Knowledge and Confidence of Iraqi Pediatric Residents in Management of Diabetic Ketoacidosis in Children

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Abstract

Background: Diabetic ketoacidosis (DKA) is a leading cause of mortality in children with type 1 diabetes mellitus. Pediatric residents in Iraqi hospitals are usually the front liners in managing pediatric emergencies. Therefore, it is important to make sure they are practicing at the highest possible standards to ensure patients' safety. **Objectives:** this study evaluates the knowledge of Iraqi pediatric residents regarding DKA recognition and management and sheds the light on the areas that need further improvement. **Methods:** An online survey was conducted. A survey link to an online questionnaire using Survey Monkey was sent to residents at different levels between first and fourth year of training (R1-R4) in general pediatrics. **Results:** About 60.9% of respondents spent more than 6 months in pediatric emergency training. The majority of residents had treated more than 10 children presented with DKA, with the highest percentage (81.8 %) found among R4s residents. Only 27.8% of residents recognized the diagnostic criteria of DKA. Three quarters of the participants could correctly calculate IV fluid infusion rate for maintenance by accounting for the deficits and subtracting the boluses before calculating the corrections over 48 hours. 68.3% of respondents would not routinely attach DKA patients to a cardiac monitor unless the patient's condition is unstable. 69.6% of survey respondents feel confident in treating children with DKA. Most participants (91.3%) think that there is a need for more DKA training/education sessions. **Conclusions:** Most of the respondents have a reasonable level of knowledge on how to manage DKA in children in Iraqi children's hospitals. Some gaps in knowledge were identified and need to be highlighted in near future. Educational sessions for the residents about DKA management in children are deemed necessary.

Keywords: *DKA, Iraq, Residents, Education, Pediatric.*

Introduction

Diabetes mellitus (DM) is a serious clinical condition that requires careful approach. Unfortunately, there is an increasing prevalence of DM globally. The trajectory of the disease estimates the number of patients to be doubled by 2025 and total number might reach to almost 642 million world-wide by 2040 [1-3]. DM in Arab countries

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is a major public health issue with an estimate of 20.5 million patients reported by 20 Arab countries in 2011 [4]. Iraq is considered to have a medium prevalence of DM (9.3%) compared to other Middle Eastern countries [4, 5], with a highest prevalence from the region (25.7%) in Bahrain [6].

Diabetic ketoacidosis (DKA) is a common acute complication of DM and it can cause increased morbidity and mortality if not effectively and timely managed [7]. DKA was first described by Julius Dreschfeld in his lecture to the Royal College of Physicians about Diabetic Comma in 1886 [8], which remained of a great concern until the discovery of insulin in 1922 and its utilisation in the treatment of DKA. In the Middle East, there is an estimated 64,000 cases on type 1 DM (T1DM) affecting children younger than 15 years old [9] while the overall incidence of DKA in the Arab region is almost 46.7% [10]. The DKA mortality is mostly due to cerebral edema but the sequence of events that leads to DKA cannot be precisely predicted for every given case [11]. However, DKA is a common clinical problem and a major cause of death in younger patients with DM [12]. so DKA management requires knowledge and skills by the medical staff to reduce the associated morbidity and mortality. Therefore, we aim in this study to evaluate the knowledge of Iraqi pediatric residents about their recognition and management of DKA in children and young people, and to identify any gaps in their knowledge and therefore working on raising the standards of provided health care.

Materials and Methods

A survey questionnaire was conducted online between February 29th and March 29th, 2020 and 70 pediatric residents in various Iraqi hospitals were provided with the survey link. The online questionnaire contained 34 items including (assessing knowledge about DKA diagnosis and severity, management of DKA including fluid and insulin and monitoring of progress, dealing with possible complications, and finally involvement of senior on call in the follow up of DKA cases). The data collection and statistical analysis in this cross-sectional study were conducted using the commercial website Survey Monkey (https://www.surveymonkey.com/). A 95% confidence interval was used and a value of $p<0.05$ was considered statistically significant.

Results

The survey was completed by 41 of 70 (response rate 58.5%) pediatric residents in Iraqi hospitals based in Baghdad, the Capital City of Iraq. 20 Male residents accounted for 48.7% of those who took part, while 21 female residents accounted for 51.2 %. About 60.9% of respondents spent more than 6 months in pediatric emergency training. Residents rated their awareness and knowledge of dealing with children presenting with DKA in the questionnaire, the bulk of residents in R2-R4 training years evaluated themselves as “good” while R1 evaluated themselves as “very good” as shown in table 1.

Table 1: Comparison between pediatric residents in terms of level of knowledge of DKA management.

	R1	R2	R3	R4
Number of participants	**6**	**18**	**6**	**11**
Self-assessment of knowledge and management of DKA in paediatrics Poor Fair Good Very good	 1, 16.7% 1, 16.7% 1, 16.7% 3, 50%	 0 3, 16.7% 11, 61.1% 4, 22.2%	 0 0 5, 83.3% 1, 16.7%	 0 2, 18.2% 6, 54.5% 3, 27.3%
Residents who could calculate rate of IV fluid [Maintenance rate + deficit] – boluses (given at resuscitation, correction over 48 hrs) [Maintenance rate + deficit] (correction over 48 hrs) Correction of fluids over 24 hrs	 5, 83.3% 0 1, 16.7%	 14, 77.8% 1, 5.6% 3, 16.7%	 3, 50% 1, 16.7% 2, 33.3%	 8, 72.7% 0 3, 27.3%
Frequency of glucose monitoring during the early hours of management (first 12 hrs) Every 30 min Every hour Every two hours Every 3-4 hrs	 0 5, 83.3% 1, 16.7% 0	 0 15, 83.3% 3, 16.7% 0	 0 5, 83.3% 1, 16.7% 0	 0 9, 81.8% 2, 18.2% 0
Cardiac monitoring of all DKA patients	1, 16.7%	4, 22.2%	3, 50%	5, 45.5%
Choice of level of blood glucose at which dextrose is added to IV fluids <9 mmol/L <14 mmol/L <5 mmol/L	 1, 20% 4, 80% 0	 3, 18.8% 10, 62.5% 3, 18.8%	 1, 16.7% 5, 83.3% 0	 3, 27.3% 8, 72.7% 0
Global confidence in handling children with DKA Very confident = 3 Confident= 2 Fair = 1 Not confident at all =0 Average score of confidence	 1, 16.7% 2, 33.3% 3, 50% 0 1.6	 1, 5.6% 13, 72.2% 4, 22.2% 0 1.8	 1, 16.7% 5, 83.3% 0 0 2.16	 0 7, 63.6% 3, 27.3% 0 1.7

The majority of residents who took part in this study had treated more than 10 children and young people presented with DKA, with the highest percentage (81.8 %) found among R4s residents, as shown in table 2.

Table 2: Comparison between junior residents (R1-R3) and final year residents (R4)

	R1-R3	R4
Number of residents	**30**	**11**
Number of DKA cases that each resident had managed during their training None Less than 5 5-10 More than 10	0 1, 3.3% 6, 20% 23, 76.7%	0 0 2, 18.2% 9, 81.8%
% of correct answers about DKA diagnostic criteria	6, 20.7%	5, 45.5%
Giving a bolus dose of IV fluids to patients with severe DKA but not in a shock 10 ml/kg of 0.9% NaCl 20 ml/kg of 0.9% NaCl	43.3% 56.7%	80% 20%
Percentage of correct responses regarding timing to switch IV insulin to SC insulin	18, 62.1%	8, 72.7%
Percentage of residents who correctly answered survey question regarding the use of sodium bicarbonate infusion to correct acidosis	27, 90%	11, 100%
Management of hypoglycaemia (<4mmol/L) in the presence of ketosis Giving a dextrose bolus Increasing IV glucose concentration Temporarily stopping insulin infusion All of the above None of the above	11, 36.7% 9, 30% 3, 10% 6, 20% 1, 3.3%	2, 18.2% 6, 54.5% 1, 9.1% 2, 18.2% 0
Number and percentage of residents who correctly recognised cerebral oedema as a life threatening complication of DKA	20, 66.7%	9, 81.8%
Recognising features of cerebral oedema during DKA Average level of knowledge	65.3%	69.1%

Assessing knowledge about DKA diagnosis and severity

The survey revealed that only 27.8% of residents recognized the diagnostic criteria of DKA (Blood glucose >11mmol/L, blood pH <7.3 or HCO_3 < 15mmol/L and ketonemia), with R4 trainees accounting for the highest percentage (45.5%) as shown in table 2. Regarding the presence of leukocytosis in DKA patients, 70.7% participants agreed that an elevated white blood cell count is usually seen in DKA and does not always signify infection.

Management of DKA

Involving the senior on-call physician

The survey results showed that almost half of residents (51.2%) would inform their seniors about the attendance of a patient with DKA only when it becomes difficult to manage. However, only 26.8% of residents, the majority of whom are R4 residents, do notify their seniors immediately, as soon as the diagnosed was confirmed.

In terms of discussing the case with the on-call endocrinologist consultants, the number of residents who consulted the on-call pediatric endocrinologist varied with 33.3% of R1-R3 and 54.5% of R4 who consulted the endocrinologist while the patient is in the emergency room.

Fluid Management

The survey showed that 40 out of 41 (97.5%) respondents give a fluid bolus intravenously (IV) to DKA patients regardless of whether they are in shock or not. Saying that, 73.9% of residents prescribe 0.9% normal saline as their IV fluid of choice for fluid replacement and maintenance in management of DKA. Almost half of respondents (53.3%) would start with 10 mL/kg of 0.9% normal saline. The majority of R4 participants (80%) have answered the question related to fluid management correctly compared with 43.3% of R1-R3 trainees, as shown in table 2.

For patients with severe DKA and in a shock, 63.4% of residents think that the fluid bolus should be given over 15 to 30 minutes, while the rest (36.5%) think it should be given slower than that i.e. over 30 to 60 minutes.

Three quarters of the participants (73.1%) could correctly calculate IV fluid infusion rate for maintenance by accounting for the deficits and subtracting the boluses before calculating the corrections over 48 hours. The greatest percentage of respondents who correctly answered the question were R1 trainees (83.3%) as shown in table 1. Majority of respondents, 27 out of 41 (65.8%) had correctly suggested adding glucose to the IV fluids if blood glucose decreases below 14 mmol/L during the course of managing the acute DKA.

Insulin therapy

Most respondents (85.3%) indicated that they would start insulin infusion 60 minutes after starting IV fluids. Meanwhile, 63.4% were able to appropriately suggest when intravenous insulin should be switched to subcutaneous insulin, with higher response of correct answer among of R4 doctors (72.7 %) in comparison with (62.1%) of R1-R3 trainees (table 2).

Monitoring the progress

The survey participants were aware of the need to monitor blood glucose very frequently during the first few hours of DKA management. The majority of respondents from each stage from R1 to R 4 indicated that they should monitor random blood sugar hourly especially during the first twelve hours of DKA (table 1). This study also showed that 89.1% of participants could correctly identify the parameters required for monitoring the patient's progress in response to the treatment plan including monitoring of blood sugar, blood or urine ketones, serum electrolytes, renal function tests, neurological evaluation and blood gas analysis.

Majority of residents (92.6%) of whom 100% of R4 did not utilize sodium bicarbonate infusion regularly to correct metabolic acidosis (table 2). The bulk of participants (87%) are mindful that cardiac arrythmia could arise from hypokalemia during the course of DKA. Despite that, 68.3% of respondents would not routinely attach DKA patients to a cardiac monitor unless the patient's condition is unstable or deteriorating. Interestingly, the residents' awareness about this critical point increases as the residents get more senior; 16.7%, 22.2%, and 50% from R1, R2 and R3s respectively (table 1). Surprisingly, only one responder was aware of the other possible causes of arrhythmias during the course of DKA management including hypophosphatemia, hypernatremia and hypercalcemia.

Dealing with possible complications

When it comes to treating hypoglycemia (<4 mmol/L) throughout DKA management, only 8 out of 41 participants (including 20% of R1-R3 and 18.2% of R4) indicated that a dextrose fluid bolus is needed, in addition to suspending the insulin infusion momentarily, and that the infused glucose concentration should be increased to avoid more hypoglycemia subsequently (table 2).

Among life-threatening complications for DKA, majority of residents (73.1%) chose cerebral edema, in comparison with only 29.2% who select hypokalemia and 14.6% who chose aspiration pneumonia. The survey revealed that 66.7% of R1-R3 respondents are aware of the signs to detect cerebral edema in comparison with 81.8% of R4 (table 2), and average level of knowledge regarding recognizing features of cerebral edema during DKA was 65.3% among R1-R3 in comparison with 69.1% of R4 (table 2).

Overall remarks

The present study showed that 69.6% of survey respondents feel confident in treating children with DKA with the highest average score of confidence (2.16) on 0 to 3 score among R3 trainees (table 1). On the other hand, most participants (91.3%) think that there is a need for more DKA training/ education sessions. No statistical significance at level of confidence was noted between senior and junior residents.

Discussion

Hyperglycemia, metabolic acidosis, and ketonemia are major components of DKA [13]. DKA is reported to cause more than 100,000 hospitalizations in the United States each year [14]. The degree of knowledge about DKA and confidence in managing pediatric patients with acute DKA in Iraq was assessed in this study.

The study revealed that majority of residents had sufficient understanding of how to start insulin therapy and to decide when to shift the patient from IV insulin to subcutaneous (SC) insulin. Meanwhile, survey results regarding overall knowledge about fluid management in DKA were satisfactory. Most participants were aware of appropriate calculation of IV fluids administration rate in DKA. These results were in line with a study done among pediatric residents in Bahrain [15] although the present study showed relatively higher awareness among Iraqi pediatric residents.

Similarly, the results regarding the confidence level scale, which ranged from poor to very good, revealed that the bulk of residents in R2-R4 training years evaluated themselves as "good" while R1 evaluated themselves as "very good". This could be due to the overconfidence of year one residents which could be associated with less competence in the management of DKA during the early years of training. As a result, this issue is important when it comes to supervising and helping the junior residents when it comes to commencing DKA management.

Senior residents involve their seniors only when the patient's condition is becoming challenging to manage. This could represent the trainees' maturity and trust in DKA management which was also concluded by Roland et al study [16]. Saying that, The British Society of Pediatric Endocrinology and Diabetes (BSPED), advocates for consulting a more senior doctor whenever a patient with DKA is identified, despite feelings of self-management confidence, because patients might swiftly deteriorate [17].

A previous study in the United Kingdom [18] assessed the knowledge of low-ranking residents about DKA and its management. The majority of residents were able to accurately diagnose DKA. Similarly, the study in Bahrain by Hasan et al. [15] found that 65% and 86.4% of R1-R3 and R4 residents, respectively, were able to correctly diagnose DKA. However, in the present study, the results are lower than those reported in the above studies where only 20.7% of R1-R3 and 45.5% of R4 correctly identified the diagnostic criteria for DKA.

In the first 12 hours of DKA care, the majority of residents in our survey, as for Bahraini pediatric residents [15], demonstrated a response to hourly glucose monitoring. Meanwhile, it is accepted that all DKA patients regardless if they are in shock or not should receive an IV fluid bolus of 10 ml/kg of 0.9% NaCl over 30 minutes ,this was reported by the updated National Institute of Clinical Excellence (NICE) [19], which is fortunately the response of majority of our pediatric residents.

The number of residents who consulted the on-call pediatric endocrinologist varied with 33.3% of R1-R3 and 54.5% of R4 who consulted while the patient is in the emergency room. However, these results are higher than pediatric residents in Bahrain (21.1%, 36.4% respectively) [15]. It appears that the decision was made solely based on the individual's own preferences, rather than on the basis of seniority or confidence. This might require additional research, and residents should be given clear guidelines on when to consult subspecialists. Different guidelines strongly urge involving responsible seniors and residents should

be provided with clear guidelines regarding that.

Several studies have demonstrated the value of using developed management pathways in minimizing medical errors and variances in practice. The use of a DKA management pathway improved overall patient care in previously published study in the United Arab Emirates [20]. Our study revealed that residents have adequate background knowledge about DKA management, but it is suggested that workshops on proper management of DKA should be provided to residents in Iraqi hospitals. One way to raise awareness of residents on DKA management is to have hands on sessions or utilize clinical scenarios with established DKA management according to guidelines. The usefulness of this has been reported in multiple trials, the most recent of which was completed in 2016 [21].

Conclusion

In conclusion, the results of the survey questionnaire demonstrated that pediatric residents in Iraq have fair knowledge and confidence in management of DKA in children. Gaps in knowledge of correctly diagnosing DKA and subsequently its management were identified. The authors suggest that more teaching sessions regarding proper management of acute DKA in children should be made available to residents during early years of training. In addition, there is a need for an updated national protocol informed by evidence-based medical reports and public health studies in this region.

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