

pathophysiology

- DKA is a syndrome of hyperglycaemia, metabolic acidosis, ketosis & severe volume depletion.
- DKA occurs in insulin dependent diabetics & severe insulin deficiency is the hallmark of this syndrome; raised levels of stress hormones (GH, glucagon, catecholamines & cortisol) are also a feature
- hyperglycaemia results in a glucose load that overwhelms the resorptive capacity of the renal tubules resulting in osmotic diuresis with fluid & electrolyte depletion
- the lack of insulin causes increased lipolysis & the formation of ketoacids

epidemiology

- accounts for approximately 6% of all diabetic admissions to hospital & occurs in a younger age group than HONK

precipitating factors

- precipitating factors associated with the development of DKA include:
 - lack of insulin due to previously undiagnosed diabetes mellitus or non-compliance
 - physical stressors such as acute infective illness, myocardial infarction, SIRS (eg pancreatitis), glucocorticoid, phenytoin or diuretic therapy
 - post surgical management
 - substance abuse

clinical features

- presenting clinical features of DKA reflect the underlying metabolic derangements of dehydration, ketosis & metabolic acidosis & include:
 - thirst & polyuria
 - tachycardia and hypotension
 - reduced skin turgor
 - dry mucous membranes
 - Kussmaul respiration & ketotic fetor
 - core temperature is often reduced

laboratory tests

- laboratory tests supporting the diagnosis of DKA include
 - hyperglycaemia
 - spurious hyponatraemia
 - preserved or high levels of serum potassium (reflecting the acid-base status and not the severe total body depletion of potassium that is present)
 - variable levels of calcium, magnesium & phosphate (although these are usually low or become low on commencement of therapy)
 - hyperosmolality
 - elevated serum urea and creatinine levels
 - elevated serum ketone levels as measured by the concentrations of beta hydroxybutyrate and acetoacetate [3-hydroxybutyrate concentrations in plasma are 2-3 times those of acetoacetate but in acidotic states this ratio is increased further. As therapy improves acidosis, levels of acetoacetate rise and methods that measure only acetoacetate concentrations in urine may suggest ketonuria is worsening
 - white cell count may be elevated and does not necessarily reflect infection
 - amylase is often elevated (without pancreatitis)

pathophysiology

- the defining features of HONK include hyperglycaemia, dehydration, & hyperosmolality without ketoacidosis
- the main differentiation from DKA appears to be the presence of at least some insulin (ie relative, rather than absolute lack of insulin), more variable levels of stress hormones or counterregulatory hormones & the fact renal dysfunction is commonly present
- renal dysfunction & impaired tubular function results in less capacity to deal with high solute & osmotic loads. This together with impaired water intake results in severe dehydration.

epidemiology:

- less common than DKA, occurs in an older age group & has a higher mortality rate

precipitating factors include all of those listed for DKA plus:

- mental obtundation, dementia or physical impairment limiting access to water
- severe dehydration
- renal dysfunction
- inappropriate diuretic use as well as steroids, beta blockers & phenytoin are risk factors

clinical features

- more commonly associated with obtundation than DKA

laboratory tests

- laboratory tests are similar to those for DKA but differ in degree
 - serum glucose levels are usually higher
 - serum sodium levels may be normal (inappropriately for serum glucose)
 - markers of renal dysfunction are worse
 - hyperosmolality is more marked
 - metabolic acidosis is not as severe
 - anion gap & serum ketone levels are normal

- DKA & HONK are life threatening syndromes caused by metabolic derangement associated with diabetes mellitus
- DKA is approximately three times as common as HONK in patients presenting with hyperglycaemic syndromes
- most deaths due to diabetic emergencies that are appropriately managed are due to coexisting disease such as myocardial infarction

	DKA	HHS
Presentation		
Prodromal illness	Days	Weeks
Coma	+	+++
Blood glucose	++	+++
Ketones	+++	0 or +
Acidaemia	+++	0 or +
Anion gap	+++	0 or +
Osmolality	++	+++
Typical deficits		
Total water (litres)	6	9
Water (ml/kg)	100	100-200
Na (mEq/kg)	7-10	5-13
Cl (mEq/kg)	3-5	5-15
K (mEq/kg)	3-5	4-6
PO ₄ (mEq/kg)	5-7	3-7
Mg (mEq/kg)	1-2	1-2
Ca (mEq/kg)	1-2	1-2

general

- the main metabolic derangements that result in morbidity & must be urgently addressed in the management of both DKA & HONK are dehydration, insulin deficit, electrolyte depletion & metabolic acidosis

- although there is no consensus on the ideal approach to fluid management in these patients, prompt restoration of the circulation with isotonic fluid, followed by more moderate replacement of the water deficit using hypotonic fluid are the underlying principles

- electrolyte depletion is treated by appropriate replacement of sodium, potassium, magnesium, phosphate & calcium as indicated by frequent testing during the early phase after presentation

- metabolic acidosis rarely requires specific therapy & corrects with volume expansion and insulin therapy. Bicarbonate is not generally advocated due to the possibilities of hypokalaemia, intracellular acidosis, reduced myocardial contractility and reduced tissue oxygenation

metabolic derangement

altered mental state

- patients who present with DKA or HONK commonly have an altered mental state which may range from delirium to coma. Often the patient is very unwell and as a consequence is stuporous and uncommunicative; less commonly delirium is the major feature.
- often improves rapidly with rehydration and correction of acidosis
- there is no good correlation between glucose level, osmolality or pH and the patient's presenting mental status which appears to be more a function of the patient's general health, comorbidities and the precipitating cause
- localising signs and lack of improvement with correction of metabolic disturbance mandate further investigation

cerebral oedema

- rapid correction of hyperglycaemia and hyperosmolality is associated with the development of cerebral oedema in patients with hyperglycaemic syndromes [animal studies suggest it is correction of hyperglycaemia and hyperosmolality rather than sodium movement or acidosis that are important]
- the use of isotonic rather than hypotonic solutions for rehydration and avoidance of over rapid correction of hyperglycaemia appear to offer protection against the development of cerebral oedema
- cerebral oedema is more common in DKA than HONK & is more common in the young
- manifests with either prolonged altered mental state or a new development of altered mental state
- in adults good supportive care is generally all that is required & manifestations gradually abate over a few days; however, in children cerebral oedema is associated with considerable mortality & urgent treatment with mannitol is often required
- seizures:
 - focal and generalised seizures are common in patients with hyperglycaemic syndromes and may be resistant to treatment

neurological sequelae

DKA

clinical features of DKA & HONK
[created by Paul Young
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HONK