

Assessing the Competence of Junior Paediatric Doctors in Managing Paediatric Diabetic Ketoacidosis: An Exploration Across Paediatric Care Units in UK

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Abstract—Advancing beyond the junior stage of a paediatrician's career is a crucial step where they accumulate essential skills and knowledge. This process prepares them for the challenges they will encounter throughout their profession, particularly in dealing with paediatric emergencies. This can be especially demanding for trainees specializing in fields like endocrinology, particularly in the management of Diabetic Ketoacidosis (DKA) in the UK. In different societal contexts, junior doctors, whether specializing in paediatrics or other medical fields, are generally expected to possess a fundamental level of knowledge and skills necessary for managing DKA emergencies. These physicians consistently concurred in recognizing prevalent problems in the healthcare facilities they examined. Such issues include the lack of established guidelines for DKA treatment and the inadequate availability of comprehensive training opportunities. The abstract underscores the critical importance of junior paediatricians acquiring expertise in managing paediatric emergencies, with a specific focus on DKA. Commonly, issues like the lack of standardized protocols and training deficiencies are recurring themes across healthcare facilities. This research proposal aims to conduct a thematic analysis of the proficiency of paediatric trainees in the United Kingdom when handling DKA in various clinical contexts. The primary goal is to assess their competency and suggest effective strategies for comprehensive DKA training improvement.

Keywords—DKA management, junior paediatricians, level of competence, standardized protocols.

I. INTRODUCTION

THE training journey of a paediatrician commences with enrolment in a foundation program upon graduation from medical school as outlined in accordance with the latest updates from the Royal College of Paediatric and Child Health (RCPCH) [1]. This curriculum provides a structured framework for educational development, assisting junior doctors during their initial two years of professional growth after medical school graduation, as outlined on the Foundation Program Curriculum page [2]. Subsequently, paediatricians, at levels ranging from senior house officer (Level 1: from Specialty Training (ST) 1 to ST3) to registrar (Levels 2 and 3: ST 4-ST7), are expected to diagnose and manage various paediatric emergencies.

Among the spectrum of paediatric emergencies, endocrine-related emergencies present a range of nonspecific symptoms,

with altered mental status being a significant concern, given their intricate pathophysiology. These rare conditions, discussed in the field of Paediatric Emergency Medicine Practice in the Paediatric Emergency Care Applied Research Network (PECARN) [3] in "Endocrine emergencies: recognizing signs and symptoms," typically fall under the purview of junior paediatricians (often at Levels 1 or 2). They often find themselves making crucial decisions in the middle of the night, as these conditions can have severe consequences if left unattended.

This paper delves into a comprehensive examination of DKA, considering the approaches of healthcare professionals from diverse cultural backgrounds across the globe. It specifically focuses on how paediatric junior doctors, including trainees and residents, manage DKA in emergency units. DKA is one of the most prevalent paediatric emergency conditions, and it accounts for a substantial percentage of paediatric diabetic emergencies, with a mortality rate of 64%.

While it has long been the norm for junior paediatric doctors to attend to DKA cases in the emergency department, numerous challenges persist in handling these cases, particularly in District General Hospitals (DGH) where adherence to trust guidelines or management protocols can be demanding. This paper will not only assess pertinent literature but also elucidate the study's approach to addressing the specified research topic through thematic analysis and qualitative description.

II. LITERATURE REVIEW

In order to quickly research the related prior experience regarding the topic of interest, several online library platforms, including those from the University of Leeds and Edinburgh, have been utilized going through variable database tools, such as Ovid Medline, Embase, and Cochrane, and using relevant keywords in the search strategy. A summary abstract evaluation was used to choose the primary selected papers. Many studies that surfaced in the search were excluded since they were not relevant.

The two primary studies that were more thoroughly investigated were those that assessed the expertise and competence of international paediatric residents (trainees) in the management of paediatric patients with DKA in Bahrain

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and Iraq.

Other distantly related research looked at health professionals' understanding of DKA management, the challenges hindering optimal care, and the adequacy of knowledge among new medical graduates in diagnosing and treating children and adolescents with type 1 diabetes (T1D) in a developing nation (Jordan).

Knowledge and Confidence of Iraqi Paediatric Residents in Management of DKA in Children, is a study among residents in several hospitals in Baghdad, the country's capital [4], which used an online survey questionnaire to assess the level of knowledge the responding paediatric residents in Baghdad displayed about their DKA management. The paper proportionately considered how an increase in years of experience would add up to the level of information these paediatric students have eventually achieved.

Another research project was titled, "The Knowledge and Confidence in Management of Diabetic Ketoacidosis among Bahraini Paediatric Residents" [5], used a similar online survey questionnaire and cross-sectional survey design to gather information from paediatric residents. Another study, which is based on baseline data from the paediatric ISPAD (International Society of Paediatrics and Adolescent Diabetes) guideline [6], discovered that while more senior trainees have a greater understanding of DKA management than their junior counterparts, there are some areas, such as escalation of care, where these trainees fall short of their juniors.

Both research literatures [4] and [5] concurred that a management guideline should be unified and more in-depth sessions on DKA management should be given to paediatric trainee doctors in order to improve overall awareness of DKA treatment. Utilizing evidence-based medicine to update local protocols aids in expanding knowledge and streamlining management. The Bahraini study [5] found that workshops and educational sessions should be held to raise residents' awareness of the practical aspects of DKA management, such as fluid management, monitoring, and self-limitation awareness, as well as the necessity of involving seniors. Creating simulation sessions with scripted scenarios of DKA cases would be one way to increase participants' knowledge of DKA management.

On the negative side, these articles' [4] and [5] selectivity of just 41 and 78 candidates, respectively, restricts their degree of significance.

Both the Kibaki study [7] and a Jordanian paper [8] differ in a few minor ways. Both studies had a wider audience in mind than just paediatricians; which is quite a different scope than what is currently researched. In fact, the Kibaki study involved a wide range of health care professionals (HCPs), including paediatricians, other medical specialists, and nursing staff. The Jordanian study [8], (published in April 2023) which also came up, assessed Jordanian students' knowledge of T1D in children and adolescents and its complications (where DKA management falls).

Both studies [7] and [8] relied on hardware questionnaires that were gathered by clinical researchers after participants gave their consent to the trial and provided answers to the questions.

A respectable number of candidates shared in each of these studies, which adds to their relevance.

The Kibaki Study (Dr. Mayabi, June 2019) [7] aims to describe the obstacles to HCPs' knowledge of DKA management. It was shown that paediatricians had the best knowledge of DKA management, scoring about 70%, while nurses and other healthcare workers had the worst knowledge, scoring around 41% and 63%, respectively.

The results of these studies' [7] and [8] analysis of the challenges revealed that the lack of medical supplies and equipment, along with a shortage of standard operating procedures and lack of ongoing medical education, in addition to the heavy workload and insufficient service training on DKA management, were the main causes of HCPs' lack of expertise in managing DKA in the paediatric population.

According to a study conducted in Jordan [8], there are substantial knowledge gaps among recent medical graduates in a few T1D-related areas. Numerous methods, such as curriculum modifications, elective courses, more exposure to clinical settings, and interprofessional education, can be used to address this. The advantages of these actions, both immediate and long-term, must be carefully assessed.

As a conclusion, all these research papers, have acknowledged that more investigation for UK-based paediatric trainees is required, alongside intensive training in the care of DKA among paediatric population needed in order to boost confidence and, consequently, the ability to handle paediatric patients who are experiencing this kind of emergency around the world and in the UK.

III. RESEARCH QUESTION

The objective of this project is to assess the level of knowledge that paediatric junior doctors have on the management of DKA and then suggest the challenges that these doctors in the UK face in advancing their role in clinical settings.

Understanding the level of expertise that junior doctors have in managing paediatric DKA is the subject of the study. As well, the study aims to highlight the barriers that junior doctors must overcome in their position.

The following is a descriptive study that will use a thematic analysis in an attempt to identify the level of knowledge of managing DKA among paediatric junior doctors in the UK.

IV. METHODOLOGY

Federal guidelines define research as a systematic investigation including research development, testing and evaluation which are designed to contribute to generalized knowledge (US Department of Health and Human Services, 2012) [9]. And for these knowledge findings to be sound, this should be based in relation to the strengths and weaknesses of the methods that were intended to answer a specific research question. Thus, the specific design and methods of a study are vitally important to the conduct and appraisal of research [10].

This research design attains a cross-sectional methodology survey, that aims at understanding the level of knowledge

among paediatric junior doctors in managing DKA.

A primary aim of qualitative research across traditions is to understand the participants' perspective – how they make sense of their world and their experiences in the world – not to measure, predict, test or confirm [11].

Between August 10 and September 29, 2023, an interview was conducted online involving 99 paediatric junior doctors from different UK institutions given the survey link. The 10-item online survey (Fig. 1) included questions about diagnosing and assessing the severity of DKA, managing DKA with fluid and insulin and monitoring progress, addressing potential complications, and lastly, involving senior on call in the follow-up of DKA cases (Fig. 2) - extracted from BSPED guideline and previous studies [12]. This cross-sectional study used Survey Monkey, a commercial service, for data collecting and statistical analysis [13].

The aforementioned approach was used to examine the degree of paediatric junior doctors' knowledge across various demographic regions of the UK.

A distinct advantage of online interviewing is the wide geographical access; people from all over the globe can be interviewed - if they have telephone and computer access [14].

V. RESULTS

The survey was completed by all 99 (response rate 100%) paediatric junior doctors in UK hospitals based across all regions of the country. About 80% respondents spent more than 6 months in paediatric service/training (Fig. 3). From which, 10% did not respond to this question.

The breakdown of candidates' response to the online questionnaire about their confidence in managing DKA in hospitals is as shown in Table I.

VI. DISCUSSION

The degree of knowledge about DKA and confidence in managing paediatric patients with acute DKA among UK trainee/junior doctors was assessed in this study.

A. Assessing Knowledge about DKA Diagnosis and Severity

Regarding junior doctors' understanding of the diagnostic criteria of DKA, (which includes acidosis with $\text{pH} < 7.3$ and p/r HCO_3 level < 15 in addition to ketone level > 0.3 mmol/l) (Fig. 4), regrettably, only 38% of them provided the correct answer. Among these, the highest scores were achieved by Level 3 doctors, including ST6-St7 and ST8, along with registrars. Remarkably, ST8 doctors answered this question correctly in its entirety.

Survey on Confidence in Dealing with Paediatric Diabetic Keto Acidosis
electronic questionnaire
Knowledge of Junior doctors about DKA management in the UK
Approval will be assumed if you provide answers to the questionnaire

1. What is your level of experience as a junior doctor?
2. How much time have you spent working in pediatric wards and A&E/CAU?
3. Which of the following definitions for Diabetic Keto Acidosis (DKA) has been adopted?
4. In the updated DKA guidelines, what is the assumed dehydration level in moderate DKA?
5. What intravenous fluid solution is used for maintenance?
6. when will you attach the patient to cardiac monitoring?
7. when will you start Insulin infusion?
8. what are the life-threatening complications of DKA in pediatrics?
9. signs of cerebral edema?
10. At what stage would you escalate the case to your senior?

Fig. 1 Online survey: Ten questions' assessment related to DKA knowledge



British Society for
 Paediatric Endocrinology
 and Diabetes

Overview Algorithm for the Management of Children and Young People under the age of 18 years with Diabetic Ketoacidosis

Version 2 - 2024-07-22

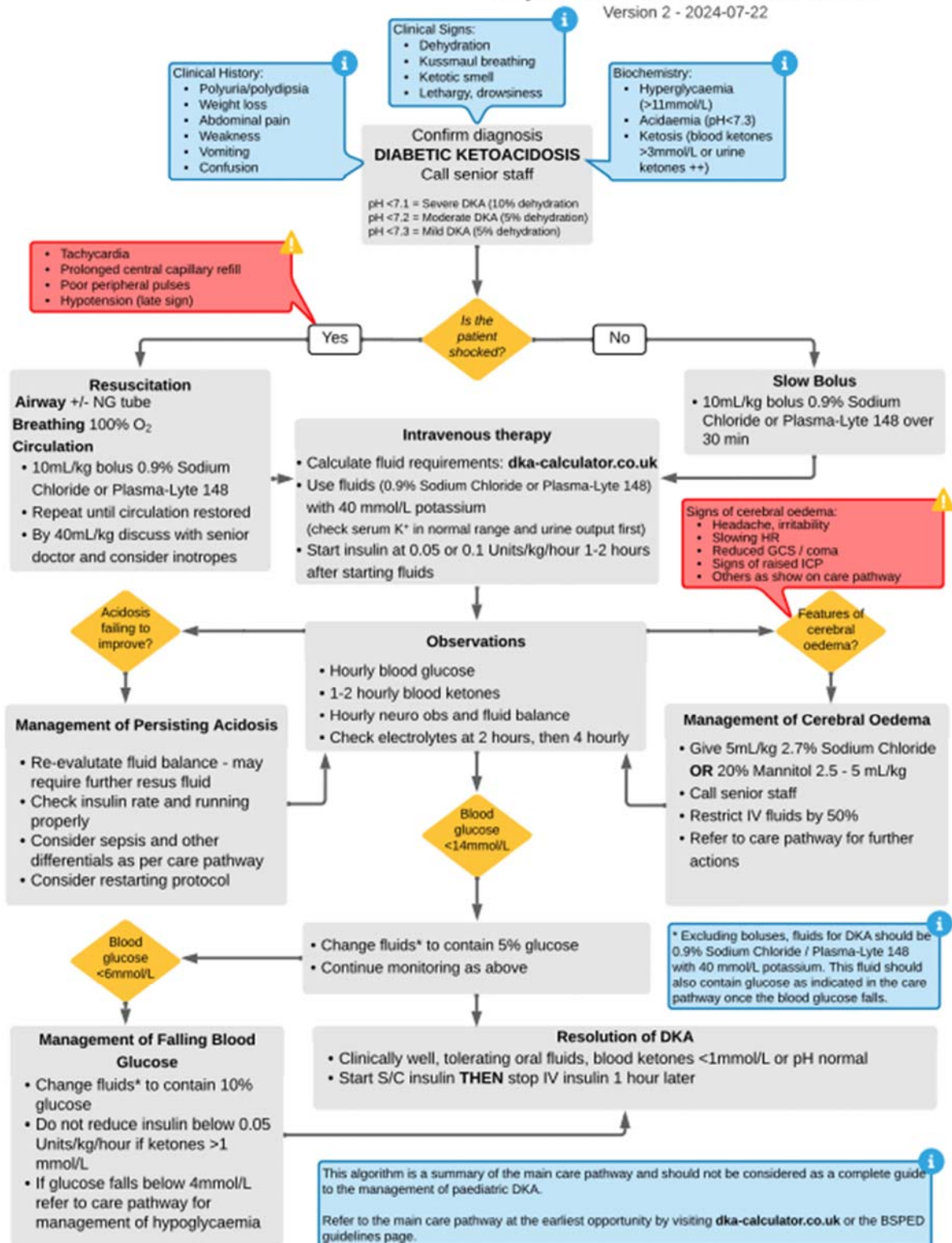


Fig. 2 BSPED, DKA management guideline

How much time have you spent working in pediatric wards and A&E/CAU?

Answered: 93 Skipped: 6

HOW MUCH TIME HAVE YOU SPENT WORKING IN PEDIATRIC WARDS AND A&E/CAU?	TOTAL
Q1: Staff Grade Reg	100.00% 21 Responses 21
Q1: Staff Grade SHO	100.00% 10 Responses 10
Q1: ST1	100.00% 10 Responses 10
Q1: ST2	100.00% 6 Responses 6
Q1: ST3	100.00% 9 Responses 9
Q1: ST4	100.00% 22 Responses 22
Q1: ST5	100.00% 7 Responses 7
Q1: ST6	100.00% 4 Responses 4
Q1: ST7	100.00% 1 Responses 1
Q1: ST8	100.00% 3 Responses 3

Fig. 3 Paediatric experience duration for each junior doctor's level

TABLE I
COMPARISON BETWEEN PAEDIATRIC JUNIOR DOCTORS IN TERMS OF LEVEL OF MANAGEMENT OF DKA IN CHILDREN

	SHO	Registrars	Level 1 trainee (ST1-ST3)	Level 2 trainee (ST4-ST5)	Level 3 trainee (ST6-ST8)
No. of participants	10.10%	23.23%	26.26%	30.30%	10.1%
Duration of experience (months = m)	23 m	8.5 years	3 years	4.4 years	12 years
Acknowledging the Latest adopted Definition of DKA (right answer = B)	A: 40% B: 20% C: 40%	A: 9% B: 30% C: 52% No answer: 9%	A: 38% B: 38% C: 23%	A: 17% B: 40% C: 36% No answer: 7%	A: 20% B: 60% C: 20%
Awareness of Categories of DKA: degree of dehydration in moderate DKA (right answer = A)	A: 10% B: 50% C: 10% D: 30%	A: 57% B: 26% C: 0% D: 17%	A: 38% B: 35% C: 0% D: 27%	A: 33% B: 43% C: 0% D: 23%	A: 33% B: 22% C: 11% D: 33%
Choice of IV fluid used in maintenance. (right answer = B)	A: 50% B: 20% C: 20% D: 10%	A: 17% B: 65% C: 17% D: 0%	A: 19% B: 42% C: 35% D: 4%	A: 20% B: 67% C: 13% D: 0%	A: 20% B: 60% C: 20% D: 0%
Cardiac monitoring at all DKA patients (answer = A)	A: 90% B: 10% C: 0%	A: 61% B: 30% C: 4%	A: 77% B: 23% C: 0%	A: 86% B: 7% C: 7%	A: 90% B: 0% C: 10%
Insulin infusion awareness, when shall it be started (right answer = C)	A: 30% B: 0% C: 70%	A: 0% B: 9% C: 87%	A: 12% B: 15% C: 73%	A: 0% B: 3% C: 97%	A: 0% B: 0% C: 100%
Life-threatening conditions happening as a consequence of DKA					
- Hypokalaemia	60%	70%	62%	80%	90%
- Cerebral oedema	100%	100%	100%	100%	100%
- Aspiration pneumonia	30%	26%	15%	33%	50%
- Inadequate resuscitation	50%	52%	74%	57%	70%
Signs of cerebral oedema					
- Headache	100%	91%	81%	73%	90%
- Irritability	90%	91%	88%	83%	80%
- Drowsiness	90%	91%	96%	93%	90%
- Low HR	60%	83%	81%	83%	80%
- Raised BP	60%	91%	81%	87%	100%
Escalation to seniors, at which level if necessary:					
- When called to see the patient	70%	39%	62%	17%	20%
- During management	20%	43%	38%	33%	50%
- if faced with difficulty	10%	13%	0%	50%	30%
Total average of right answer score	63%	70%	67.2	68.6%	74%

A comparison was conducted among junior doctors at various levels, considering different variables.

When it comes to recognizing the level of dehydration, with an example provided to illustrate moderate dehydration, approximately two-thirds of the Level 3 trainee juniors provided the correct answer (Fig. 5). In contrast, only 10% of the senior house officers answered this question correctly. On average, around 36% of all junior doctors answered this question accurately.

B. Management of DKA

Fluid Management

According to the BSPED guidelines, the preferred intravenous fluid for maintenance is 0.9% Sodium Chloride with the addition of 20 mmol of Potassium Chloride. This choice was selected by approximately 63% of all candidates (Fig. 6). Interestingly, only 10% of both ST3 doctors and senior house officers (SHOs) opted for Plasmalyte as their solution.

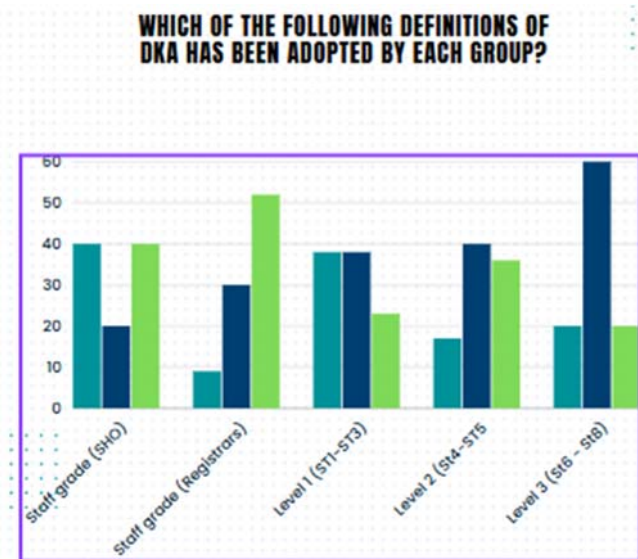


Fig. 4 Diagnostic criteria for DKA

In the updated DKA guidelines, what is the assumed dehydration level in moderate DKA?

Answered: 98 Skipped: 1

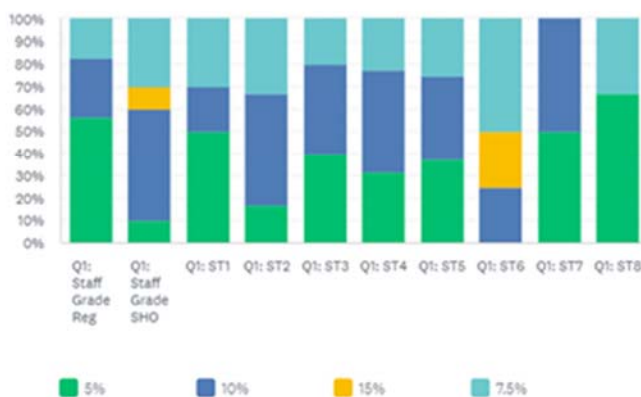


Fig. 5 Knowledge of junior doctors about dehydration level in DKA

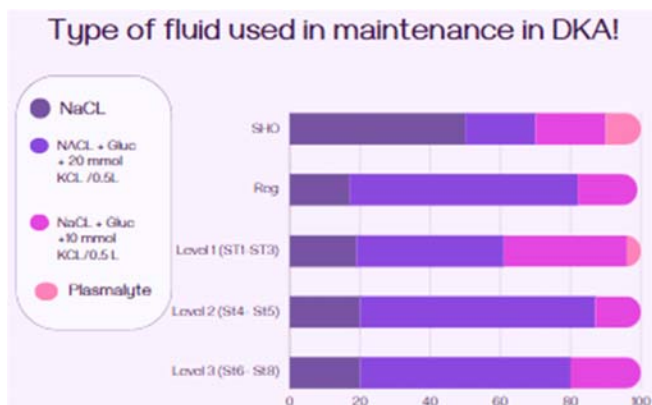


Fig. 6 Junior doctor's idea about the fluid Type used in DKA maintenance

Insulin Therapy

It is quite remarkable to note that the average number of candidates who concurred with initiating insulin therapy after

60 minutes of fluid infusion in DKA patients was approximately 85% (Fig. 7).

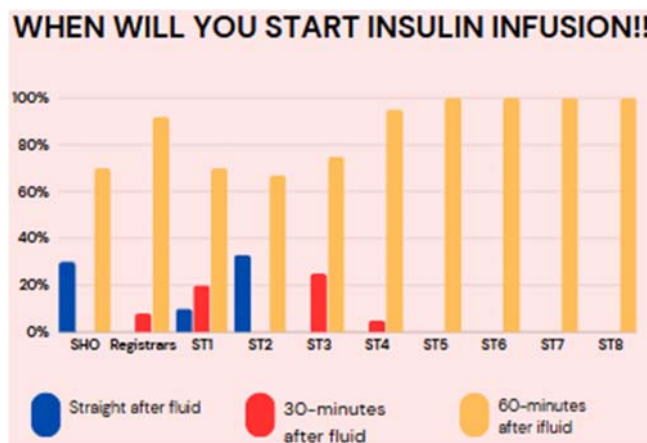


Fig. 7 When to start insulin according to junior doctor's expectations

Cardiac Monitoring

The survey participants were well aware of the importance of cardiac function monitoring at some point during DKA management, as indicated by the sample question. However, it is interesting to note that the majority, around 80%, recommended initiating monitoring at the outset of the management (Fig. 8). What is impressive is that even Level 3 doctors shared this high rate of early monitoring with the junior

doctors. On the other hand, about 14% of overall junior doctors suggested that monitoring could begin during the management phase, with a portion of registrars (approximately one-third) adopting this view. Only a few participants, around 4% of the total, agreed to consider cardiac monitoring if electrolyte disturbances were anticipated. It is worth mentioning that most of these were Level 3 doctors, accounting for 10% of the respondents in this category.

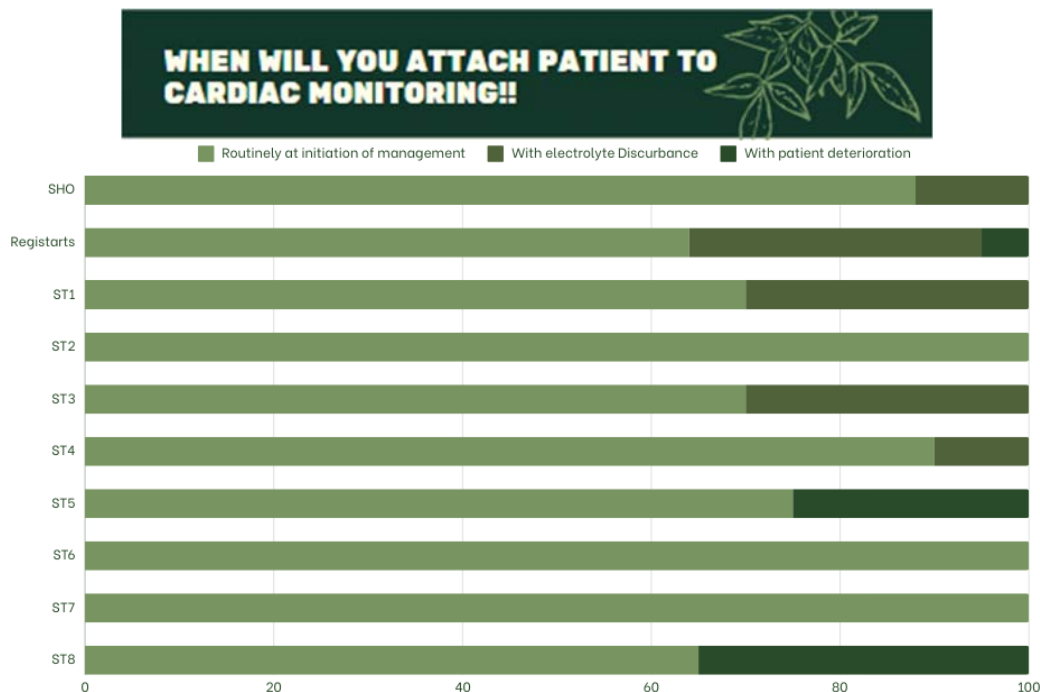


Fig. 8 Junior doctor's decision about the time they attach DKA patients to cardiac monitor

C. Possible Complications (Fig. 9)

- When considering life-threatening complications of DKA, it is noteworthy that all doctors, regardless of their level of experience, unanimously recognized cerebral oedema as a life-threatening complication. In addition to cerebral oedema, hypokalaemia was identified as a life-threatening complication by 72.4% of the candidates.
- However, it is interesting to observe that the least recognized life-threatening complication was aspiration pneumonia, which was chosen by only 30% of respondents, with a majority of them being at Level 3 of training or service. In contrast, those at Level 1 were less likely to select this option.
- Inadequate resuscitation is a known life-threatening complication in DKA patients, but only two-thirds of trainees and service doctors were able to acknowledge this, with most of them being at Level 1 of their training or service.
- An overall, a moderate level of knowledge was observed regarding the characteristics of cerebral edema DKA (Fig. 10). Specifically, this knowledge was approximately 85.7% among trainees and 1% less among junior doctors who were not in a training program. This was 82.7% among less

experienced doctors (including those at Level 1 and senior house officers) while seniors, including those at Levels 2-3 and registrars, demonstrated a slightly higher level of knowledge at 87.65%.

D. Escalation of Care

The survey results regarding the escalation of care revealed some interesting trends (Fig. 11). Approximately 50% of respondents at level 2 indicated that they would inform their senior colleagues about the presence of a DKA patient only when it becomes challenging to manage. In contrast, around half of the level 3 doctors would notify their senior consultants during the management process. The majority of senior house officers (SHOs) expressed their readiness to inform their seniors immediately, as soon as the DKA diagnosis was confirmed.

Overall Remark

The results of this study revealed that over 60% of the survey participants achieved a level of performance deemed "good" according to the questionnaire grading, which is in line with the updated BSPED guidelines. Interestingly, Level 3 trainees achieved the highest average scores, with an impressive 74%. This suggests that additional structured training, including

simulations, may be necessary at trust-based hospitals for trainees and non-trainees at all levels. Such training can help

bolster their knowledge and, consequently, their confidence in effectively managing DKA emergencies.

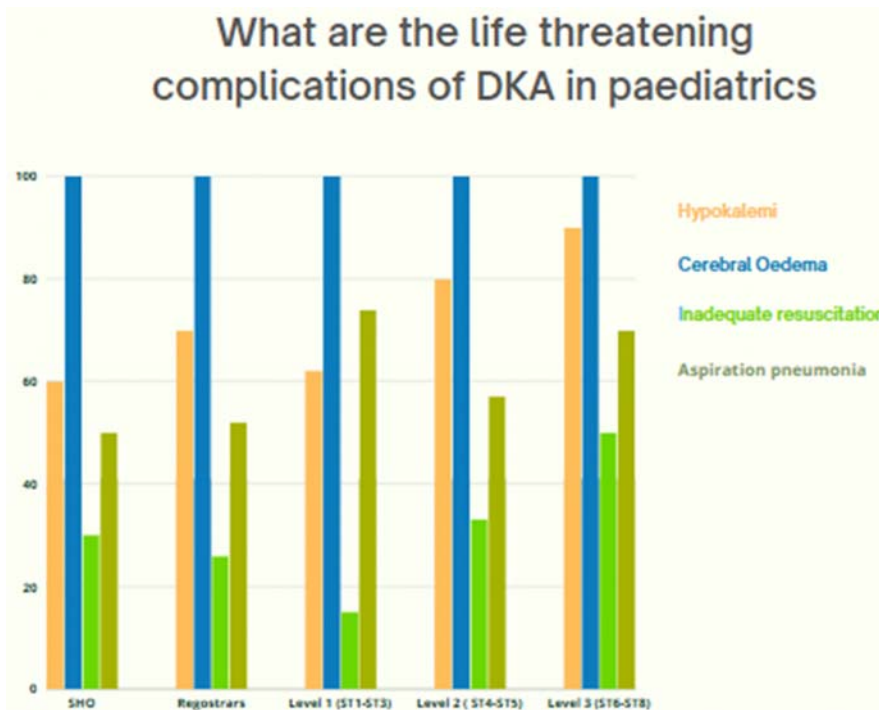


Fig. 9 Knowledge about life-threatening complications of DKA in paediatrics among junior doctors

signs of cerebral edema?

Answered: 99 Skipped: 0

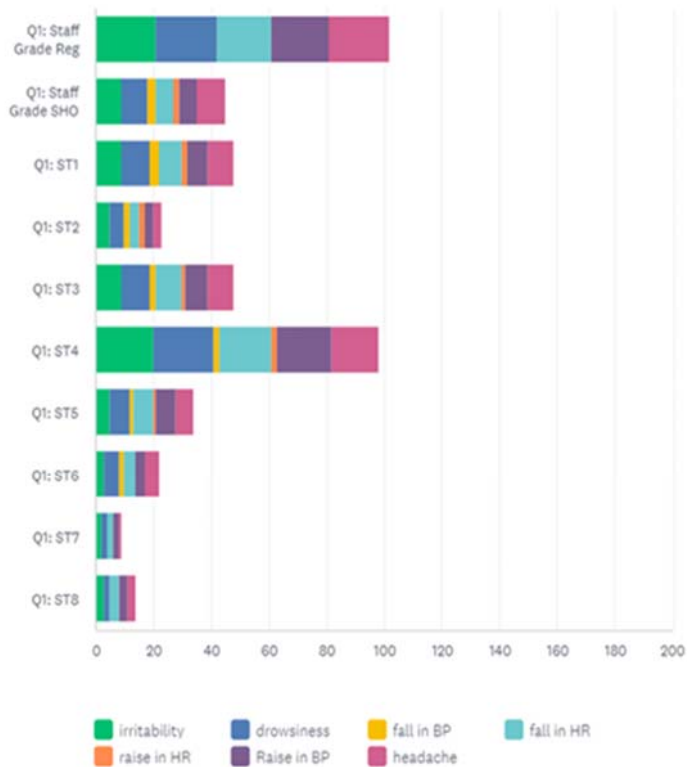


Fig. 10 Signs of cerebral oedema which are recognized by junior doctors

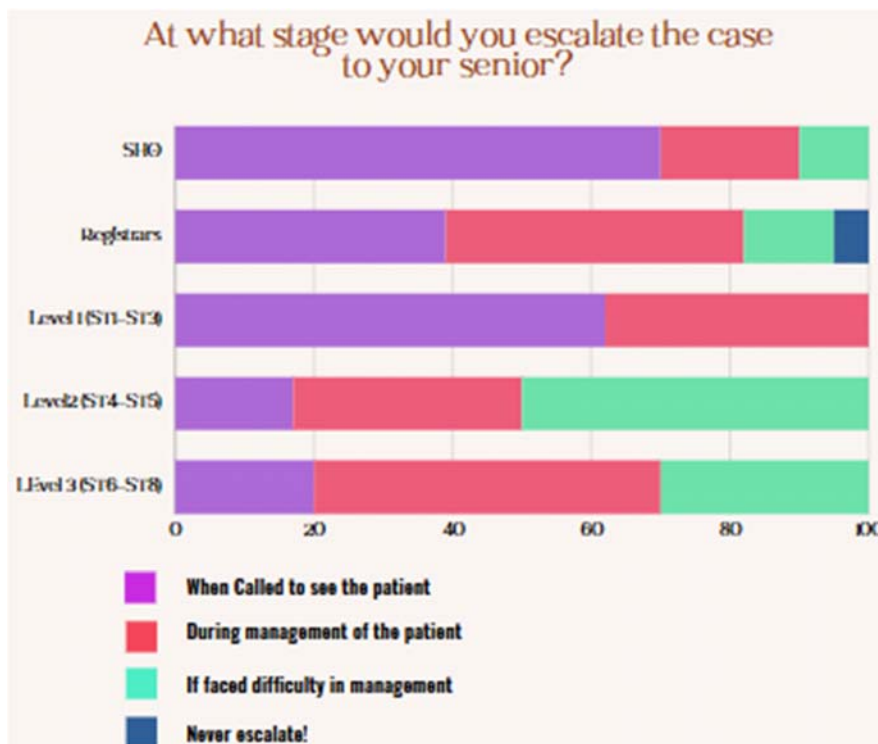


Fig. 11 Stage of senior escalation according to junior doctor's level

VII. LIMITATION OF THE STUDY

- There may be confounding factors in this study. For instance, non-trainee doctors often have diverse international backgrounds, which can contribute to their overall experience from different healthcare systems. This does not necessarily imply that they lack confidence or knowledge in managing DKA patients. However, their background knowledge might not align with the new guidelines they are expected to follow in the UK. Therefore, further research should investigate the relationship between international backgrounds and the management of children in the UK healthcare system.
- While data collection was anonymized and randomly distributed among patients to enhance the study's robustness, it also led to discrepancies in the sizes of different groups at each level of candidates participating in the study. As a result, comparing the performance among these groups may not be entirely realistic.

VIII. CONCLUSION

In conclusion, the results of the survey questionnaire indicate that paediatric junior doctors in the UK possess a fair level of knowledge and confidence in managing DKA, and areas where improvement is needed have been identified. It is recommended that more teaching sessions focusing on the proper management of acute DKA in children should be provided to junior doctors within each trust. Additionally, doctors should be familiarized with the valuable and updated information derived from evidence-based medical reports such as those from BSPED or equivalent sources. Making this information accessible through

trust induction pathways can further enhance the quality of care provided to DKA patients.

ETHICAL CLEARANCE

Respondents were informed that their responses would be used as part of a research paper reviewing paediatric knowledge of DKA among junior doctors in the UK. They willingly participated in the study by completing the online questionnaires electronically.

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