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# Role of Infections in Children with Diabetic Ketoacidosis- A Study from South India

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**Abstract**

Cerebral edema is the commonest cause of mortality in DKA worldwide. Infections are known to precipitate new onset DKA, they also adversely affect the outcome of DKA in children from developing countries. Infections are major contributory factors for DKA in children with established diabetes mellitus (DM) along with poor compliance to therapy. This study among 118 episodes of DKA from a pediatric tertiary care Institute has identified infections as a significant risk factor for severe metabolic derangements, complications and poor outcome in children with DKA. Infections were significantly associated with severe persistent acidosis, higher base deficit, higher osmolality at 6 hours, longer duration of insulin infusion, longer hospital stay, hypoglycemic episodes and complications like shock, cerebral edema and renal failure. Multivariate analysis revealed infections complicating DKA to be significantly associated with mortality and longer hospital stay in the study population. Fever with or without a focus is an indication to start antibiotics. It is essential to consider antibiotics in children with persistent acidosis despite 6 hours of therapy. Prevention of infection and early management of infections in DKA among children from developing countries may reduce existing high mortality.

**Keywords**

DKA, Infections, Mortality

## Introduction

DKA in children is a preventable illness both in new onset DM and among children with established diabetes [1,2]. Infections are known to predispose to significant metabolic imbalance and precipitate DKA and to increase mortality in children with DKA. However this is not a major concern in developed countries based on the existing literature. Cerebral edema is still the major cause for mortality and morbidity in DKA world over. However the increased mortality in developing countries could be attributed to factors like infection, renal failure and shock in DKA. Earlier identification of infections and appropriate management may prevent DKA and help decrease mortality related to DKA in children.

## Methodology

The study was conducted to identify the role of infections in children with DKA. Infections as precipitating factor in DKA and infections as a risk factor for cerebral edema, shock, renal failure and mortality were analysed. Study setting was the pediatric intensive care unit (PICU) of Institute of Child Health and Hospital for Children, Chennai, India, which is a pediatric tertiary care hospital run by the Government of TamilNadu. Our institute caters to children below 12 years of age and comprises children predominantly those from lower socio economic strata. All consecutive admissions with a diagnosis of DKA were studied. All Children with DKA were treated at PICU. Children with DKA treated elsewhere and referred without initial details were excluded from the study. DKA was diagnosed, classified and treated as per the ISPAD criteria [3]. New onset DKA was applied to children diagnosed to have diabetes for the first time and presenting with DKA. Criteria for diagnosis of DKA included Hyperglycemia - Blood glucose ≥200mg/dl, Venous pH <7.3 or bicarbonate <15mmol/l with Ketonemia and/or ketonuria. Severity of DKA was categorized as mild moderate and severe [3]. (Mild- Venous pH<7.3 or bicarbonate <15mmol/L, Moderate venous pH<7.2 or bicarbonate<10mmol/L, Severe- Venous pH <7.1 or bicarbonate <5mmol/L). Study parameters included clinical presentation, severity, hemodynamic status and sensorium at admission, fluid therapy at emergency room, presence of infections, initial total counts, lab investigations, complications and final outcome. Sensorium was defined as per AVPU scale- A alert, V – response to verbal command, P- responsive to pain, U – unresponsive. Presence of fever was considered as infection in children with DKA to start on antibiotics at presentation. However for the purpose of analysis, of infections the following criteria were used in this study. Infections were categorized as sepsis, bronchopneumonia, urinary tract infection, skin and soft tissue infection, otitis media and acute CNS infection based on clinical and /or radiological or other laboratory investigations. If there was no identifiable focus of infection it was categorized as fever without a focus and was not included for analysis. Isolated mucosal candidiasis of the external genitalia or oral cavity was not considered as an infection predisposing to DKA. Sepsis for the purpose of this study was defined as follows: 2 of the four SIRS (Systemic Inflammatory Response Syndrome) criteria plus documented blood stream infection. SIRS was defined as temp more than 38°C or less than 36°C, tachycardia or bradycardia for age, tachypnea, leucopenia or leukocytosis. Any child with documented blood stream infection alone was also considered as sepsis.

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**Table 1:** Comparison of clinical presentation and complications in DKA.

| Sl No | Presenting feature/ complications | With infection (47) | No. infection (71) | OR | P value |
|---|---|---|---|---|---|
| 1 | Breathlessness | 42 | 60 | 1.53(0.50-5.22) | 0.32 |
| 2 | Vomiting | 35 | 56 | 0.87(0.35-2.25) | 0.47 |
| 3 | Altered sensorium | 37 | 46 | 1.99(0.86-4.86) | 0.07 |
| 4 | Fever | 34 | 27 | 6.63 (2.6-16.64) | **0.00** |
| 5 | Dehydration | 26 | 25 | 2.26(1.06-4.87) | **0.02** |
| 6 | Abdominal pain | 18 | 23 | 1.39(0.63-3.04) | 0.26 |
| 7 | Hypoglycemia | 12 | 6 | 3.66(1.27-11.43) | **0.01** |
| 8 | Shock at presentation | 10 | 5 | 3.523(1.13- 12.21) | **0.02** |
| 9 | Cerebral edema | 20 | 8 | 5.74(2.28-15.4) | **0.00** |
| 10 | Inotropes during therapy | 13 | 4 | 6.29(1.98-23.93) | **0.00** |
| 11 | Need for ventilation | 12 | 4 | 5.65(1.75-21.64) | **0.003** |
| 12 | ARF | 9 | 2 | 8.02(1.80-56.94) | **0.00** |
| 13 | Death | 11 | 2 | 10.349(2.41-71.87) | **0.00** |

Bronchopneumonia was considered only with radiological evidence in X ray chest as reported by radiologist.UTI was diagnosed only with culture results with colony count more than 1lakh. Skin and soft tissue infections, and acute suppurative otitis media were diagnosed as per clinical criteria. Acute CNS infection was considered only with CSF suggestive of infection or Latex positivity. Wherever feasible pus or any other body fluid was collected for culture and sensitivity. Other infections were appropriately investigated depending on the clinical presentation. Shock was defined as tachycardia and signs of poor end organ perfusion, as defined by poor peripheral pulses with normal central pulses, prolonged capillary refill or flash refill, altered sensorium, cool extremities, decreased urine output. Normotensive shock was considered if blood pressure was normal. Hypotensive shock as considered if systolic blood pressure was below the fifth percentile for age. Septic shock was considered with tachycardia and signs of poor end organ perfusion, as defined by poor peripheral pulses with normal central pulses, prolonged capillary refill or flash refill, altered sensorium, cool extremities, decreased urine output, with hypothermia or hyperthermia, tachypnea, leukocytosis or leucopenia in the background of suspected or confirmed infection. ARDS was defined as: acute onset, bilateral CXR infiltrates, non-cardiac etiology and PaO2/ F1O2 ratio <200.Acute Renal failure [4]. As defined by Pediatric- modified RIFLE Criteria. estimated creatinine clearance decrease by 75% or estimated creatinine clearance less than 35ml/ mt/1.73m2 or Urine output less than 0.3ml/kg/hour for 24 hours or Anuria for 12 hours. Children with azotemia at presentation whose values normalized at or less than 6 hours of fluid therapy were considered to be prerenal and not categorized as ARF. Cerebral edema was diagnosed as per the diagnostic criteria, major and minor criteria as suggested by Muir et al. [5]. Diagnostic criteria: Abnormal motor or verbal response to pain, decorticate or decerebrate posture, cranial nerve palsy (especially 3,4 and 6), abnormal neurogenic respiratory pattern (e.g. Cheyne – Stokes respiration, Apneusis). Major criteria: Altered mental status/ fluctuating level of consciousness, sustained heart rate deceleration (decline more than 20bpm) not attributable to impaired intravascular volume or sleep state, age inappropriate incontinence. Minor criteria: Vomiting, headache, lethargy or being not easily aroused from sleep, diastolic pressure >90mmHg, age <5 years. Any blood glucose value below 70mg was considered as hypoglycemia. Poor compliance to therapy was defined as missing one or more doses of insulin without medical indications. All children were evaluated for infections with a total blood count, peripheral smear x ray chest, blood for non enteric culture and appropriate investigations if necessary. Bedside glucose monitoring was done using One Touch Sure Step glucometer. All investigations were done at the Institute's biochemistry and microbiology departments. Children with and without infections were compared for the clinical presentation, lab parameters and complications like cerebral edema, shock, renal failure and death. Data was collected in pre structured questionnaire and entered in Excel format and analyzed using Epi Info TM 7.1.1.0 and SPSS software. Proportions were calculated. As a part of the nested case control design, children with infections were compared with children without infections. Comparison of study parameters between the two groups was done and P<0.05 was considered as significant by univariate analysis. Study was approved by the Institutional ethical committee. Informed written consent was obtained from the parents or the caregivers of the children who participated in the study.

## Results

During the study period of 36 months from 2010-2013, 118 episodes of DKA were studied. Of the total 120 episodes 2 episodes treated outside were not included as the initial treatment parameters were not traceable. Both the children recovered without sequelae. All children were followed up till recovery to discharge or death. The study group comprised of 44 males (37.3%) and 74 (62.7%) females. New onset diabetes was encountered in 68 children and 50 episodes were among known diabetic children. In this study of 118 DKA episodes among 100 children, 13 children died with a mortality of 11%. Mortality among the new onset DKA was 9 out of 68 (13%) and among the children with established diabetes it was 4 out of 50 (8%). Gender distribution showed 5 boys and 8 girls. Among the study group infections were encountered in 61 episodes (56%). The median age at the time of DKA was 8.5 years. Among all episodes 92 children presented with one episode of DKA, 2 children presented with 2 episodes, 4 children with 3 episodes and 1 with 4 episodes and one with 6 episodes.

Clinical features of study group at presentation have been summarized in table 1. Duration of DKA symptoms like breathlessness, vomiting, abdominal pain, and altered level of sensorium ranged from 1-5 days with a mean of 1.74 days. Shock at admission was encountered in 15 episodes of DKA (12.7%). The initial fluid resuscitation in the emergency department varied from 0–100ml/kg and the median was 20ml/kg. Among the 118 episodes 50 were alert on admission, 31 were verbal responsive (26.3%), 31 were pain responsive (26.3%) and 6 (5%) were unresponsive. Being pain responsive or unresponsive at admission was significantly associated with infections in comparison to being alert or verbally responsive (p-0.004). Severity of DKA at presentation did not reveal any statistically significant difference among those with and without infections. The weight centiles and BMI centiles [6] among the two groups did not show any statistically significant difference. Presence of fever, clinical evidence of dehydration and shock at presentation were significantly high among children with infections in DKA (Table 1).

Fever was encountered in 61 episodes at presentation. 34 of the 47 episodes with infection and 27 of the 71 episodes without infection had fever at presentation. However infections were identified in 47 episodes overall. There were 10 episodes with documented infections in the absence of fever at presentation in this study group (8.5%) and three children developed fever with infections during hospital stay. Whitish discharge from the genitalia was a presenting complaint in 10 girl children but retrospective history and examination revealed genital candidiasis in 25 children (21%). Among the 25 children 20 were girls and 5 were boys. UTI, skin and soft tissue infections, bronchopneumonia and sepsis were the common infections encountered in this study group. Comparison of the mean total

**Table 2:** Infections among children with DKA (n=52).

| Infections | N (new,old) | Infections | N (new,old) |
|---|---|---|---|
| Urinary tract infection | 14(7,7) | Skin and subcutaneous infection | 12(3,9) |
| Septicemia (Culture positive) | 13(8,5) | Bronchopneumonia | 5 (3,2) |
| Mucormycosis | 2(0,2) | Pharyngotonsillitis | 1(1,0) |
| Enteric fever | 1(0,1) | Parotitis | 1(1,0) |
| Peritonitis | 1(0,1) | Dengue shock | 1(0,1) |
| ASOM | 1(1,0) | | |

**Table 3:** Laboratory parameters during treatment in DKA.

| Parameter | With infections mean ± SD | Without infections mean ± SD | P value |
|---|---|---|---|
| Anion gap at adm | 28 ± 5.22 | 27.2 ± 5.34 | 0.58 |
| Anion gap at 6hrs | 22.47 ± 6.6 | 21.64 ± 4.91 | 0.54 |
| Mean fluids at ER ml/kg | 22.4 ± 23 | 16.12 ± 13.7 | 0.13 |
| Base deficit | 28.08 ± 6.3 | 21.6 ± 7.8 | **0.008** |
| Tco2 | 4.92 ± 2.95 | 7.29 ± 5.03 | 0.08 |
| Hct at admission | 39.03 ± 7.45 | 39.68 ± 6.37 | 0.64 |
| Urea mg/dl | 48.23 ± 31.0 | 37.32 ± 16.6 | **0.014** |
| Glucose mg/dl | 507 ± 108 | 519 ± 113 | 0.436 |
| pH at admission | 7.03 ± 0.19 | 7.11 ± 0.14 | **0.02** |
| pH at 6 hours | 7.19 ± 0.18 | 7.27 ± 0.12 | **0.009** |
| Sodium mEq/L | 144 ± 017 | 142 ± 6.03 | 0.48 |
| Sodium at 6 hrs | 141.3 ± 10.5 | 138 ± 6.86 | 0.058 |
| Osmolality at adm Mosm/l | 303.4 ± 14.57 | 302 ± 12.7 | 0.87 |
| Osmolality at 6 hrs Mosm/l | 298.5 ± 20.95 | 288 ± 20.6 | **0.016** |
| hrs for gl to reach 250mg/dl | 9 ± 8.4 | 9.8 ± 13.3 | 0.72 |
| Hrs of acidosis duration | 45 ± 50.39 | 22 ± 18.8 | **0.016** |
| Insulin infusion hours | 49.15 ± 49 | 25.6 ± 19.69 | **0.00** |
| Hrs of IV fluids | 50.3 ± 49 | 26.54 ± 19.9 | **0.00** |
| HBA1c | 11.57 ± 2.55 | 12.17 ± 2.9 | 0.25 |
| Hosp stay days | 9.67 ± 6.96 | 7.54 ± 4.40 | **0.046** |

**Table 4:** Multivariate analysis of the factors associated with infection in DKA.

| Parameter | Odds ratio | 95% CI | SE | P value |
|---|---|---|---|---|
| Ph at admission | 1.02 | 0.002- 3.10 | 1.85 | 0.18 |
| Ph at 6 hours | 3.59 | 0.006 -1954 | 3.21 | 0.69 |
| Osmolality at 6 hours | 1.02 | 0.99-1.04 | 0.01 | 0.26 |
| Need for inotropes | 1.66 | 0.12-22.89 | 1.34 | 0.71 |
| Need for ventilation | 0.18 | 0.01-4.17 | 1.59 | 0.28 |
| shock | 0.50 | 0.06-4.17 | 1.08 | 0.52 |
| ARF | 0.66 | 0.05-9.39 | 1.35 | 0.76 |
| Cerebral edema | 2.20 | 0.61-7.94 | 0.65 | 0.23 |
| Death | 65.93 | 1.26-3429 | 2.01 | **0.04** |
| Hospital stay | 1.16 | 1.01-1.32 | 0.07 | **0.03** |

count among the group with and without infections did not reveal any significant difference (p-0.07). The causative organism in urinary tract infections were Klebseilla in 7, E.coli in 4, Candida in 2 and Pseudomonas in 1. Among the children with sepsis the organisms were Klebseilla in 7, E.coli in 4 and Staphylococcus aureus in 2 and Salmonella typhi in one child. Five children with skin and soft tissue infections had staphylococcal infection. This included boils, abscesses, cellulitis, furunculosis and paronychia. Other serious infection was Rhino cerebral mucormycosis in two children. Among the two children with mucormycosis one was identified to be Rhizopus. Table 2 summarizes the infections encountered in children with DKA. Overall there were 52 infections among 47 episodes of DKA. Children with established diabetes had more number of skin and soft tissue infections in comparison to new onset DKA (p-0.017).

Infections were encountered in 35% (24/68) of new onset DKA. Precipitating factors for DKA among the children with established diabetes included infections in 46% (23/50). 14% (7/50) children had both infections and poor compliance to therapy. 18(36%) had poor compliance to therapy. No precipitating factor could be identified in other children. Comparison of various infections among the new onset diabetes and those with established diabetes showed a higher number of skin and soft tissue infections in those with established diabetes (p-0.017).

Other lab parameters have been summarized in Table 3. As shown in Table 3, infections were significantly associated with lower pH at admission and at 6 hours, higher base deficit, and longer duration of acidosis, and higher osmolality at 6 hours, longer duration of insulin infusion and intravenous fluids, and longer hospital stay in DKA. Hypoglycemia during therapy, need for isotopes and mechanical ventilation were significantly high among those with infections. Majority of the above factors except the duration of hospital stay were also significant factors for mortality in children with DKA in this study. Infections were significantly associated with occurrence of complications like shock, cerebral edema and renal failure (p=0.02, 0.00, 0. 00). Among all infections sepsis and UTI were significantly associated with cerebral edema in children with DKA. (p=0.00, 0.02). Death was higher among those children with infections and this was statistically significant (p-0.00). Multivariate analysis of factors like ph at admission, acidosis at 6 hours, osmolality at 6 hours, shock, acute renal failure, cerebral edema, need for ventilation, need for inotropes, duration of hospital stay and death revealed infections complicating DKA to be significantly associated with mortality and increased duration of hospital stay (Table 4).

## Discussion

Infections complicating DKA is much more common in developing countries. However the role of infections in complications of DKA like shock, cerebral edema renal failure and death has not been studied. There are no prospective studies from developing countries addressing these issues. The present study has identified infections to be a major risk factor for complications in DKA and its final outcome. Literature from developed countries have not identified infections shock, renal failure as a major associated factor either for mortality or for morbidity in DKA [3,7,8]. Recent retrospective studies from developing countries like Pakistan, Bangladesh and India have identified various infections in DKA. Shock in DKA is uncommon in western literature, however has been uniformly reported from developing countries recently. Cerebral edema and shock have been shown to be associated with infection based on studies from Chandigarh, India [9]. Renal failure has not been identified as a major factor for mortality in DKA. Renal failure in DKA has been shown to increase the mortality in children with DKA based on studies from South India [10].

Though there are no prospective studies on infections in DKA, literature from developing countries have shown infections to be common in children with DKA. Zabeen et al. [11] from Pakistan in the year 2008 published a retrospective study on DKA in children. In this study of children with established diabetes, 28% of DKA episodes were precipitated due to omission of insulin and 48% due to infections and another 11.5% due to both. Mortality was 13.4%. The causes of death were cerebral edema, sepsis and bronchopneumonia. Madiha et al. [12] from Pakistan published a retrospective study in the year 2011 involving 88 children with DKA. Blood culture positive sepsis was encountered in 4.5%. Presence of infection was documented to be significantly associated with mortality in DKA. The overall mortality was 3.4%. Cerebral edema, sepsis and ARDS were the causes of death in DKA in the study group. In 2012 Lone SW et al. [13] from Pakistan published a retrospective case record review of 117 children with DKA. Out of the 50 children with Infections established diabetes insulin omission was encountered in 38% and infections were encountered in 32% (UTI in 29% and enteric fever in 12%). Among the children with new onset DKA, UTI was encountered in 23.8%. None of the children had cerebral edema or renal failure. There was no mortality in the study group. Studies from Iran by Afshin et al. [14] among 63 children with DKA revealed 13 of them to have identified infections. This was inclusive of pneumonia, tuberculosis, diarrhea and upper respiratory infections. The study documented acute renal failure in 4.7%.

Jahagirdhar et al. [15] from Maharashtra in India published a retrospective case record analysis of 12 episodes of DKA treated during the period 2005-2006. One of them presented with shock, their study did not reveal renal failure, sepsis or cerebral edema or mortality. Jeyashree et al. [9] from India in the year 2004 published a retrospective data analysis of 67 episodes of DKA. New-onset diabetes with sepsis was reported in 37%, new-onset diabetes alone was reported in 31%, insulin omission in 15%, and infection with insulin omission 7%. The infections reported were respiratory, soft tissue infections, meningitis, gastrointestinal and others. Surprisingly there was no report of UTI in comparison to other reports. Though septic shock was identified to be a significant risk factor for mortality in the univariate analysis it was not significant in multivariate analysis. Overall mortality was 13.2%. Septic shock was the cause of death in 4, cerebral edema in 2, cerebral edema with pulmonary edema in 2 and hypokalemia with ventricular tachycardia in one child.

Lokesh Kumar et al. [16] from India published a retrospective analysis of 77 children with DKA during the period between 2005 and 2009. Hypotensive shock was reported in 48.1 % of the study group. Diabetes with sepsis was reported high. They reported new onset diabetes with sepsis in 63%, new-onset diabetes alone in 7%, insulin omission in 11% and sepsis with insulin omission in 5%. Pneumonia and gastroenteritis were the most common infections in the study group. Cerebral edema was diagnosed in 26%. Reported mortality among the study population was 9%. Septic shock with MODS was the cause of death in 6 children, one died due to raised ICP.However this was done among the very sick DKA treated at PICU. Kanwal SK et al. [17] from India published in 2011, a retrospective study on 55 children with DKA treated during the year 2008-2010. Cerebral edema was reported in 14.5% and renal failure in 7.2%. Infections were documented in 16.3%. Evidence of pneumonia was seen in 7.2% and 5.4% had UTI. Blood culture grew E.Coli and Klebsiella in 3.6%. Mortality was 12.7%, with cerebral edema with or without renal failure and sepsis accounting for most of the deaths.

Based on the existing literature various retrospective studies from developing countries have identified different infections and some have identified sepsis and shock to be risk factors for mortality in DKA. Mortality in DKA from developing countries is very high. Western literature reports [18-22] death to be at 0.1-0.3 % while the reported mortality in developing countries like Pakistan, Bangladesh and India are very high up to 13.5% [9,11,12,16,17,23]. Factors that contribute to this high mortality have been identified to be cerebral edema, sepsis, shock and renal failure. Shock in DKA is predominantly hypovolemia due to delayed presentation or can be due to septic shock. In this study two third of children had features of septic shock. It is difficult to delineate septic shock from hypovolemic shock in DKA. However there are chances of over diagnosis and under diagnosis of shock. The signs of volume contraction may not be evident in children with shock in DKA. Presence of prolonged capillary refill time alone cannot be taken as evidence of shock in DKA [24]. Similarly presence of tachycardia, tachypnea, and altered sensorium may be due to underlying dehydration, acidosis and cerebral edema. Hence one needs to be cautious about diagnosis shock in DKA. The management of septic shock in DKA is challenging as liberal fluids may be a risk factor for cerebral edema. Restriction of fluids in sepsis may also precipitate renal failure in DKA. There is no specific guidelines for managing septic shock in DKA [25,26]. Existing guidelines recommend up to 30 ml/kg of fluids for resuscitation, however in this study setting it was not uncommon for hypertensive shock despite 100 ml/kg. Presence of leucocytosis in DKA does not always suggest sepsis as this may be a stress response [27]. Both cerebral edema and renal failure, the two complications with fluid therapy, have been reported to have high mortality in DKA, from developing countries. Based on this study infection also play a significant role in cerebral edema and renal failure in DKA by univariate analysis but not in multivariate analysis.

Presence of fever in DKA should be considered as infection unless proved otherwise. Antibiotics must be initiated early in these children even in the absence of obvious focus as per the existing ISPAD guidelines. However infection could not be isolated in all 61cases of fever in this study. Despite absence of fever at presentation children can have infections as identified in this study. Sepsis complicating DKA may lead to worsening of acidosis. Severe and persistent acidosis at 6 hours of therapy in the absence of renal failure warrants antibiotics in DKA. This study has shown that severe and persistent acidosis, longer duration of insulin and intravenous fluid therapy to be significantly associated with infections in univariate analysis. It may be a useful intervention to start on antibiotics in children with DKA until infection has been ruled out in view of high mortality among children with DKA and infections.

Despite decades of management of DKA the exact pathophysiology of DKA related cerebral edema and the implications of fluid therapy are not known. This study has identified infections to be one of the major risk factors for death in DKA. Sepsis is particularly associated with poor outcome in DKA. Infections are significantly associated with various risk factors like cerebral edema, shock and renal failure in DKA.

Multivariate analysis has revealed infections complicating DKA to be significantly associated with increased duration of hospital stay and mortality. Existing guidelines for management of DKA from western literature do recommend antibiotics for children with DKA [28] though sepsis is not a major issue in their setting. Infections in DKA is known to increase the complications as well as mortality in DKA hence it is mandatory to start empirical antibiotics in children with fever irrespective of presence of a focus of infection. Since not all children with infection present with fever at presentation it may be considered to start antibiotics in all children with DKA until infection has been ruled out in this population. Similarly there is a need for urgent studies on implication of fluid therapy in children with DKA complicated by shock as there are no recommendations about fluid therapy in children from developing countries. Adequate management of infections in children with new onset DM as well as in established DM will greatly help decreasing the occurrence of DKA and its mortality.

## Conclusions

- Sepsis, UTI, Bronchopneumonia and skin and soft tissue infections are the common infections in children with DKA.

- Infections are significantly associated complications like shock, cerebral oedema and renal failure and mortality in DKA in univariate anlysis.

- Infections are significantly associated with severe and persistent

acidosis, persistent higher osmolaity, and increased hospital stay in DKA in univariate analysis

• Multivariate analysis has revealed infections complicating DKA to be significantly associated with mortality and increased duration of hospital stay

• Empirical antibiotics have to be initiated in children with fever with or without a focus of infection in children with DKA and persistent acidosis despite 6 hours of therapy in the absence of renal failure.

• Children with infection can present without fever in DKA. Consider to start antibiotics in all DKA episodes until infections have been ruled out based on units protocol, as infections are significantly associated with mortality in DKA in developing countries.

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