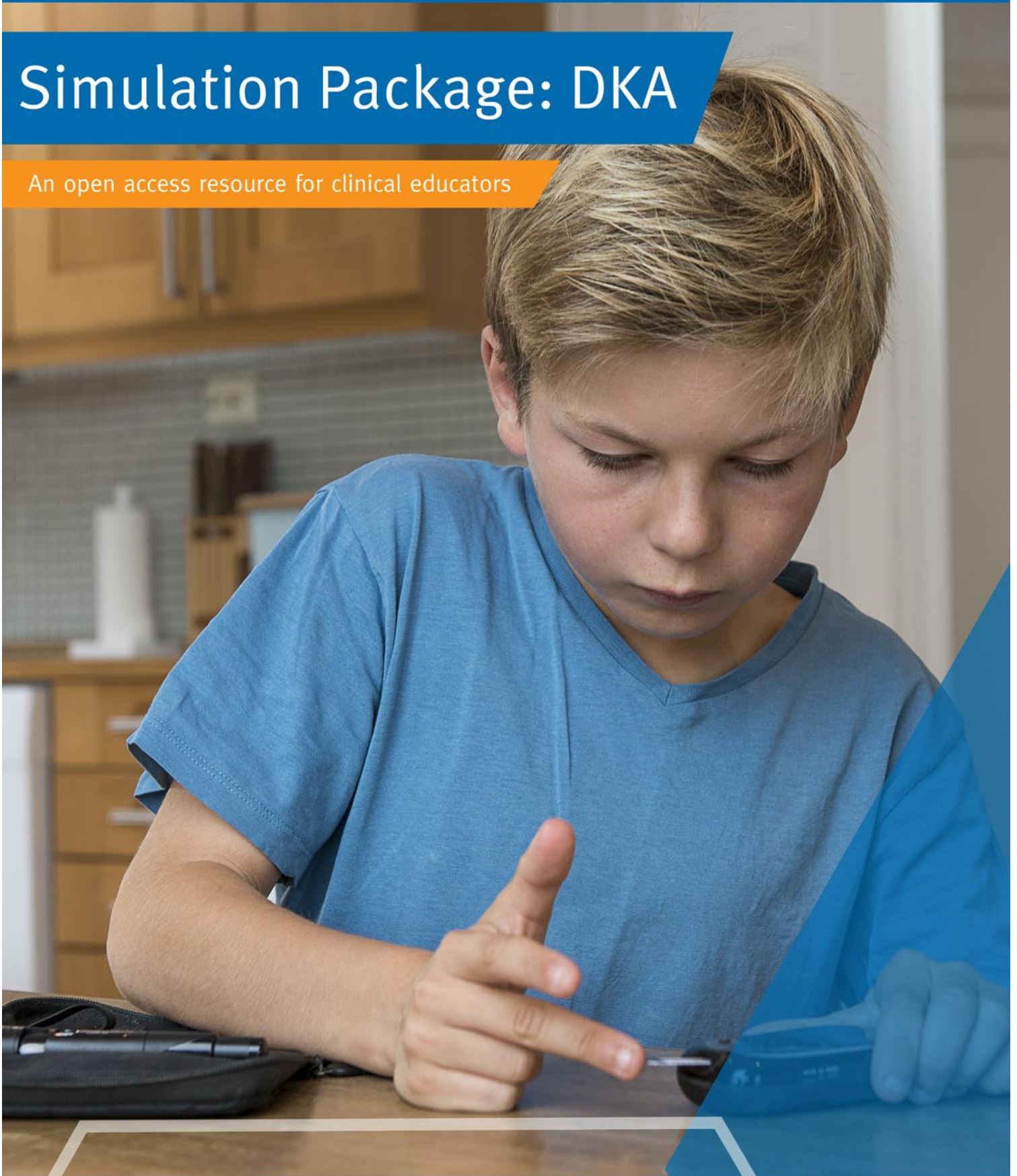


Simulation Package: DKA

An open access resource for clinical educators



Optimus
BONUS



Optimus BONUS

Bank Of iNdependently Useful Simulations

Part of the Children's Health Queensland 'Optimus' curriculum.

Published by the State of Queensland (Queensland Health), January 2026



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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

An electronic version of this document is available at <https://www.childrens.health.qld.gov.au/research/education/queensland-paediatric-emergency-care-education/optimus-bonus/>

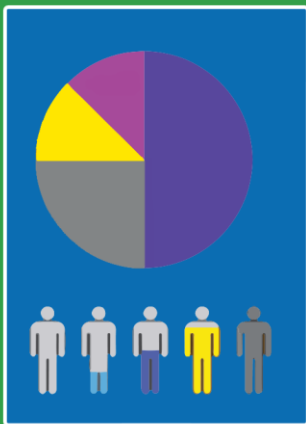
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Contents of this educational package:



Simulation



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

Simulation Introduction by Professor Jerry Wales

Director of Endocrinology at Queensland Children's Hospital DM, MA, BM BCh, MRCP, FRACP, FRCPC, FRACP, DCH



Professor 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
Review Date:	Jan 2025
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, Dr Fiona Brown (2025) update

Section III: Curriculum

Learning Goals & Objectives	
Educational Goal:	<ul style="list-style-type: none"> • Management of Paediatric DKA including provision of fluids and insulin • Recognition and Management of Cerebral Oedema in DKA
Skills Rehearsal:	<ul style="list-style-type: none"> • Administration of Fluids in DKA • Administration of Insulin in DKA
Systems Assessment:	<ul style="list-style-type: none"> • Resources on DKA including : <ul style="list-style-type: none"> ○ 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 with altered consciousness today.
 - 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.

Simulation Adaptations

Simulation modality – Manikin vs VEMS

This scenario works well as a VEMS tabletop exercise with laminated equipment and patient. More information regarding VEMS as a simulation format can be found [here](#).

This simulation can also be run with a manikin. Equipment for both modalities are listed below.

Simulation and debrief vs. Pause and discuss

- This simulation can be **run from start to finish** with facilitators moving through different stages depending upon learner's actions, with a group **debrief at the end**. Example debriefing questions are outlined at the end of the scenario.
- This simulation can also be run as a '**pause and discuss**' sim, whereby the facilitators pause the sim at specified points (at the end of each phase) and discuss learning points or highlight examples of good communication and appropriate clinical management. If learners are struggling, this is also an opportunity to scaffold their learning and offer advice as to next steps for when the sim is recommenced.

Adapting to your clinical environment

- Please adapt this scenario for use in your clinical area
- If you are in a regional area, PICU advice could be changed to retrievals advice

Section IV: Equipment and Staffing

Scenario Cast							
Patient:	<input type="checkbox"/> Mannequin or Printed laminate						
Clinical Expert Over the phone.	<p>Paediatric Retrieval Consultant, Paediatric Endocrinologist or General Paediatrician.</p> <ul style="list-style-type: none"> • Recommends team using the Paediatric DKA guideline utilised by your service <ul style="list-style-type: none"> • 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 <p>Expert is helpful and available to the team.</p> <ul style="list-style-type: none"> • Can guide the team through the scenario if needed. 						
Confederate 1:	Paramedic						
Confederate 2: If available	<p>Parent.</p> <p>Calm, caring, cooperative. Gives extra history re background.</p>						
Required Monitors (physical or laminated)							
<input type="checkbox"/> ECG leads				<input type="checkbox"/> Temp probes			
<input type="checkbox"/> NIBP cuff							
<input type="checkbox"/> Pulse oximeter							
Required Equipment (physical or laminated)							
<input type="checkbox"/> Gloves		<input type="checkbox"/> Nasal prongs		<input type="checkbox"/> LMA			
<input type="checkbox"/> Stethoscope		<input type="checkbox"/> Hudson mask		<input type="checkbox"/> Cannulation equipment			
<input type="checkbox"/> IV bags/ lines		<input type="checkbox"/> Non-rebreather mask		<input type="checkbox"/> Blood test tubes and VBG syringe			
<input type="checkbox"/> IV medications		<input type="checkbox"/> Laryngoscope		<input type="checkbox"/> Glucometer/ketone meter			
<input type="checkbox"/> Infusion pump x 2		<input type="checkbox"/> Endotracheal tubes		<input type="checkbox"/> Role stickers			
Extra equipment if running VEMS							
Whiteboard markers							
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

Section V : Scripts

Ambulance service pre-alert



"Hi this is ambulance comms. I am calling to inform you that an ambulance is 5 minutes away with a 5 year old boy with vomiting and abdominal pain and reduced level of consciousness.

They are working on a weight of 17kg

Obs; SaO2 99%, RR 60, HR 160, BP 85/60, Temp 37, CRT 3 secs, BSL HI and GCS 11.

They have inserted 1 x IV line and are enroute."

Paramedic Handover on arrival of patient



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

- Toby is a previously well child with no past medical history.
- His parents called the ambulance as Toby looked pale and was hard to wake up this morning.
- He has had vomiting and abdominal pain for 2 days. His parent says he thought Toby had gastroenteritis – Toby's sister had it last week.

Observations: Airway patent, Breathing seems laboured with RR 60 but normal SaO2 99% on room air, HR 160, BP 85/60, 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.

- I've inserted one IV cannula and brought him to you. Our glucometer reads High and we don't carry a ketone meter. Our ambulance protocols don't allow us to give fluid in this situation.
- His parents are following on in the car.

History from parent

Please play the role of the parent without leaning into stereotypes. You are a supportive, capable parent who is concerned but interacts with staff appropriately. Please adjust the responses according to interactions with staff.



Hi, I am Toby's dad.

Toby is usually well with no previous medical problems and no allergies. Immunisations are up to date.

He started complaining of abdominal pain a couple of days ago and then has been vomiting this morning. His sister had gastro from daycare last week so I thought Toby must have the same. He has not had any diarrhoea or fevers at home. We have not travelled anywhere recently.

This morning he looked really pale and was hard to wake up, so I called the ambulance.

Over the last couple of weeks I have noticed that he needs the toilet all the time and he has had a few accidents at night.

He has also lost some weight – he was 20kg last month and is now only 17kg but he has been eating as normal and always seems to be thirsty.

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	<input checked="" type="checkbox"/> Prepare for arrival of patient	<u>Pause and discuss moments: [optional]</u> <ul style="list-style-type: none"> How did team role allocate? Team pre-briefing and shared vision/mental model Preparation of equipment and resources – consider how to optimise preparation in real clinical environment



“Hi this is ambulance comms. I am calling to inform you that an ambulance is 5 minutes away with a 5 year old boy with vomiting and abdominal pain and reduced level of consciousness. They are working on a weight of 17kg

Obs; SaO2 99%, RR 60, HR 160, BP 85/60, Temp 37, CRT 3 secs, BSL HI and GCS 11.
They have inserted 1 x IV line and are enroute.”

State 2 : Handover and Assessment

Rhythm: NSR HR: 160 BP: 90/60 Cap refill: 3s RR: 54, deep O₂ SAT: 99%RA T: 37.2 AVPU = V GCS 13 = E3 M6 V4 BSL 34, ketones 6.9	Airway: Patent Breathing: Clear chest with deep breathing (Kussmal) Circulation: Pale, cool peripheries, pulses present Disability/Exposure: Pale, no rashes, only responding to voice PEARL	<input checked="" type="checkbox"/> Structured assessment <input checked="" type="checkbox"/> 2 nd IV access <input checked="" type="checkbox"/> Take bloods; FBC, chem 20, VBG, Consider TSH, coeliac screen TTG, Spare tubes for extended testing. <input checked="" type="checkbox"/> Collateral history from parent if available	<u>Pause and discuss moments: [optional]</u> <ul style="list-style-type: none"> Highlight positive communication between team – consider closed loop, use of names Observe for use of recaps and explore the benefits of these Primary survey – ensuring prompt assessment and initiation of management Consideration of differential diagnoses, including gastroenteritis, sepsis, acute abdomen and identify cognitive biases
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State 3 : Commencing Treatment for DKA

Rhythm: NSR
HR: 160 -> 140 post fluid
BP: 88/55
Cap refill: 2s (after fluid bolus)
RR: 54
O₂ SAT: 99%RA
T: 37.2
AVPU = V but becoming more alert and responding to questions after initial management
GCS 14 = E3 M6 V5
BSL 34, ketones 6.9

Airway: Patent
Breathing: Air entry bilaterally, no recession but deep breathing (Kussmal)
Circulation: Pale, cool peripheries, pulses present
Disability/Exposure: Pale, no rashes, only responding to voice
PEARL

- ☒ Identify DKA
- ☒ Treat shock with fluid boluses
- ☒ Start ongoing fluids
- ☒ Get advice; protocol or call specialist (retrieval or endocrine)
- ☒ Draw up insulin – but only commence after 1 hour fluids
- ☒ Organise retrieval/ PICU transfer

Scenario ends after initial management instigated and ongoing maintenance fluid calculated (using online calculator) or after PICU/endocrine/retrieval referral.

Pause and discuss moments [optional]

- Explore how team stores and accesses paediatric clinic guideline (printed vs online)
- Encourage use of QPEC DKA guideline and CREDD book
- Highlight DKA fluid calculator as part of guideline
- Discussion of potential complications including cerebral oedema
- Patient disposition – PICU (or retrieval to PICU). Use of retrieval checklist.

Advice from Intensive Care if called



Hi, this isfrom PICU (or retrievals). How can I help?

(Listen to phone call and provide supportive, considerate advice regarding treating shock and delaying insulin until 1 hour post initiation of fluids)

It sounds like this patient needs to come to PICU for ongoing management. I will liaise with endocrine team also and we will sort a bed/retrieval ASAP.

If asked about 3% saline or mannitol - reflect back that the GCS seems to be improving and therefore not to give now but can be considered if GCS worsens. Advise to sit head up 20 degrees to help prevent aspiration

Section VII: Supporting Documents, Laboratory Results, & Multimedia

Venous Gas : Arrival

VBG	Results	Units	Normal Range
pH	6.96		7.32 – 7.42
pCO ₂	19	mmHg	41 - 51
pO ₂	32	mmHg	25 - 40
O ₂ Saturations	53	%	40 - 70
Bicarb	6	mmol/L	22 - 33
BE	-27.6	mmol/L	-3 - +3
HCT	0.55		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:	<ul style="list-style-type: none"> • Management of Paediatric DKA including provision of fluids and insulin • Recognition and Management of Cerebral Oedema in DKA
Skills Rehearsal:	<ul style="list-style-type: none"> • Administration of Fluids in DKA • Administration of Insulin in DKA
Systems Assessment:	<ul style="list-style-type: none"> • Resources on DKA including : <ul style="list-style-type: none"> ○ Local protocols on investigation, management and disposition ○ Access to specialist services including; Retrieval, PICU, Paediatric Endocrinology

Sample Questions for Debriefing

- What were 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

Paediatric DKA

Basics of Emergency Management

Quantify Acidosis :



Mild
pH 7.2 – 7.3
or $\text{HCO}_3^- < 15$

Moderate
pH 7.1 – 7.2
or $\text{HCO}_3^- < 10$

Severe
pH < 7.1
or $\text{HCO}_3^- < 5$

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



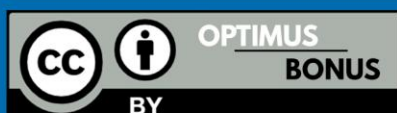
Aspiration



Rapid Electrolyte Shift



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



Diagnostic Report of In Situ Simulation

Simulation can provide important data about unrecognised latent safety threats within your service.

This form is provided to prompt recording of any Quality and Safety / Systems issues that need escalation within your department.

It is **not** to be used as a recording of personal performance management or to violate candidates' confidentiality.

Category	Issue identified	Action recommended	Should be escalated to	Follow up date
Team				
Environment				
System				

Simulation Occurred on

Follow up date re : identified issues on

Resources for DKA Simulation Participants



Fluids in DKA – Elliot Long



Children's Health Queensland
DKA guideline



DFTB DKA Case study

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
<ul style="list-style-type: none"> Assessment of the sick child Assessment of respiratory distress in a child. IV access in the unwell child GCS assessment 	<ul style="list-style-type: none"> Fluid administration in shock Organising retrieval in the critically unwell child 	<ul style="list-style-type: none"> Fluid administration in child with severe DKA. insulin infusion – Prescription and administration Working with retrieval, PICU and specialist endocrine services in child with DKA.

This package is designed to offer your **department** a systems level check regarding :

Access to paediatric resources on: <ul style="list-style-type: none"> Management of Paediatric Diabetic Ketoacidosis Safe prescription and administration of IV fluids in children 	<input type="checkbox"/> <input type="checkbox"/>
Equipment Check : <ul style="list-style-type: none"> Infusion pumps and guardrails for paediatric insulin infusion 	<input type="checkbox"/>
Departmental Protocols for: <ul style="list-style-type: none"> Paediatric Diabetic Ketoacidosis Disposition planning for severe DKA within your service 	<input type="checkbox"/> <input type="checkbox"/>

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. 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 .

References

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

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