

Management of Hyperglycemia in Emergency Rooms

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Received: September 29, 2021; Published: October 29, 2021

Abstract

Introduction: The occurrence of hyperglycemia is common in emergency rooms where patients are under extreme stress-inducing conditions like pain, trauma, infection, or are suffering from diabetes mellitus. The highest occurrence of hyperglycemia in emergency rooms is seen in patients with diabetes mellitus as 30 - 40% of patients admitted are diabetic, the incidence of hyperglycemia is 30 - 40% in general wards, increasing to up to 80% in Intensive care units. Long-standing chronic hyperglycemia with high blood glucose levels causes severe damage to other body organs like the kidney, cardiovascular system, damage to the extremities and eyes.

Aim of the Study: This review aims at highlighting the various management therapies for patients with hyperglycemia admitted to the emergency department.

Methodology: This review is a comprehensive research of PUBMED and Google Scholar from the year 1979 to 2020.

Conclusion: The prevalence of Hyperglycemic crisis in the emergency department is extremely high because of the huge population affected by diabetes. Emergency setting plays a paramount role in the diagnosis of hyperglycemic emergencies, explaining the underlying cause of the disease, prevention of arduous complications, and enhancing the overall clinical outcome of the condition. Once the patient is admitted to the emergency department for hyperglycemia, closer attention can be paid to the underlying cause and a better self-management education post-discharge. Hyperglycemia in patients admitted to the emergency department should not be ignored as it helps in enhancing the clinical outcome of the primary disease.

Keywords: Emergency Department; Hyperglycemia; Diabetic Ketoacidosis; Insulin Therapy; Hyper Osmolality

Introduction

The definition of hyperglycemia was given by the American Diabetes Association using a cut-off of 180 mg/dL, where glucose level above this cut-off was considered as a Hyperglycemic condition. The occurrence of hyperglycemia is common in emergency rooms where patients are under extreme stress-inducing conditions like pain, trauma, infection, or are suffering from diabetes mellitus. These circumstances can induce an increased sugar content in the blood. A blood sugar level exceeding 180 mg/dL is considered hyperglycemic but may not show symptoms; considerable organ damage starts occurring after the patient maintains a high level in the range of 250 to

300 over a long period of time. To declare hyperglycemia in patients with diabetes, the sugar level reading varies from patient to patient depending on his glucose tolerance [1].

The highest occurrence of hyperglycemia in emergency rooms is seen in patients with diabetes mellitus as 30 - 40% of patients admitted are diabetic, the incidence of hyperglycemia is 30 - 40% in general wards, increasing to up to 80% in Intensive care units. Hyperglycemia induced due to stress, more commonly known as stress hyperglycemia, was initially thought to be a part of hospital admission and was not sought for treatment unless the patient showed any symptoms or the value increased to more than 200 mg/dL. Off-late the correlation of increased blood glucose during admission with a longer stay at the hospital, frequent shift of the patients to ICU, and a more compromised prognosis has been found, which now necessitates the treatment of hyperglycemic condition at its first occurrence [2].

Hyperglycemia can be divided into temporary and chronic, depending on the duration of increased blood glucose. Temporary hyperglycemia is not as threatening and the changes caused are reversible and go back to normal once the blood glucose level is normalized. On the other hand, long-standing chronic hyperglycemia with long-standing high blood glucose levels causes severe damage to other body organs like the kidney, cardiovascular system, damage to the extremities and eyes [3].

Pathogenesis of hyperglycemic adverse effects

There are many factors that play a role in the correlation between hyperglycemia and the adverse effects caused by it. An increased level of blood glucose causes increased production of proinflammatory cytokines, which in turn causes many adverse effects like thickening of the basement membrane of the blood capillaries, decreased immunity, an increased level of free oxygen radicals (oxidative stress), which leads to severe tissue damage, a decreased or increased metabolism of lipid, the contraction capacity of the vessels decrease, platelets tend to adhere more with each other, increased levels of blood clotting factors, and an increased concentration of C-reactive protein. All these factors end up in severe tissue damage. In addition to the common causes of increased blood glucose levels, factors that lead to hyperglycemia are Increased levels of various hormones that induce stress like the growth hormone, catecholamine, cortisol, glucagon, medications administered during the emergency stay like glucocorticoid therapy [5].

Incidence of hyperglycemia in the emergency department

In the last decade, it has been seen that more than 20% of patients admitted to the emergency department are diagnosed with hyperglycemia. Between the years 2006 and 2011, there was an increased rate of admission for people suffering from hyperglycemic crises in the emergency department. The patients admitted neither have ketoacidosis nor a hyperosmolar hyperglycemic state, patients who are unaware of their hyperglycemic state make the bulk of the admissions [6].

A study conducted in the USA concluded that most of the patients getting admitted in the emergency ward for the hyperglycemic crisis were unaware of their existing diabetic or pre-diabetic condition, with numbers ranging from 36.4 to 38%, respectively [7]. Patients reporting in the emergency wards have shown to have the presence of risk factors and hence can be suspected for pre-diabetic conditions. Another study examined patients getting admitted to the emergency wards with high blood glucose levels and concluded that 11% of such patients were diabetic on examination. HBA1c test gives a fairly good assessment of the blood glucose level of the patient in the past three months [8]. In a study conducted by Charfen., *et al.* in 2009, they studied various risk factors like age above 45, polyuria, polydipsia, and a blood sugar level above 155 mg/dL could be used to predict diabetic condition [9]. Such patients should be informed about their condition, and communication should be made to the next care team to avoid clinical inertia and provide glycemic control. The other group of patients who are to be admitted to the hospital after discharge from the Emergency department should be informed, and treatment for diabetes in the initial stages should be initiated as a report suggests that only 10% of the patients were informed about their hyperglycemic condition once getting moved from the emergency ward to inpatient wards [10].

Management of hyperglycemia in the emergency rooms

Patients getting admitted to the emergency wards should be checked for hyperglycemic symptoms, presence of diabetic ketoacidosis, and control of any existing diabetic condition. The management for such patients should be decided in a stepwise strategy according to the existing conditions and interventions provided at each step (Figure 1) [11].

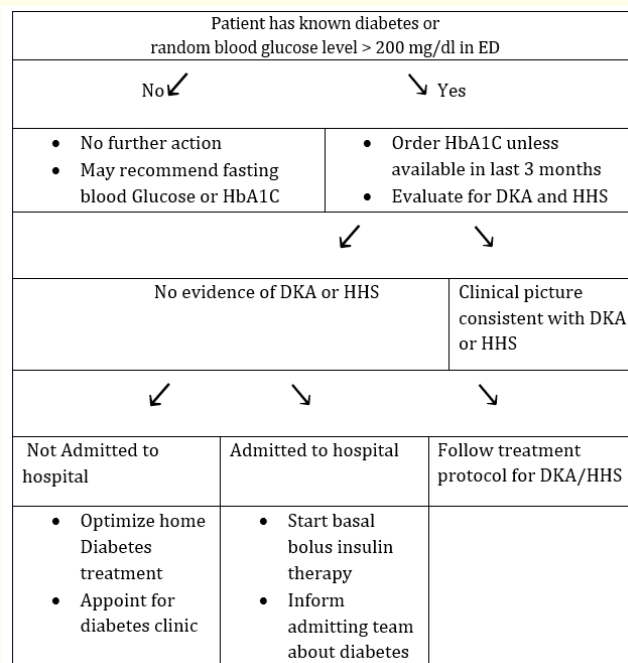


Figure 1: Management algorithm from hyperglycemia in the emergency department [11].

Opening evaluation

Once the patients report to the emergency department with hyperglycemia, it is of extreme importance that they are evaluated for Diabetic ketoacidosis and Hyperglycemic hyperosmolar state as both these conditions have a high mortality rate. Following measures should be taken after the admission (Table 1).

1. Evaluate if airway protection is needed to ensure ample oxygenation and ventilation.
2. Intravenous access to medications
3. Cardiac monitoring
4. Strict observation of intake: output ratio
5. The medical history of the patient should be duly noted to evaluate the cause of the episode.
6. Following Biochemical assessments should be run immediately: <ul style="list-style-type: none"> a. Blood glucose levels b. Complete blood count c. Serum phosphate and magnesium d. Hb1Ac e. Liver enzymes f. Blood Clotting profile g. Urine and blood cultures

Table 1: Steps to be taken after admission of a patient with hyperglycemia in emergency rooms [11].

The underlying cause for hyperglycemia should be assessed for a better treatment strategy. The various triggers for hyperglycemia like infection, pancreatitis, cardiac episodes should be assessed and ruled out. This initial biochemical assessment helps to know the levels of electrolytes in the serum-like serum sodium, serum osmolality, free water, etc. Once the therapy starts, serum glucose and electrolyte should be assessed to evaluate the efficiency of the treatment [4].

Management therapies for hyperglycemia

IV Fluid

The first line of treatment in hyperglycemia and diabetic ketoacidosis is intravenous hydration, as it decreases the serum glucose and ketones by increasing urinary clearance, which in turn increases the renal perfusion and intravascular volume. The intravenous fluid used in the first instance is isotonic saline which helps in restoring the perfusion and expanding the intravascular volume. There is a fluid deficit in patients with diabetic ketoacidosis and hyperosmolar state that ranges between 3 - 10 mL. The rate of infusion for isotonic saline is at 500 - 1000 mL/h, and it's infused for a duration of 120 - 240 minutes [12]. Once this phase is over, the serum sodium, hydration state, and urine output are measured, which determines the further infusion process. Patients who have a low sodium level are continued on isotonic saline, whereas patients with elevated sodium then receive 0.45% sodium chloride. Once the glucose reaches around 200-250mg/dL, dextrose is administered in order to avoid hypoglycemia and control ketonemia [4].

Insulin therapy

The mainstay of treatment of hyperglycemia is insulin therapy. To date, patients admitted to the emergency department with hyperglycemia are administered insulin intravenously [13]. In cases of mild Diabetic ketoacidosis, insulin can also be administered subcutaneously. Subcutaneous and intravenous administration both have proven to take the same time for resolution of diabetic ketoacidosis, although, in an emergency setup, subcutaneous administration is a more practical option due to the shortage of staff members. The mechanism of action for insulin is the reduction of glucose production, suppression of lipolysis, and ketogenesis. Serum potassium levels should be checked before administration of insulin to help prevent the flow of potassium from extracellular to intracellular space [14].

Insulin administration can be done in two ways, the first being administration of a bolus of 0.1 unit/kg, which is then succeeded by a continuous flow of 0.1 U/kg/h. The second way is to directly administer insulin without the bolus dose; in this case, the administration is done at a rate of 0.14 U/kg/h; both the techniques of administration have shown a similar result [15]. The aim of insulin administration is a fall of serum glucose level by 50 mg/dL every hour. According to the existing literature, a combination of insulin therapy with hydration helps to reduce the serum glucose level. The desired glucose concentration during insulin therapy should be between 150 - 200 mg/dL and the dosage of insulin can be adjusted according to the serum glucose level. Often, insulin sensitivity can be seen in patients, which are counteracted by infusion of dextrose-containing fluids, which helps in decreasing chances of hypoglycemia [16].

Administration of phosphorus and potassium

Patients who report diabetic ketoacidosis often show a decreased level of potassium [17]. Due to a combination of insulin deficiency and acidosis, potassium tends to shift from the intracellular compartment to the extracellular. Insulin therapy tends to cause hypokalemia as it shifts the potassium in the intracellular compartment, which may lead to cardiac arrest. Potassium administration should be initiated when the potassium levels fall below 5 mEq/L and should be maintained between 4-5 mEq/L during the therapy. In cases of low urine output and renal dysfunction, potassium should not be administered unless the level is low [4].

Once the patient resumes eating after their admission, phosphate depletion occurs on its own and hence need not be administered. While administering phosphate, calcium levels should be evaluated, and hypocalcemia should be avoided [18].

Therapy monitoring and reversal of hyperglycemic crisis

Urine output and electrolyte and fluid balance should be assessed while the patients are in the emergency ward with the help of frequent biochemical and clinical reassessment. Serum ketoacidosis should be evaluated every hour with the help of a basic metabolic panel that monitors the potassium levels and anion gaps. A fingerstick glucose test should also be frequently repeated to check if the patient is turning hypoglycemic. These tests should be performed every 18 - 24 hours in the emergency wards. Biochemical readings which ensure resolution of ketoacidosis are [18]:

- Serum glucose level reaches less than or equal to 250 mg/dL
- Serum bicarbonate level greater than or equal to 18 mEq/L
- Normal anion gaps
- A venous or arterial pH greater than or equal to 7.3.

Some patients may develop a Hyperchloremic state because of excessive administration of saline, which converts the bicarbonates into chloride; the bicarbonates level also takes some time to revert back to normal. Blood and urine ketoacids take around 24 - 36 hours to get eliminated from the system. In the Hyperosmolar hyperglycemic state, the plasma glucose level goes below 250 mg/dL upon resolution, and osmolality remains less than 310 nmol/kg [18].

How to avoid a visit to the emergency department post-discharge with hyperglycemia

Once the patient is discharged from the emergency ward, a lack of proper outpatient management may lead to readmission in the emergency ward. An emergency admission helps the hospital staff to assess the patient status and classify the high-risk group who need long-term diabetic treatment. A study was done by Magee, *et al.* where they educated the emergency department patients who had blood glucose levels beyond 200 mg/dL in diabetes self-management education showed better adherence to medication and good glycemic control [19]. These strategies are difficult to handle on a large scale, but a close associate of the patient with a diabetes nurse or a pharmacist will show improvement in glycemic control and reduction revisits to the emergency department [20].

Conclusion

The prevalence of the Hyperglycemic crisis in the emergency department is extremely high because of the huge population affected by diabetes. Emergency setting plays a paramount role in the diagnosis of hyperglycemic emergencies, explaining the underlying cause of the disease, prevention of arduous complications, and enhancing the overall clinical outcome of the condition. Once the patient is admitted to the emergency department for hyperglycemia, closer attention can be paid to the underlying cause and a better self-management education post-discharge. Hyperglycemia in patients admitted to the emergency department should not be ignored as it helps in enhancing the clinical outcome of the primary disease.

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Volume 17 Issue 11 November 2021

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