as the Glasgow Coma Scale (GCS) or AVPU scale (Alert, Verbal, Pain, Unresponsive). Vital signs including pulse, blood pressure, respiratory rate, and oxygen saturation are recorded to detect hemodynamic instability or distress (Clawson et al., 2014).

Point-of-Care Testing: Capillary blood glucose measurement is an essential diagnostic tool in prehospital diabetes care. Using a glucometer, paramedics can rapidly assess blood glucose levels by obtaining a small capillary blood sample, usually from a fingertip. Accurate testing involves proper preparation of the site, disposal of the first drop of blood, and correct use of the device. Capillary blood glucose testing is preferred in acute settings given its speed and minimal invasiveness, and although venous samples can be used, capillary sampling is optimal in acute illness (Mathew et al., 2023).

Differential Diagnosis of Altered Mental Status

Altered mental status (AMS) is common in diabetic emergencies but has a broad differential diagnosis. Besides hypoglycemia, paramedics must consider other causes such as stroke, seizures, intoxication, metabolic or infectious encephalopathies. Rapid identification of reversible causes like hypoglycemia is critical because timely treatment can prevent severe morbidity or mortality. Paramedics use comprehensive clinical evaluation and point-of-care glucose testing to differentiate hypoglycemia from other causes and initiate appropriate management such as intravenous dextrose administration (Singhal, 2019).

Prehospital Management Strategies for Diabetic Patients by Paramedics

Prehospital management of diabetic emergencies is a critical responsibility of paramedics, requiring rapid recognition, accurate diagnosis, and timely intervention to prevent complications and improve patient outcomes. This section focuses on prehospital management strategies for hypoglycemia, diabetic ketoacidosis (DKA), and hyperosmolar hyperglycemic state (HHS), outlining the recognition, diagnostic confirmation, interventions, and transport considerations.

Hypoglycemia Management

Recognition

Recognition of hypoglycemia in the prehospital setting relies on identifying characteristic signs and symptoms including diaphoresis, tremors, palpitations, anxiety, hunger, and neurological manifestations such as confusion, irritability, seizures, and altered mental status ranging from agitation to coma. Mental status changes are often key indicators necessitating rapid assessment via clinical examination and glucose measurement.

Diagnostic Confirmation

Paramedics confirm hypoglycemia diagnosis using fingerstick capillary blood glucose measurement with glucometers approved for prehospital use. Indications for testing include altered mental status, seizure, coma, and diabetic emergency presentations. Accurate measurement guides treatment decisions and is documented for continuity of care.

INTERVENTIONS

1. Oral Glucose Administration

   For conscious patients with intact airway and swallowing reflex, administration of 15-20 grams of fast-acting oral glucose is recommended. This may be delivered as glucose gel, tablets, sugary beverages such as orange juice, or readily available carbohydrate sources. Oral glucose can be repeated if blood glucose remains low or symptoms persist (Myers et al., 2022).

2. Intravenous Dextrose Protocols

   In patients unable to take oral glucose due to altered consciousness, intravenous administration of dextrose solutions (commonly 25-50 mL of D50W) is employed. Rapid IV access is sought to enable dilution and controlled administration of dextrose to quickly restore normoglycemia. This remains the preferred treatment when feasible (Maharjan et al., 2024).

3. Intramuscular or Subcutaneous Glucagon

   When IV access is not possible, glucagon administration via intramuscular or subcutaneous routes is an effective alternative to raise blood glucose. A dose of 1 mg glucagon is typical for adults, with pediatric dosing based on weight. Glucagon stimulates hepatic glycogenolysis leading to increased glucose release into circulation and rapid improvement in consciousness within minutes. Intranasal glucagon is emerging as a needle-free option demonstrating efficacy (Haamid et al., 2023).

4. Post-Intervention Observation and Repeated Glucose Checks

   Following treatment, patients require ongoing observation with repeated glucose monitoring to ensure sustained recovery and avoid rebound hypoglycemia. If glucose remains low or symptoms recur, additional treatment dose may be needed (Priambodo et al., 2024b).

5. Avoiding Recurrent Hypoglycemia

   Once stabilized, patients should be advised to consume carbohydrate-containing food to maintain euglycemia and prevent recurrence. Proper education and communication with receiving facilities are essential for ongoing care (Myers et al., 2022).

Hyperglycemia (DKA and HHS) Management

Prehospital Recognition

Recognition of DKA and HHS relies on patient history and clinical examination. Typical presentations include polyuria, polydipsia, dehydration, abdominal pain, nausea/vomiting, fruity acetone breath (in DKA), Kussmaul respirations (deep, labored breathing), tachycardia, hypotension, and altered mental status ranging from lethargy to coma. Blood glucose levels are often elevated >250 mg/dL in DKA and higher in HHS (often >600 mg/dL). DKA is more common in type 1 diabetes, while HHS typically occurs in type 2 diabetes or older adults (Umpierrez et al., 2024).

On-scene Priorities

1. Airway Management and Oxygen Therapy

   Assessment of airway patency and breathing is essential. Oxygen therapy is administered if hypoxia is present or respiratory distress is noted.

2. Vascular Access

Establishment of vascular access is crucial for fluid resuscitation and medication administration if within paramedic scope of practice.

3. Fluid Resuscitation Protocols

   Initial fluid replacement with isotonic saline (0.9% sodium chloride) is standard to restore intravascular volume, improve tissue perfusion, and reduce hyperosmolarity. Studies support rapid initiation of fluids within the first hour of recognition as it significantly improves outcomes. Balanced crystalloids like lactated Ringer's may be preferred in some settings due to lower risk of hyperchloremic acidosis.

Monitoring

Continuous monitoring for cardiac arrhythmias, shock signs, and neurological status changes is critical, as electrolyte imbalances and dehydration significantly impact these parameters.

Limitations in Prehospital Insulin Administration

In many jurisdictions, paramedics are not authorized to initiate insulin therapy in the field due to risks including hypoglycemia and need for close monitoring. Insulin administration is generally reserved for hospital management. However, some protocols may allow limited insulin use under medical direction (Turan, Yurtseven, Basa, Gökşen, & Ulaş Saz, 2020c).

Indications for Rapid Transport versus On-scene Stabilization

Given the high acuity and potential for rapid deterioration in DKA and HHS, rapid transport to an appropriate facility is generally prioritized. On-scene interventions focus on airway, breathing, circulation support, and initial fluid resuscitation to stabilize patients during transport.

Prehospital Monitoring and Supportive Care of Diabetic Patients by Paramedics

Effective prehospital management of diabetic patients requires vigilant monitoring and supportive care tailored to the metabolic and cardiovascular risks these patients face. Paramedics play a crucial role in early detection and immediate intervention which can significantly impact patient outcomes.

Continuous Glucose Monitoring in Some Systems

Some advanced emergency medical service (EMS) systems have begun integrating continuous glucose monitoring (CGM) devices to enhance the real-time management of diabetic emergencies. CGM provides ongoing glucose readings, trends, and directional changes by measuring interstitial glucose, enabling paramedics to detect both hypo- and hyperglycemia dynamically during prehospital care. Although traditionally glucose levels are assessed via point-of-care capillary blood sampling, CGM adoption in prehospital settings is emerging due to its ability to reduce glucose excursions and facilitate timely interventions. The use of CGM remains adjunctive to standard glucometry due to accuracy considerations but holds promise in improving prehospital glycemic control and preventing complications associated with sudden glucose fluctuations (Cappon et al., 2019).

Electrocardiography and Cardiac Monitoring

Diabetic patients, especially those with acute metabolic disturbances, are at increased risk for cardiovascular complications such as myocardial ischemia and infarction, often presenting atypically. Hypokalemia, which can occur in diabetic emergencies such as diabetic ketoacidosis or with certain treatments, predisposes patients to arrhythmias. Therefore, paramedics routinely use electrocardiography (ECG) to monitor cardiac rhythm and detect ischemic changes in diabetic patients. Continuous cardiac monitoring allows early recognition of life-threatening events including ST-elevation myocardial

infarction (STEMI) and electrolyte-induced arrhythmias, facilitating rapid transport and prehospital notification to receiving centers for urgent care (Ravn Jacobsen et al., 2020).

Use of Pulse Oximetry and Capnography When Needed

Oxygenation and ventilation assessment are vital supportive measures in diabetic emergencies complicated by altered mental status or respiratory compromise. Pulse oximetry is a standard non-invasive tool widely used by paramedics to monitor oxygen saturation continuously. Additionally, capnography, which measures end-tidal carbon dioxide (ETCO2), has gained importance as a non-invasive monitor of ventilation and metabolic status. This is especially relevant when airway management devices are in use or during respiratory distress. Studies confirm that capnography, alongside pulse oximetry, improves assessment accuracy and may serve as a safe alternative to arterial blood gas analysis in certain scenarios, aiding in adjustments of oxygen therapy or ventilation support (Moradian et al., 2022).

Neurological Assessment and Repeated Vital Signs

Frequent and thorough neurological examination is imperative in diabetic patients, particularly those with altered consciousness, to evaluate for hypoglycemic effects or complications such as stroke. Paramedics conduct repeated assessments of Glasgow Coma Scale, pupil reactivity, and limb movements, alongside serial vital signs monitoring including blood pressure, heart rate, respiratory rate, and temperature. This continuous monitoring is essential for detecting clinical deterioration or improvement, tailoring transport urgency and interventions. Neurological status guides the differentiation of diabetic emergencies from other acute neurological conditions, optimizing prehospital management (Farhat, Alinier, et al., 2023b).

Identifying Patients Requiring Advanced Airway Management

Diabetic patients experiencing severe hypoglycemia, ketoacidosis, or cerebral edema may present with decreased consciousness or airway compromise necessitating advanced airway management. Paramedics assess the airway patency, protective reflexes, and respiratory effort to identify indications for airway intervention. Modern prehospital protocols allow trained paramedics to escalate to medication-facilitated advanced airway techniques, including rapid sequence airway insertion using supraglottic airway devices or endotracheal intubation in selected cases. Early airway management ensures adequate oxygenation and ventilation, preventing hypoxic injury during transport (Johnston et al., 2022).

Preventing Complications During Transport

During transport, preventing complications such as hypoglycemia rebound, worsening hyperglycemia, aspiration, or respiratory failure is paramount. Paramedics ensure continuous glucose monitoring or intermittent glucometry, maintain intravenous access when indicated, and provide dextrose or insulin therapy per protocols. Positioning the patient to protect the airway and prevent aspiration, maintaining oxygenation, and monitoring for signs of cardiac and neurological deterioration contribute to minimizing en-route risks. Communication with hospital teams regarding prehospital interventions and changes in status ensures continuity of care upon arrival (Farhat, Alinier, et al., 2023).

Clinical Decision-Making and Destination Choice in Managing Diabetic Patients by Paramedics in the Prehospital Setting

Paramedics play a critical role in the management of diabetic emergencies in the prehospital environment, requiring precise clinical decision-making supported by protocol-based triaging to determine when to transport patients to the emergency department (ED) versus when treatment and referral without transport is appropriate. This process involves evaluating patient condition, risk factors, response to treatment, and ensuring coordinated communication with receiving facilities, while considering ethical and medico-legal aspects of non-transport decisions.

Protocol-Based Triaging

Protocols guiding paramedic triage in diabetic emergencies typically specify criteria for transport versus treat-and-refer decisions. For instance, patients presenting with hypoglycemia that is promptly corrected in the field and who meet a series of safety criteria may be safely treated and released without mandatory transport. Criteria often include restoration of normal mental status, stable vital signs, ability to ingest carbohydrates, and presence of a reliable caregiver to monitor the patient at home. Structured treat-and-release protocols have shown to reduce unnecessary hospital transports while maintaining patient safety (Schwerin & Svancarek, 2023a).

In diabetic ketoacidosis (DKA) or hyperglycemic emergencies, protocols generally mandate transport for all patients due to the need for complex hospital-based management including fluid resuscitation, insulin therapy, and close monitoring. Special attention is given to children, elderly, and patients with severe DKA or complicated comorbidities. The protocols emphasize timely initiation of treatment in the prehospital phase and rapid transport to specialized care (Turan, Yurtseven, Basa, Gökşen, Saz, et al., 2020).

Red Flags Requiring Immediate ED Transfer

Paramedics must identify critical red flags indicating the need for immediate ED transport. Persistent altered mental status despite hypoglycemia treatment, recurrent hypoglycemic episodes, and severe metabolic derangements such as diabetic ketoacidosis are clear indications for conveyance. Psychiatric risk factors, including suicidal ideation or agitation, as well as the presence of frailty or advanced age, increase the risk of complications and warrant hospital evaluation (Farhat, Alinier, et al., 2023).

Additionally, abnormal vital signs outside protocol-defined ranges, failure to respond to initial treatment, or uncertainty about diagnosis require rapid hospital transfer. These red flags ensure that patients at highest risk receive timely advanced care, reducing morbidity and mortality.

Communication with Receiving Hospitals for Coordinated Care

Effective communication during patient handover is paramount to ensure continuity of care. Paramedics are advised to provide detailed patient information including presenting symptoms, blood glucose levels before and after treatment, administered therapies, vital signs, and mental status changes. Coordination facilitates preparedness of emergency departments to initiate specialized interventions rapidly upon arrival, particularly in complex cases such as severe DKA or comorbid emergencies (Turan, Yurtseven, Basa, Gökşen, Saz, et al., 2020).

Some prehospital systems incorporate structured communication protocols or electronic transmission of prehospital data to hospital teams, improving clinical outcomes through streamlined coordination (Kasper et al., 2022a).

Ethical and Medico-Legal Considerations of Non-Transport after Hypoglycemia Reversal

Choosing not to transport a patient after hypoglycemia is corrected in the field is accompanied by ethical and medico-legal responsibilities. Paramedics must ensure informed consent, assessing patient capacity and comprehension of potential risks. The decision to release a patient without hospital transport must align with established clinical guidelines and local protocols, supported by thorough documentation of assessment, treatment, patient education, and witness presence or caregiver availability (Schwerin & Svancarek, 2023b).

There is ongoing debate and variability in protocols regarding non-transport safety. Some studies report safe outcomes with structured treat-and-release policies, while others caution on risks of repeated hypoglycemia or unidentified complications without hospital evaluation. Continuous training in patient

selection, thorough risk assessment, and clear follow-up instructions are essential to mitigate medico-legal liability and ethical concerns (Schwerin & Svancarek, 2023b).

Education and Training of Paramedics

Paramedic education on diabetes emergencies encompasses foundational knowledge about diabetes epidemiology and pathophysiology, focusing on recognizing acute complications such as hypoglycemia and diabetic ketoacidosis. Curricula typically include content on diabetes complications, pharmacology, self-management, and social determinants of health, enhanced with clinical scenarios and practical simulations. Simulation training serves as an essential component for paramedics, allowing them to rehearse diabetes-related emergency scenarios safely and build confidence in managing acute episodes such as severe hypoglycemia. Continuing professional development through courses and virtual modules reinforces competence and updates paramedics on best practices (Kasper et al., 2022).

Paramedics rely heavily on standardized protocols and clinical guidelines from prominent organizations such as the American Heart Association (AHA), American Diabetes Association (ADA), Joint Royal Colleges Ambulance Liaison Committee (JRCALC), and European Resuscitation Council (ERC) to guide treatment decisions in the field. These protocols outline treatment pathways including glucose administration, glucagon use, and criteria for patient transport or release. Experience level impacts paramedic ability to recognize subtle presentations and apply guidelines effectively, influencing patient outcomes (Clawson et al., 2014).

Challenges in Prehospital Diabetes Care

Prehospital care faces diagnostic limitations, as paramedics have no access to laboratory testing and can only use point-of-care blood glucose measurements, which restricts comprehensive assessment of glycemic emergencies. Protocol variation exists across EMS systems internationally, leading to inconsistency in management approaches and treatment options (Turan, Yurtseven, Basa, Gökşen, Saz, et al., 2020).

A frequent challenge is patient refusal of transport after hypoglycemia treatment. While out-of-hospital care is generally safe and effective, refusal complicates follow-up and may result in repeat emergencies, although studies show similar relapse rates between transported and non-transported patients. Rural settings pose unique difficulties such as longer response times, greater distances to hospitals, and limited specialist availability, which adversely affect diabetes care quality compared to urban areas (Foss et al., 2023).

Communication barriers arise especially with unconscious or confused patients, complicating history taking and assessment. Furthermore, hypoglycemia-related agitation or aggression in some patients presents safety risks for paramedics at the scene, requiring heightened vigilance and scene management strategies (Duncan et al., 2018).

Integration with Community and Preventive Care

Community paramedicine plays an increasingly important role in diabetes care by providing chronic disease management and preventive services outside the traditional emergency response model. Community paramedics (CPs) receive additional training in chronic disease management and social determinants of health, enabling them to deliver diabetes self-management education and support (DSMES) directly in patients' homes. This approach improves diabetes knowledge, self-care behaviors, glycemic control, and overall quality of life for diabetic patients, particularly those at high risk for complications like severe hypoglycemia (Bhagra et al., 2025).

Follow-up visits by community paramedics for high-risk diabetic patients help monitor disease progression, reinforce self-management skills, and reduce emergency department visits and hospital

admissions. These visits provide an opportunity for paramedics to educate patients about medication adherence and glucose monitoring, helping to identify issues such as noncompliance or improper use of insulin and oral hypoglycemics (Bhagra et al., 2025).

Paramedics collaborate closely with nurses, diabetes educators, and primary care providers to enhance continuity of care. Interprofessional collaboration facilitates task sharing, improves patient education, and supports preventive interventions that reduce hospitalizations and improve health outcomes. Nurses and diabetes educators often provide specialized education, while paramedics extend the reach of these services into the community, creating a coordinated, patient-centered care network (Szafran et al., 2019).

Telemedicine has emerged as a valuable tool for paramedics managing complex diabetes cases. It allows remote consultation with specialists, real-time monitoring of glucose and other biometric data, and enhanced patient coaching. Telemedicine enhances glycemic control, patient and provider satisfaction, and access to specialty care, particularly in underserved or rural areas (Dhediya et al., 2022).

Special Populations

Managing diabetic emergencies in special populations requires paramedics to adapt care according to unique risks and needs:

- **Pediatric diabetic emergencies:** Children with insulin-dependent diabetes are at risk of diabetic ketoacidosis (DKA) and hypoglycemia. Prehospital care variations exist in fluid administration and insulin dosing, with evidence indicating suboptimal EMS utilization and knowledge gaps in managing pediatric DKA. Prompt recognition, appropriate fluid therapy, and insulin administration follow protocols to prevent complications such as cerebral edema (Turan, Yurtseven, Basa, Gökşen, & Saz, 2020).
- **Elderly diabetic patients:** Older adults often have multiple comorbidities and face challenges like polypharmacy and cognitive impairment. Polypharmacy increases the risk of adverse drug interactions and complicates glycemic management. Careful medication review and simplification strategies are critical to optimize outcomes and minimize risks in this population (Salh et al., 2025).
- **Pregnant patients with diabetes:** Diabetes during pregnancy, including pre-existing type 1 or type 2 diabetes and gestational diabetes, is associated with increased risks of miscarriage, fetal malformation, stillbirth, and other complications. Surveillance and early intervention protocols are fundamental, and paramedics play a key role in recognizing pregnancy-related diabetic emergencies and facilitating timely transport to tertiary care (Kulshrestha & Agarwal, 2016).
- **Patients with substance abuse or psychiatric disorders:** These patients present additional complexities, as substance use and severe mental illness (SMI) can worsen diabetes control and interfere with management. Education and monitoring should be tailored to their needs, with mental health and diabetes teams collaborating closely. Antipsychotic medications also increase diabetes risk, necessitating vigilant assessment and management (Wu et al., 2018).

Here is a detailed and comprehensive section for a scientific review on managing diabetic patients in the prehospital setting by paramedics, focusing on innovations and future directions with cited sources:

Innovations and Future Directions in Prehospital Diabetes Management by Paramedics

The prehospital management of diabetic patients is undergoing significant transformation through technological advancements and expanded paramedic roles. Innovations in portable testing, artificial intelligence (AI), telemedicine, and community paramedicine approaches are shaping future emergency care and chronic disease management in this patient population.

Portable Technology for Glucose and Ketone Testing in the Field

Advances in portable point-of-care testing (POCT) devices have empowered paramedics to conduct rapid glucose and ketone assessments directly at the scene. Devices such as the EMS Stat analyzer use capillary blood samples to deliver laboratory-quality glucose, ketone, lactate, hemoglobin, and hematocrit results within seconds through single-use biosensors. These tools facilitate immediate detection of hyperglycemia and diabetic ketoacidosis (DKA), allowing paramedics to initiate appropriate management and communicate critical data to receiving emergency departments (EDs). The accessibility and accuracy of these devices have been validated, enabling faster clinical decision-making and improved triage in the field, which can be crucial for patient outcomes (Ceriotti et al., 2014).

A recent feasibility study demonstrated that ambulance clinicians using capillary blood ketone meters could accurately identify 'high-risk' DKA patients and instigate early fluid therapy, improving prehospital care quality and hospital alerting. This real-time biochemical monitoring enhances paramedic capabilities beyond basic glucose assessment and supports safer, more tailored interventions prior to hospital arrival (Prothero et al., 2024).

Artificial Intelligence and Clinical Decision Support Tools in Ambulances

Integration of artificial intelligence (AI) into ambulance systems represents a promising frontier for optimizing emergency medical services for diabetic patients. AI algorithms can analyze complex patient vitals and symptom data in real time, supporting paramedics in rapid diagnosis, triage, and decision-making. Beyond patient monitoring, AI-driven systems optimize ambulance routing using real-time traffic and environmental data, minimizing delays and ensuring timely transport to appropriate facilities (A et al., 2024).

Emerging AI-equipped ambulance models incorporate multiple biosensors monitoring heart rate, respiration, temperature, and glucose-related indicators, alerting paramedics to critical changes and recommending interventions. Combined with decision-support systems, AI can assist in prioritizing patients by risk severity and adapting care pathways dynamically during prehospital care, potentially enhancing survival and reducing complications in diabetic emergencies (Sujan et al., 2022).

Smartphone-Based Teleconsultation with Endocrinologists or Emergency Physicians

Telemedicine is increasingly integrated into prehospital care, allowing paramedics to consult remotely with specialists such as endocrinologists or ED physicians via smartphone or tablet-based platforms. This direct communication facilitates expert guidance on complex diabetic cases, personalized treatment adjustments, and decision support, especially in rural or resource-limited settings (Vimalananda et al., 2022).

Teleconsultations support ongoing management decisions, reduce unnecessary hospital transfers, and enhance patient safety through timely specialist input. Wearable devices and mobile app-based remote monitoring complement telemedicine by providing endocrinologists with real-time glucose data, enabling proactive telehealth interventions. This approach improves chronic disease management continuity and acute crisis resolution through enhanced healthcare team collaboration in the prehospital phase (SeyedAlinaghi et al., 2024).

Expanded Paramedicine Roles in Chronic Disease Management

Community paramedicine models are evolving to encompass not only emergency responses but also comprehensive, proactive diabetes care in the community. Paramedics with extended training deliver chronic disease management services, including self-management education, regular monitoring, and coordination with other healthcare and social services.

Expanding paramedic scope to include diabetes rescue, engagement, and management programs addresses upstream prevention of recurrent hypoglycemia and hospital admissions. Such programs focus on patient education, medication adherence, and social determinants of health, aiming to reduce emergency call volume and improve quality of life for diabetic patients. This expanded role leverages paramedics' accessibility and trust within communities to deliver cost-effective, longitudinal diabetes care beyond episodic emergencies (Drennan et al., 2014).

Research on Outcomes of Treat-and-Release Protocols for Hypoglycemia

Increasing evidence supports safe and effective treat-and-release protocols for hypoglycemic patients in the prehospital setting, potentially reducing ED overcrowding and healthcare costs. Studies have retrospectively validated criteria that allow paramedics to treat hypoglycemia with glucose administration on scene and safely release patients without transport if they meet defined clinical stability markers.

These criteria include rapid restoration of blood glucose levels, return to baseline mental status, and absence of complicating conditions. Prospective research is underway to further validate and optimize treat-and-release protocols, which hold promise for patient-centered, resource-efficient prehospital diabetes care pathways (Myers et al., 2022).

CONCLUSION

The growing global prevalence of diabetes places a considerable burden on emergency medical services, with acute metabolic complications frequently requiring prehospital intervention. Paramedics play a pivotal role in bridging the gap between onset of diabetic emergencies and definitive hospital care, making timely recognition and management essential for reducing morbidity and mortality. Evidence supports structured protocols and decision-making frameworks that balance on-scene treatment with the need for hospital transport. Ongoing challenges, including variability in practice, patient refusal of transport, and resource constraints, necessitate continuous professional education, protocol refinement, and system-level innovations. Emerging technologies such as portable biochemical testing, artificial intelligence–driven decision support, and telemedicine consultations promise to enhance diagnostic accuracy and intervention timeliness. Furthermore, expanding paramedic roles into chronic disease management through community paramedicine models has the potential to reduce recurrent emergencies and improve long-term patient outcomes. Ultimately, strengthening prehospital diabetes care is a critical step toward improving patient safety, optimizing healthcare resource utilization, and addressing the escalating global burden of diabetes.

REFERENCES

1. A, P. J. N. L., S.Manoj, M.Praveen, M.Johnson, & S.Shyam. (2024). Smart Artificial Intellligence Ambulance with Decision Making System. International Journal of Engineering Research & Technology, 13(4). https://doi.org/10.17577/IJERTV13IS040339
2. Adeyinka, A., & Kondamudi, N. P. (2023). Hyperosmolar Hyperglycemic Syndrome. In StatPearls [Internet]. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK482142/
3. Banday, M. Z., Sameer, A. S., & Nissar, S. (2020). Pathophysiology of diabetes: An overview. Avicenna Journal of Medicine, 10(4), 174–188. https://doi.org/10.4103/ajm.ajm_53_20
4. Benoit, S. R., Kahn, H. S., Geller, A. I., Budnitz, D. S., Mann, N. C., Dai, M., Gregg, E. W., & Geiss, L. S. (2018). Diabetes-Related Emergency Medical Service Activations in 23 States, United States 2015. Prehospital Emergency Care, 22(6), 705–712. https://doi.org/10.1080/10903127.2018.1456582
5. Bhagra, S., Ducharme-Smith, A. L., Juntunen, M. B., Liedl, C. P., Golembiewski, E. H., Sundt, W. J., Krpata, T. S., Lampman, M. A., Espinoza, A. L., & McCoy, R. R. (2025). Diabetes rescue, engagement, and management (D-REM) for hypoglycemia: Clinical trial protocol of a community paramedic program to improve diabetes management among adults with severe hypoglycemia. PLOS ONE, 20(6), e0322177. https://doi.org/10.1371/journal.pone.0322177

6. Cappon, G., Vettoretti, M., Sparacino, G., & Facchinetti, A. (2019). Continuous Glucose Monitoring Sensors for Diabetes Management: A Review of Technologies and Applications. Diabetes & Metabolism Journal, 43(4), 383–397. https://doi.org/10.4093/dmj.2019.0121
7. Ceriotti, F., Kaczmarek, E., Guerra, E., Mastrantonio, F., Lucarelli, F., Valgimigli, F., & Mosca, A. (2014). Comparative Performance Assessment of Point-of-Care Testing Devices for Measuring Glucose and Ketones at the Patient Bedside. Journal of Diabetes Science and Technology, 9(2), 268–277. https://doi.org/10.1177/1932296814563351
8. Clawson, J., Scott, G., Gardett, I., Patterson, B., Barron, T., & Olola, C. (2014). Ability of a diabetic problems protocol to predict patient severity indicators determined by on-scene EMS crews. Resuscitation, 85, S111. https://doi.org/10.1016/j.resuscitation.2014.03.275
9. Dhediya, R., Chadha, M., Bhattacharya, A. D., Godbole, S., & Godbole, S. (2022). Role of Telemedicine in Diabetes Management. Journal of Diabetes Science and Technology, 17(3), 775–781. https://doi.org/10.1177/19322968221081133
10. Drennan, I. R., Dainty, K. N., Hoogeveen, P., Atzema, C. L., Barrette, N., Hawker, G., Hoch, J. S., Isaranuwatchai, W., Philpott, J., Spearen, C., Tavares, W., Turner, L., Farrell, M., Filosa, T., Kane, J., Kiss, A., & Morrison, L. J. (2014). Expanding Paramedicine in the Community (EPIC): Study protocol for a randomized controlled trial. Trials, 15, 473. https://doi.org/10.1186/1745-6215-15-473
11. Duncan, E. A. S., Fitzpatrick, D., Ikegwuonu, T., Evans, J., & Maxwell, M. (2018). Role and prevalence of impaired awareness of hypoglycaemia in ambulance service attendances to people who have had a severe hypoglycaemic emergency: A mixed-methods study. BMJ Open, 8(4), e019522. https://doi.org/10.1136/bmjopen-2017-019522
12. Farhat, H., Aifa, K. E., Alinier, G., Nashwan, A., Gangaram, P., Khadhraoui, M., Al-Shaikh, L., Gargouri, I., & Laughton, J. (2023). Understanding patient non-transport decision theories in the pre-hospital setting: A narrative review. International Journal of Emergency Medicine, 16, 69. https://doi.org/10.1186/s12245-023-00528-7
13. Farhat, H., Alinier, G., El Aifa, K., Athemneh, K., Gangaram, P., Romero, R., Khenissi, M. C., Al Shaikh, L., & Laughton, J. (2023a). Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting. BMJ Open Quality, 12(1), e002007. https://doi.org/10.1136/bmjoq-2022-002007
14. Farhat, H., Alinier, G., El Aifa, K., Athemneh, K., Gangaram, P., Romero, R., Khenissi, M. C., Al Shaikh, L., & Laughton, J. (2023b). Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting. BMJ Open Quality, 12(1), e002007. https://doi.org/10.1136/bmjoq-2022-002007
15. Farhat, H., Alinier, G., El Aifa, K., Athemneh, K., Gangaram, P., Romero, R., Khenissi, M. C., Al Shaikh, L., & Laughton, J. (2023c). Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting. BMJ Open Quality, 12(1), e002007. https://doi.org/10.1136/bmjoq-2022-002007
16. Farhat, H., Alinier, G., El Aifa, K., Athemneh, K., Gangaram, P., Romero, R., Khenissi, M. C., Al Shaikh, L., & Laughton, J. (2023d). Quality improvement tools to manage emergency callbacks from patients with diabetes in a prehospital setting. BMJ Open Quality, 12(1), e002007. https://doi.org/10.1136/bmjoq-2022-002007
17. Fayfman, M., Pasquel, F. J., & Umpierrez, G. E. (2017). Management of Hyperglycemic Crises: Diabetic ketoacidosis and hyperglycemic hyperosmolar state. The Medical Clinics of North America, 101(3), 587–606. https://doi.org/10.1016/j.mcna.2016.12.011
18. Foss, R., Fischer, K., Lampman, M. A., Laabs, S., Halasy, M., Allen, S. V., Garrison, G. M., Sobolik, G., Bernard, M., Sosso, J., & Thacher, T. D. (2023). Disparities in Diabetes Care: Differences Between Rural and Urban Patients Within a Large Health System. Annals of Family Medicine, 21(3), 234–239. https://doi.org/10.1370/afm.2962
19. Haamid, A., Christian, E., Tataris, K., Markul, E., Zaidi, H. Q., Mycyk, M. B., & Weber, J. M. (2023). Prehospital Intranasal Glucagon for Hypoglycemia. Prehospital Emergency Care, 27(3), 356–359. https://doi.org/10.1080/10903127.2022.2045406

20. Johnston, B. J., Leung, A. K., Hwang, C. W., Jones, J. M., Chowdhury, M. A. B., Buck, A., Fitzpatrick, D. E., Meurer, D. A., & Becker, T. K. (2022). Medication-Facilitated Advanced Airway Management with First-Line Use of a Supraglottic Device – A One-Year Quality Assurance Review. Prehospital and Disaster Medicine, 37(4), 561–565. https://doi.org/10.1017/S1049023X22000802
21. Kasper, A. L., Myers, L. A., Carlson, P. N., Johnson, R. F., Schultz, J. L., Meyer, D., Liedl, C. P., Juntunen, M. B., & McCoy, R. G. (2022a). Diabetes Management for Community Paramedics: Development and Implementation of a Novel Curriculum. Diabetes Spectrum : A Publication of the American Diabetes Association, 35(3), 367–376. https://doi.org/10.2337/ds21-0095
22. Kasper, A. L., Myers, L. A., Carlson, P. N., Johnson, R. F., Schultz, J. L., Meyer, D., Liedl, C. P., Juntunen, M. B., & McCoy, R. G. (2022b). Diabetes Management for Community Paramedics: Development and Implementation of a Novel Curriculum. Diabetes Spectrum : A Publication of the American Diabetes Association, 35(3), Article 3. https://doi.org/10.2337/ds21-0095
23. Kulshrestha, V., & Agarwal, N. (2016). Maternal complications in pregnancy with diabetes. JPMA. The Journal of the Pakistan Medical Association, 66(9 Suppl 1), S74-77.
24. Lotter, N., Lahri, S., & van Hoving, D. J. (2021). The burden of diabetic emergencies on the resuscitation area of a district-level public hospital in Cape Town. African Journal of Emergency Medicine, 11(4), 416–421. https://doi.org/10.1016/j.afjem.2021.05.004
25. Maharjan, J., Pandit, S., Arne Johansson, K., Khanal, P., Karmacharya, B., Kaur, G., & Kumar Aryal, K. (2024). Effectiveness of interventions for emergency care of hypoglycaemia and diabetic ketoacidosis: A systematic review. Diabetes Research and Clinical Practice, 207, 111078. https://doi.org/10.1016/j.diabres.2023.111078
26. Mathew, T. K., Zubair, M., & Tadi, P. (2023). Blood Glucose Monitoring. In StatPearls [Internet]. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK555976/
27. Moradian, S. T., Beitollahi, F., Ghiasi, M. S., & Vahedian-Azimi, A. (2022). Capnography and Pulse Oximetry Improve Fast Track Extubation in Patients Undergoing Coronary Artery Bypass Graft Surgery: A Randomized Clinical Trial. Frontiers in Surgery, 9, 826761. https://doi.org/10.3389/fsurg.2022.826761
28. Myers, L. A., Swanson, K. M., Glasgow, A. E., & McCoy, R. G. (2022a). Management and Outcomes of Severe Hypoglycemia Treated by Emergency Medical Services in the U.S. Upper Midwest. Diabetes Care, 45(8), 1788–1798. https://doi.org/10.2337/dc21-1811
29. Myers, L. A., Swanson, K. M., Glasgow, A. E., & McCoy, R. G. (2022b). Management and Outcomes of Severe Hypoglycemia Treated by Emergency Medical Services in the U.S. Upper Midwest. Diabetes Care, 45(8), 1788–1798. https://doi.org/10.2337/dc21-1811
30. Myers, L. A., Swanson, K. M., Glasgow, A. E., & McCoy, R. G. (2022c). Management and Outcomes of Severe Hypoglycemia Treated by Emergency Medical Services in the U.S. Upper Midwest. Diabetes Care, 45(8), 1788–1798. https://doi.org/10.2337/dc21-1811
31. Myers, L. A., Swanson, K. M., Glasgow, A. E., & McCoy, R. G. (2022d). Management and Outcomes of Severe Hypoglycemia Treated by Emergency Medical Services in the U.S. Upper Midwest. Diabetes Care, 45(8), 1788–1798. https://doi.org/10.2337/dc21-1811
32. Priambodo, A. P., Karisa, P., & Audly, T. B. (2024a). Pre Hospital Management in Emergency Hypoglycemia: A Case Report. Indonesian Journal of Global Health Research, 6(4), 2049–2058. https://doi.org/10.37287/ijghr.v6i4.3351
33. Priambodo, A. P., Karisa, P., & Audly, T. B. (2024b). Pre Hospital Management in Emergency Hypoglycemia: A Case Report. Indonesian Journal of Global Health Research, 6(4), 2049–2058. https://doi.org/10.37287/ijghr.v6i4.3351
34. Prothero, L. S., Strudwick, T., Foster, T., Lake, A. K., Boyle, A., Clark, A., Williams, J., Rayman, G., & Dhatariya, K. (2024). Ambulance clinician use of capillary blood ketone meters to improve emergency hyperglycaemia care: A stepped-wedged controlled, mixed-methods feasibility study. Diabetic Medicine: A Journal of the British Diabetic Association, 41(9), e15372. https://doi.org/10.1111/dme.15372

35. Ravn Jacobsen, M., Jabbari, R., Glinge, C., Kjær Stampe, N., Butt, J. H., Blanche, P., Lønborg, J., Wendelboe Nielsen, O., Køber, L., Torp-Pedersen, C., Pedersen, F., Tfelt-Hansen, J., & Engstrøm, T. (2020). Potassium Disturbances and Risk of Ventricular Fibrillation Among Patients With ST-Segment–Elevation Myocardial Infarction. Journal of the American Heart Association: Cardiovascular and Cerebrovascular Disease, 9(4), e014160. https://doi.org/10.1161/JAHA.119.014160
36. Russo, M. P., Grande-Ratti, M. F., Burgos, M. A., Molaro, A. A., & Bonella, M. B. (2023). Prevalence of diabetes, epidemiological characteristics and vascular complications. Archivos De Cardiologia De Mexico, 93(1), 30–36. https://doi.org/10.24875/ACM.21000410
37. Salh, H. J. H., Aziz, T. A., Mahwi, T. O., Hussen, N. H., & Aziz, D. F. (2025). The Relation Between Polypharmacy, Potentially Inappropriate Medications, Organ Function, and Quality of Life in Elderly Patients with Type 2 Diabetes. Hospital Pharmacy, 00185787251337592. https://doi.org/10.1177/00185787251337592
38. Sapra, A., & Bhandari, P. (2023). Diabetes. In StatPearls [Internet]. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK551501/
39. Schwerin, D. L., & Svancarek, B. (2023a). EMS Diabetic Protocols For Treat and Release. In StatPearls [Internet]. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK560612/
40. Schwerin, D. L., & Svancarek, B. (2023b). EMS Diabetic Protocols For Treat and Release. In StatPearls [Internet]. StatPearls Publishing. https://www.ncbi.nlm.nih.gov/books/NBK560612/
41. SeyedAlinaghi, S., Yarmohammadi, S., Mirzapour, P., Dehghani, S., Ahmadi, S., Abbaspour, F., Pashaei, A., Molla, A., Pashaei, A., Ahmadi, S., & Mehraeen, E. (2024). A Systematic Review of Telehealth Applications in Endocrinology. Telemedicine Reports, 5(1), 269–289. https://doi.org/10.1089/tmr.2024.0032
42. Singhal, V. (2019). Clinical Approach to Acute Decline in Sensorium. Indian Journal of Critical Care Medicine : Peer-Reviewed, Official Publication of Indian Society of Critical Care Medicine, 23(Suppl 2), S120–S123. https://doi.org/10.5005/jp-journals-10071-23188
43. Strachan, M. W. J. (2007). Physiological responses to hypoglycaemia – not all 'just in the head'. The Journal of Physiology, 582(Pt 2), 475–476. https://doi.org/10.1113/jphysiol.2007.136648
44. Sujan, M., Thimbleby, H., Habli, I., Cleve, A., Maaløe, L., & Rees, N. (2022). Assuring safe artificial intelligence in critical ambulance service response: Study protocol. British Paramedic Journal, 7(1), 36–42. https://doi.org/10.29045/14784726.2022.06.7.1.36
45. Szafran, O., Kennett, S. L., Bell, N. R., & Torti, J. M. I. (2019). Interprofessional collaboration in diabetes care: Perceptions of family physicians practicing in or not in a primary health care team. BMC Family Practice, 20, 44. https://doi.org/10.1186/s12875-019-0932-9
46. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Saz, E. U. (2020a). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology, 12(2), 189–196. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121
47. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., Saz, E. U., Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Saz, E. U. (2020a). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121
48. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., Saz, E. U., Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Saz, E. U. (2020b). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121
49. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., Saz, E. U., Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Saz, E. U. (2020c). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121

50. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Ulaş Saz, E. (2020b). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology, 12(2), 189–196. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121
51. Turan, C., Yurtseven, A., Basa, E. G., Gökşen, D., & Ulaş Saz, E. (2020c). The Effects of Prehospital Care on Outcome in Pediatric Diabetic Ketoacidosis. Journal of Clinical Research in Pediatric Endocrinology, 12(2), 189–196. https://doi.org/10.4274/jcrpe.galenos.2019.2019.0121
52. Umpierrez, G. E., Davis, G. M., ElSayed, N. A., Fadini, G. P., Galindo, R. J., Hirsch, I. B., Klonoff, D. C., McCoy, R. G., Misra, S., Gabbay, R. A., Bannuru, R. R., & Dhatariya, K. K. (2024). Hyperglycemic Crises in Adults With Diabetes: A Consensus Report. Diabetes Care, 47(8), 1257–1275. https://doi.org/10.2337/dci24-0032
53. van Woerden, H., Bucholc, M., Clubbs Coldron, B., Coates, V., Heaton, J., McCann, M., Perrin, N., Waterson, R., Watson, A., & MacRury, S. (2021). Factors influencing hospital conveyance following ambulance attendance for people with diabetes: A retrospective observational study. Diabetic Medicine, 38(4), e14384. https://doi.org/10.1111/dme.14384
54. Villani, M., Earnest, A., Smith, K., de Courten, B., & Zoungas, S. (2018). Geographical variation of diabetic emergencies attended by prehospital Emergency Medical Services is associated with measures of ethnicity and socioeconomic status. Scientific Reports, 8(1), 5122. https://doi.org/10.1038/s41598-018-23457-5
55. Vimalananda, V. G., Brito, J. P., Eiland, L. A., Lal, R. A., Maraka, S., McDonnell, M. E., Narla, R. R., Roth, M. Y., & Crossen, S. S. (2022). Appropriate Use of Telehealth Visits in Endocrinology: Policy Perspective of the Endocrine Society. The Journal of Clinical Endocrinology and Metabolism, 107(11), 2953–2962. https://doi.org/10.1210/clinem/dgac494
56. Wu, L.-T., Ghitza, U. E., Zhu, H., Spratt, S., Swartz, M., & Mannelli, P. (2018). Substance use disorders and medical comorbidities among high-need, high-risk patients with diabetes. Drug and Alcohol Dependence, 186, 86–93. https://doi.org/10.1016/j.drugalcdep.2018.01.008