Sustaining improvement in Diabetes-related ketoacidosis management through Quality Improvement Project

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Brief Intro about DKA and QIP

Hypothesis and how QI started

Initial results with interventions

Follow-up findings without any interventions

Can QI go beyond improvement

Sharing our learning with each other
Background

• Diabetic ketoacidosis (DKA)- extreme metabolic state due to insulin deficiency.

• Joint British Diabetes Society (JBDS) guidelines in 2010; further revised in 2013 and 2021

• Many trainee doctors and frontline staff are not fully confident in managing DKA.

Savage et al. Diabetic Medicine. 2011
Quality Improvement

Improvement tools

Systems approach
Hypothesis
Implementing a QI for limited clinical criteria and frequent feedback improves DKA management
Methods

• All patients diagnosed with DKA from April 2014 to September 2016 were included.

• Patients managed in intensive care units were excluded from the study to avoid one-to-one care bias.

• We adopted the plan-do-study-act (PDSA) method for the QIP
Primary drivers, Secondary drivers and outcomes

Duration of DKA
- Fluids
- Fixed rate insulin infusion (FRII)
- Glucose measurements
- Ketone measurements
- Specialist referral

Clinical
- Emergency medicine
- Acute medicine
- Department of diabetes

Acute Medicine
Confirming diagnosis
Optimising treatment
Hourly measurements

Department of Diabetes
Early referral
Discharge planning
Follow-up

Emergency Department
Diagnosis
Initiation of treatment
Transfer to Acute Medicine

Non-clinical
- Bed management
- Clinical governance
- Information-technology

Bed management
Transfer of patients from ED to CDU and then to appropriate ward

Information technology
Optimising all referrals and providing appropriate patient list

Clinical Governance
Permit to undertake the QIP and approve amendments in the guidelines

Oct 2014 - QIP initiated
Dec 2014 - FRII and hourly measurements
Feb 2015 - Introducing DKA mnemonic

Nov 2014 - Automatic Referral and fluid
Jan 2015 - Blood gases on electronic patient records
Mar 2015 - Revamping DKA protocol

Primary drivers, Secondary drivers and outcomes

Plan
Do
Act
Study
Regular and frequent feedback of specific clinical criteria delivers a sustained improvement in the management of diabetic ketoacidosis.

Authors: Punith Kempegowda, Ben Coombs, Peter Nightingale, Joht Singh Chandan, Jaffar Al-Sheikhli, Bhavna Shyamnar, Kasun Theivendran, Anitha Vijayan Melapatte, Umesh Salanke, Mohammed Akker, Sandip Ghosh and Parth Narendran.
2017-2018

I moved to another Trust in 2017

Came back in 2018 and was keen to see how things were with DKA

Particularly interested to see if the improvement sustained
What are the new findings?

- We were able to reduce DKA duration with tailored interventions and sustain the improvement with regular feedback. The trend of DKA duration headed toward baseline in the absence of regular feedback.

How might these results change the clinical practice?

- Incorporating regular feedback to end users may help provide better care to patients with DKA.

**Figure 5** Duration of DKA per year. DKA, diabetic ketoacidosis.
Management of DKA

**Diagnostic criteria**

All three of the following should be present:

1. Capillary blood glucose >11mmol/L or history of diabetes
   (glucose may be ≥ 11mmol/L in hyperglycaemic ketoacidosis)
2. Capillary ketone >3mmol/L or urine ketones >2+
3. Venous pH <7.3 and/or bicarbonate <15mmol/L.

**When to refer to critical care unit**

- Young (18-25) or elderly
- Pregnancy
- Heart or liver or kidney failure
- Severe DKA judged by: blood ketones >6 mmol/L, bicarb <5mmol/L, pH <7.1, hypokalaemia, GCS <12, SpO2 <92%, brady/teachycardia or anion gap >16

**0-60 minutes**

- Restore circulating volume
  • Give 500ml bolus of 0.9% sodium chloride infusion until systolic BP >90mmHg
  • Once systolic BP >90mmHg, give 11 of 0.9% sodium chloride over one hour.

**Start insulin therapy:**

- Start fixed rate insulin infusion at 0.1-0.2units/kg/hr (prescribed as Actrapid Inf DKA on PICS).
- Continue patient's long acting subcutaneous insulin.

**60 minutes to 6 hours**

- Reassess patient and continue monitoring:
  • Hourly blood ketone and glucose monitoring
  • Venous gas for pH, bicarbonate and potassium at end of each fluid bag

**Continue fluid management:**

- 0.9% sodium chloride with potassium, over 2 hours
- 1L 0.9% sodium chloride with potassium, over 2 hours
- 1L 0.9% sodium chloride with potassium, over 4 hours

**Continue insulin therapy:**

- Hourly capillary blood glucose monitoring
- Venous bicarbonate and potassium at 60 minutes, 24 hours and 2 hourly thereafter.
- 4 hourly plasma electrolytes

**6-12 hours**

- Reassess and monitor vital signs:
  • Seek senior medical advice if patient not improving
  • If glucose <14mmol/L start 10% glucose at 125mls/hr alongside sodium chloride

**Continue fluid management:**

- 0.9% sodium chloride with potassium, over 4 hours
- 1L 0.9% sodium chloride with potassium, over 6 hours
- Reassess at 12 hours

**12-24 hours**

- DKA should have resolved by now
- Reassess and monitor vital signs

**Review Metabolic parameters:**

- At 12 hours check venous pH, bicarb, potassium, as well as ketones and glucose.
- Check if DKA has resolved. If not seek senior advice.

**Resolution of DKA**

- Resolution is defined as ketones less than 0.6mmol/L and venous pH over 7.3.
- If DKA has resolved:
  - convert to s/c insulin if patient eating and drinking well
  - Switch to variable rate intravenous insulin infusion if patient is unwell or unable to eat and drink.

**Potassium supplementation**

This should be according to blood K+ (mmol/L):

- >5.5: No potassium replacement
- 3.5-5.5: 40mmol per litre of infusion fluid
- <3.5: Senior review to assess the risks and benefits of replacement

**Rule out Hyperglycaemic ketoacidosis and Hyperglycaemic Hyperosmolar State (HI+5) in high risk acutely unwell patients with diabetes (Eg: Pregnancy, those on SGLT-2 inhibitors (gliflozins))**
Can QI go beyond improvement?

• We aimed to explore the differences in the demographics, presentation and management of DKA in adults with type 1 and type 2 diabetes
• Impact of age, sex, ethnicity
786 consecutive DKA episodes

18 excluded due to missing or incomplete records

768 DKA episodes included in final analysis

583 (75.9%) people with type 1 diabetes

184 (24.1%) people with type 2 diabetes
Precipitating Aetiology

Type 1 and Type 2 Diabetes

- Type 1 Diabetes
  - intercurrent illness: 3.6%
  - suboptimal compliance to treatment: 2.4%
  - unclear: 0.3%
  - surgical: 3.0%
  - new diagnosis of T1DM: 0.2%
- Type 2 Diabetes
  - alcohol-related: 16.3%
  - SGLT2-related: 15.7%
  - COVID-19: 5.4%
  - drug-induced: 6.0%
  - immunotherapy-induced: 16.2%
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Outcome of DKA

DKA duration

Length of hospitalisation
Age and sex-based differences
Clinical and biochemical profile of 786 sequential episodes of diabetic ketoacidosis in adults with type 1 and type 2 diabetes mellitus

Emma Ooi, Katrina Nash, Lakshmi Rengarajan, Eka Melson, Lucretia Thomas, Agnes Johnson, Dengyi Zhou, Lucy Wallett, Sandip Ghosh, Parth Narendran, Punith Kempegowda

ABSTRACT

Introduction We explored the clinical and biochemical differences in demographics, presentation and management of diabetic ketoacidosis (DKA) in adults with type 1 and type 2 diabetes.

Research design and methods This observational study included all episodes of DKA from April 2014 to September 2020 in a UK tertiary care hospital. Data were collected on diabetes type, demographics, biochemical and clinical features at presentation, and DKA management.

Results From 786 consecutive DKA, 583 (75.9%) type 1 diabetes and 185 (24.1%) type 2 diabetes episodes were included in the final analysis. Those with type 2 diabetes were older and had more ethnic minority representation than those with type 1 diabetes. Intercurrent illness (29.8%) and suboptimal compliance (36.8%) were the

Significance of this study

What is already known about this subject?

- Diabetic ketoacidosis (DKA) is generally associated with type 1 diabetes mellitus (T1DM) but can also develop in people with type 2 diabetes mellitus (T2DM).
- Common precipitants of DKA in T1DM and T2DM are intercurrent illness and suboptimal treatment.
- DKA in people with T1DM and T2DM are currently managed using the same clinical protocols.

What are the new findings?

- DKA in those with T2DM is more common in people of ethnic minority background.
Let’s share best practices

• We were then interested to see if this can be adapted to other centres as well
• Reduce duplication of work, bring in uniformity in data collection
• A system that identifies DKA episodes based on prescriptions for fixed rate intravenous insulin infusion (FRIII) and pulls data from electronic notes to collect all relevant information.
Digital Evaluation of Ketosis and Other Diabetes Emergencies (DEKODE)

Simplifying
A registry for DKA across various centres allows uniform data storage

Centralising
analysis limits time gap between data collection and intervention

Learning
Learning from each others’ best practices
Methods (continued)

- Each admission was assigned a unique code (Eg: SWBH-001, QEHB-0001) for pseudonymised data collection
- Use of pre-approved data collection tool
- Analysed using SPSS version 27.0
- Independent-Samples Kruskal-Wallis Test
Methods continued

- Year of birth
- Gender
- Ethnicity
- Type of diabetes
- Weight
- Height
- Previous insulin treatment – form and dose
- Other diabetes medications
- Admission and discharge date and time
- Precipitating cause for DKA

- pH, bicarbonate, glucose, ketones, lactate at admission
- Sodium, potassium, urea at admission
- Date and time of DKA diagnosis
- Date and time of DKA resolution
- Rate of fixed rate insulin
- Details of glucose measurements between DKA diagnosis and resolution
- Details of ketone measurements between diagnosis and resolution
- Details of potassium monitoring between diagnosis and resolution

+ whether the following were done during the inpatient episode:
  - ECG
  - Urine MSU
  - ITU referral
  - ITU admission
  - Basal insulin continued alongside fixed rate
  - Management in a monitored bed
  - Fluid balance maintained
  - 10% dextrose started when blood glucose <14mmol/L
  - Specialist review by diabetes team
  - Follow up with diabetes team arranged after discharge
  - VTE prophylaxis during DKA
Results

switching to excel to show some fresh off the oven outcome measures
• Current version of guidelines incorporated into all participating hospitals in DEKODE
There's been a change in the Diabetic Ketoacidosis (DKA) guidelines!

**UHB and (JBDS) Update:**

1. Once blood glucose levels reach $\leq 14$ mmol/l.

2. Reduce the insulin infusion rate from 0.1 units/kg/hr to 0.05 units/kg/hr.

3. This is alongside 10% glucose 125 ml/hr administration.

This would decrease the incidence of hypoglycaemia and hypokalaemia.
Discussion

Uniform data collection is possible across multiple sites and hospitals without breaching information governance regulations.

Each centre excel is some but not all aspects of DKA management, suggesting there is scope to share best practices between the centres.

Information is powerful and letting people see data will change behaviour

Getting medical students and junior doctors involved has helped them get more insight into QIP and D&E, which has translated into better HCPs and hopefully future leaders in our speciality
Future directions

- Invite more hospitals into the DKA Registry, in order to continue to learn from each other
- Innovative interventions to improve the understanding of the pathophysiology and management of DKA - #CoMICs
- Implement feedback system in each centre
- Implement best practices from other centres in each hospital
Junior doctors
- Amy Birchenough
- Anne De Bray
- Ben Coombs
- Bhavana Shyamanur
- Catherine Cooper
- Eka Melson
- Jaffar Al-Sheikhli
- Joht Singh Chandan
- Kasun Theivendran
- Lakshmi Rengarajan
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- Shamath Soghal

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- Anjitha Anilkumar
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