

Hyperglycaemic and Hypoglycaemic Emergencies

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Glycaemic Emergencies

- ▶ Diabetic ketoacidosis
 - Euglycaemic ketoacidosis
- ▶ Hyperglycaemic, non-ketotic decompensation
- ▶ Hypoglycaemia

Diabetic Ketoacidosis (DKA)

- ▶ Significant insulin deficiency leads to –
 - Inadequate glucose inflow to cells
 - Uncontrolled liver glucose production
 - Breakdown of fat stores into free fatty acids (FFA)
- ▶ ... in turn leading to –
 - Hyperglycaemia (usually but **NOT** always)
 - Dehydration (if plasma glucose elevated)
 - Hyperkalaemia BUT low total body potassium
 - Metabolic acidosis (due to ketoacids from FFA)

Causes of Ketoacidosis

- ▶ Reduced insulin provision
 - Newly-diagnosed Type 1 diabetes
 - Reduction or omission of insulin dose
 - Denaturation of insulin (eg after freezing)
- ▶ Increased insulin requirement
 - Intercurrent illness
 - ▶ Especially sepsis, major vascular event
 - Pregnancy
- ▶ Investigation of cause a part of treatment!

Initial Investigation of DKA

- ▶ Plasma urea/electrolytes (inc HCO_3^-)/glucose
- ▶ Full blood count/CRP/ESR
- ▶ Blood cultures/urine culture
- ▶ Electrocardiogram
- ▶ Chest X-Ray
- ▶ Full history and clinical examination
 - ...why has this happened?
- ▶ Further investigations as dictated by clinical picture

Initial Management of DKA

- ▶ Protect airway if drowsy or vomiting
 - ...consider insertion of naso-gastric tube
- ▶ Establish venous access
- ▶ Commence rehydration with 0.9% saline
- ▶ Administer insulin by IV infusion or IM bolus
- ▶ Consider potassium replacement
- ▶ Begin continuous ECG monitoring (ideally)
- ▶ Consider CVP monitoring/catheterisation
 - ..on a case-by-case basis

Intravenous Fluids in DKA - 1

- ▶ The most important single treatment!!
- ▶ Most patients 3-6 litres dehydrated
- ▶ 0.9% saline the key to initial treatment
 - 1litre in the first hour
 - 0.5 litres per hour thereafter
 - Slower infusion in children and the elderly
 - ▶ Risks of cerebral oedema or fluid overload
- ▶ Monitor urine output and adjust accordingly
- ▶ Continue until blood glucose $<12\text{mmol/l}$

Intravenous Fluids in DKA – 2

- ▶ Once blood glucose $<12\text{mmol/l}$, switch to dextrose infusion (5% or 10%)
 - 500ml every 3-4 hours usually sufficient
 - Use 10% if persisting ketosis/acidosis
 - Continue 0.9% saline **in addition** if still clinically dehydrated
- ▶ If blood glucose rises above 12mmol/l –
 - Continue dextrose infusion at same rate
 - Increase insulin infusion to control glucose level
 - **DO NOT** switch back to 0.9% saline infusion

Insulin Administration in DKA

- ▶ Continuous low-dose administration ideal
 - IV infusion of 6Un/hr (soluble insulin)
 - IM injection of 10Un hourly
 - SC absorption not good in dehydrated patients
- ▶ Higher doses may be required at times
 - Severe intercurrent illness
 - Obesity/insulin resistance
 - 10Un/hr (or even 20Un/hr) may be needed
- ▶ Reduce to 1-3 Un/hr once glucose <12mmol/l

Failure to Control Glucose

- ▶ If blood glucose fails to fall as expected –
 - Check infusion pump is running properly!
 - Check pump contains insulin (new syringe!)
 - Check the infusion is delivering to the patient
 - Consider presence of severe insulin resistance
 - ▶ Eg 'piqûre' diabetes with brain injury
 - Check plasma Mg and PO_4 – replace if low
- ▶ If all else fails, give more insulin – this usually works eventually!

Potassium Replacement in DKA

- ▶ Plasma K^+ usually high initially...
 - ...but total body potassium low
- ▶ Plasma K^+ falls rapidly with correction of acidosis and hyperglycaemia
- ▶ Hypokalaemia can be fatal!
- ▶ Begin to replace potassium once plasma $K^+ < 5.5 \text{ mmol/l}$
 - 10 mmol/hr, increasing to 20 mmol/hr if needed

IV Bicarbonate in DKA

- ▶ No evidence on any improvement in outcomes
- ▶ May cause problems across the blood-brain barrier
- ▶ Use normally limited to severe acidosis **and** an additional cause of acidosis on top of DKA (eg lactate in shock)
- ▶ 50 mmol (as 8.4% solution) the usual dose

Monitoring the DKA Patient

- ▶ ECG – continuous if possible
- ▶ Fluid input/output – hourly at bedside
- ▶ Glucose – hourly at bedside, 3-hourly in lab
- ▶ Urea/electrolytes/HCO₃ – 3-hourly in lab
- ▶ All suggested doses/infusion rates adjusted according to patient response – a dynamic situation

Things that can go Wrong!

- ▶ Cerebral oedema – headache and reduced conscious level
 - Slow fluid replacement and rate of glucose fall
 - Consider IV mannitol
- ▶ Untreated infection
 - Patients with DKA **alone** may have high WCC/CRP
 - DKA alone does NOT cause pyrexia
 - Be alert to any pyrexia and manage vigorously
- ▶ Aspiration pneumonia
 - Protect airway ± nasogastric tube

Post-DKA Management

- ▶ Continue IV dextrose/potassium/insulin until biochemistry normal and eating/drinking well
- ▶ Restart SC insulin at usual (or higher) dose
- ▶ Consider need for education to prevent recurrence
 - “sick day rules”
- ▶ Follow-up soon after discharge to ensure everything is ‘back to normal’

Hyperosmolar, Non-Ketotic Decompensation (HONK)

- ▶ Usually in Type 2 diabetes
- ▶ Modest insulin deficiency
 - Enough insulin to prevent ketoacidosis
 - Insufficient insulin to prevent increased liver glucose output and reduced peripheral uptake
- ▶ Leads to severe dehydration but no DKA
 - Glucose often $>50\text{mmol/l}$ (and urea $>20\text{mmol/l}$)
 - Plasma osmolality $>350\text{ mmol/kg}$
- ▶ Severe dehydration may lead to thrombosis

Causes and Presentation of HONK

- ▶ Similar to DKA
- ▶ Infection/vascular events common
- ▶ Diuretics and ACE inhibitors may promote
- ▶ Often presents late with severely ill, dehydrated, semi-conscious patient
- ▶ Mortality is usually higher than DKA
 - ...sometimes due to the precipitating illness

Management of HONK

- ▶ Basically similar to DKA in principle, **BUT** -
 - Fluid replacement should be slower (50% rate)
 - 0.9% saline preferred even if plasma Na high
 - Insulin doses needed are less (50% of DKA)
 - Potassium replacement likely to be less
 - Plasma osmolality should fall by 1-2 mmol/kg/hr
 - Supportive care identical to DKA
 - Management of precipitating illness crucial
 - Prophylaxis of thrombosis (eg heparin) usual

Post-HONK Management

- ▶ Continue IV therapy until patient eating/drinking well
- ▶ Many patients will not need insulin (or even oral hypoglycaemics) long-term
 - ...though a few weeks is not unusual
- ▶ Look closely at the whole patient (and their medication) to avoid recurrence

Hypoglycaemia

- ▶ Low blood glucose, symptomatic or not
 - Mild/moderate if treated by the patient
 - Severe if needing the help of someone else
 - ▶ ...even if that help is just to take oral carbohydrate
- ▶ Hypoglycaemia awareness may be reduced
 - Long-standing diabetes
 - Pregnancy
 - Recurrent hypoglycaemia
 - Drug therapies (eg beta-adrenoceptor blockers)

Causes of Hypoglycaemia

- ▶ Insulin/sulphonylurea/meglitinide therapy
 - ...not with other drugs in mono-therapy
- ▶ Excessive dose (eg overdose)
- ▶ Reduced need
 - Reduced food ingestion
 - Increased exercise
 - Alcohol
- ▶ Time-action profile wrong
 - short-acting analogue in long-duration patient
 - ...or accidental wrong insulin type!

Hypoglycaemia Risks

► Risks **for** hypoglycaemia

- Duration of diabetes
- Tight glycaemic control
- Underlying pancreatic/hepatic disease
- Alcohol

► Risks **from** hypoglycaemia

- Elderly or frail patients
- Living (especially sleeping) alone
- Alcohol (and drug) misuse

Hypoglycaemia Treatment

- ▶ Alert or no risk to airway
 - Oral (especially liquid) sugar
 - Buccal glucose gel (or jam!)
- ▶ Reduced consciousness/risk to airway
 - 25g IV glucose (10% or 20% - NOT 50%!)
 - SC/IM glucagon 1mg
 - ▶ Glucagon not effective in liver disease/alcohol excess
- ▶ Oral complex carbohydrate once recovered
- ▶ Address cause to minimise recurrence

Things that can go Wrong!

▶ Wrong diagnosis

- Reduced conscious level not always hypo
- Always check capillary blood glucose

▶ Over-treatment

- 25g glucose IV usually enough
- Don't give more and cause high glucose
- Consider other causes of coma
 - ▶ ...or cerebral oedema from hypoglycaemia
- Always check (and act on) capillary blood glucose

▶ Recurrence after recovery

- Establish cause **AND** give complex CHO

Recurrent Hypoglycaemia

- ▶ Excessive dosage
 - ...look for weight gain
- ▶ Over-tight glycaemic control
 - ..."make 4 (mmol/l) the floor!"
- ▶ Poor hypoglycaemic awareness
 - ...may improve if control relaxed/hypo avoided
- ▶ Kidney/liver impairment
- ▶ Hypoadrenalism
- ▶ Alcohol/drug misuse

Hyperglycaemic and Hypoglycaemic Emergencies

- ▶ Serious, potentially life-threatening
- ▶ Fully treatable with excellent outcomes
 - ...therefore very rewarding to treat
- ▶ Do not require expensive technology
 - ...therefore within the scope of all
- ▶ Management can be protocolised
 - ...to help junior and non-specialist staff
- ▶ Can go wrong if simple steps not followed
 - ...a training issue for all!