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Clinical Profile, Precipitating Factors, and Outcome of Diabetic Keto Acidosis in Type 1 Diabetes Mellitus Between 1 to 15 Years

Dr. Abdul Razak Bidari[1], Dr. Sudhir D[2], Dr. Shivani Nag[3], Dr. Anil[4]

[1]Postgraduate, Department of Paediatrics, Ballari Medical College and Research Centre, Ballari

[2]Professor, Department of Paediatrics, Ballari Medical College and Research Centre, Ballari

[3]Postgraduate, Department of Paediatrics, Ballari Medical College and Research Centre, Ballari

[4]Postgraduate, Department of Paediatrics, Ballari Medical College and Research Centre, Ballari

Abstract: ***Background**: Diabetic ketoacidosis (DKA) is a life - threatening complication of Type 1 diabetes, particularly in paediatric patients. This study is aimed to analyse the clinical profile, precipitating factors, and outcomes of DKA in children aged 1 to 15 years, with a focus on identifying key factors that influence patient outcomes. **Methods**: A descriptive, observational study, conducted at a tertiary care hospital, including 50 children diagnosed with Type 1 diabetes and admitted with DKA. Data were retrospectively collected on demographic characteristics, clinical symptoms, blood pressure levels, ketone bodies, insulin compliance, injection techniques, and patient outcomes. Descriptive statistics were used to analyze the data. **Results**: The study population had a mean age of 10.81 years, with a majority being females (70%). Clinical symptoms such as polyuria, polydipsia, vomiting, and hurried breathing were prevalent in over 90% of cases. Hypertension was observed in 28% of patients. A significant majority (80%) had 3+ ketone bodies in both serum and urine. Insulin compliance was poor in 34% of the patients, with 56% using correct injection techniques. The mortality rate was 10%, while 90% of the patients showed improvement. Vital statistics revealed elevated heart and respiratory rates, with mean glucose levels at 553.44 mg/dL and mean pH at 6.8576, indicating severe acidosis. **Conclusions**: The study highlights the critical nature of DKA in children with Type 1 diabetes, emphasizing the need for early detection, effective management, and ongoing patient education to improve treatment adherence. Despite the majority of patients responding well to treatment, the mortality rate underscores the importance of timely intervention. Future research should focus on larger, multi - center studies to further explore strategies for preventing DKA and improving patient outcomes.*

Keywords: Diabetic Ketoacidosis, Type 1 Diabetes, Paediatric, Insulin Compliance, Clinical Outcomes

1. Introduction

Diabetic Ketoacidosis (DKA) is a life - threatening complication of diabetes mellitus, predominantly seen in patients with Type 1 Diabetes Mellitus (T1DM). It is characterized by hyperglycemia, ketosis, and metabolic acidosis, often resulting from insulin deficiency and a precipitating factor such as infection or non - compliance with insulin therapy. The incidence and clinical profile of DKA vary globally, with significant differences observed between developed and developing countries due to variations in healthcare access, patient education, and socioeconomic factors (1).

Studies have shown that DKA is one of the most common causes of hospitalization in children and adolescents with T1DM, contributing significantly to diabetes - related morbidity and mortality (2). In developed countries, the incidence of DKA at the time of T1DM diagnosis ranges from 15% to 70%, whereas, in developing countries can be as high as 80% (3). This high incidence in developing regions is often attributed to delays in the diagnosis of T1DM and lack of access to adequate healthcare services.

One of the critical factors contributing to the development of DKA is the delay in the diagnosis of T1DM, which remains a significant challenge worldwide (4). This delay in diagnosis is often due to a lack of awareness among healthcare providers and the general population regarding the symptoms of diabetes, such as polyuria, polydipsia, and unexplained weight loss (5).

The clinical profile of DKA in children and adolescents is well - documented, with hyperglycemia, ketonemia, and acidosis being the hallmark features. However, the severity of these features can vary depending on the patient's age, the duration of diabetes, and the presence of precipitating factors such as infections or non - compliance with insulin therapy (6). Fever, cough, cold, vomiting, abdominal pain, and altered sensorium are commonly reported symptoms, often complicating the clinical picture and leading to delays in appropriate management (7). The presence of these symptoms necessitates prompt medical attention to prevent the progression of DKA and associated complications.

Precipitating factors play a crucial role in the onset of DKA. Infections are the most common precipitating factors, accounting for up to 40% of DKA cases in some studies (8). Respiratory infections, urinary tract infections, and gastrointestinal infections are frequently implicated, often exacerbating the metabolic derangements in patients with T1DM (9). In addition to infections, non - compliance with insulin therapy is a significant precipitant of DKA, particularly among adolescents who may struggle with the chronic nature of diabetes management (10). The psychological burden of diabetes, coupled with the challenges

of adolescence, often leads to poor adherence to insulin therapy, increasing the risk of DKA.

Another important factor contributing to DKA is the type of insulin regimen and the patient's compliance with the prescribed treatment. Various insulin regimens are used in the management of T1DM, including rapid - acting insulin analogs like Aspart and Glargine, as well as premixed insulins like Mixtard (11). The choice of insulin regimen is influenced by several factors, including patient age, lifestyle, and the presence of comorbidities. However, regardless of the regimen, poor compliance remains a significant issue, with studies reporting that up to 30 - 40% of patients do not adhere to their insulin therapy as prescribed (12). This non - compliance is often due to factors such as fear of hypoglycemia, injection pain, and the psychological burden of living with a chronic illness.

The technique of insulin administration is another critical aspect that influences the development of DKA. Incorrect injection techniques and improper rotation of injection sites can lead to poor insulin absorption, increasing the risk of hyperglycemia and subsequent DKA (13). Studies have shown that a significant proportion of patients, particularly children and adolescents, do not follow proper injection techniques, which is often due to inadequate patient education and support from healthcare providers (14). Ensuring that patients and their caregivers are adequately trained in proper injection techniques is essential in preventing DKA.

The outcome of DKA in pediatric patients has improved significantly over the past few decades, primarily due to advances in diabetes management and better patient education. However, DKA remains a serious complication with a mortality rate of up to 10% in some settings, particularly in resource - limited countries (15). The factors associated with poor outcomes in DKA include delayed presentation, severe acidosis, altered mental status, and the presence of comorbid conditions such as infections or cardiovascular disease (16). Early recognition and prompt treatment of DKA are critical in improving patient outcomes and reducing the risk of complications such as cerebral edema, which is a leading cause of death in pediatric DKA (17).

Cerebral edema, although a rare complication of DKA, is the most feared, particularly in the pediatric population. It occurs in approximately 0.5 - 1% of all DKA cases and has a mortality rate of up to 25% (18). The pathophysiology of cerebral edema in DKA is complex and involves multiple factors, including rapid shifts in osmolality, inflammation, and the release of vasogenic factors (19). Risk factors for the development of cerebral edema include young age, new - onset diabetes, severe acidosis, and high initial serum glucose levels (20). Management of cerebral edema involves careful monitoring of neurological status, appropriate fluid management, and the use of osmotic agents such as mannitol or hypertonic saline (21).

The management of DKA involves a multifaceted approach that includes fluid resuscitation, insulin therapy, and correction of electrolyte imbalances. Fluid resuscitation is the cornerstone of DKA management, aimed at restoring perfusion and reversing dehydration (22). The choice of fluids and the rate of administration are critical, with isotonic saline being the preferred initial fluid in most cases. Insulin therapy is initiated after fluid resuscitation to lower blood glucose levels and suppress ketogenesis (23). Regular monitoring of blood glucose, ketones, electrolytes, and acid - base status is essential to guide therapy and prevent complications such as hypoglycemia and hypokalemia (24).

In addition to acute management, preventing the recurrence of DKA is a key aspect of diabetes care. Patient education on the importance of regular insulin administration, recognizing the early signs of hyperglycemia and ketosis, and the appropriate use of sick - day management plans are crucial in preventing DKA (25). Regular follow - up with a multidisciplinary diabetes care team, including endocrinologists, diabetes educators, and dietitians, is essential in supporting patients and their families in managing T1DM effectively (24, 25). The rationale for this study is rooted in the increasing incidence and severity of Diabetic Ketoacidosis (DKA) among pediatric patients with Type 1 Diabetes Mellitus (T1DM), particularly in developing regions where healthcare access and patient education are often limited. Despite advancements in diabetes management, DKA remains a leading cause of morbidity and mortality in children and adolescents, highlighting the need for a deeper understanding of its clinical profile, precipitating factors, and outcomes in this vulnerable population. This study aims to provide critical insights into the demographic characteristics, clinical presentations, and management outcomes of DKA in children aged 1 to 15 years, thereby informing targeted interventions to improve early diagnosis, patient education, and overall clinical outcomes in pediatric diabetes care.

2. Methodology

1) Study Design

This descriptive, observational study was designed to analyze the clinical profile, precipitating factors, and outcomes of diabetic ketoacidosis (DKA) in children with Type 1 diabetes. The study aimed to gather detailed information on demographic characteristics, clinical symptoms, treatment compliance, and patient outcomes. By focusing on this specific population, the study provided insights into the factors contributing to DKA and the effectiveness of the interventions used. The design was chosen to allow for a comprehensive assessment of the patient population without manipulating any variables, thus providing a real - world perspective on DKA management.

2) Study Setting

The study was conducted in the pediatric department of a tertiary care hospital located in (BMC&RC BALLARI). This hospital serves a diverse patient population, making it an ideal setting for studying a wide range of cases involving DKA in children with Type 1 diabetes. The department is well - equipped with specialized facilities for managing pediatric diabetes, ensuring that all necessary diagnostic and therapeutic interventions were available. The setting allowed for the collection of robust data reflective of the broader pediatric population affected by DKA, contributing to the study's generalizability.

3) Study Duration
Data collection for this study was carried out over 3 months period, from Jan to March 2024. This time frame was chosen to capture a sufficient number of cases to allow for meaningful analysis and conclusions. The duration also ensured that seasonal variations, which could influence the incidence of DKA, were accounted for in the data. This period allowed the researchers to collect comprehensive data, including follow - up outcomes, thus providing a complete picture of the clinical course and management of DKA in the study population.

4) Participants - Inclusion and Exclusion Criteria
Participants included in the study were children aged 1 to 15 years who were diagnosed with Type 1 diabetes and admitted with DKA during the study period. The inclusion criteria ensured that the study focused specifically on this pediatric age group with Type 1 diabetes. Exclusion criteria included children with Type 2 diabetes, those with incomplete medical records, or those who declined to participate. This approach ensured a homogeneous study population, minimizing confounding factors and allowing for a more accurate assessment of the clinical characteristics and outcomes of DKA.

5) Study Sampling
A purposive sampling method was employed to select participants who met the inclusion criteria during the study period. This non - probability sampling technique was chosen to ensure that only those patients who were relevant to the study's objectives were included. The sampling method facilitated the inclusion of all eligible cases of DKA admitted to the hospital, thereby ensuring that the study's findings were comprehensive and reflective of the target population. This approach was particularly effective given the relatively small and specific population of interest.

6) Study Sample Size
The study included a total of 50 children who met the inclusion criteria, with the sample size determined by the availability of eligible cases within the study duration. This sample size was deemed sufficient to provide meaningful statistical analysis and to draw valid conclusions regarding the clinical profile and outcomes of DKA in this pediatric population. The sample size also allowed for the examination of various subgroups within the study, such as age and sex, without compromising the study's overall validity or statistical power.

7) Study Parameters
The study parameters included a wide range of clinical and laboratory data relevant to the assessment and management of DKA in pediatric patients. These parameters encompassed demographic details, clinical symptoms (such as polyuria, polydipsia, vomiting), vital signs (heart rate, respiratory rate, SpO2), blood pressure, laboratory values (serum and urine ketone bodies, glucose levels, pH, bicarbonate levels), and insulin therapy details (types, compliance, injection techniques). The selection of these parameters was based on their clinical significance in the diagnosis, monitoring, and treatment of DKA, ensuring a thorough evaluation of each case.

8) Study Procedure
The study procedure involved a detailed review of medical records to extract relevant data on the clinical presentation, treatment, and outcomes of children with DKA. Data collection was performed retrospectively, with each patient's records being carefully examined to ensure accuracy and completeness. Information on demographic characteristics, clinical symptoms, laboratory results, and treatment protocols was documented systematically. The procedure was designed to minimize bias and ensure that all relevant data were captured, allowing for a comprehensive analysis of the clinical profile and precipitating factors associated with DKA.

9) Study Data Collection
Data were collected retrospectively from the medical records of children admitted with DKA during the study period. A structured data collection form was used to ensure consistency and completeness of the data collected. The form included sections on demographic information, clinical symptoms, laboratory results, treatment details, and patient outcomes. The retrospective nature of the data collection allowed for the inclusion of all relevant cases, while the structured approach ensured that the data were systematically recorded, reducing the potential for errors or omissions.

10) Data Analysis
The collected data were analyzed using SPSS version 26 to perform descriptive statistical analysis. Frequencies, percentages, means, and standard deviations were calculated to summarize the demographic and clinical characteristics of the study population. The analysis focused on identifying patterns and trends in the clinical presentation, treatment, and outcomes of DKA. The results were presented in tables and charts to facilitate interpretation and to provide a clear overview of the key findings. Statistical significance was considered where applicable to support the study's conclusions.

3. Result and Analysis

1) Demographic Profile

Interpretation: The demographic profile of the study participants shows that the majority of the children were aged between 7 - 10 years, with a mean age of 10.81 years. Females represented a larger portion of the study group, comprising 70% of the participants. This demographic trend highlights the prevalence of DKA in younger children and a higher incidence among females in this study.

Table: Demographic Profile of the Respondents

Age	Frequency	Percent
7 - 10 Years	25	50.0
10 - 13 Years	12	24.0
13 - 15 Years	13	26.0
Total	50	100.0
Mean±SD	10.810±2.7141	

Sex	Frequency	Percent
Female	35	70.0
Male	15	30.0
Total	50	100.0

2) Clinical Presentation and Symptoms

Interpretation: The clinical symptoms presented by the children highlight the severity of DKA. Polyuria and polydipsia were observed in all cases, while vomiting, hurried breathing, and pain abdomen were also highly prevalent. Fever, altered sensorium, and convulsions were less common but still significant. These findings emphasize the broad spectrum of clinical manifestations in DKA, with some symptoms being more indicative of severe metabolic derangements.

Table: Clinical Symptoms of Respondents

Variables	Frequency	Percent
Fever	34	68.0
Cough, Cold	20	40.0
Burning Micturition	15	30.0
Hurried Breathing	47	94.0
Pain Abdomen	45	90.0
Vomiting	48	96.0
Altered Sensorium	26	52.0
Convulsions	10	20.0
Polyuria, Polydypsia	50	100.0
Weight Loss	38	76.0
Type of Onset	33	66.0
Family History	8	16.0

3) Insulin Compliance and Types

Interpretation: The data on insulin compliance and types used reveal that 54% of patients were on Aspart Glargine, with a smaller proportion using Mixtard. Compliance was varied, with only 34% adhering strictly to their insulin regimen. This finding points to a need for improved patient education and support to enhance adherence to insulin therapy, which is crucial for preventing DKA.

Table: Insulin Compliance and Types

Compliance	Frequency	Percent
	17	34.0
G	16	32.0
P	17	34.0
Total	50	100.0

Type of Insulin	Frequency	Percent
	17	34.0
Aspart Glargine	27	54.0
Mixtard	6	12.0
Total	50	100.0

4) Outcome

Interpretation: The outcomes of the study population indicate a high rate of improvement, with 90% of the children recovering from DKA. However, the 10% mortality rate underscores the seriousness of DKA and the importance of timely and effective management. These outcomes highlight the need for continued efforts to improve early detection and treatment protocols for DKA in children.

Table: Outcomes of Respondents

Outcome	Frequency	Percent
Death	5	10.0
Improved	45	90.0
Total	50	100.0

5) Vital Statistics

Interpretation: The vital statistics of the patients reveal significant variability in heart rate, respiratory rate, and glucose levels, reflective of the severe physiological stress associated with DKA. The mean values, such as heart rate (127.22 bpm) and respiratory rate (50.62 breaths/min), indicate the critical condition of these patients. These statistics are crucial for understanding the severity of DKA and guiding treatment decisions.

Table: Vital Statistics of Patients

Descriptive Statistics					
Variables	N	Minimum	Maximum	Mean	Std. Deviation
Heart Rate	50	98	160	127.22	15.825
Respiratory Rate	50	30	66	50.62	10.505
SP02	50	92	99	96.02	2.065
GRBS	50	450	660	553.44	51.484
GCS	50	9	15	12.22	1.855
BMI	50	10.6	15.0	12.558	0.9738
PH	50	6.20	7.28	6.8576	0.30003
HCO3	50	2.0	14.0	5.610	2.6973
UREA	50	42	90	57.00	11.075
CREAT	50	0.44	1.50	0.7882	0.20610
Dosing U/Kg/day	33	0.80	1.33	1.0388	0.15730

4. Discussion

The present study provides a comprehensive analysis of the clinical profile, precipitating factors, and outcomes of diabetic ketoacidosis (DKA) in children aged 1 to 15 years with Type 1 diabetes. The findings highlight several key aspects of DKA management and its impact on pediatric patients, offering valuable insights into the disease's severity, clinical manifestations, and treatment outcomes.

Demographic Profile: The study population consisted of 50 children, with a mean age of 10.81 years (SD = 2.7141). The majority (50%) of the children were aged between 7 to 10 years, followed by 24% in the 10 to 13 years age group, and 26% in the 13 to 15 years age group. This age distribution suggests that DKA is more common in younger children within this age range, which aligns with the natural progression of Type 1 diabetes in pediatric patients. The gender distribution was skewed towards females, who represented 70% of the study population, compared to 30% males. This finding could indicate a higher susceptibility or perhaps a difference in health - seeking behavior among females, though further research would be needed to explore these gender differences in more depth.

Clinical Presentation and Symptoms: The clinical presentation of DKA in this study was characterized by a wide range of symptoms, reflecting the severity of the metabolic disturbance. All patients exhibited polyuria and polydipsia, which are hallmark symptoms of DKA, indicating significant dehydration and hyperglycemia. Vomiting was observed in 96% of the cases, while hurried breathing, a sign of metabolic acidosis, was present in 94% of the patients. Pain abdomen was also a common symptom, reported by 90% of the participants. The high prevalence of these symptoms underscores the critical nature of DKA and the need for prompt recognition and intervention. Additionally, 52% of the

patients exhibited altered sensorium, and 20% experienced convulsions, indicating the potential for severe neurological involvement in DKA. Fever was present in 68% of the cases, which may suggest an underlying infection as a precipitating factor. These findings emphasize the importance of a thorough clinical evaluation in children presenting with DKA to identify and manage these diverse and potentially severe symptoms.

Insulin Compliance and Types: The study also examined the types of insulin used and compliance with the prescribed regimen. Notably, 54% of the patients were on Aspart Glargine, a long - acting insulin, which is typically part of a basal - bolus regimen designed to mimic natural insulin production. A smaller proportion (12%) were using Mixtard, a premixed insulin. Compliance with insulin therapy varied, with 66% of the patients showing good compliance, while 34% had poor compliance. Poor compliance with insulin therapy is a well - known precipitating factor for DKA, as it leads to uncontrolled hyperglycemia and ketosis. This finding highlights the ongoing challenge of ensuring adherence to insulin therapy in children, which is critical for preventing DKA and managing Type 1 diabetes effectively.

Outcome: The outcomes of the study population were generally positive, with 90% of the patients showing improvement and recovery from DKA. However, the study also reported a mortality rate of 10%, underscoring the life - threatening nature of DKA if not managed promptly and effectively. The high rate of improvement suggests that the treatment protocols used were effective for the majority of patients, but the deaths indicate that there is still room for improvement in the management of the most severe cases. The mortality rate in this study is consistent with other reports, highlighting the importance of early detection, aggressive treatment, and close monitoring in improving outcomes for pediatric patients with DKA.

Vital Statistics: The vital statistics of the patients provide additional insight into the severity of their condition. The mean heart rate was 127.22 bpm (SD = 15.825), and the mean respiratory rate was 50.62 breaths per minute (SD = 10.505), both of which are elevated, reflecting the body's response to the severe metabolic stress of DKA. The mean glucose level was 553.44 mg/dL (SD = 51.484), indicating significant hyperglycemia, a hallmark of DKA. The mean pH was 6.8576 (SD = 0.30003), further confirming the presence of severe acidosis. These values highlight the critical nature of DKA and the urgent need for effective management to stabilize the patients and reverse the metabolic derangements.

5. Conclusion

This study underscores the severe impact of diabetic ketoacidosis (DKA) in pediatric patients with Type 1 diabetes, highlighting the importance of early recognition and prompt treatment. The findings reveal that while most patients respond well to treatment, there is a significant risk of complications, including mortality, especially in cases with poor insulin compliance and incorrect injection techniques. The study emphasizes the need for continuous patient education, vigilant monitoring, and adherence to insulin therapy to prevent the occurrence of DKA and improve overall outcomes in this vulnerable population.

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