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UNVEILING THE HIDDEN CULPRIT AND ROLE OF INSULIN AS A SAVIOR, IN AN INFANT WITH DIABETIC KETOACIDOSIS – A CASE REPORT

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Abstract: Background: Diabetic ketoacidosis (DKA) is a life-threatening metabolic emergency with significant mortality in children, especially in developing countries.So,high index of clinical suscipicion,early diagnosis and prompt intervention with Intravenous fluids ,electrolyte correction and the continuous infusion of life saving drug Insulin is very crucial.Reporting a 9-month-old female infant ,who presented with fever, vomiting, tachypnea, and altered sensorium, initially suspected as lower respiratory tract infection. Laboratory evaluation revealed severe DKA with hyperglycemia, metabolic acidosis, and ketonuria. The child was successfully managed with standard DKA protocol and later diagnosed with type 1 diabetes mellitus (T1DM) and on Insulin therapy. This case highlights the importance of early screening for hyperglycemia in critically ill infants and the role of Insulin in preventing mortality, when given at right time.

Keywords: Diabetic ketoacidosis, Infant, Type 1 diabetes mellitus, Hyperglycemia, Shock

INTRODUCTION

Discovery and development of Insulin :

Insulin is found to be one of the most important medical discoveries in the treatment of diabetes. In the year 1921, researchers Frederick Banting and Charles Best began experiments in Toronto using the pancreatic extracts to treat diabetes in dogs. A major breakthrough came when a dog named Marjorie survived for almost 70 days with these injections. This success led to the first life-saving insulin injection in a human in the year 1922, marking a turning point in the management of Type 1 Diabetes.[1]

Since then, Insulin production has evolved significantly. Early insulin was then derived from animal sources such as cattle and pigs. By the 1980s, advances in biotechnology enabled the insulin analogues which were introduced—genetically modified forms were designed for better control and flexibility. More recently, biosimilarinsulins have emerged in the market, offering similar effectiveness with slight structural differences due to distinct manufacturing processes.

Overall, the discovery and evolution of insulin have transformed diabetes from a fatal disease into a manageable condition, saving millions of lives worldwide both adults and children.[2]

Mechanism of action of Insulin:

Insulin, a hormone which is composed of 51 amino acids, and plays an important role in glucosehomeostasis, cell growth, and metabolism. Insulin exterts its action as it binds to specific receptors on the target cells (muscle, adipose tissue, and liver), leads to following effects[3,4] :

- Increased glucose uptake
- Glycogen synthesis
- Reduced gluconeogenesis
- Enhanced fat and protein synthesis

Thus lowering of blood glucose levels.

The metabolism of glucose is very much known to be triggered by food intake, leading to simultaneous increase in insulin secretion and production and decrease in glucagon secretion to bring serum glucose levels back to normal[5,6,7] .

Insulin Signaling Pathways [8,9]

After being secreted from pancreatic cells and circulating through the body, insulin starts its function as it binds to insulin receptors (IRs) on target cell membranes. This binding and activation results in the phosphorylationof insulin receptor substrate (IRS) and the subsequent activation of two primarysignaling pathways, viz. the phosphoinositide3-kinase (PI3K)/protein kinase B (Akt) pathway and the mitogen-activated protein kinase (MAPK) pathway (Figure 1).

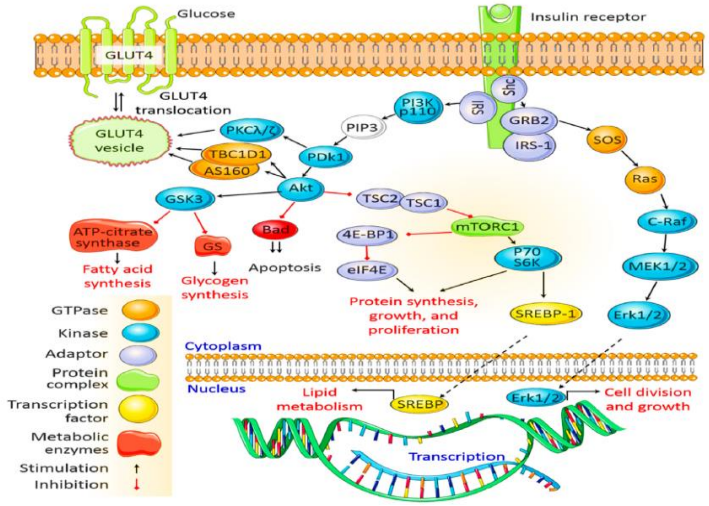

Figure 1. *Classic insulin signaling pathway. Insulin regulates cellular functions and metabolic activity by binding to the insulin receptor. Core cellular processes downstream of the insulin signaling system include the PI3K/Akt and MAPK signaling pathways; details on these pathways are given in Section 3. IRS, insulin receptor substrate; IR, insulin receptor; PI3K, phosphoinositide3-kinase; MAPK, mitogenactivated protein kinase; PIP3, phosphatidylinositol 3,4,5-triphosphate; PDK1, 3-phosphoinositide dependent protein kinase-1; Grb2, growth factor receptor-bound protein 2; GSK, glycogen synthase kinase; GS, glycogen synthase; mTORC1, mammalian target of rapamycin complex 1; SREBP, sterol regulatory element-binding protein; glucose transporter 4, GLUT4; MEK, MAPK/Erk kinase; ERK, extracellular signal-regulated kinase.*

Insulin And Diabetes Mellitus

Type 1 diabetes is due to autoimmune destruction of pancreatic beta cells which leads to insufficient insulin production resulting in hyperglycemia[10] .The common symptoms presenting in type 1 diabetes are

polyuria, polydipsia, and weight loss .[11]Severe fall in insulin levels leads to increase in lipolysis which in turn will lead to increase in level of ketone bodies resulting metabolic acidosis and compensatory respiratory alkalosis .[12]Diabetes ketoacidosis (DKA) is the common presentation of type 1 diabetes mellitus seen in children. The prevalence of onset of diabetic ketoacidosis among type 1 diabetes mellitus was found to be 26.3% in one of the studies [13].Common complications observed due to ketoacidosis are electrolyte abnormalities like hypokalemia, hyponatremia leading to cerebral edema and shock .[14]If Diabetic ketoacidosis is not treated on time, the compensatory mechanism will fail soon and leading to cerebral edema, mental confusion, unconsciousness, coma and death .[12,15]DKA is the most common cause of death in children and adolescents with type 1 diabetes and cause of half of all deaths in diabetic patients under the age of 24 years.[16]Immediate and aggressive intervention is required. Early medical management could prevent complications like cerebral edema, mental confusion, shock and death.[17]

Types of Insulin[18]

There are many different types of insulin.

Rapid-Acting - This insulin starts working within 15 minutes and it should be taken just before or just after we eat.

Short-Acting - This insulin starts working within 30 minutes to 1 hour and It should be taken 30-45 minutes before we eat.

Intermediate-Acting - This insulin starts working within 2-4 hours and known to reach its highest level in around 6-8 hours after taking it. It is often used to help control the blood sugar between meals.

Long-Acting - This insulin starts working within 2 to 4 hours and It can last in the body for up to 24 hours. It is often used in the morning or at bedtime to help control the blood sugar throughout the day.

Pre-Mixed - This is a mix of two different types of insulin. It includes one type that is known to help to control your blood sugar at meals and another type that helps between meals.

Insulin Devices[19,20]

There are many different ways to use and inject insulin. Few People use a needle and syringe to inject their insulin. Others are known to use an insulin pen, jet injectors, inhaler, or pump are also available.

Side effects of Insulin therapy[20,21]

- Hypoglycaemia (low blood sugar): The most commonly found and severe side effect, Symptoms include shakiness, sweating, confusion, and, in severe cases, loss of consciousness and coma.
- Weight gain: Insulin can also lead to weight gain, which may be managed through diet and exercise.
- Injection site reactions: Redness, swelling or itching occurs usually at the injection sites.
- Insulin resistance: In some cases, the body also may become less responsive to insulin over time.
- Allergic reactions: Rare but they can occur. Symptoms may include rash, difficulty breathing or swelling.
- Lipodystrophy: Changes are noticed in fat tissue at injection sites can affect insulin absorption.

CASE PRESENTATION

A 9-month-old female infant presented with fever, cough, and respiratory distress suggestive of Lower respiratory tract infection[LRTI] , along with altered sensorium. On admission, the child was in shock with signs of severe dehydration.

Initial laboratory findings revealed:

- Capillary blood glucose: 558 mg/dL
- Arterial pH: 6.9
- Serum bicarbonate: 5 mEq/L
- Urine ketones: 4+
- HbA1c: 7.2%
- Low C-peptide levels

Further evaluation showed positive glutamic acid decarboxylase (GAD) antibodies. There was a significant family history, with the father diagnosed with Type 1 Diabetes Mellitus and positive autoantibodies.A diagnosis of severe DKA with shock secondary to new-onset T1DM was made.The child was managed according to standard DKA protocols with intravenous fluid resuscitation ,Continuous insulin infusion and Electrolyte correction .

Gradual clinical improvement was observed. Hemodynamic stability was achieved, and metabolic parameters normalized. DKA resolved within 24 hours.

The patient was transitioned to a basal-bolus insulin regimen:Insulinglargine: 0.7 IU and Pre-meal regular insulin: 0.7 IU .The child tolerated feeds well and maintained stable glucose levels at discharge.

DISCUSSION

Diabetic ketoacidosis is an acute, life threatening diabetic emergency. Overall mortality in children with DKA varies from 3.4% to 13.4% in developing countries[22]. Hence Accurate diagnosis and management are paramount.DKA as the first presentation of T1DM in infancy is rare but has been increasingly recognized. Infections such as LRTI can act as precipitating factors due to stress-induced counter-regulatory hormone release.

This case Presented here is notable for:

- Very early onset of T1DM (infancy)
- Strong autoimmune association (positive GAD

antibodies)
- Positive family history suggesting genetic predisposition

Infants often present with nonspecific symptoms such as lethargy, poor feeding, or respiratory distress, which can cause delay in diagnosis. Severe acidosis (pH < 7.0) and shock can further increase the risk of complications.

Early screening for hyperglycemia in sick infants—especially those with dehydration or altered sensorium—is critical for timely diagnosis.

AssumptaChapp etal reported a 9month old male presented to the children's emergency room of the Abia state university teaching hospital with a 3 day history of fever and a one day history of frequent stooling and vomitting.This case of permanent diabetes first diagnosed with ketoacidosis at 9 months of age .[23]

The reported frequency of DKA as the first presentation of childhood T1DM found in various studies ranges from 15% to 67.[24] More meaningfully, more than half of children younger than 3 years of age present with DKA as their first presentation of T1DM[24.]

Other case reported in infants which were similar to our case but was diagnosed as Neonatal diabetes a nd are as follows.

Fredrick F Etal[25]	**7 Weeks Old Neonate**	**Neonatal Diabetes Mellitus With Diabetic Ketoacidosis, Septicemia, And Severe Malaria.**
Doua Khalid Al Etal[26]	A Six-Month-Old Boy Born	Neonatal Diabetes With Diabetic Ketoacidosis (DKA)
Elhammaleki Etal[27]	A Four-Month-Old Infant Boy	Diabetic Ketoacidosis

CONCLUSION

This case underscores the importance of considering DKA in infants presenting with severe illness and dehydration. Routine blood glucose screening in such scenarios will definitely help identify previously undiagnosed diabetes. Early diagnosis and prompt management are lifesaving and prompt use of INSULIN in this situation .

"Unveiling the hidden culprit" emphasizes how physiological stress can reveal underlying autoimmune diabetes even in very young infants and INSULIN saved the life.

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