Changing trends in the aetiology and management of Diabetic Ketoacidosis (DKA) – the effect of quality improvement programmes and of new therapies

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Background

- Diabetic ketoacidosis (DKA) is a preventable but often life-threatening complication of type 1 diabetes.
- The Joint British Diabetes Societies (JBDS) UK outlines the criteria for diagnosis as: ketonemia > 3.0mmol/L **or** significant ketonuria (more than 2+ on standard urine sticks), blood glucose > 11.0mmol/L or known diabetes mellitus, and acidosis of venous pH < 7.3 (and/or Bicarbonate (HCO3-) < 15.0mmol/L).

Aims

Effective management of DKA in accordance with national guidelines improves clinical outcomes and may reduce long hospital stays. We have previously demonstrated that quality improvement program (QIP) can improve DKA management that persist for 4 years. We wanted to explore if these improvements could persist long term.

Methods

A retrospective study of consecutive DKA episodes from April 2014 to March 2020 was done. Data on demographics, aetiology, DKA duration, fluid replacement, fixed rate insulin infusion, glucose, ketone, potassium measurements were collected. Data regarding hypokalaemia, hyperkalaemia and hypoglycaemia were recorded for all episodes. All data were collected from the time of DKA diagnosis until resolution or up to 12 hours from diagnosis (whichever was longest). The data was analysed using Statistical Analysis Software Package version 23 (IBM Corp., New York, USA) and are expressed in percentage and median with inter-quartile range.

Results

A total of 711 consecutive DKA episodes were included in the study. 70% of DKA were due to illness, suboptimal adherence or new diagnosis. Newer therapies with SGLT2-inhibitors and immune checkpoint inhibitors contributed to more recent DKAs. The DKA duration improved following implementation of the QIP programme and remained significantly better than baseline for the entirety of the 6-year follow-up. There was a trend to a reduction in kalaemic and hypoglycaemic complications.

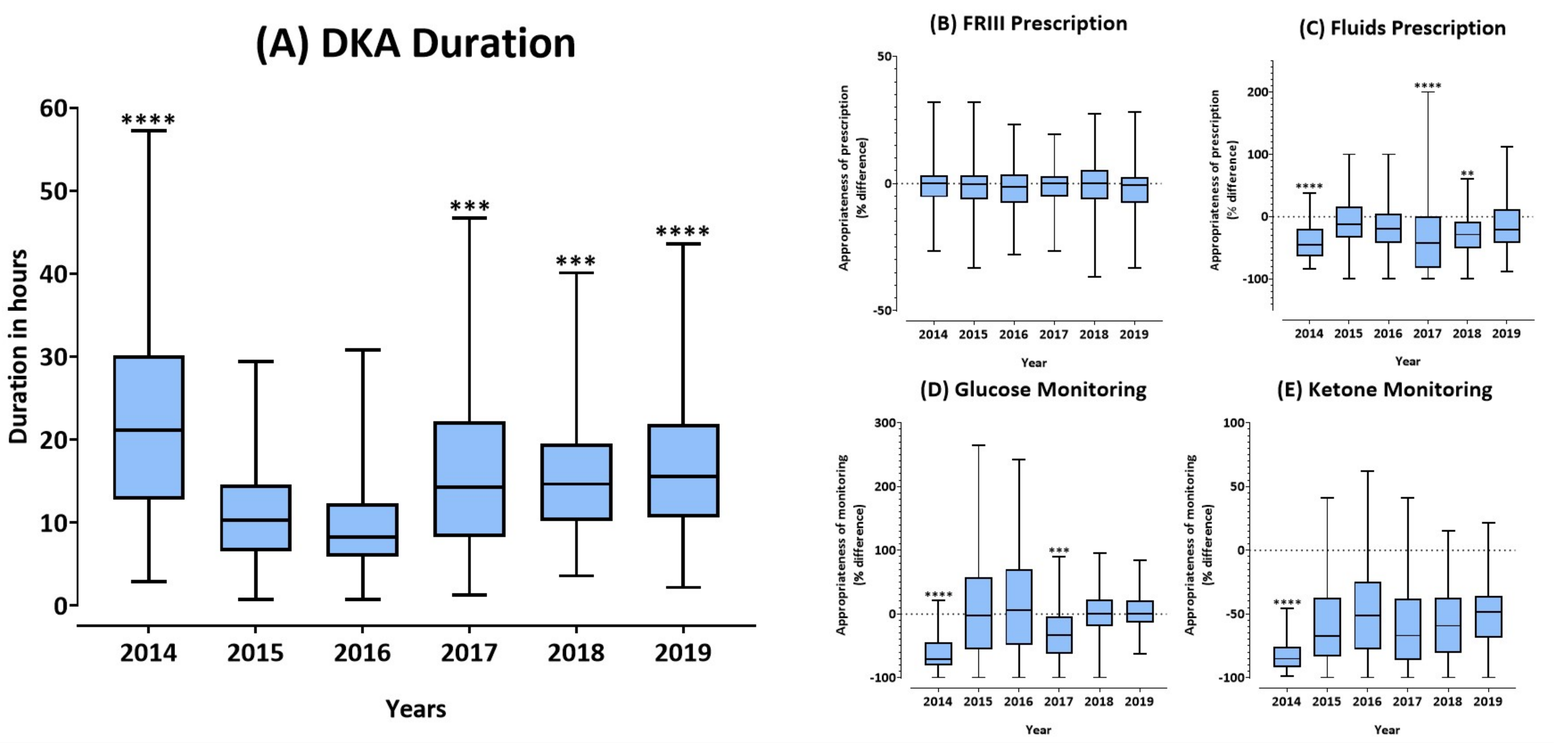

Figure 1. (A) yearly DKA duration, (B) appropriateness of fixed rate intravenous insulin infusion prescription, (C) appropriateness of fluid prescription, (D) appropriateness of glucose monitoring, (E) appropriateness of ketone monitoring. Graphs represent the dispersion of each measure from the baseline recommendation. For example, the standard recommendation for FRIII rate for a patient weighing 60 kg is 6 units/hour (0.1 unit × weight of the patient). A prescription of 6 units/hour would register at '0' on the y-axis, whereas a prescription of 3 and 9 units for the same patient would register at −50% and 50%, respectively. Median DKA duration and appropriateness of all parameters were compared to 2015 data.

Aetiology	2014*	2015	2016	2017	2018	2019	Total
Alcohol-related	6 (7.79)	2 (1.87)	5 (4.55)	4 (3.51)	3 (2.38)	4 (2.74)	24 (3.53)
Drug induced	0 (0)	0 (0)	0 (0)	2 (1.75)	0 (0)	1 (0.68)	3 (0.44)
Inter-current illness	19 (24.68)	24 (22.43)	34 (30.91)	36 (31.58)	53 (42.06)	55 (37.67)	221 (32.5)
Poor compliance	20 (25.97)	44 (41.12)	26 (23.64)	31 (27.19)	23 (18.25)	32 (21.92)	176 (25.88)
Sepsis	7 (9.09)	7 (6.54)	8 (7.27)	0 (0)	7 (5.56)	7 (4.79)	36 (5.29)
Surgical	8 (10.39)	11 (10.28)	5 (4.55)	3 (2.63)	5 (3.97)	10 (6.85)	42 (6.18)
New diagnosis of type 1 diabetes	8 (10.39)	8 (7.48)	9 (8.18)	14 (12.28)	7 (5.56)	12 (8.22)	58 (8.53)
Unclear	9 (11.69)	11 (10.28)	23 (20.91)	24 (21.05)	26 (20.63)	20 (13.7)	113 (16.62)
SGLT2 related	0 (0)	0 (0)	0 (0)	(0)	2 (1.59)	2 (1.37)	4 (0.59)
Immunotherapy induced	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	3 (2.05)	3 (0.44)

Table 2. Year-wise breakdown of aetiologies of DKA. Results are expressed in n (%).
* Patients were included from 1st April 2014 to 31st December 2014.

Conclusions

This is the largest series of consecutive DKA episodes managed at a single centre. It demonstrates that a well-run QIP leads to sustained improvements. Regular performance feedback may help sustain these improvements. Aetiology of DKA is changing but new diagnosis, poor education and compliance remain major contributors. More education and awareness on complications of DKA management is needed.