Diabetic Ketoacidosis SIM Case

Section 1: Case Summary

Scenario Title:	Diabetic Ketoacidosis
Keywords:	DKA, hyperkalemia
Brief Description of Case:	22-year-old male patient with poorly controlled T1DM presented with DKA. He independently walked into the triage complaining of nausea, vomiting and general malaise. Case occurred in a rural community (Dawson Creek) where the hospital was staffed by one resident and two nurses in house. Lab and X-ray were available on a call-in basis. Staff physician is at home, 10 mins drive away and has decided to let you 'run the department' tonight. A RTVS physician was called to support the case virtually.

Goals and Objectives	
Educational Goal:	Use RTVS support in the management of DKA
Objectives: (Medical and CRM)	1. Develop an approach to DKA 2. Practice peer to peer support with RTVS-RUDI
EPAs Assessed:	Effective communication skills and leadership

Learners, Setting and Personnel				
Target Learners:	☒ Junior Learners	☒ Senior Learners	☐ Staff	
	☐ Physicians	☐ Nurses	☐ RTs	☐ Inter-professional
	☐ Other Learners:			
Location:	☒ Sim Lab	☐ In Situ	☐ Other:	
Recommended Number of Facilitators:	Instructors:			
	Sim Actors:			
	Sim Techs:			

Scenario Development	
Date of Development:	Jun 2021
Scenario Developer(s):	Rachel Chen
Affiliations/Institutions(s):	UBC/UHNBC
Contact E-mail:	
Last Revision Date:	Nov 26, 2023
Revised By:	Dr Jeanne Macleod
Version Number:	

Section 2A: Initial Patient Information

A. Patient Chart					
Patient Name: Steven			Age:22	Gender: M	Weight: 65 kg
Presenting complaint: nausea, vomiting, feeling unwell					
Temp: 36.7	HR: 127 regular	BP: 123/69	RR: 22	O_2Sat: 100%	FiO_2:
Cap glucose: 30.9			GCS: (E V M) 15		
Triage note: Walked in the ED by self. Has been feeling unwell for past few days. Developed nausea and vomiting overnight. One day history of fatigue, nausea and abdominal generalized pain. No fever or chills. Given that it's just you and one nurse in house. Your preceptor is 20 minutes away; you decide to reach out to RTVS physician network for support.					
Allergies: NKDA					
Past Medical History: 1. T1DM 2. Hx of seizure disorder.			Current Medications: 1. Basaglar 15 units subcu b.i.d. 2. Insulin humalog 4 unites subcu t.i.d. 3. Levetiracetam 1000 mg p.o. b.i.d.		

Section 2B: Extra Patient Information

A. Further History
Include any relevant history not included in triage note above. What information will only be given to learners if they ask? Who will provide this information (mannequin's voice, sim actors, SP, etc.)? Patient admits to missed insulin injections before presenting to ED. Patient has fluctuating blood glucose level between 10 to 22 on average. He has a fear of hypoglycemia as it was associated with seizure activities in the past so he tends not to take his insulin regularly. He has had DKAs in the past in which he developed profuse nausea and vomiting. He thinks he's in DKA again because of the similar symptoms. Apart from some visual blurriness, he otherwise feels himself. There has not been any recent illness or fever.

B. Physical Exam	
List any pertinent positive and negative findings	
Cardio: tachycardic at 120s. Regular rhythm. Normal S1/S2.	Neuro: alert and orient x 3. GCS 15
Resp: tachypenic at RR of 30 with bilateral clear air entry on auscultation.	Head & Neck: Dry oral mucosa with a distinct sweet and fruity breath odor.
Abdo: abdomen is soft and diffusely tender to palpation.	MSK/skin: no diabetic foot ulcer

Section 3: Technical Requirements/Room Vision

A. Patient
☒ Mannequin *(specify type and whether infant/child/adult)*
☐ Standardized Patient
☐ Task Trainer
☐ Hybrid
B. Special Equipment Required
C. Required Medications
1. Insulin Infusion 2. IV Saline
D. Moulage
Young adult male, dressed in casual clothing. Appears well.
E. Monitors at Case Onset
☐ Patient on monitor with vitals displayed ☒ Patient not yet on monitor
F. Patient Reactions and Exam
Shallow rapid breathing. Sweet fruity breaths. *Mild diffuse abdominal pain on palpation.*

Section 5: Scenario Progression

Scenario States, Modifiers and Triggers				
Patient State/Vitals	Patient Status	Learner Actions, Modifiers & Triggers to Move to Next State		Facilitator Notes
1. Baseline State Rhythm: regular HR: 127 BP: 123/69 RR: 30 O_2SAT: 100% T: 37.7°C GCS: 15	A/O x3. Appeared UNwell. C/o of mild visual blurriness and stomach pain- in the epigastric area. Looks Pale When patient speaks, he reeks a strong fruity sweet odor. Also noted to be tachypneic.	<u>Expected Learner Actions</u> ☐ Call RTVS – RUDI Doc. ☐ Alert preceptor and call in additional nursing staff. ☐ focused history and thorough physical exam ECG **Diffuse abdominal tenderness** ☐ monitor, full vitals ☐ NOTE ☐ TACHYPNEA!! ☐ CBGM check ☐ urine dip ☐ 2 large bore IVs IV fluid bolus + IV insulin	<u>Modifiers</u> - IV fluid -> HR drops to 110 - CBGM -> nurse notifies a reading > 30 - urine dip -> + + ketones - ECG <u>Triggers</u> - Starts to have ++ vomiting and worsening abdominal pain, becomes pale and clammy.	Lab technician on the way. Labs temporarily unavailable. Currently available labs: CBGM and urine ketones, both are significantly elevated. Ask if patient is taking ASA? Consider UGI Bleed Hx of ETOH/Liver disease? Melena?
2. Deterioration Rhythm: Sinus tachycardia HR: 150/min BP: quickly drops to 70/50 RR: 34 O_2SAT: 99% T: 37.5°C	Patient vomits. **Complaining of abdominal pain** GCS 12 E3V4M5	<u>Expected Learner Actions</u> ☐ recovery position. ☐ elevate head of bed, suction ☐ re-evaluate GCS and repeat ☐ glucose ☐ labs (CBC, E10, VGB, lactate, serum ketones, osmols) ?Blood cultures ?LFT, Lipase? Urine Culture ASA level?	<u>Modifiers</u> -	RUDi Physician please guide the case if learner asks for help Provide antiemetics: Ondansetron 8mg IV or Gravol 50mg IV. Morphine 2.5- 5mg IV q 10 min prn for pain.

3.Managing DKA BP improves with 2 litre fluid bolus to 100/80. HR decreases to 110, remains afebrile	GCS 14	<u>Expected Learner Actions</u> ☐ Locates pre printed orders on ☐ hospital system for DKA ☐ management.	<u>Modifiers</u> - labs-> Increased Anion Gap metabolic acidosis, K =5.6	If not already done- finish secondary survey and look for triggers of DKA- ischemia/infection/overdose- order CXR, follow up labs ?Can salicylate level be ordered? Review Increased Anion Gap Metabolic Acidosis: Methanol Uremia DKA Propylene Glycol INH Lactic Acidosis Ethylene Glycol Salicylates Methanol (still always good to do a quick review and avoid anchoring just on DKA)

4.Managing Hyperglycemia		☐ Refer to pre printed orders (see attached Interior Health Orders)	Note according to algorithm start IV Insulin 0.1 Units/kg/hour but initially withhold K in fluids since > 5.5. Repeat lytes in one hour and then once K< 5.0 add K to Iv Fluids.	
4. Reassess prior to transfer Rhythm: Sinus HR: 90 /min BP: 105/60 RR: BVM O_2SAT: 99% T: 36.5^{o}C	GCS 15	Expected Learner Actions ☐ repeat ECG ☐ call for transfer to higher level of care ☐ ☐ ☐	Look for signs of infection Can blood cultures be drawn? Urine cultures? Order Chest X-ray ?abdominal x-ray (looking for perforated viscus) Give broad spectrum Antibiotics- Ceftriaxone IV. Follow algorithm for checking glucose/VBG and lytes. PTN answers the call -> end of case	

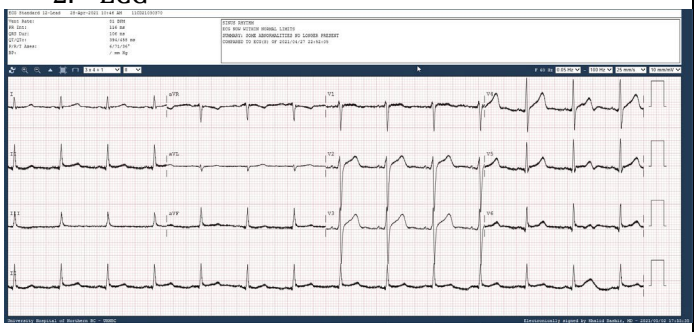
Appendix A: Laboratory Results

CBC WBC 35.7 Hgb 149 Plt 497 Lytes Na 125 K 5.6 Cl 71 HCO3 17 AG 32 Urea 10.4 Cr 132 Glucose 46 Extended Lytes Ca 2.8 Mg 0.77 PO_4 2.94 Albumin 53 TSH N/A VBG pH 7.1 pCO_2 15 pO_2 97 HCO_3 14 Lactate 12.6	Cardiac/Coags Trop N/A D-dimer N/A INR N/A aPTT N/A Biliary AST 516 ALT 94 GGT 130 ALP 128 Bili 5 Lipase 66 Tox N/A EtOH ASA Tylenol Dig level Osmols Other A1C 10.2 Urine ++ ketones COVID swab negative

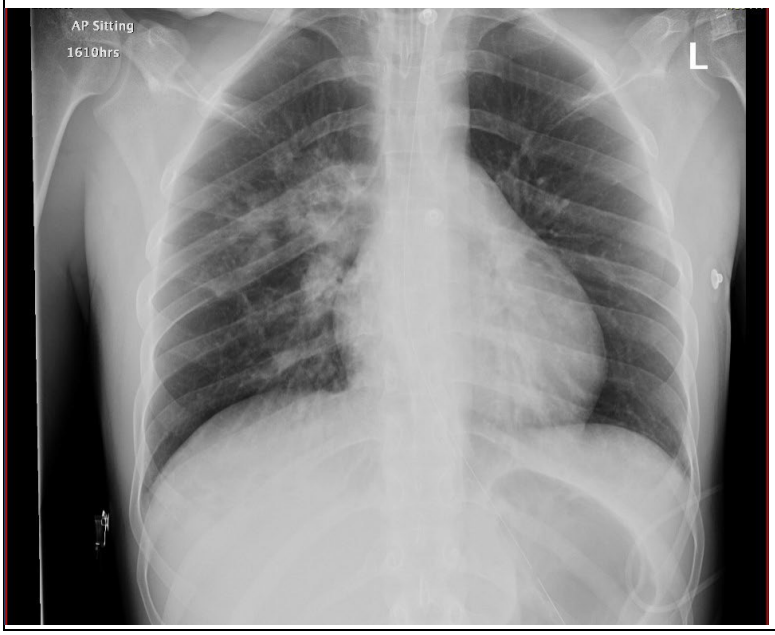
Appendix B: ECGs, X-rays, Ultrasounds and Pictures

Paste in any auxiliary files required for running the session. Don't forget to include their source so you can find them later!

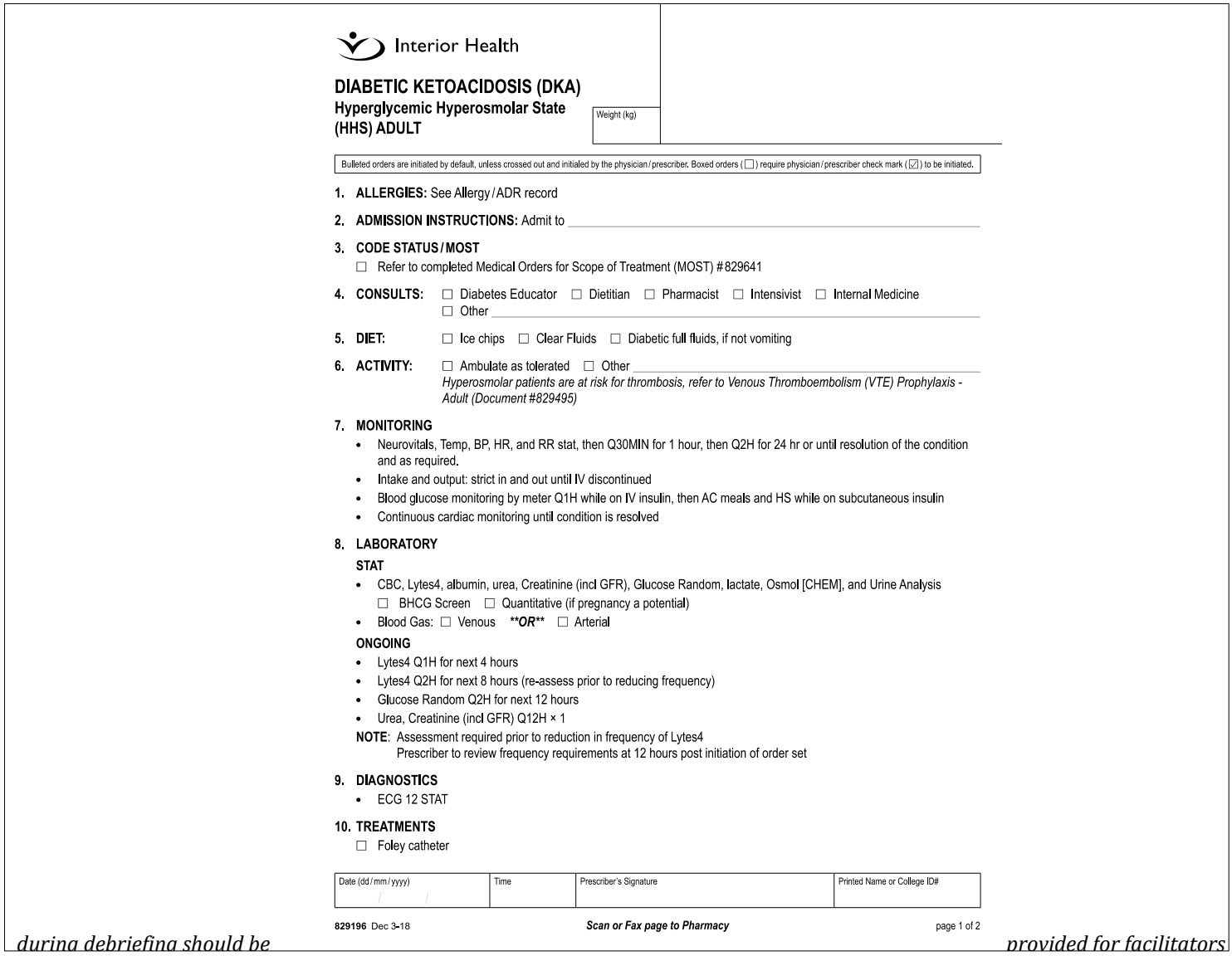
2. ECG



3. CXR



Appendix C: Facilitator Cheat Sheet & Debriefing Tips



Interior Health

DIABETIC KETOACIDOSIS (DKA)
Hyperglycemic Hyperosmolar State (HHS) ADULT

Weight (kg)

Bulleted orders are initiated by default, unless crossed out and initialed by the physician/prescriber. Boxed orders (☐) require physician/prescriber check mark (☑) to be initiated.

1. **ALLERGIES:** See Allergy/ADR record
2. **ADMISSION INSTRUCTIONS:** Admit to _____
3. **CODE STATUS/MOST**
   ☐ Refer to completed Medical Orders for Scope of Treatment (MOST) #829641
4. **CONSULTS:** ☐ Diabetes Educator ☐ Dietitian ☐ Pharmacist ☐ Intensivist ☐ Internal Medicine
   ☐ Other _____
5. **DIET:** ☐ Ice chips ☐ Clear Fluids ☐ Diabetic full fluids, if not vomiting
6. **ACTIVITY:** ☐ Ambulate as tolerated ☐ Other _____
   Hyperosmolar patients are at risk for thrombosis, refer to Venous Thromboembolism (VTE) Prophylaxis - Adult (Document #829495)
7. **MONITORING**
   - Neurovitals, Temp, BP, HR, and RR stat, then Q30MIN for 1 hour, then Q2H for 24 hr or until resolution of the condition and as required.
   - Intake and output: strict in and out until IV discontinued
   - Blood glucose monitoring by meter Q1H while on IV insulin, then AC meals and HS while on subcutaneous insulin
   - Continuous cardiac monitoring until condition is resolved
8. **LABORATORY**
   STAT
   - CBC, Lytes4, albumin, urea, Creatinine (incl GFR), Glucose Random, lactate, Osmol [CHEM], and Urine Analysis
     ☐ BHCG Screen ☐ Quantitative (if pregnancy a potential)
   - Blood Gas: ☐ Venous ***OR*** ☐ Arterial

   ONGOING
   - Lytes4 Q1H for next 4 hours
   - Lytes4 Q2H for next 8 hours (re-assess prior to reducing frequency)
   - Glucose Random Q2H for next 12 hours
   - Urea, Creatinine (incl GFR) Q12H × 1

   NOTE: Assessment required prior to reduction in frequency of Lytes4
   Prescriber to review frequency requirements at 12 hours post initiation of order set
9. **DIAGNOSTICS**
   - ECG 12 STAT
10. **TREATMENTS**
    ☐ Foley catheter

Date (dd/mm/yyyy)	Time	Prescriber's Signature	Printed Name or College ID#
/ /			

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during debriefing should be provided for facilitators

References

1.
2.
3.

Interior Health

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   - Blood glucose monitoring by meter Q1H while on IV insulin, then AC meals and HS while on subcutaneous insulin
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8. **LABORATORY**

   STAT
   - CBC, Lytes4, albumin, urea, Creatinine (incl GFR), Glucose Random, lactate, Osmol [CHEM], and Urine Analysis
     ☐ BHCG Screen ☐ Quantitative (if pregnancy a potential)
   - Blood Gas: ☐ Venous ***OR**** ☐ Arterial

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   - Lytes4 Q1H for next 4 hours
   - Lytes4 Q2H for next 8 hours (re-assess prior to reducing frequency)
   - Glucose Random Q2H for next 12 hours
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   NOTE: Assessment required prior to reduction in frequency of Lytes4
   Prescriber to review frequency requirements at 12 hours post initiation of order set

9. **DIAGNOSTICS**
   - ECG 12 STAT

10. **TREATMENTS**
    - ☐ Foley catheter

Date (dd/mm/yyyy)	Time	Prescriber's Signature	Printed Name or College ID#
/ /			

Canadian Diabetes Association Clinical Practice Guidelines (2018)
DKA Emergencies in Adults

J. Goguen, J. Gilbert / Can J Diabetes 42 (2018) S109–S114

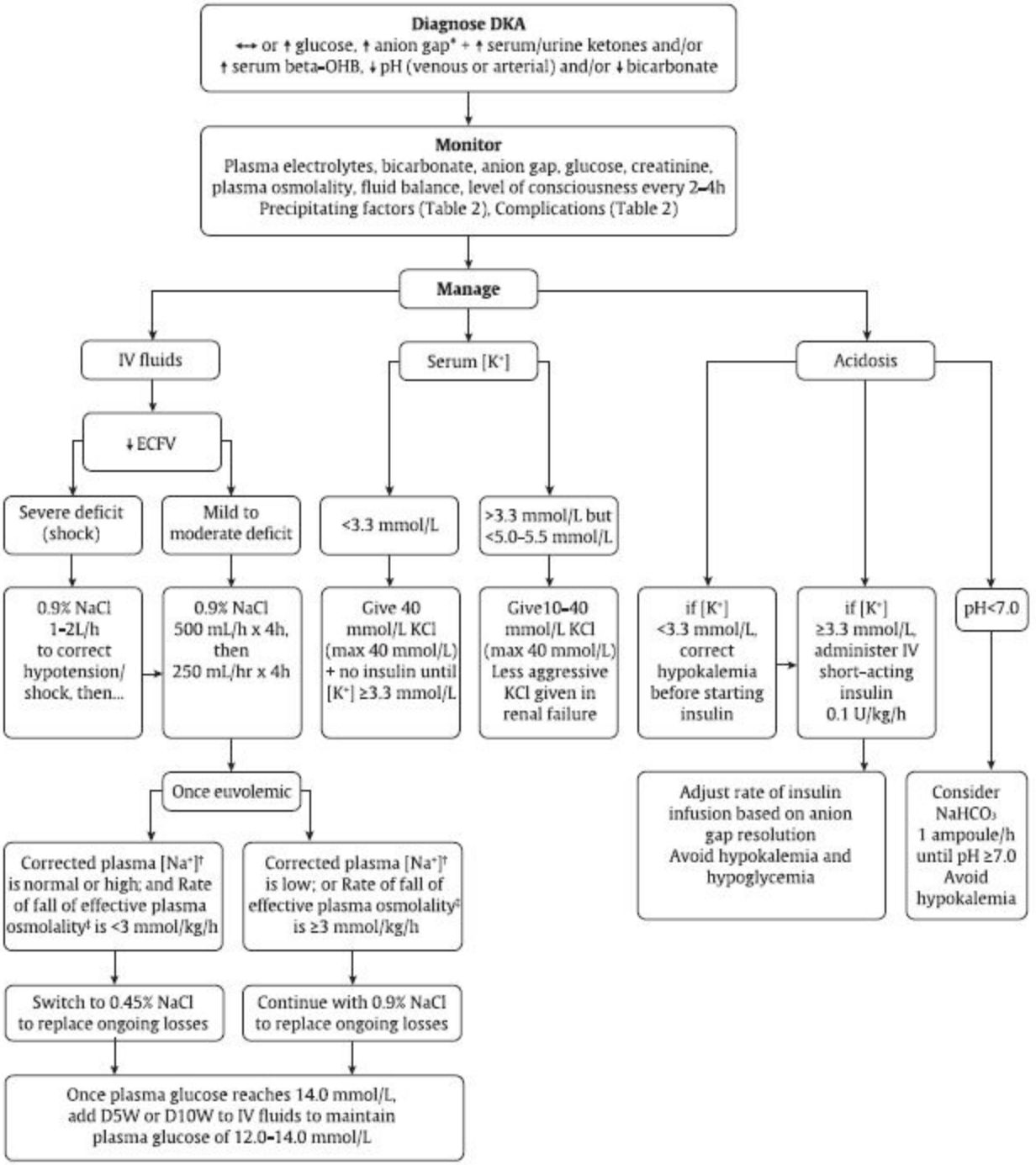

Figure 1. Management of diabetic ketoacidosis in adults.
Beta-OHB, beta-hydroxybutyric acid; *DKA*, diabetic ketoacidosis; *ECFV*, extracelluar fluid volume; *IV*, intravenous.
*Plasma glucose may be lower than expected in some settings.
**Anion gap = plasma [Na+] – plasma [Cl^-] – plasma [HCO_3^-].
†Corrected plasma [Na+] = measured [Na+] + 3/10 × ([plasma glucose (mmol/L)] – 5).
‡Effective plasma osmolality = [Na+] × 2 + [plasma glucose (mmol/L)], reported as mmol/kg.

Interior Health

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Hyperglycemic Hyperosmolar State (HHS) ADULT

Weight (kg)

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11. INTRAVENOUS THERAPY AND HYDRATION (IV)

☐ **Severe Fluid Deficit (SHOCK)**

- sodium chloride 0.9% IV at 2 L/hr in first hour, OR _____ L/hr in first hour, THEN
  sodium chloride 0.9% IV at 500 mL/hr for 4 hours, then 250 mL/hr for 4 hours

OR

☐ **Mild to Moderate Fluid Deficit**

- sodium chloride 0.9% IV at 500 mL/hr for 4 hours, THEN 250 mL/hr for 4 hours

When Hydration complete, notify physician for maintenance IV therapy

12. MEDICATIONS

Potassium chloride (KCL)

☐ **potassium chloride (KCl) 40 mmol (= 40 mEq) by minibag IV over 4 hours**
(if central line, may infuse over 2 hours) **PRN** for serum K+ less than 3.3 mmol/L

☐ **potassium chloride (KCl) 20 mmol (= 20 mEq) by minibag IV over 2 hours**
(if central line, may infuse over 1 hour) **PRN** for serum K+ 3.3 to 4.9 mmol/L

- **HOLD** potassium chloride (KCL) for serum K+ greater than 5 mmol/L or if urine output is not documented
- Total K+ from all IVs not to exceed 20 mEq/hr per peripheral line or 40 mEq/hr per central line

Insulin Human (Regular) Infusion

- insulin human regular _____ units/H IV
  (start infusion at 0.1 units/kg/H × _____ kg = _____ units/H, rounding off to whole unit)
  (Minibag – 100 units insulin in 100 mL NS or Syringe – 50 units insulin in 50 mL NS = final concentration 1 unit/mL)

Insulin Infusion Titration Table	
Blood Glucose (target 12 – 14 mmol/L)	**Insulin Infusion** (Do not decrease insulin infusion to zero until DKA is resolved and physician order is received)
Blood Glucose greater than 14 mmo/L	0.1 units/kg/H
Blood Glucose drops by 4.1 mmol/L to 6 mmol/L in one hour	Decrease insulin infusion by 50%
Blood Glucose drops by 6.1 mmol/L or greater in one hour	Decrease insulin infusion by 50% and call prescriber
Blood Glucose 12 mmol/L – 14 mmol/L	Call prescriber for orders to add dextrose and reduce insulin infusion
Potassium (K+)	
Serum potassium (K+) is less than 3.3 mmol/L	**HOLD** insulin infusion and correct hypokalemia *(see above)*
Anion Gap	
If anion gap is greater than 12 and does not decrease over two hours	Call prescriber
If anion gap is greater than 12 and decreasing	Titrate insulin as outlined above

Date (dd/mm/yyyy)	Time	Prescriber's Signature	Printed Name or College ID#
/ /			

ADULT DIABETIC KETOACIDOSIS (DKA) PROTOCOL
AND THE HYPERGLYCEMIC HYPEROSMOLAR STATE (HHS)
Adult = 18 years of age and older

Laboratory Diagnostic Criteria for DKA and HHS			
Parameter	Normal Range	DKA	HHS
Plasma Glucose (mmol/L)	4.2 to 6.4	Greater than or equal to 14*	Greater than or equal to 34
Arterial pH‡	7.35 to 7.45	Less than or equal to 7.30	Greater than 7.30
Serum Bicarbonate (mmol/L)	22 to 28	Less than or equal to 15	Greater than 15
Effective serum osmolality (mmol/kg) [Na+] x 2 + [Glucose (mmol/L)]† + [Urea (mmol/L)]	275 to 295	Less than or equal to 320	Greater than 320
Anion Gap = plasma [Na+] – plasma [Cl-] – plasma [HCO_3-]†	Less than 12	Greater than 12	Variable
Serum Ketones	Negative	Moderate to high	None or trace
Urine Ketones	Negative	Moderate to high	None or trace

Reference: Adapted from CMAJ April 1, 2003; 168(7):859-866

* Rare but possible DKA without elevated glucose in the case of starvation, pregnancy or use of SGLT2i (Sodium Glucose c0-transporter inhibitors)

‡ If venous pH is used, a correction of 0.03 must be made.

† From Canadian Diabetes Association 2008 Clinical Practice Guidelines. May 2010. pS66-S76

Resolution of Condition and Parameters to Switch to Subcutaneous Insulin:

Resolution of DKA and HHS

Glucose less than 13 mmol/L, normalized level of consciousness, tolerating oral intake and all of the following:

- Sodium bicarbonate greater than 18 mmol/L
- Anion gap less than 12
- Venous pH greater than 7.3

Switching to SC insulin

Start patient on both basal and bolus insulin, or restart insulin pump. Refer to documents below, depending on whether the patient is eating or needs to be NPO for tests or surgery.

- Insulin Subcutaneous Adult – NPO Acute Care: Document #829524
- Insulin Subcutaneous Adult – Eating Acute Care: Document #829523
- Insulin Pump Management in Emergency and Acute Care Order: Document #826387

Sodium Bicarbonate Guideline:

Consider if pH less than 7 after 1 hour of hydration and patient in shock. May cause hypokalemia.
Write order for: sodium bicarbonate 50 mEq in 1 L sodium chloride 0.45% IV over 1 hour.

Guidelines for Maintenance Intravenous Therapy and Suggested Template for Writing an Order

When fluid hydration (see section 11) is complete, physician provides direction to move to maintenance IV therapy

- For corrected plasma sodium (Na+) less than or equal to 145 mmol/L:
  Sodium chloride 0.9% at _____ mL/hr, include KCL as required
- For corrected plasma sodium (Na+) greater than 145 mmol/L:
  Sodium chloride 0.45% at _____ mL/hr, include KCL as required
- When BG less than 14 mmol/L change maintenance to the following:
  - D5W + sodium chloride 0.9% at _____ mL/hr, include KCL as required, ***OR***
  - D5W + sodium chloride 0.45% at _____ mL/hr, include KCL as required