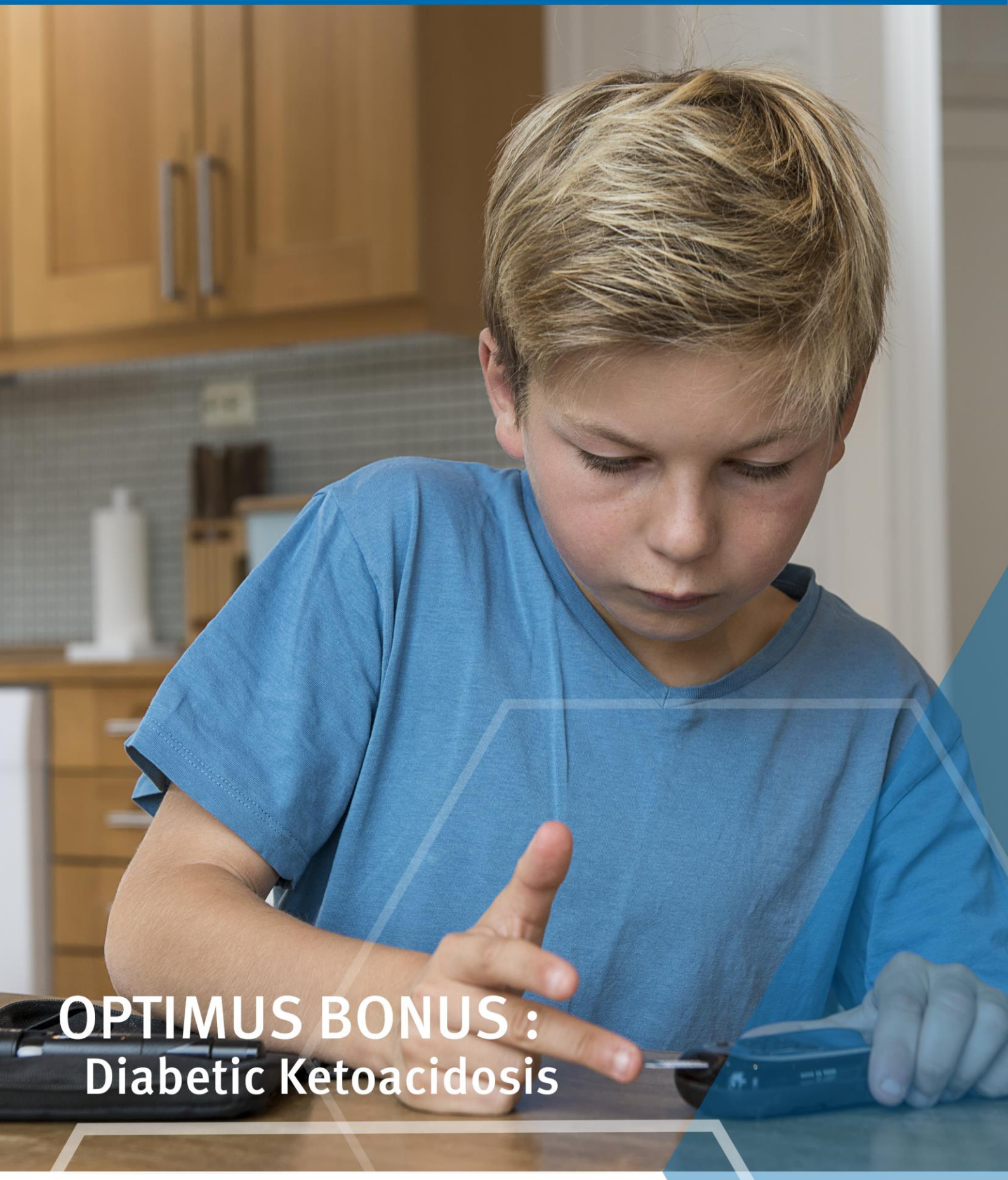


OPTIMUS BONUS :
Diabetic Ketoacidosis

Queensland Government

OPTIMUS BONUS : Paediatric DKA

Published by the State of Queensland (Queensland Health), [Aug 2019]

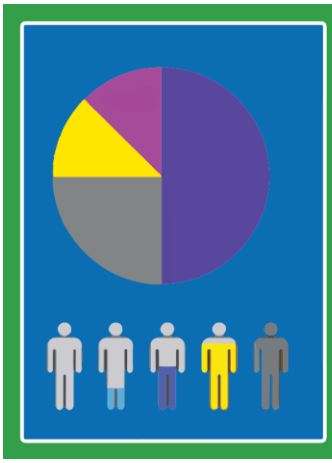
For more information contact:

Simulation Training Optimising Resuscitation for Kids (STORK) Unit, Queensland Children's Hospital, 501 Stanley St, South Brisbane QLD 4101, stork@health.qld.gov.au

Contents of this educational package:

Simulation

Management of Paediatric DKA
Use of resources to help manage DKA
Recognise & manage Cerebral Oedema



Infographic

For sharing in the weeks before or after your simulation via email or in poster format.

Further Reading

Podcasts and Blog Posts
Online Videos
Journal Articles

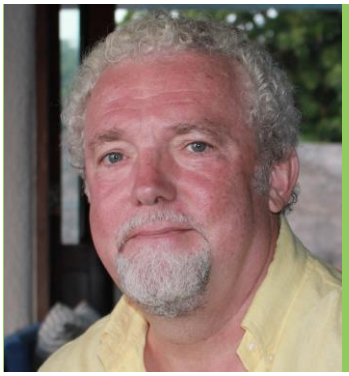
Fill out our online survey!

Scan the QR code with your phone camera

Scan me

Simulation

Introduction by Professor Jerry Wales
Director of Endocrinology at Queensland Children's Hospital
DM, MA, BM BCh, MRCP, FRACP, FRCPCH, FRACP, DCH



Jerry Wales trained in Oxford University and the NHS then worked for 25 years as a paediatric endocrinologist and head of department at Sheffield Children's Hospital. He served on many international and national committees during this time. He was awarded an Oxford University DM degree by thesis in 1991. He was Chairman of the BSPED for 5 years and granted honorary life membership in 2017. He Chaired the NICE UK review of paediatric diabetes for 4 years before moving to Australia in 2014. He is currently Director of Endocrinology at the Queensland Children's Hospital, honorary Professor at University of Queensland and chair of the APEG diabetes sub-committee.

"DKA is a metabolic disorder that is the leading cause of morbidity and mortality in children and adolescents with type 1 diabetes. It is caused by a decrease in effective circulating insulin, insulin resistance and increased production of counter-regulatory hormones. The resulting increased hepatic and renal glucose production, and impaired peripheral glucose utilisation, causes hyperglycaemia and hyperosmolality. In addition, increased lipolysis with the overproduction of ketones leads to ketonaemia and metabolic acidosis. Hyperglycaemia and acidosis causes osmotic diuresis, dehydration and obligate loss of electrolytes.

Children may present with DKA at any age, with or without a previous diagnosis of type 1 diabetes. DKA can also occur in newly diagnosed type 2 diabetes. Rarely, patients diagnosed with diabetes may have symptomatic ketoacidosis without a raised blood sugar level.

Remember children can die from DKA.

They can die from;

- Cerebral oedema - a rare but devastating complication of diabetes, occurring in approximately 1% of children with DKA. It is typically described as having a sudden onset and manifesting as rapidly progressive neurological deterioration (altered/fluctuating conscious level, headache, vomiting, bradycardia, hypertension, cranial nerve palsy, abnormal posturing). Clinical cerebral oedema can occur at any time but most commonly occurs 4-12 hours after commencement of treatment.
- Hypokalaemia - this is preventable with careful monitoring and management
- Aspiration pneumonia - use a naso-gastric tube in semi-conscious or unconscious children.

With careful management, these complications can be avoided. Guidelines can be useful to ensure you are providing evidence based management to this critically unwell child and the paediatric endocrinologist in your network is always available to give phone advice."

Section I: Scenario Demographics

Scenario Title:	BONUS – DKA
Date of Development:	10/8/2019
Target Learning Group:	Multidisciplinary Teams that look after Paediatric Patients

Section II: Scenario Developers

Scenario Developers:	Dr Sonia Twigg, Dr Benjamin Symon, Ms Louise Dodson, Dr Ben Lawton, Mrs Tricia Pilotto, Dr Carolina Ardila
Reviewed by :	Prof Jerry Wales

Section III: Curriculum

Learning Goals & Objectives	
Educational Goal:	• Management of Paediatric DKA including provision of fluids and insulin • Recognition and Management of Cerebral Oedema in DKA
Skills Rehearsal:	• Administration of Fluids in DKA • Administration of Insulin in DKA

Systems Assessment:	• Resources on DKA including :
	  ○ Local protocols on investigation, management and disposition
	  ○ Access to specialist services including; Retrieval, PICU, Paediatric Endocrinology

Case Summary: Brief Summary of Case Progression and Major Events

- 5yo boy with severe DKA as a first presentation of Type 1 Diabetes Mellitus.
  - Symptoms included vomiting and abdominal pain for 2 days and then hard to wake up this morning.
  - He has a mildly altered level of consciousness that could be due to Cerebral Oedema or could be due to poor perfusion and shock.
- The ambulance service recognise the child is in DKA, insert an IV cannula and notify the ED 5 minutes before arrival.
- The scenario is centred around the initial management of a child with severe DKA.

Section IV: Equipment and Staffing

Scenario Cast	
Patient:	☐ Mannequin

Clinical Expert Over the phone.	Paediatric Retrieval Consultant, Paediatric Endocrinologist or General Paediatrician.
	• Recommends team using the Paediatric DKA guideline utilised by your service
	  • The Children's Health Qld online DKA guideline is available via this link [or advise team to google dka chq guideline]
	  • Give advice in accordance with the guideline appropriate for your service
	Expert is helpful and available to the team.
	• Can guide the team through the scenario if needed.

Confederate 1:	Paramedic. Gives good handover.
Confederate 2: If available	Parent. Calm, caring, cooperative. Gives extra history re background.

Required Monitors	
☐ ECG leads	☐ Temp probes
☐ NIBP cuff	
☐ Pulse oximeter	

Required Equipment		
☐ Gloves	☐ Nasal prongs	☐ LMA
☐ Stethoscope	☐ Hudson mask	☐ Cannulation equipment
☐ IV bags/ lines	☐ Non-rebreather mask	☐ Blood test tubes and VBG syringe
☐ IV medications	☐ Laryngoscope	☐ Glucometer
☐ Infusion pump x 2	☐ Endotracheal tubes	☐

Moulage
No moulage. IV drainage bags x 2 attached to cannula for fluid infusions. (One of these should be labelled 'no IV yet'.

Approximate Timing							
Set-Up:	15 m	Prebrief :	15 mins	Scenario:	15 mins	Debriefing:	15 mins

A. Patient Profile and History

Patient Name: Toby		**Age:** 5yo	**Weight:** 17kg
Gender: N			
Chief Complaint: DKA			
History of Presenting Illness: Altered conscious level this morning – hard to wake. 2 days of vomiting and abdo pain. 2 months of weight loss, polyuria, polydipsia, polyphagia, enuresis.			
Past Medical History:	NVD at term	Medications: nil regular	Immunisations: up to date.
Allergies: NKDA			
Social History: nil significant			
Family History: nil significant			

Phone Warning followed by Paramedic Handover

Ambulance Comm calls :

"Hi this is ambulance comms. I am calling to inform you that the ambulance service is 5 minutes away with a 5yo boy with altered level of consciousness who we suspect is in DKA – his mother says he weighs 17kg.

Obs; SaO2 99%, RR 60, HR 160, BP 85/60, BSL 34 and GCS 11.
They have inserted 1 x IV line and are enroute."

Paramedic arrival :

I Hi. I'm the paramedic looking after Toby – our 5yo patient. His parent says he weighs 17kg (weighed a few days ago).

M I am concerned he might have DKA.

I Toby has had vomiting and abdominal pain for 2 days. His parent says he thought Toby had gastroenteritis – Toby's sister had it last week. This morning Toby was hard to wake up so they called the ambulance.

S Airway is intact, Breathing seems laboured with RR 60 but normal SaO2 99%, Circulation – HR 160, BP 85/60, Disability; BSL 34, GCS on our arrival was 11 E 2, M 5, V4, He would open his eyes and sound confused after a painful stimulus, Pupils equal and reactive to light.

T I've inserted 1 IVC and brought him to you. Our ambulance protocols don't allow us to give fluid in this situation – check.

A He has no allergies.

M He takes no regular medications.

B He has apparently been a well child before this and is fully immunised.

O His parent is on the way in their car.

Section VI: Scenario Progression

Scenario States

State 1 : Anticipation and Planning

Patient State	Patient Status	Learner Actions, Modifiers & Triggers to Move to Next State	
Pre arrival	Pre-arrival	☒ Role allocation ☒ Call for help – senior medical officer and extra nursing staff if possible called to attend. ☒ Team leader briefs team on expected pathology and priorities for management. ☒ Locate protocol ☒ Draw up fluids ☒ Consider drawing up insulin ☒ Consider if intubation or brain imaging anticipated	Modifiers Triggers 5 minutes or completed tasks

State 2 : Handover and Assessment

Rhythm: NSR **HR:** 160 **BP:** 90/60 **Cap refill**: 3s **RR:** 60 **O_2 SAT**: 99%RA **T:** 37.2 **AVPU** = V **GCS** 13 = E3 M6 V4 **BSL** 34	Intial assessment	☒ ABCD assessment ☒ 2nd IV ☒ Take bloods; FBC, chem 20, VBG, TSH, coeliac screen TTG, Spare tubes for extended testing. ☒ Take history from parent if available	Modifiers If GCS not assessed or team moves to intubate then patient starts talking more and moving more – still mildly confused. History from parent if confederate available. Toby is usually well with no previous medical problems. But they were going to go to their GP this week because he has lost weight – used to be 20kg and now 17kg His parent noticed his clothes were loose even though he eats really well. He also seems to go to the toilet all the time. And has started wetting the bed at night. Triggers 5 minutes or tasks completed

State 3 : Commencing Treatment for DKA			
Rhythm: NSR **HR:** 160 **BP:** 90/60 **Cap refill**: 3s **RR:** 60 **O_2 SAT**: 99%RA **T:** 37.2 **AVPU** = V **GCS** 13 = E3 M6 V4 **BSL** 34	Initial management	☒ Consider a small bolus of fluid 10ml/kg ☒ Start ongoing fluid calculated as maintenance + replacement of losses over 48 hours – according to protocol. ☒ Ensure Potassium in the ongoing fluid ☒ Get advice; protocol or call specialist (retrieval or endocrine) ☒ Make a plan to commence insulin ☒ Organise retrieval/ PICU transfer	<u>Modifiers</u> • If on the wrong track, or have not mentioned a protocol or calling for retrieval or PICU transfer then retrieval consultant or intensive care consultant calls and says that ambulance comms informed them there is a child who might have severe DKA and need a PICU admission and can they help in any way? • If an appropriate DKA protocol not being utilised, expert advises to do internet search for “CHQ DKA Guideline” and access this guideline. • If asked about intubation, the consultant should explore reasons to intubate but steer them away from emergency intubation at this stage due to the currently intact airway and the risks of worsening the acidosis by decreasing the RR. • If asked about 3% saline or mannitol, consultant can reflect back that the GCS seems to be improving and therefore not to give now but to get ready in case needed. Advise patient to sit head up at least 20°.

Section VII: Supporting Documents, Laboratory Results, & Multimedia

Venous Gas : Arrival

VBG	Results	Units	Normal Range
pH	6.96		**7.32 – 7.42**
pCO2	29	mmHg	**41 - 51**
pO2	32	mmHg	**25 - 40**
O2 Saturations	53	%	**40 - 70**
Bicarb	6	mmol/L	**22 - 33**
BE	-27.6	mmol/L	**-3 - +3**
HCT			**0.3 - 0.42**
Hb	173	g/L	**105 - 135**
Na+	149	mmol/L	**135 - 145**
K+	3.8	mmol/L	**3.2 - 4.5**
Ca++ (ionised)	1.4	mmol/L	**1.15 – 1.35**
Glucose	34	mmol/L	**3.0 – 7.8**
Lactate	3.5	mmol/L	**0.7 – 2.5**

Section VIII: Debriefing Guide

Objectives	
Educational Goal:	• Management of Paediatric DKA including provision of fluids and insulin • Recognition and Management of Cerebral Oedema in DKA
Skills Rehearsal:	• Administration of Fluids in DKA • Administration of Insulin in DKA
Systems Assessment:	• Resources on DKA including : ○ Local protocols on investigation, management and disposition Access to specialist services including; Retrieval, PICU, Paediatric Endocrinology

Sample Questions for Debriefing

- What was your differential diagnoses after talking to Ambulance Comms?
- What resources do you have available to help you manage this case? (examples include; protocol, retrieval services on call, specialists on call).
- How did you make your decision regarding how much and what fluid to give this child?
  - What is the risk of a fluid bolus?
  - How do you calculate the rate of ongoing fluid for this child?
- When do you start insulin?
- What can cause an altered mental status in a child with DKA?
  - How do you diagnose cerebral oedema in a child with DKA?
  - How do you manage cerebral oedema in a child with DKA? What if the symptoms are mild as in this case?

Key Moments

- Handover of patient in DKA by paramedic
- Consideration of reasons for altered mental status
- Preparation for managing a child with DKA; protocol, fluids, insulin
- Choice of fluid for resuscitation and rate of administration
- Deciding when to start insulin
- Deciding on disposition; retrieval or transfer to PICU

Ask participants to complete our online survey!

Scan the QR code with their phone camera

Scan me

Paediatric DKA

Basics of Emergency Management

Quantify Acidosis :

Mild	Moderate	Severe
pH 7.2 – 7.3 or HCO_3 < 15	pH 7.1 – 7.2 or HCO_3 < 10	pH < 7.1 or HCO_3 < 5

Assess Hydration :

Acidosis and Tachypnoea can lead to overestimation of fluid deficit.

Replace Fluid Sensibly :

Treat shock with 10mL/kg doses and reassess.
Replacement over 48 hours.
Start with NS 0.9% + 40mmol KCL
- unless anuria or potassium > 5.5
Fluids alone will drop BGL in the first hour

Give Insulin :

Mild DKA : Subcutaneous may be suitable
Mod to Severe. : Infusion rate is 0.1 units/kg/hr
Aim to drop BGL by no more than 5 mmol/L per hour

Monitor for complications :

Cerebral Oedema

Aspiration

Rapid Electrolyte Shift

↓K
↑↓Na

For further detail, scan this QR code with your phone camera to access Children's Health Queensland online DKA guideline

Resources for DKA Simulation Participants

Emergency Medicine Cases Podcast
Episode 63 – Pediatric DKA

Recent evidence on fluids in DKA
ALiEM Podcast w Dr Kuppermann
& Dr Glaser

Children's Health Queensland
DKA guideline

Curriculum

This package is designed for **individuals** to refresh and retain the following skills learned in previous OPTIMUS courses as well as add new knowledge on ….

OPTIMUS CORE	OPTIMUS PRIME	OPTIMUS BONUS
Assessment of the sick child	Management of the deteriorating child	Fluid administration in child with severe DKA.
Assessment of respiratory distress in a child.	Fluid administration in the child in shock	insulin infusion – Prescription and administration
IV access in the unwell child	Organising retrieval in the critically unwell child.	Working with retrieval, PICU and specialist endocrine services in child with DKA.
GCS assessment		

This package is designed to offer your **department** a systems level check regarding :	
Access to paediatric resources on: • Management of Paediatric Diabetic Ketoacidosis • Safe prescription and administration of IV fluids in children	☐ ☐
Equipment Check : • Infusion pumps and guardrails for paediatric insulin infusion	☐
Departmental Protocols for: • Paediatric Diabetic Ketoacidosis • Disposition planning for severe DKA within your service	☐ ☐

If you would like any assistance obtaining access or advice for any of the above issues, please contact stork@health.qld.gov.au

About the Creators :

Dr Sonia Twigg : Primary Author
@LankyTwig
FACEM, MBBS, BA, BSc
Fellow, STORK (Simulation Training Optimising Resuscitation for Kids)
Queensland Children's Hospital

Dr Sonia from STORK is an emergency physician doing subspecialty training in Paediatric Emergency Medicine and works at the Queensland Children's Hospital as a fellow in the emergency department and for the STORK simulation team.
She is part of the ALIEM faculty incubator program for 2019-2020 and facilitated the 2019 Health Workforce Queensland workshops for GPs on Paediatric Emergency Medicine. Sonia is interested in critical care, medical education and ultrasound. She is passionate about fun, creativity and innovation in education.

Dr Ben Symon : Consultant Supervisor, Infographics and Editor
@symon_ben
RACP PEM, MBBS, BAnim
Simulation Consultant and Paediatric Emergency Physician
Queensland Children's Hospital and The Prince Charles Hospital

Dr Symon is a PEM Physician and Simulation enthusiast with a passion for translating clinical and educational research to front line health care workers. He is co-producer of the podcast 'Simulcast' and facilitates the Simulcast Online Journal Club, an online journal club for simulation educators throughout the world. He is faculty on the APLS Educational Skills Development Course and has recently been invited to join as international faculty for the Master Debriefer Course by the Debriefing Academy. His original degree in Animation has proved surprisingly useful in his career in medical education.

About the BONUS Project :

The OPTIMUS BONUS project is a bank of useful scenarios that are open access and available for free use. It has been designed by the Simulation Training Optimising Resuscitation for Kids team for Children's Health Queensland.

We aim to use the packages to provide :

- Spaced repetition to reinforce learning objectives from CORE and PRIME
- Connections to high quality, up to date paediatric resources for health professionals
- Quality and Safety checks for local hospitals regarding paediatric clinical guidelines, resources and equipment

The scenarios have been designed in response to :

- Paediatric coronial investigations in Queensland, Australia.
- Clinical skills issues revealed through In Situ Translational simulations in hospitals throughout Queensland.
- Quality and Safety Initiatives

About STORK

In 2014, Children's Health Queensland funded the 'Simulation Training Optimising Resuscitation for Kids' service. STORK is a paediatric education team focused on improving healthcare outcomes for children throughout the state.

STORK has developed a number of courses aimed at different phases of paediatric critical care :

- CORE is a course for first responders to a paediatric emergency, and teaches recognition of the deteriorating patient, Children's Early Warning Tools, and resuscitation competencies.
- PRIME is a course for mid phase responders who look after unwell patients while awaiting for retrieval or escalation to an Intensive Care. It aims at contextualising Seizure Management, Intubation and Inotrope Administration within host hospital's real clinical environments in order for healthcare teams to generate their own practice improvement strategies as well as link peripheral hospitals with high quality resources.
- BONUS was proposed as a solution to skill and knowledge decay after these courses are run.

If you would like to know more information about STORK or acquire copies of our resources, please contact us at stork@health.qld.gov.au .

Resources for Participants

- Helman, A, Reid, S, Curtis, S. Pediatric DKA. Emergency Medicine Cases. April, 2015. https://emergencymedicinecases.com/pediatric-dka/. Accessed 10/08/19.
- Monette, D. PEM Practice changing paper: Clinical Trial of Fluid Infusion Rates for Pediatric DKA. June 2018. Available at: https://www.aliem.com/2018/06/pem-practice-changing-paper-clinical-trial-fluid-infusion-rates-pediatric-dka/
- Diabetic Ketoacidosis (DKA) and Hyperosmolar Hyperglycemic State (HHS) – Emergency Management in children. Queensland Paediatric Guideline. Children's Health Queensland Hospital and Health Service, June 2019. Available at: https://www.childrens.health.qld.gov.au/guideline-dka-emergency-management-in-children/

References

This educational package has been reviewed by content experts and a Statewide Steering Group Review on behalf of Children's Health Queensland.

1. Kupperman N, Ghetti S, Shunk, J et al, Clinical trial of fluid infusion rates for pediatric DKA. NEJM Jun 2018, 378 (24): 2275-2287.
2. Lawton, B, Sweet and Salty – Fluids in DKA. Don't Forget the Bubbles. 2018. Available at: http://doi.org/10.31440/DFTB.16130
3. Soto-Rivera C, Asaro L, Agus M et al, Suspected cerebral edema in diabetic ketoacidosis: Is there still a role for head CT in treatment decisions. Pediatric Critical Care Medicine. Mar 2017, 18 (3): 207-212.
4. Wolfsdorf J, Glaser N, Agus M et al, ISPAD Clinical Consensus Practice Guidelines 2018: Diabetic ketoacidosis and the hyperosmolar hyperglycemic state. Pediatric Diabetes, Oct 2018, 19 (Suppl. 27): 155-177.
5. The Simulation Template has been adapted from the template from emsimcases.com, available at : https://emsimcases.com/template/