Pediatric Diabetic Ketoacidosis

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2015

MEMORIAL

Outline and Objectives

- **Review pediatric diabetic ketoacidosis**
  - recognition
  - management

- **Update on NLdkaP**

Johnnie

- 2 ½ year old boy
- Presented to ER with 2 week history of **polyuria, polydipsia, & weight loss**
- **Irritable, vomiting, rapid breathing**
- Previously healthy

Johnnie

- Diagnosed with a "viral infection"
  - …no fever
- Vomiting
  - …no diarrhea
- Rapid breathing
  - …no lung findings
- Very thirsty
  - ….lots of wet diapers

Johnnie

- Physical exam:
  - lethargic
  - Moderately dehydrated
  - Tachycardia, tachypnea
  - Afebrile
  - Abdominal pain

- Lab Data:
  - glucose 32.7
  - Blood gas:
    - metabolic acidosis
  - Urinalysis:
    - +++glucose
    - +++ ketones

Diabetes in childhood is common

- DKA is a frequent presentation of new onset diabetes
  - Preschool children are at highest risk of DKA
  - presenting symptoms may be atypical, leading to other diagnoses
    - Eg. UTI, URTI, gastroenteritis, otitis media

Rewers A, Klingensmith G, Davis C, et al. Pediatrics. 2008;121:e1258-e1266.
Mallare JT, Cordice CC, Ryan BA, et al: Clin Pediatr (Phila). 2003;42:591-597.

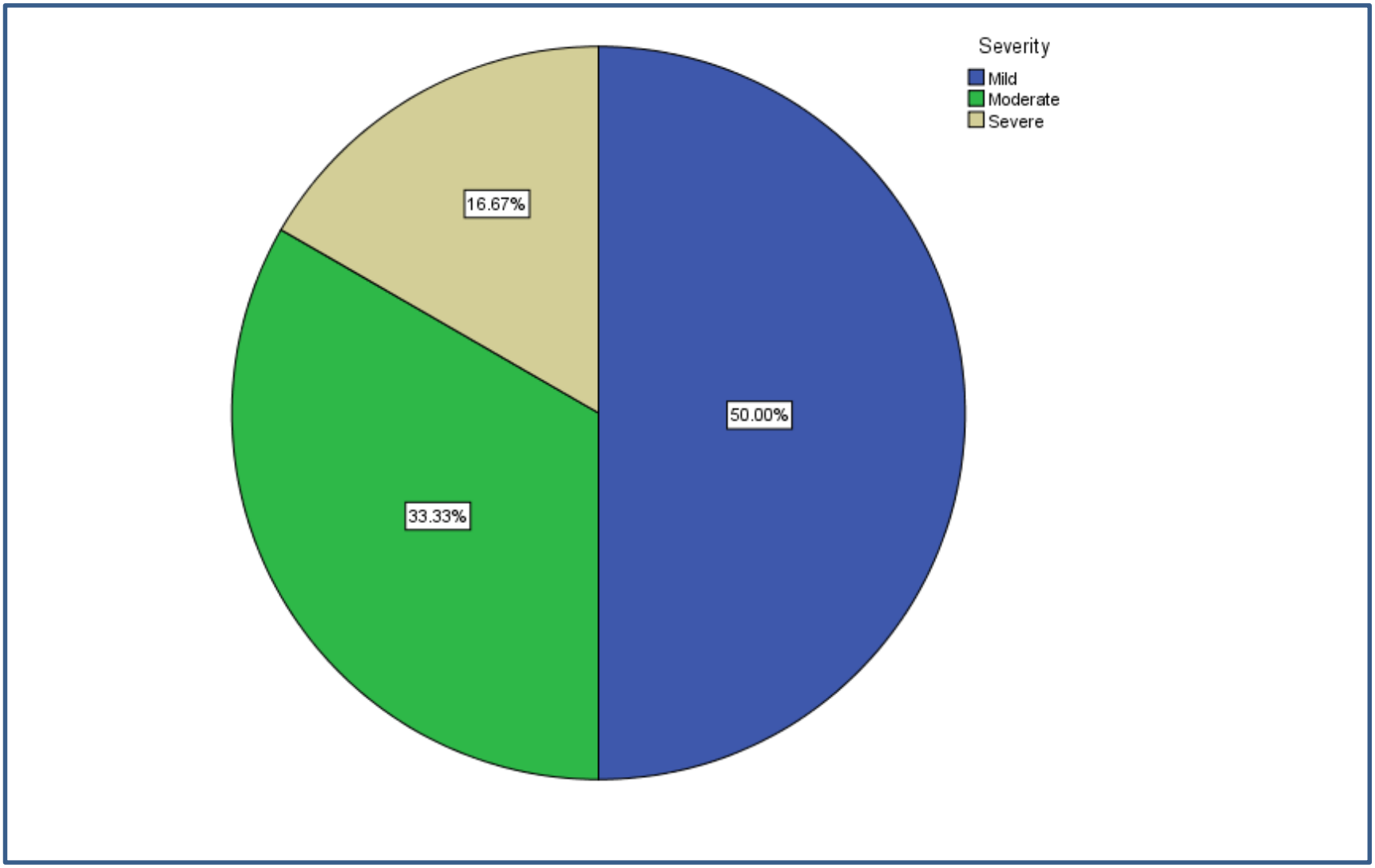
Retrospective chart audit, Janeway Hospital

BMC Research Notes 2015

- 90 admissions 2007-2011
- 22% DKA rate for new patients
  - Younger
  - More severe DKA
  - 64% saw MD prior to DKA
- 49% recurrent DKA
- Pre-existing patients
  - Insulin pump
  - infection

DKA Severity:

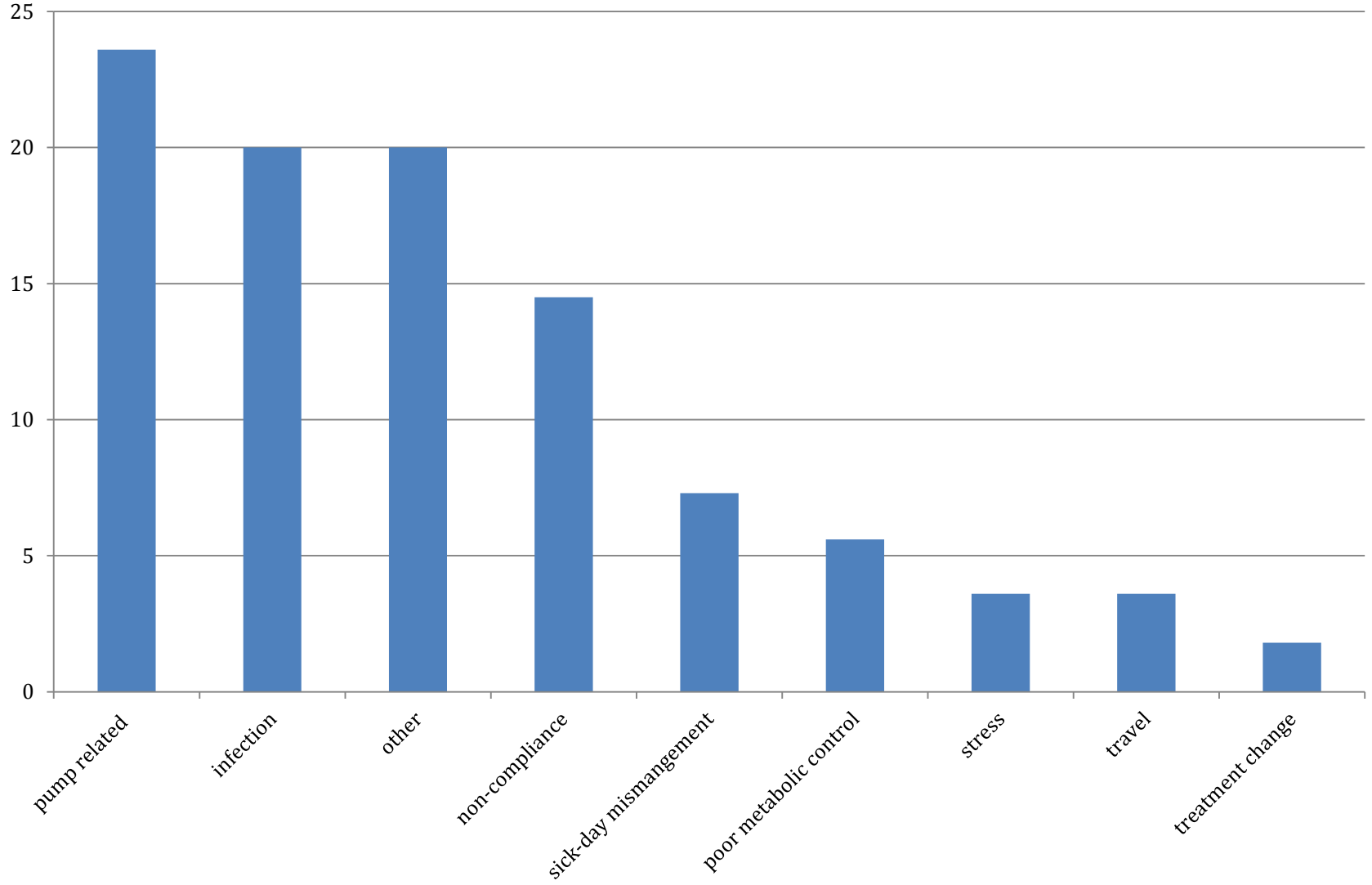
Mild: pH<7.3, Moderate: pH <7.2, Severe: pH < 7.1



Characteristics presenting symptoms of DKA/DM

symptoms	Newly diagnosed diabetes %	Pre-existing diabetes %
Weight loss	**100**	0.0
Bedwetting	**100**	0.0
Polyuria	**79.5**	20.5
Polydipsia	**72.3**	27.7
Neurologic symptoms (Altered LOC or irritability)	**66.7**	33.3
Abdominal pain	31.0	**69.0**
vomiting	25.4	**74.6**
other	42.4	57.6
Treated at peripheral hospital prior to admission to tertiary care center	42.9	57.1
Seen by physician days/weeks prior to admission for DKA	**64.1**	

Figure 1: Reasons for DKA in previously diagnosed patients



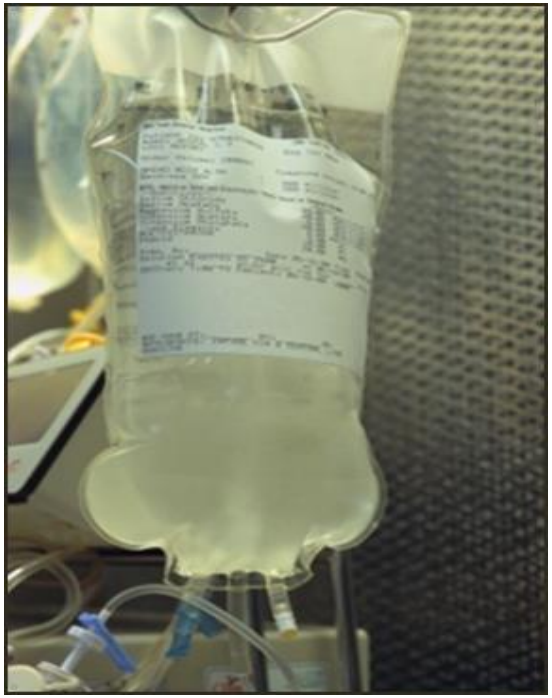
DKA Risk Factors

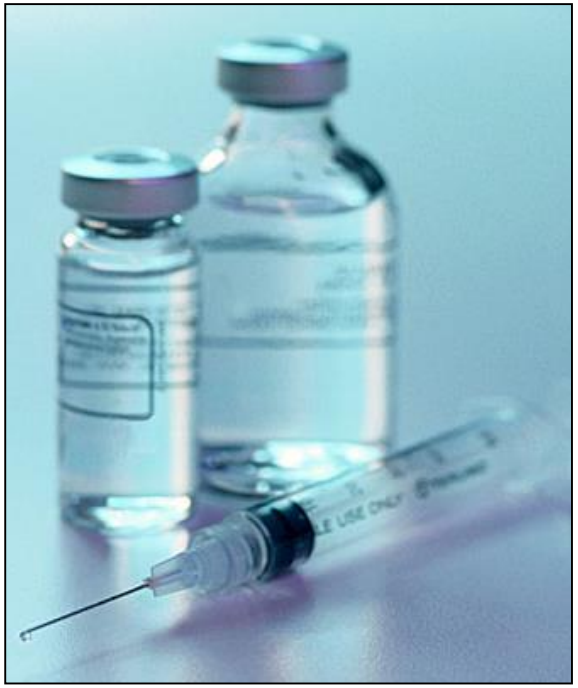
- T1DM
- T2DM
  - 11% dka
  - 2% hyperglycemic hyperosmolar state
- Age < 5 years
- Adolescent (F>M)

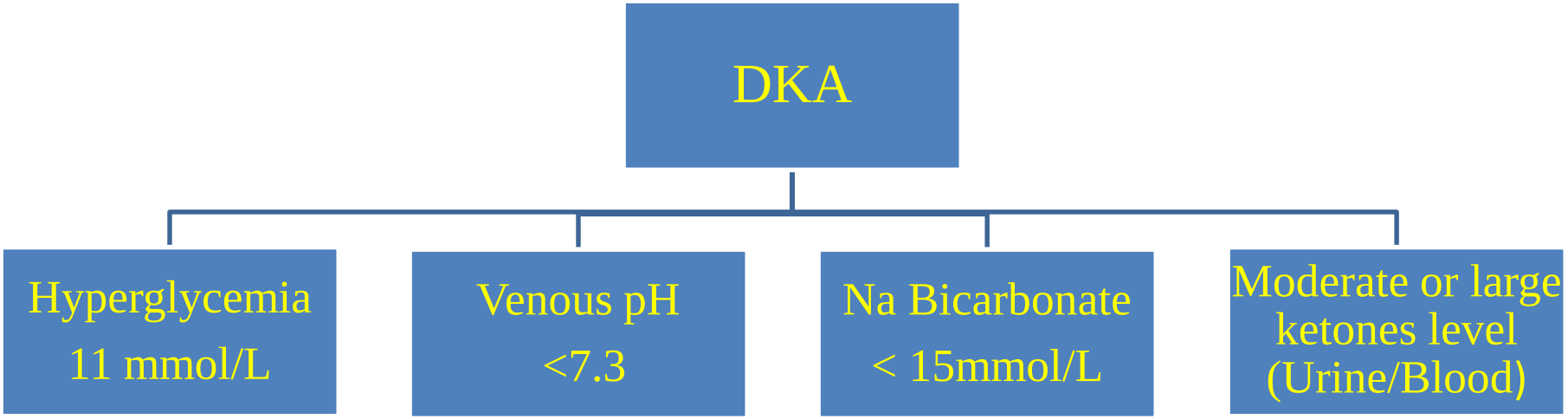
- Infection/Trauma
- Insulin pump therapy
- Sick day mismanagement

- Poor metabolic control
- Lower socioeconomic status
- Psychosocial stress
  - Nonadherence
  - Eating disorders

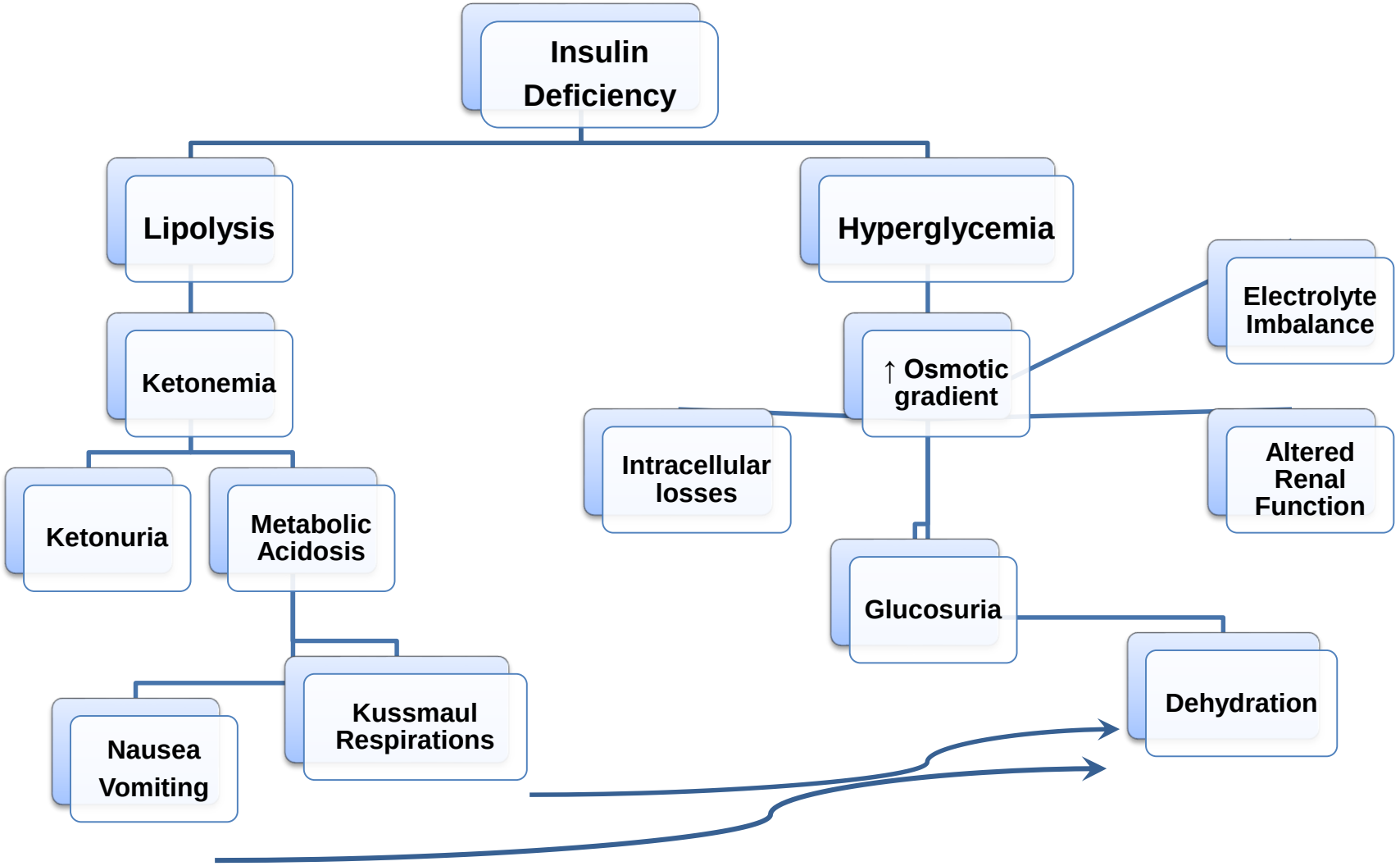
Management of DKA

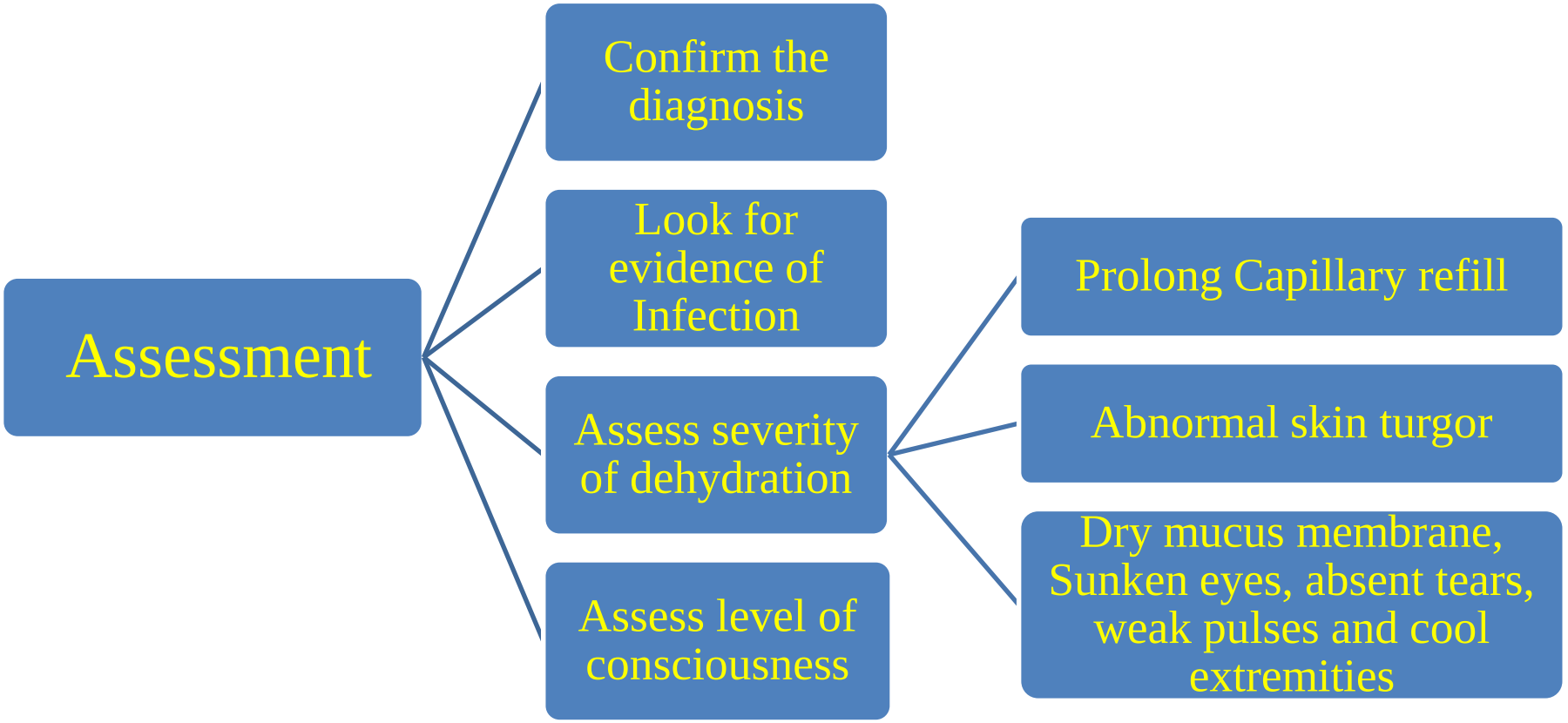


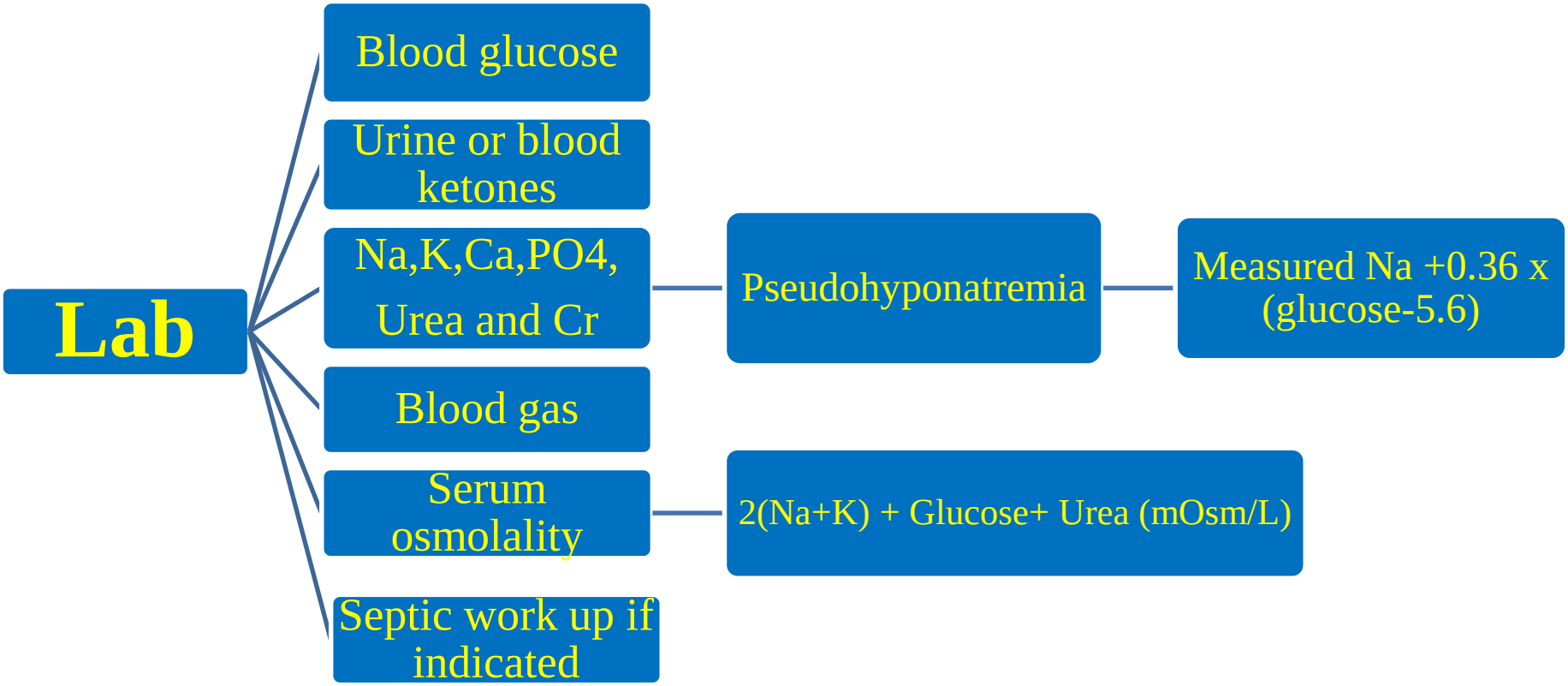



DKA
Hyperglycemia
11 mmol/L
Venous pH
<7.3
Na Bicarbonate
< 15mmol/L
Moderate or large
ketones level
(Urine/Blood)

PATHOPHYSIOLOGY




Assessment
Confirm the diagnosis
Look for evidence of Infection
Assess severity of dehydration
Assess level of consciousness
Prolong Capillary refill
Abnormal skin turgor
Dry mucus membrane, Sunken eyes, absent tears, weak pulses and cool extremities


Lab
Blood glucose
Urine or blood ketones
Na,K,Ca,PO4, Urea and Cr
Pseudohyponatremia
Measured Na +0.36 x (glucose-5.6)
Blood gas
Serum osmolality
2(Na+K) + Glucose+ Urea (mOsm/L)
Septic work up if indicated

Supportive measures

- Peripheral IVs
- Cardiorespiratory monitoring
- Secure airway if decreasing level of consciousness
- Oxygen to patients with severe circulatory impairment or shock
- Antibiotic if suspicion for infection

Monitoring

- Frequent vital signs
- Frequent neurological assessments
- Ins and Outs
- Frequent blood glucose
- Frequent electrolyte
- Urine or Blood ketones until cleared
- Calculation of:
  - Anion Gap,
  - Corrected Na
  - effective osmolality

IV Fluids

- Calculate deficit (body weight X % dehydration)
- Add maintenance fluid for 48 hours
  - Subtract fluid bolus
- Divide total volume over 48 hours
- 0.9% Normal Saline
  - KCL or KPO4

- Fluid bolus rarely needed
- Recommended only if Patient is in shock (hypotension, weak pulses)
  - ✓ 10 – 20 cc/kg over 1-2 hours and may be repeated if necessary if hypotensive shock;
  - ✓ 7 cc/kg if non-hypotensive shock

Pediatric DKA, fluid therapy and cerebral injury: a RCT

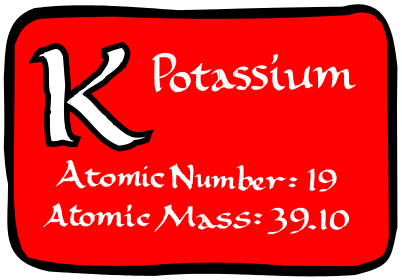
- **Glasser et al**
  - **PECARN DKA fluid study group**
  - **Pediatr Diabetes 2013**
- Controversies about how much fluid, type, and how fast
  - Primary outcome abnormal GCS
  - Patients will be randomised to 4 treatment protocols

Insulin Therapy

- Start insulin infusion @ 0.1 u/kg/hr 1-2 hours after fluid replacement therapy
- Continue insulin infusion until resolution of acidosis
- Do not give insulin bolus
- Add dextrose once glucose level is b/w 14-17 mmol/L
- May need to add dextrose sooner if glucose is dropping rapidly (> 5 mmol/L/h)
- Aim to keep blood glucose level at about 11 mmol/L until resolution of DKA

Low-dose vs standard-dose insulin in pediatric dka: a RCT

- **Nallasamy et al**
  - **JAMA Pediatr 2014**
- 0.05 u/kg per hour vs 0.1 u/kg per hour
- Low dose non-inferior to standard dose



- **Absolute Potassium Depletion**
  - Serum potassium may be normal to high initially

- Add potassium when K< 5 and with urination
  - K >5.5 – no potassium in IVF
  - K 4.5 – 5.5 – 20 meq/L K+
  - K <4.5 – 40 meq/L K+

Complications of DKA

- Cerebral edema
- Stroke

- Shock
- Cardiac arrhythmias
  - Prolonged QTd

- Acute renal injury

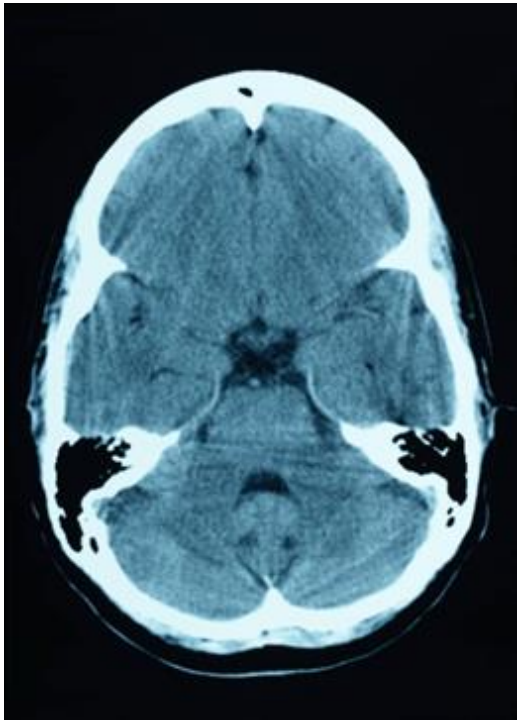
- Electrolyte abnormalities

- Hypoglycemia

- hypercoagulability

Cerebral edema

- Incidence
  - 0.5% to 0.9%
- Mortality
  - 21-24%

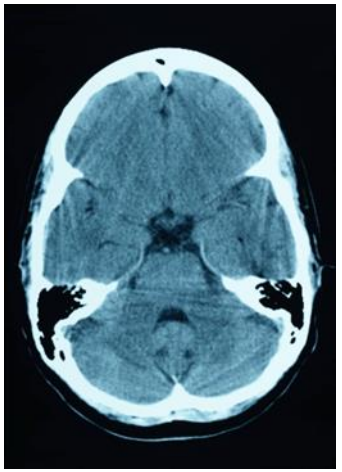


- High Risk
  - Age < 5 years
  - New onset DM
  - Longer duration of Sx
  - Severely Dehydrated

  - Acidosis pH < 7.1
  - pCO2 < 20
  - High urea

  - bicarbonate treatment
  - Insulin tx before rehydration
  - Fluid >50cc/kg first 4 hrs

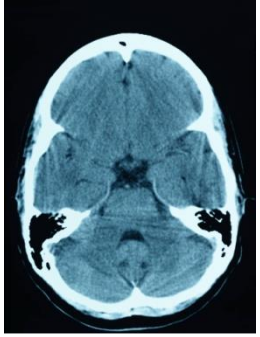
Signs of Cerebral edema



- Abnormal response to pain
- Abnormal posture
- Cranial nerve palsy
- Abnormal respiration pattern
- Age inappropriate incontinence
- Altered level of consciousness
- Bradycardia with elevated blood pressure

Pediatric Glasgow Coma Scale

	1	2	3	4	5	6
Eyes	Does not open eyes	Opens eyes in response to painful stimuli	Opens eyes in response to speech	Opens eyes spontaneously	N/A	N/A
Verbal	No verbal response	Inconsolable, agitated	Inconsistently inconsolable, moaning	Cries but consolable, inappropriate interactions	Smiles, orients to sounds, follows objects, interacts	N/A
Motor	No motor response	Extension to pain (decerebrate response)	Abnormal flexion to pain for an infant (decorticate response)	Infant withdraws from pain	Infant withdraws from touch	Infant moves spontaneously or purposefully

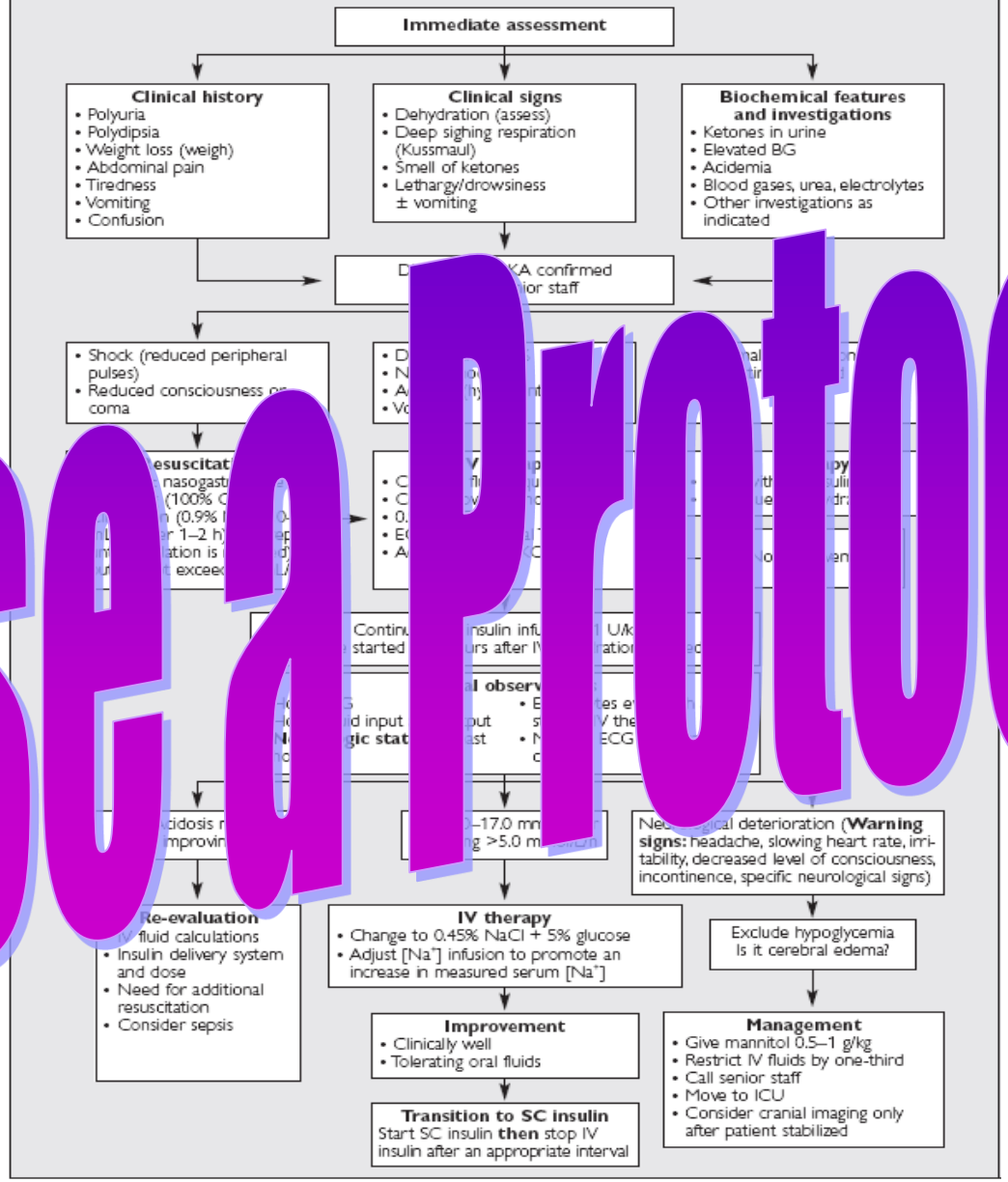


Treatment of Cerebral edema

- **Elevate the head of the bed**
- **Reduce the fluid administration by one-third**
- **Give mannitol 0.5-1 g/kg IV over 20 minutes**
- **Hypertonic saline 3 ml/kg over 30 min as an alternative to mannitol or second line of therapy**
- **Intubation may be necessary**
- **CT head to r/o thrombosis or hemorrhage**

New England Journal of Medicine 2001;344(4):264–9

Figure 1. Immediate assessment and management of DKA in children



BG = blood glucose
DKA = diabetic ketoacidosis
ECG = electrocardiogram
ICU = intensive care unit
IV = intravenous
PG = plasma glucose
SC = subcutaneous

Adapted with permission from Reference 50.

Neurologic consequences of DKA in children

- **Cameron et al Diabetes Care 2014**
- Cerebral white matter changes
- Persistent alterations in memory and cognition at 6 months
  - Osmotic effects cell swelling
  - Breakdown of BBB and vasogenic edema
- Greatest risk younger and more severe acidosis

- 17 yo male
- Obese, FHx T2DM
- Polyuria, polydipsia, decreased energy
- Decreased LOC
- Glucose 55
- Not acidotic

HHS

- Rare in pediatric population but increasing
  - Glucose > 33 mmol/L
  - Plasma osmolality > 320 mOsm/kg (275-295 normal)
- May also have ketoacidosis (28%)
- Mortality 10-32%
- Obesity, FHx T2D, developmental delay
- Little research

- Severe dehydration
  - Electrolyte imbalances
  - Thrombosis
  - Cerebral edema
  - Malignant hypothermia
  - Rhabdomyolysis
  - Renal failure
  - Pancreatitis
- Fluid resuscitation crucial
- Delay insulin infusion, lower dose


Get file to the rain
Dat Insulin
Dat Adele
Purple
Dat
Special
Dat Storm :)
High sugars
Black Magic Woman
Dat Deadly Drawing

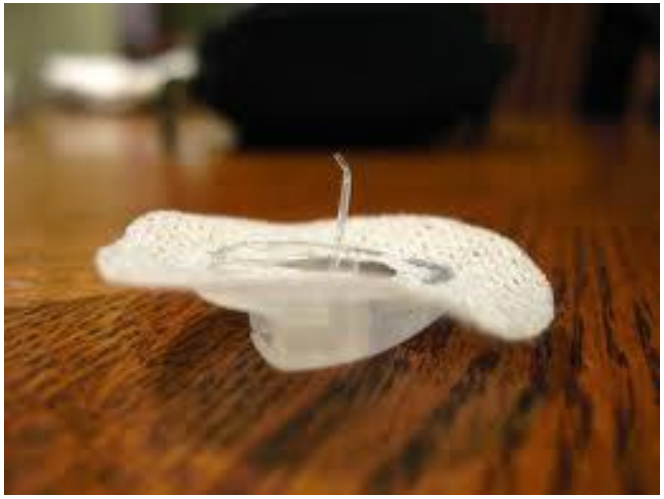
Johnnie

- Now 4 years old
- On insulin pump for 6 months
- Presents in ER with early DKA
- Parents thought he had gastroenteritis…
- What went wrong?

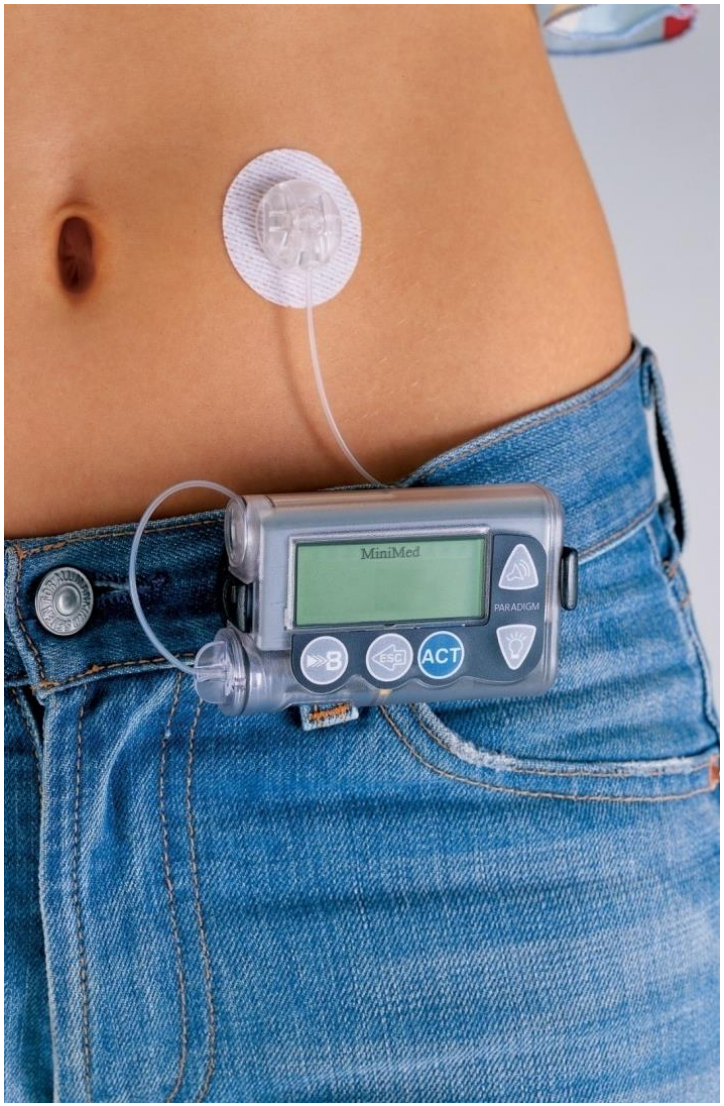
DKA and the Insulin Pump

- Only rapid acting insulin, duration 4-6hours
- Problem with infusion site or set
- Not checking sugar
- Pump suspended too long
- Pump malfunction rare

Kinked or blocked Cannula

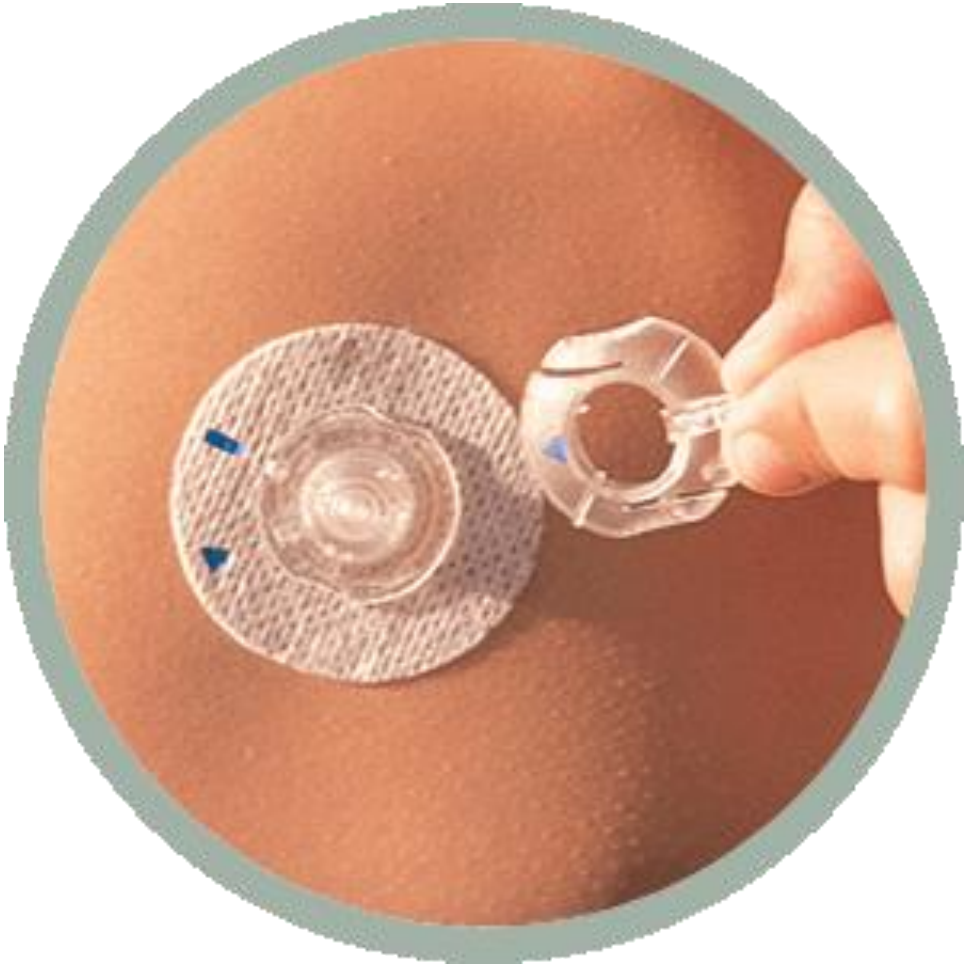


Cracked tubing



Poor connection of the infusion set

- Insulin smells like bandaids



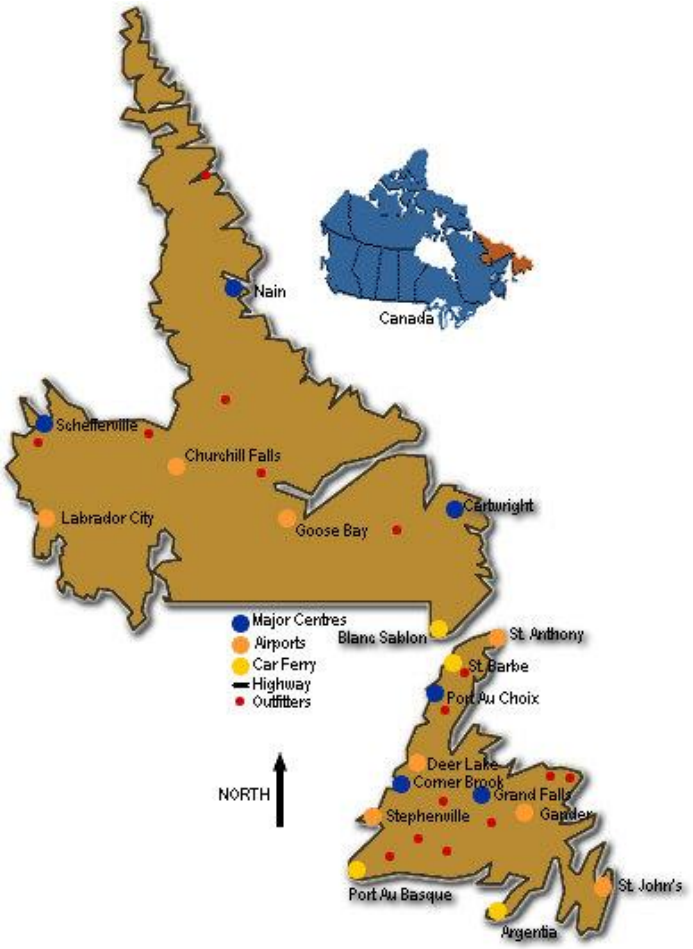
Problems at the site

Leaky tubing

Changing site at bedtime

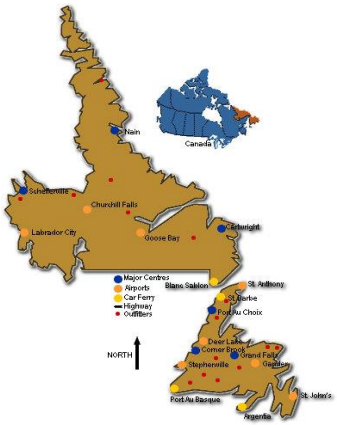
NLdkaP

- Burin Peninsula Health Care Centre
- Carbonear General Hospital
- Dr. G.B. Cross Memorial Hospital
- Western Memorial Regional Hospital
- James Paton Memorial Hospital
- Central Newfoundland Regional Health Centre
- Labrador Health Centre
- Captain William Jackman Memorial Hospital
- Dr. Charles S. Curtis Memorial Hospital
- Janeway Hospital



NLDKAP: DKA can be Prevented?

- DKA is <u>always</u> preceded by symptoms of hyperglycemia
  - Symptoms are misinterpreted or misdiagnosed by caregivers and health care providers
  - Represents a missed opportunity for earlier diagnosis and prevention of DKA



Project components

- Family Education
  - Keep Away DKA
- HCP Education
  - MD:CME course (in development); web-based national
- Community Education
  - Posters and information campaign
  - Schools, PHN, MD offices, Pharmacies
- Resource development (website, videos)
- Research
  - Focus groups with families to identify barriers to ideal DKA prevention and needed resources
  - Chart review of DKA cases (2007-2011)
  - Hospitalization study pre and post intervention


PUMP UP DAT INSULIN
SQUAK!
I GOT DIABEETUS
DKA
1.3
KEEP SIX YO
4:20
Bolus:
10.5 U
ACT
La sucre est CRAY
YO SICK
MOSH YOUR HEART OUT

Reducing episodes of diabetic ketoacidosis within a youth population: a focus group study with patients and families.

Chafe R, Albrechtsons D, Hagerty D, Newhook L

- BMC Research Notes 2015
  - Qualitative study
  - Focus groups with youth, parents

Focus Groups

- What are the main barriers to DKA prevention?

- What resources might help to improve DKA prevention and diabetes management?

Barriers to DKA prevention

- stress associated with temporary guardians,
- risk of information overload at initial diagnosis
- long period from initial diagnosis when most diabetes education is received.
- Families from rural areas
  - Lack of local supports
  - Some developed own community supports

DKA PREVENTION

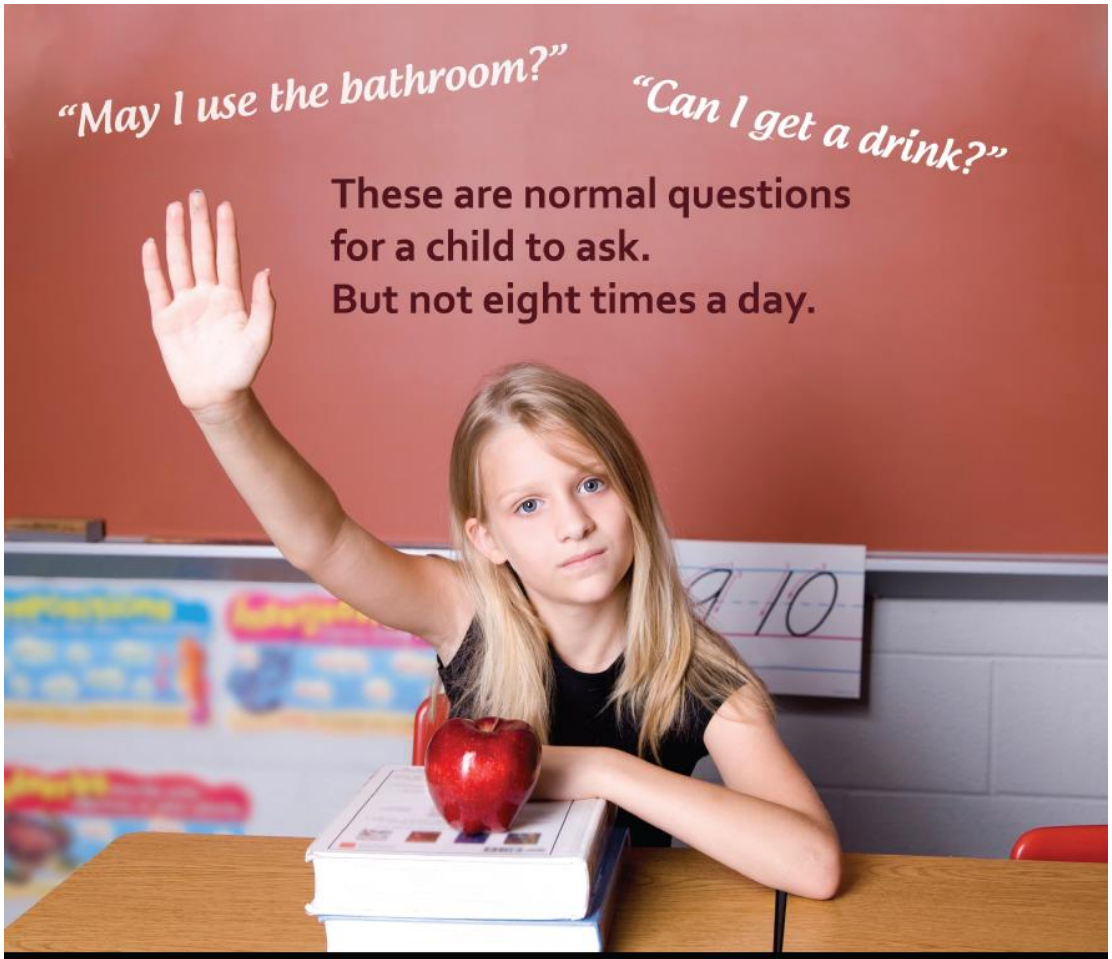
If Ketones are NEGATIVE

- √ Bolus with pump & check blood sugar in 2 hrs. to ensure sugars are ↓. If sugars are not ↓ you may need another bolus.
- √ Check sugars until stable.

If Ketones are POSITIVE or blood sugars ARE NOT ↓

- √ Give insulin with syringe
- √ Drink water
- √ Change your infusion set
- √ Check sugars until stable

Call 777-6300 for Emergency advice,
ask for the doctor on call for pediatric diabetes



Newfoundland and Labrador has one of the highest rates of Type I diabetes worldwide.

If you have noticed these symptoms in your child, see your family doctor today.

- Increased thirst
- Increased appetite
- Sudden weight loss
- Bedwetting
- Using the bathroom more frequently
- Decreased energy
- Yeast infections
- Fruity smelling breath

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Public Health Agency of Canada

Frequent drinking and bathroom use are signs of diabetes in children.

Newfoundland and Labrador has one of the highest rates of Type I diabetes worldwide.

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Key points

- Most children do not need fluid bolus unless in shock
- Start insulin infusion 1-2 hours post fluid initiation
  - Do not bolus insulin
  - Do not give bicarbonate
- Total body potassium deficit therefore give potassium once voiding
- Have a high index of suspicion for cerebral edema
- Guidelines may change with new research
- Most cases of DKA can be prevented

Questions?


Easier
Life
Starts
Here