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**Practical Anaesthesia**

**Patient on Steroids**
- lower dose steroid supplementation now recommended
- if <3/12 since stopped steroids ⇒ Rx as if on steroids
- >3/12 since stopped then assume normal HPA axis
- specifics:
  - <10mg/day ⇒ normal HPA axis. No cover
  - >10mg/day ⇒ Rx based on surgery:
    - minor = routine preop steroids & 25mg Iv hydrocort at induction
    - moderate = as minor but cont hydrocort 6hrly for 24hr
    - major = as moderate but cont hydrocort for 48-72hrs
  - high dose immunosupression eg 60mg pred ⇒ convert to IV hydrocort until can resume PO
    └ 10mg PO pred = 40mg IV hydrocort; 1.5mg dex
    └ 20mg hydrocort = 0.05mg fludrocortisone

**HPA Axis Suppression**
- endogenous cortisol = 25-30mg/24hr in circadian rhythm
- during stress can ↑ to 75-100mg/day & stay high for up to 72hrs post major stress
- prednisone:
  - glucocorticoid action ~ x3 more potent than hydrocort
  - mineralcorticoid = much less active
  └ useful for chronic conditions as avoids water retention issues
- measure using synacthen test:
  - 250mcg IV
  - serum cortisol measured at 0,30 & 60min
  - norm peak cortisol = 420-700
- fludrocortisone only available in oral form
Diabetes Mellitus

Preoperative
= progressive pancreatic beta-islet cell failure resulting in -> either decreased insulin secretion or insulin resistance

- insulin:
  ‣ stimulates: glucose uptake and lipid synthesis at adipose & mm cell only
  ‣ inhibits: lipolysis, proteolysis, gluconeogenesis, glycogenolysis and ketogenesis

- DM I (20%) = immune mediated beta-islet cell destruction
- DM II (80%) = insulin resistance

- significant increase in perioperative morbidity with high sugars ie HbA1c >69 (increased length of stay, increased wound infections, increased mortality, worse long term prognosis, prothrombotic state, cardiac sympathetic overactivity, dehydration)

HISTORY
- Symptoms:
  ‣ polyuria
  ‣ thirst
  ‣ polydipsia
  ‣ dehydration
- control: diagnosis, recent trends, hypoglycaemic attacks
- complications:
  ‣ Macro:
    - HTN
    - stroke
    - Renal failure
    - IHD & HF
    - PVD
  ‣ Micro:
    - retinopathy,
    - nephropathy,
    - neuropathy: peripheral, autonomic
- co-morbid conditions: PVD, IHD, CHF, infections, ulcers, amputations, HT, CVA, GORD

- Medications:

1. Insulin sensitisers + control hepatic glucose production = biguanides, thiazolidineiones
2. ↑ insulin release = sulfonylureas, meglitinides)
3. ↓ absorption of starch = alpha-glucosidase inhibitors
4. ↑insulin production and ↓ glucose production = incretin mimetics, DDP 4 inhibitors
5. Insulin

EXAMINATION
- BSL
- observations

AIRWAY: glycosylation of TMJ or neck joints -> decreased ROM, neck movement
GI - delayed gastric emptying
CVS: postural BP, resting HR, pulses, heart size, JVP
RESP: creps
NEURO: peripheral neuropathy, eyes
INVESTIGATIONS
- BSL
- ECG - silent MI
- Blds -
- urine for ketones & protein
- glucose
- HbA1c (<7% or <69mmol/ml) - if higher refer to DM team preop
- IHD investigation (particularly if has silent ischaemia)

MANAGEMENT
Key points:
- Tight perioperative control:
  1. keep basal insulin going:
     - 50% amount during fasting (use local guideline to give equivalent dose of protaphane)
     - 100% when eating
  2. IV sliding scale insulin (VIII):
     - Used for all major surgery & long fasting (>1 missed meal or NBM >6hrs)
     - glucose/insulin given through same cannula with pump & anti reflux valve
     - add 20mmol KCL to litre bags if K <4.5mmol
  3. Subcut insulin:
     - stop regular short acting insulin
     - if prolonged fast or major surgery ⇒ VIII
     - give short acting for minor surgery with ↑BSL peri-op:
       - use standardised s/c bolus regimes
       - Example dosing bolus dose for ↑BSL:
         - Type 1DM - give 1unit ⇒ ↓BSL by 3
         - Type II DM - give 0.1U/kg ⇒ recheck BSL 1 hr later
- avoidance of hypoglycaemic attacks
- prevent ↓K, ↓Mg, ↓PO4

Intraoperative
- final check preop of BSL:
  - if >12mmol - check urinary ketones. If ketones ++++ then defer surgery
  - continue controlled BSL's throughout OT
  - give insulin and dextrose through same cannula so insulin not given without dextrose
  - check BSL 1 hourly
  - RSI if indicated
  - RA may be appropriate
  - have pressors ready c/o autonomic dysfunction
  - treat hypoglycaemia aggressively (<4mmol/L)
    - no signs in anaesthetised pt
    - 150mL of 10% glucose (2ml/kg) over 10mins
    - 1mg glucagon IM or IV
    - 2-4 teaspoons of sugar in mouth/NGT

- must not drive on day of surgery
- early IV access
- if K+<4.5 -> add 10mmol KCl to dextrose bag

**Postoperative**
- continue control as above
- coming off variable IV insulin infusions:
  - oral hypoglycaemic agents:
    - restart once when ready to eat & drink
    - ↓ sulphonylurea if not on full diet
    - metformin should be restarted only if GFR >50
  - subcut insulin:
    - wait until E&Ding with no vomiting
    - switch at next meal with normal s/c insulin due
    - restart normal preop regime (may need titrating up due to stress response)
    - stop VRIII 30-60min after s/c injection & meal
- prev on long acting subcut insulin:
  - resume to 100% when eating
- prev BD fixed mixed regime:
  - stop VIII at appropriate insulin mealtime
- consult endocrinology if concerned

**Pregnancy**
- more aggressive control (glucose 4-6mmol/L)
- may require massive doses of insulin
- run 5% dextrose around time of delivery if not eating (stops ketosis)
- insulin infusion if required
- halve insulin infusion rate once baby born and continue dextrose in DM I

**Acromegaly**

**Preoperative**
= rare clinical syndrome caused by hypersecretion of GH from anterior pituitary

**HISTORY**
- ↑ ICP signs eg morning headaches & vomiting
- neck stiffness
- N+V
- visual disturbance
- growth issues
- looks funny

- associated conditions: HTN (30%), IHD, cardiomyopathy, heart failure and valve disease (AR), OSA, DM (25%)

- drugs:
  - somatostatin analogues (octreotide, lanreotide) - side effect of D&V
  - bromocriptine = long acting dopamine agonist ⇒ can ↓GH levels but can lead to severe postural hypotension

**EXAMINATION**
- AIRWAY: large jaw, head, jaw, tongue and lips, hypertrophy of larynx and trachea -> vocal cord thickening and chondrocalcinosis of larynx, OSA and look for enlarged thyroid with tracheal displacement
- CVS: murmurs, BP, heart failure

**INVESTIGATIONS**
- ECG: if indicated
- CXR: if indicated
- ECHO: for murmurs
- BSL: 25% are DM
- U+E: imbalanced c/o electrolyte regulation altered
- Bloods for endocrine axis:
  ‣ GH, TFT, Short Synacthen Test, LH, FSH

**MANAGEMENT**
- discussion with endocrinologist (optimization and perioperative management of hormone therapy)
- discussion with neurosurgeon (approach, position, blood loss)
- BSL cares
- prehydration cares

**Intraoperative**
- large facemasks
- large blades
- AFOI if indicated
- pressure cares
- protect nerves as are particularly at risk (ulna elbow, median wrist & peroneal at fibula head)
- OSA cares

**Postoperative**
- ICU/HDU if indicated

**Special Points**
- Pan-hypopituitarism patients eg post resection of adenoma or defunctionning adenoma should be referred to endocrinologist for hormone replacement:
  ‣ hydrocortisone ⇒ ACTH adrenal insufficiency
  ‣ thyroxine ⇒ TSH hypothyroidism
  ‣ testosterone ⇒ GnRH male hypogonadism
  ‣ Oestradiol + progesterone ⇒ GnRH female hypogonadism
  ‣ Growth hormone - injection
  ‣ DDAVP nasal spray ⇒ ADH central diabetes insipidus

**HyperThyroid Disease**

**Causes**
- Graves disease
- Toxic multi nodular Adenoma
- Toxic Adenoma
- Amiodarone/iodine induced

**Preoperative**

**History**
- sweating
- anxiety
- palpitations
- eyes protruding (Graves disease)
- weight loss
- insomina
- hyperphagia
- tremor
- heat intolerance
- diarrhea
- vomiting

- if goitre present: stridor (>50% compression), positional dyspnoea, dysphagia, SVC obstruction, hoarseness
Other complications - atrial fibrillation, high output heart failure, myocardial infarction

- when thyroid disorder diagnosed and how it presented
- treatments
- whether symptoms are currently controlled
- recent endocrinology assessment
- previous surgery to neck
- other endocrine/autoimmune diseases:
  - adrenal hyperplasia, acromegaly, SLE, RA, addisons, IHD
- amiodarone use - can cause either hyper/hypothyroidism
- socially - smoking history – risk factor for thyroid carcinoma, ET-OH history

EXAMINATION

- euthyroid =
  - HR <80
  - no hand tremor
  - delay all surgery if possible if not euthyroid

- airway assessment - thyroid palpation for size, tenderness, nodules, displacement of trachea, stridor

- signs of SVC obstruction – facial plethora, pembertons sign, distended neck veins, SOB

- eye lid retraction
- exopthalmos
- conjunctivitis

- thyroid examination – inspection (swallow H2O), palpation from behind, bruit

- focussed CVS, RESP examination – pulse, BP (hypertension), JVP, HS, praecordium and chest signs - for signs of heart failure and pleural effusions, arrhythmias

INVESTIGATIONS

- BLOODS – TFT’s (recent), FBC – anaemia with hypothyroidism, U+E – electrolyte abnormalities, thyroid anti-bodies (graves disease)
- CXR – tracheal compression and position
- NECK CT/MRI – assessment of goiter and impingement of airway
- RADIOLABELLED STUDIES – see where nodules are
- PRE-OT – quantification of vocal cord function (damage to recurrent laryngeal nerve can take place)
- ECG: AF or sinus tachycardia

MANAGEMENT

- drugs:
  - antithyroid medications: carbimazole 30-45mg daily for 6-8wks,
  - beta-blockers (propanolol = non selective)
    - given if assoc tremor
    - ß1 block symptoms of ↑HR
    - ß2 block periph conversion of T4 to T3
  - Lugol’s iodine – decreases vascularity if give 1/52 course prior to operation

- aim for HR 80/min and no tremor
- operation being planned
- positioning of patient

Intraoperative

- standard care

Postoperative

- keep beta-blockers going
Thyroid Storm

- monitor for **Thyroid Storm**:

**CLINICALLY**
- life threatening exacerbation of hyperthyroid state with 1 or more organ dysfunction
- 20-30% mortality
- 6-24 hours post surgery with:
  - fever
  - sweating
  - HR >140/min
  - coma
  - D&V

**MANAGEMENT**

**Supportive**
- IVF (saline & glucose)
- cooling cares
- paracetamol (no NSAIDS or aspirin -> displaces thyroxine from proteins)
- propanolol increments (1mg IV) or esmolol boluses -> infusion (50-100mcg/kg/min). Target HR <90

**Specific**
- hydrocortisone 200mg IV QID
  - action:
    - adrenal insufficiency
    - decreases T4 release and conversion
- propylthiouracil
  - 1g load PO or via NGT then 250mg QID
  - action:
    - inhibit thyroid hormone release
    - decrease peripheral conversion from T4-T3
- then give either:
  - sodium iodide 500mg tds IV
  - potassium iodide 5 drops via NGT
  - Lugol's iodine 5-10drops via NGT

**HypoThryroidism**

**Causes**
- iodine deficiency
- Congenital defect
- Autoimmune thyroiditis (Hashimoto)
- CNS tumour
- Acquired:
  - Thyroid tumour
  - Amiodarone
  - lithium
  - Surgery

**Preoperative**

= commonly autoimmune thyroid destruction

**Problems**
- CVS: ↓blood volume, ↓CO, ↓HR, ↓bp, IHD, pericardial effusions
- Haem: ↓Hb, ↓BSL, ↓Na
- Impaired hepatic drug metabolism
**HISTORY**
- fatigue
- depression
- hypersomulence
- cold intolerance
- OSA
- pulmonary hypertension

**EXAMINATION**
- weight gain
- thin hair
- decreased blood volume
- bradycardia
- hypotension
- pleural effusions

Airway Assessment - thyroid palpation for size, tenderness, nodules, displacement of trachea, stridor

Signs of SVC obstruction – facial plethora, pembertons sign, distended neck veins, SOB

Focussed CVS, RESP examination – pulse, BP (hypertension), JVP, HS, praecordium and chest signs- for signs of heart failure and pleural effusions, arrhythmias

**INVESTIGATIONS**
- TFT’s :
  - low Thyroid hormones in sick people are not reliable
  - euthyroid sick syndrome = false low T3/T4
- as per clinical assessment
- BLOODS – TFT’s (recent), FBC – anaemia with hypothyroidism, U+E – electrolyte abnormalities, thyroid anti-bodies (graves disease)
- CXR – tracheal compression and position
- NECK CT/MRI – assessment of goiter and impingement of airway
- RADIONLABELLED STUDIES – see where nodules are
- PRE-OT – quantification of vocal cord function (damage to recurrent laryngeal nerve can take place)

**MANAGEMENT**
- delay elective surgery until euthyroid
- liaise with endocrinologist
- start thyroxine 25-50mcg increasing to 100-200mcg/day over weeks
  - use half measures in elderly due to risk of ↑myocardial work
- if surgery urgent can use liothyronine (T3) 10-50 mcg IV slowly with ECG monitoring -> 25mcg TDS IV

**Intraoperative**
- give all drugs slowly
- have pressors ready - refractory ↓bp
- actively warm
- IPPV
- drug metabolism can be slow
- ↓relaxant & opioid dose

**Hypothyroid Coma**
- post op problem
- rare decompensated hypothyroidism - mortality 15-20%

**CLINICALLY**
- coma
- hypoventilation
- bradycardia
- hypotension
- severe dilutional hyponatraemia

- precipitants: infection, trauma, cold, CNS depressants

**MANAGEMENT**
- IV glucose + saline
- supportive care ABC
- passive slow external warming (to avoid extreme periph vasodilation
- IV levothyroxine 200-400mcg then 100mcg next day
  ↷ smaller dose if CVS disease
- hydrocortisone 100mg IV QID
- IV liothyronine (T3) 0-50mcg if surgery urgent
- ICU

**Parathyroid Disease**
- PTH actions:
  - bones - release of Ca into ECF/serum via osteoclast activity
  - Kidney - retain Ca, lose PO4
  - ↑vit D activation

**HyperParaThyroid Disease**
- classified by cause:
  - primary
  - secondary
  - tertiary

**Primary Hyperparathyroid**
**Preoperative**
= usually adenoma causing increased secretion of PTH
* assoc with familial multiple endocrine neoplasia (MEN) type 1

**HISTORY**
- asymptomatic
- anorexia
- dyspepsia
- nausea
- vomiting
- constipation
- polydipsia
- polyuria
- poor memory
- drowsiness
- ‘bones, stones, groans and psychic moans’

**EXAMINATION**
- hypertension
- rarely palpable

**INVESTIGATIONS**
- shortened QTc
- high serum Ca²⁺
- low phosphate
- to adjust Ca²⁺ for albumin: add 0.1mmol/L to Ca²⁺ for each 5g/L that albumin below 40g/L

**MANAGEMENT**
- often need methylene blue 1mg/kg to locate glands
- hydrate
- anti-calcium drugs (pamidronate)
- normalise Ca²⁺ and proceed (aim <3mmol/L)
- if any of:
  - Ca >3
  - abnormal ECG
  - CVS or renal impairment
  - postpone op (if able) until after treatment

**Intraoperative**
- monitor response to neuromuscular blockade

**Secondary Hyperparathyroid**

**Preoperative**
- associated with chronic renal failure causing compensatory parathyroid hyperplasia due to low Ca ⇒
  - high PTH,
  - normal or low Ca²⁺
  - high phosphate

**HISTORY**
- chronic renal failure
- excessive bone resorption -> radial aspect of middle phalanx of second digit
- soft tissue calcification of the vascular and soft tissues (including kidneys, heart, lung and skin)

**EXAMINATION**
- soft tissue Ca²⁺ deposition

**INVESTIGATIONS**
- X-ray changes
- high PTH
- normal or low Ca²⁺
- high phosphate

**MANAGEMENT**
- medical Treatment (fails in 15%):
  - dietary phosphate restriction
  - dietary or supplemental Ca²⁺ & vitamin D
- parathyroidectomy
- dialyse prior to surgery

**Intraoperative**
- renal failure cares

**Postoperative**
- post-parathyroidectomy -> monitor for:
  1. bleeding
  2. recurrent hyperparathyroidism
  3. hypoparathyroidism
  4. injury to recurrent laryngeal nerve
  5. hypocalcaemia
6. hypomagnesaemia

**Tertiary Hyperparathyroid**

**Preoperative**
- parathyroid hyperplasia progresses to autonomous secretion behaving like an adenoma
- continues despite correction of renal failure
- only few require op

**HISTORY**
- CRF
- symptoms of hypercalcaemia (stones, bones, groans and psychic moans)

**Intraoperative**
- standard cares

**Postoperative**
- standard cares
- see primary hyperparathyroidism

**Hypercalceamic Crisis**
- most commonly in elderly with undiagnosed hyperparathyroidism & malignancy
- dehydration $\Rightarrow$ anorexia & D&V $\Rightarrow$ exacerbation
- other features = weakness, lethargy, mental changes, coma
- Ca >4.5 = life threatening
- First line Treatments:
  - IVF - 4-6 litres fluid may be required
  - pamidronate - 60mg in 500ml saline over 4 hrs
  - calcitonin:
    - 4unit/kg IV then 4unit/kg s/c bd
    - rapid but temp ↓Ca & PO4 release from bone
- Other treatments:
  - hydrocortisone 200-400mg IV daily - in malignancy
  - IVF & diuresis with furosemide 40mg IV (↓prox tubular reabsorption of Ca)
  - dialysis - reserved for renal failure

**HypoParaThyroid**

**Preoperative**
- under active parathyroid gland
- usual causes:
  - post parathyroidectomy,
  - radiotherapy to neck
  - idiopathic

**HISTORY**
- carpopedal spasm
- tetany

**EXAMINATION**
- Chvostek and Trousseau positive
- hypotension

**INVESTIGATIONS**
- dysrhythmias
- low Ca2+ (corrected) <2.2
trough level post thryoidectomy occurs at 20hrs & normalises by day 2-3
- low PTH
- ECG: prolonged PR and QT

**MANAGEMENT**
- calcium gluconate 10mL of 10% over 10min
- replace Mg2+
- vitamin D
- oral Ca2+
- replace prior to OT

**Intraoperative**
- standard care
- monitor neuromuscular blockade

**Postoperative**
- monitor Ca2+

**Adrenocortical Insufficiency**

= destruction of the adrenal cortex –
  - Glomerulosa = Mineralocorticoids - aldosterone
  - Fasiculata = Glucocorticoids - cortisol
  - Reticularis = androgens - DHEA, testosterone

**Classification**

**Primary (Addison’s Disease)**
- causes:
  1. autoimmune destruction (80%)
  2. infection (TB)
  3. septicaemia
  4. AIDS
  5. haemorrhage
  6. metastases
  7. surgery
- both glucocorticoid and mineralocorticoid deficiency

**Secondary**
- due to insufficient ACTH to stimulate adrenal cortex
  - caused by pituitary suppression by:
    - exogenous steroids
    - generalised hypopituitarism - tumour
- only see glucocorticoid deficiency

**Acute Crisis**
- crisis ether =
  - chronic insufficiency without adequate steroid cover
  - acute adrenal haemorrhage
  - pituitary apoplexy
  - sudden neuro impairment usually due to vasc process eg bleed or infarction

**Preoperative**

**HISTORY**
- chronic insufficiency symptoms:
  - weakness
  - fatigue (100%)
skin hyperpigmentation - primary only (90%)
postural symptoms - pronounced in primary (90%)
D&V
weight loss (60%)
myalgia
joint pain
salt craving - primary only
pale skin - secondary only

EXAMINATION
- postural hypotension
- pallor (secondary)
- pigmentation (primary)

INVESTIGATIONS
- low glucose
- low Na+ (90%)
- raised K+ (70%)
- raised U and Cr (primary only)
- raised Ca2+ (primary only)
- early morning low cortisol (<165nmol/L - primary or <100nmol/L - secondary)
- short synacthen test - peak cortisol <500nmol/L (30mins post 250mcg synacthen)

Table 8.5 Biochemical diagnosis of adrenal insufficiency

<table>
<thead>
<tr>
<th>Test</th>
<th>Normal range</th>
<th>Definite adrenal insufficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early morning cortisol</td>
<td>165-680nmol/L and ACTH &gt; 22.0 pmol/L</td>
<td>Cortisol &lt; 165nmol/L and ACTH &gt; 22.0 pmol/L</td>
</tr>
<tr>
<td>Early morning ACTH</td>
<td>1.1-11.0 pmol/L</td>
<td>Not diagnostic</td>
</tr>
<tr>
<td>Synacthen test Peak cortisol</td>
<td>&gt; 500nmol/L</td>
<td>Peak cortisol &lt; 500nmol/L</td>
</tr>
<tr>
<td>Insulin tolerance test Peak cortisol</td>
<td>&gt; 500nmol/L</td>
<td>Peak cortisol &lt; 500nmol/L</td>
</tr>
</tbody>
</table>

MANAGEMENT
- hydrocortisone 20mg mane, 10mg nocte PO
- fludrocortisone 0.1mg PO (primary only)
- give all medication morning of surgery

Intraoperative
- hydrocortisone 25mg IV @ induction then 5mg/hr as infusion
  → alternatively 100mg IM
- see perioperative steroid guideline

Postoperative
- Q4 hourly glucose
- daily U+E's
- consult endocrinologist but rough steroid cover:
  → should repeat induction steroid strategy 6hrly until eating & drinking
  → then double normal oral steroid dose for:
    - major surgery = 48hr
    - minor surgery = 24hr
  → then return to normal steroid regime
  → any issues return to high dose oral steroids
- replacing mineralocorticoid:
20mg of hydrocortisone = 0.05mg fludrocortisone.
∴ once giving >50mg of hydrocortisone you don’t need to worry about fludro supplementation.

**Acute Adrenal Crisis (Addisonian Crisis)**
- classical presentation:
  - bp
  - ↓Na, ↑K, ↓BSL
  - abdo pain
- looks like hypovolaemic shock but can mimic septic shock ie fever, vasodilation, high CO
- if DM type 1: may present as deterioration of glycaemic control with recurrent hypo's
- Rx:
  - supportive care
  - IVF resus
  - take baseline cortisol & ACTH then give.....
    (تبادل if unable then can give 4mg IV dex as doesn’t interfere with testing)
  - hydrocort 200mg IV then 100mg qds
  - treat precipitant

**Cushing’s Syndrome**

**Preoperative**
- syndrome due to excess plasma cortisol
- causes:
  1. iatrogenic steroid administration (commonest)
  2. pituitary adenoma (80% of remainder)
  3. ectopic ACTH (small cell carcinoma) (15% remainder)
  4. adrenal adenoma (4%) /carcinoma (rare)

**CLINICAL**
- appearance: moon face, truncal obesity, proximal myopathy
- tissue: Osteoporosis, easy bruising, thin skin
- co-morbidities: DM, OSA, GORD, peptic ulcer disease
- CVS: hypertension, LVH, IHD

**INVESTIGATIONS**
- Diagnosis:
  - dex suppression test (8mg)
  - ACTH level:
    - normal/high ≈ pituitary
    - low ≈ adrenal, ectopic cortisol admin
    - very high ≈ ectopic ACTH
  - plasma cortisol - high with loss of diurnal variation
  - urinary 17-OH-steroids
- Assoc findings:
  - bloods: ↑Na+, ↑K, ↓Ca
  - ↑HCO3-
- ECG - high voltage QRS, inverted T waves
  - bp - 80% bp

**MANAGEMENT**
- treat cause
- DM cares
- steroid supplementation perioperatively if indicated
**Intraoperative**
- difficult veins
- careful airway assessment
- peptic ulcer prophylaxis
- monitor electrolytes
- pressure area cares

**Postoperative**
- standard care

---

**Conn’s Syndrome**

**Preoperative**
= excessive secretion of aldosterone from either:

1. an adenoma (60%)
2. benign hyperplasia (35-40%)
3. adrenal carcinoma (rare)

- results:
  - ↑Na+ reabsorption & ↑K+ excretion ⇒ serum ↑Na, ↓K
  - increase in ECF H2O
  - tubular secretion of H+ and Mg2+ -⇒ metabolic alkalosis

**CLINICALLY**
- hypertension
- hypervolaemia
- metabolic alkalosis
- muscle weakness or paralysis from low K+ [late sign]
- polyuria (nephrogenic DI from tubular damage
  ⌫ opposite to what might think
- impaired glucose tolerance (50%)

**INVESTIGATIONS**
- low K+ (<3.5mmol/L)
- low serum aldosterone
- adosterone:renin ratio >400
- imaging: adrenal vein sampling, CT/MRI

**MANAGEMENT**
- spirinolactone (inhibits aldosterone) – up to 400mg/day
- aim for normal K+ and HCO3-
- exclude end-organ damage from HT
- anti-hypertensives (Ca2+ channel blockers or ACE-I)
- may need adrenalectomy

**Intraoperative**
- adrenalectomy (open or laparoscopic): phentolamine, MgSO4, BSL monitoring, invasive monitoring
- ↓K intra-op causes:
  - prolonged action of NMBs
  - ↓BSL
  - Suppress baroreceptors
- If bilat adrenalectomy - need to replace mineralocorticoids & glucorticoids

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**Endocrine Disease - 16**
Postoperative
- IV hydrocortisone -> PO prednisone + PO fludrocortisone
- monitor and manage BP

Anaesthesia for pt with Conn’s syndrome for Non-Adrenal Surgery
- pt has bilat hyperplasia of zona glomerulosa
- HTN more severe ⇒ ↑ing doses of antiHTN required - ACEI useful
- aim restore K prior to theatre

Carcinoid Tumours
Preoperative
= syndrome produced from vasoactive peptide secretion from carcinoid tumours
- derived from argentaffin cells ⇒ produces peptides and amines
- found in: GI tract (75%), bronchus, pancreas and gonads
- Tumours:
  ▪ most benign
  ▪ of malignant ones: only 25% release vasoactive substances into systemic circulation ⇒ carcinoid syndrome
  ▪ mediators metabolised in liver ⇒ only produce syndrome if:
    - tumour with hepatic metastasis
    - non-portal venous drainage
  ↓ about 10% with carcinoid tumours have syndrome
- vasoactive substances: serotonin, bradykinin, histamine, substance P, prostaglandins, vasoactive intestinal peptide
- Summary:
  ▪ asymptomatic carcinoid tumour have simple disease & no specific anaesthetic issues
  ▪ it is carcinoid syndrome ⇒ major problems

Carcinoid Syndrome
- affects 10% with carcinoid tumours
- symptoms from:
  ▪ mass effect from primary tumour eg bowel obstruction, pulmonary symptoms eg haemoptysis
  ▪ vasoactive peptides:
    - flushing 90% (esp head/neck/torso)
    - diarrhoea 78% ⇒ dehydration & electrolyte imbalance
    - bronchospasm 20%
    - CVS: ↓↑bp, ↑HR, R heart failure (endocardial fibrosis of PV & TV)
    - ↑BSL
  ↓↑mediators metab’ed in lung prior to reaching L heart

INVESTIGATIONS
- dependent on symptoms
- blds: FBC, UEs, LFTs, coag
- cross match
- ECG ?RV hypertrophy
- ECHO
- CXR
- spirometry

MANAGEMENT
- symptomatic: antidiarrhoeals, bronchodilators, hydration, replace electrolytes, heart failure
- octreotide 100mcg SC tds for 2 weeks prior to surgery (prevents mediator release)
- avoid factors that may produce crisis = stress, catecholamines, histamine releasing drugs (morphine)

**Intraoperative**
- octreotide 100mcg IV @ induction (if not already treated)
- tertiary referral
- be ready for
  - severe hypo/hypertension
  - explosive bronchospasm
  - electrolyte problems
  - fluid shifts
- monitor electrolytes
- invasive monitoring
- consider epidural:
  - ↓stress response from surgery ⇒ ↓carcinoid crisis
  - careful LA top up as ↓bp ⇒ bradykinergic crisis
- prevent pressor response to intubation
- sux has be used safely
- TIVA or volatile
- octreotide boluses 10-20mcg boluses for severe hypotension
- avoid all histamine releasing drugs
- labetalol, esmolol good for hypertension

**Postoperative**
- ICU or HDU
- may wake very slowly (thought 2nd to serotonin)
- PCA fentanyl or epidural
- be ready for hypotensive episodes ⇒ IV octreotide 10-20mcg
- wean octreotide over 7 days post resection

**Gastrinoma**
= excess production of gastrin by benign adenoma, malignancy or hyperplasia for D pancreatic islet cell
- gastrin ⇒ ↑acid production from parietal cells

**CLINICALLY**
- may produce
  - Zollinger-Ellison syndrome,
  - severe peptic ulceration
  - diarrhoea
- GI bleeds
- GI perforation
- electrolyte disturbance
- volume depletion

**INVESTIGATIONS**
- FBC
- coag’s (vit K may not be absorbed)
- LFT’s

**MANAGEMENT**
- PPI
- H2 antagonists
- octreotide
- invasive monitoring
**VIPoma**

= rare tumour secreting vasoactive intestinal peptide (VIP) – inhibits gastrin release

**CLINICALLY**
- profuse watery diarrhoea
- intestinal ileus
- abdominal distension
- confusion
- drowsiness
- tetany

**INVESTIGATIONS**
- ↓K, ↓Cl, ↓Mg2+
- ↑BSL
- metabolic alkalosis

**MANAGEMENT**
- 60% become malignant with liver mets so all warrant resection
- give H2 antagonists prior to surgical excision c/o rebound gastric hypersecretion
- IVF
- octreotide - if fails ⇒ methylprednisolone & indomethacin
- invasive monitoring
- monitor electrolytes
- monitor ABG’s

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**Insulinoma**

= rare tumour of beta cells of pancreas that secrete insulin

**CLINICALLY**
- symptoms of hypoglycaemia

**INVESTIGATIONS**
- low plasma glucose (<2.2mmol/L)
- increased insulin
- increased C peptide
- absence of sulphonylurea in plasma

**MANAGEMENT**
- if surgery fails try diazoxide (= non-diuretic benzothiazide which inhibits release of insulin) ⇒ unpredictable efficacy
- monitor glucose and treat

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**Glucagonoma**

= tumour of alpha cells of pancreas ⇒ increased glycogenolysis, gluconeogenesis and increased plasma glucose ⇒ DM
- ketogenesis rare as insulin also increased

**CLINICALLY**
- rash (necrotising migratory erythema in groin/perineum and migrates to distal extremities)
- weight loss
- glossitis
- stomatitis
- anaemia
- diarrhoea
- liver met
INVESTIGATIONS
- BSL
- MRI
- glycogen level

MANAGEMENT
- debulk tumour
- somatostatin analogues
- increased risk of DVT -> prophylax
Electrolytes

**Hypokalaemia**

- Hypokalaemia = K+ <3.5

Mild - 3.0-3.5
Moderate – 2.5-3.0
Severe - <2.5

** Causes:**
- decreased intake
- increased loss – vomiting, diarrhoea, N/G loss, diuretics, RTA, hyperaldosteronism, Mg depletion, leukaemia
- intercompartmental shift – insulin, salbutamol, steroids, alkalosis

**CLINICALLY**
- weakness, tetnay, ileus
- ECG – T wave flattening and inversion, prominent U waves, ST depression, prolonged PR interval
- dysrrhythmias, decreased contractility
- decreased insulin, GH and ALD secretion

**MANAGEMENT**
- check U+E & glucose
- Must replace Mg before K
- exclude Cushings (overnight dexamethasone suppression and 24hr cortisol) and Conns (aldosterone and cortisol)
- oral or IV replacement - aim for K >4 if arrhythmia:
  - Max conc
    - peripheral IV = 40mmol/L
    - central IV = 40mmol in 100ml saline/1hr
  - K depletion of 0.3mmol/L = total body loss of ~100mmol from total store
- ?on digoxin ⟹ aim for K >4 as ↑risk of dig toxicity at low K levels
- risk of arrhythmia
- prolongation of NMB
- preop requirements:
  - elective = K>3 - otherwise postpone (although controversial and should consider acute change in K and other co-morbidities)
  - emergency = K >3.5.
    - Aim to replace K in 24hrs prior to surgery
    - check HCO3 - if ↑ed then likely chronic ↓k ≈ low intracellular K ⟹ may take days to replace

**Hyperkalaemia**

K+ > 5.5 mmol/L

Mild – 5.5-6.0
Moderate – 6.0-7.0
Severe >7.0

**Causes**
- increased intake – IV administration or rapid blood transfusion
- decreased urinary excretion – renal failure, adrenocortical insufficiency, drugs (K+ sparring diuretics, ACEI, cyclosporine)
- intercompartmental shift – acidosis, rhabdomyolysis, trauma, MH, sux, familial periodic paralysis, tumour lysis syndrome
- pseudohyperkalaemia ie lab error/haemolysis
CLINICALLY
- nausea, vomiting, diarrhoea
- ECG: peaked T waves -> widen QRS -> prolonged PR -> loss of P waves -> loss of R wave amplitude -> ST depression
  -> VF -> asystole
- mm weakness >8

MANAGEMENT
- treat cause
- treat urgently if K >6.5 or ECG changes:
  › insulin
    - 10U in 150mL of 10% dextrose over 30min
    - fastest onset of action
    - shifts K into cells
    - rebound occurs within 2hrs
  › salbutamol: response by ~30min. DUration action >2hrs
  › calcium
    - gluconate 10% 10mL, chloride 10% 5mL
    - stabilises myocardium by ↑threshold potential
    - rapid onset, short lived effect
  › HCO3- if acidotic (50mmol)
  › calcium resonium - oral 15g PO 8hrly to bind K in gut
- haemofiltration/dialysis
- avoid saline - acid load has bigger effect on serum K than that in Plasmalyte
- avoid sux
- avoid hypothermia
- avoid resp acidosis
- monitor K+

Hyponatraemia
- = Na+ < 135:
  › Mild 125-134
  › Moderate 120-124
  › Severe <120
- ECF volume proportional to total body Na content
- renal Na excretion controls ECF volume ∴ total body Na

CLINICALLY
- speed of onset more important than level
- 125-130 = mostly Gi symptoms is D&V
- <125 =
  › neuropsychiatric symptoms
  › muscular weakness
  › headache
  › lethargy
  › psychosis
  › raised ICP
  › seizures
  › coma

DIAGNOSIS
- diagnose based on fluid status:
  › Hypovolaemic:
    - Urinary Na <30mmol/L = extrarenal cause ie D&V, burns, pancreatitis, trauma
    - Urinary Na >30mmol/L = primary renal problem ie diuretic/osmotic fluid losses, mineralcorticoid deficiency (addisons), salt wasting nephropathy, prox renal tubular acidosis
  › Euvolaemic (psychogenic polydipsia, hypotonic IVF, bowel prep, SIADH)
  › Hyerpervaemic (renal failure, hepatic cirrhosis, CHF, nephrotic syndrome, TURP syndrome)
Drugs!

**MANAGEMENT**
- treat cause
- acuteness of change important rather than actual level
- rare to have signs >125mmol/L
- no elective surgery until
  - Na+ > 120mmol/L and asymptomatic
- asymptomatic - fluid restrict to 1L/day
- asymptomatic hyponatraemia (often chronic)
  - fluid restrict to 1L/d
  - treat cause
- acute and symptomatic (<48hrs)
  - raise by 2mmol/L/hr until symptoms resolve
  - hypertonic saline (3%)
    - 1-2ml/kg/hr & measure Na hourly
    - if severe neuro symptoms raise to 4-6ml/kg/hr
  - if fluid excess then give frusemide 20mg IV
- chronic symptomatic (>48 hrs or unknown duration)
  - correct Na+ by 5-10mmol/L/day
  - faster correct = central pontine myelinolysis, subdural haemorrhage, cardiac failure
  - if hypovolaemia: correct with 0.9% NSL
  - if hypervolaemic:
    - fluid restrict
    - frusemide 20mg IV
  - if SIADH:
    - fluid restrict
    - give demeclocycline 300mcg daily
  - monitor electrolytes ev 12hrs

**Anaesthesia**
- postpone elective surgery <120 or symptomatic
- if emergency consider risks/benefits & consult endocrinologist

**Hypernatraemia**
- = Na+ > 145
  - Mild 145-150
  - Moderate 151-160
  - Severe >160

**CAUSES**
- define on fluid status:
  - hypovolaemic =
    - renal - diuretics, intrinsic renal disease, post obstruction
    - extra-renal - D&V, burns, excessive sweating, fistulae
  - euvolaemia = DI, insensible losses
  - hypervolaemic:
    - Salt ingestion/hypertonic saline, Conn syndrome, Cushings syndrome

**CLINICALLY**
- CNS symptoms if >155 - due to hyperosmolar state & cell dehydration:
  - thirst, confusion, seizures, coma
MANAGEMENT
- treat cause
- correct over 48 hours
- use oral route if possible - give free water
- specifics:
  ‣ hypovolaemia (Na deficiency) ➞ balanced crystalloid until corrected
  ‣ euvolaemia (water depletion) ➞ estimate TBW deficit ➞ give 5% glucose
  ‣ hypervolaemia (Na excess) ➞ diuretics & 5% glucose +/- dialysis
  ‣ DI: replace urinary losses, desmopressin 1-4mcg daily

Anaesthesia
- no elective surgery until Na+ <155 or normovolaemic
- invasive monitoring