29 Toxicology

PRINCIPLES OF MANAGEMENT

RRSI-DEAD

Resuscitation
- ABC
- Detect & correct (glc, seizures)
- Emergency *antidote*

Risk assessment
- Drug, dose, duration until presents
- Clinical presentation/progress, phx

Supportive care & monitoring
- BP: fluid/vasopressors, HDI, methylene blue, ECMP
- ↑HR: *adenosine, amiodarone, $MgSO_4$, $NaHCO_3$*
- ↓HR: *atropine*, pacing incl overdrive
- Seizure: *$NaHCO_3$, BZDP*, NEVER ~~Phenytoin~~

Investigate
- Routine: ECG, BSL, bHCG, paracetamol
- Coma: *salicylates, BAL*
- Specific drugs: Fe, digoxin, lithium, phenytoin, valproate, CBZP, theophylline, K+

Decontamination
- DAWG: AC, Repeated AC, WBI, GL

Enhanced elimination
- MUDE: MDAC, Urinary Alkalisation, Dialysis, Endoscopy

Antidotes

Disposition

GENERAL APPROACH

Pathognomonic Signs

- **Salicylism**: tinnitus, nausea, vomiting
- **Cinchonism**: tinnitus, vertigo, high fq hearing loss, flushed, sweaty skin

Coma

- Cause: direct, indirect, co-morbid condition
- Rapid reversal: *↓ BSL or Opiate*
- If I&V ensure *resp compensation matched* on ventilator
- Focal neuro = not tox

Complications of prolonged coma

- Aspiration
- AKI
- Hypoxic brain injury
- Rhabdomyolysis
- Compartment syndrome
- Pressure areas

Hypotension

1. ECG & Correct arrythmia
2. IV access & Fluid bolus: more for losses eg *Fe, Colchicine*
3. Antidotes eg *dig-specific antibody, Ca*
4. *Atropine* & pacing (overdrive or regular)
5. Vasoactives: *Noradrenaline, Adrenaline, Dobutamine*
6. Central monitoring
7. *HDI*
8. ECMO

Seizure

Common Causes

- *Venlafaxine*
- *Bupropion*
- *Tramadol*
- *Amphetamines*

Other

- Anticonvulsants
- Antihistamines
- *Antidepressants*
- *Antipsychotics*
- *Hypoglycemics*
- LA
- Nicotine
- NSAIDs
- Opiates
- *Salicylates*
- Sympathomimetics
- Amphetamines
- *Withdrawal*

Management

DO NOT use *phenytoin*

1. AB - I&V if coma before seizure
2. O_2
3. Check Output & BSL
4. IV access
   → *BZDP*
   → *Phenobarbitone* 100-300mg IVI (10-20mg/kg)
   → *Pyridoxine* as 3rd line if from *isoniazid*

Delirium/agitation

Stepwise Approach

1. Environment
2. BZDP
3. Antipsychotics (not anticholinergic synd), atypical less SE
4. ECG
5. Other causes
6. Antidotes
7. DVT/Pressure prophylaxis

Specific Mx

Anticholinergics	*Physostigmine*
NMS	*Bromocriptine*
Salicylates	Urinary alk, CVVHD
Serotonin Syndrome	*Cyproheptadine*, I&V&Paralysis
Theophylline	MDAC, CVVHD

RISK ASSESSMENT

Drug

1 Pill Can Kill Drugs in Kids

ABCD-POSTV

- Amphetamines
- Baclofen
- CCB, CBZP, Clozapine, Chloroquine
- Dextroproxyphene
- Propranolol
- Opiates
- Sulfonylureas
- Theophylline, TCAs
- Venlafaxine

1 Sip Can Kill Drugs in Kids

PHONC

- *Paraquat*
- *Hydrocarbons*
- *OG*
- *Naphthalene*
- *Camphor*
- *Corrosives*
- *Strycnine*

Important Drugs for Adults

1. **CCB**
2. **Beta-Blockers**
3. **TCA**
4. **Salicylates**
5. **Digoxin**
6. **Lithium**
7. **Iron**
8. **Alcohols**
9. **Paracetamol**
10. **Venlafaxine**

Drug Properties

See drugs for more details on critical levels

- CCB > 10 tablets
- Salicalytes; <150,150-300, > 300, > 500
- Digoxin; K > 5, > 10mg ingested, Lv > 15 nmol/L
- Lithium; > 25g, Lv > 2.5 nmol/L
- Fe; < 20, 20-60, 60-120, > 120
- Venlafaxine; > 4.5g = 100% seizure, > 7.5g = LV dysfunction
- TCA; 5-10 mg/kg = anticholinergic, > 10 serious, > 30 dead

ECGS IN TOX

Blocked	ECG Δ	Causative Agents	
Na Ch	QRS > 100ms Terminal R in aVR[1]	- *TCAs* - *Phenothiazines* - *Propanolol*	- *Class 1a,c* - *CBZP* - *LA*
K Ch	Prolonged QT → TdP	- *Antipsychotics* - *Class 1a, c, 3* - *Antihistamines*	- *TCAs* - *Propanolol* - *Abx*[2]
Na-K Block	↑ Automaticity AV block 1-3	- *Digoxin*	
Ca Ch	↓ HR AV block 1-3	- *CCB*	
B-rec	Same as CCB	- *B-blockers*	

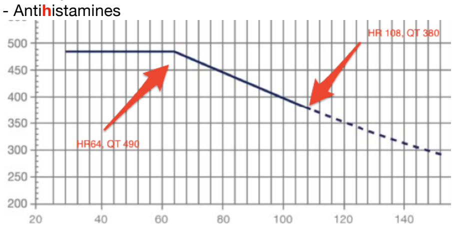
[1] Represent R axis deviation, pathognomonic with *TCA* OD
[2] *Fluroquinolones, macrolides* eg *azithromycin*

Torsades

- Caused by R-on-T when QTc prolonged

Causes

Anti-abdph
- Antiarrythmics eg *flecainide, sotalol*
- Antibiotics eg *Erythromycin*
- Antidepressants eg *TCAs, citalopram*
- Antipsychotics
- Antihistamines



DECONTAMINATION

Ipecac & Cathartics no longer considered

DAWG
- Activated charcoal (AC)
- Whole bowel irrigation (WBI)
- Gastric lavage

Activated Charcoal (AC)

- *Into lung = fatal*
- Doesn't work for
  - Anything on periodic table: Li, Fe, K, Pb, Ar, Hg
  - Alcohols
  - Corrosives
- *1g/kg max 50g*, can mix with ice-cream
- Ideally dose based eg *10:1* AC:drug (ie msg req less)

Whole Bowel Irrigation (WBI)

- Takes ~ 6hrs
- Indications (*ABC PIL*)
  Arsenic, Body packers, CCB, Potassium, Iron, Lead
  Fe 60mg/kg, KCL 2.5 mmol/kg
- Technique
  - Mix *PEG-ELS* in 4L H_2O
  - Give *50g AC*
  - Give *2L/hr (24ml/kg/hr)*
  - Consider *Maxolon*
  - Rectal tube or commode
  - *Stop when clear*

Gastric Lavage (GL)

- Pills < 40G OGT ie 13mm
- L decubitus, head 20
- Confirm location
- 200ml warm H_2O lavage
- *Stop when clear*
- 50g *AC*

ENHANCED ELIMINATION

MUDE
- Multi-dose AC (MDAC)
- Urinary Alkalisation (UA)
- Dialysis
- Endoscopy

MDAC

Indications

- *CBZP* (most common) & *Phenobarbitone* = ↓ ETT time
- *Dapsone* = ↓ MetHb production
- *Quinine* & *Theophylline* = supportive, not commonly used

Technique

- Usual *AC* ie 50g or 1g/kg → *25g or 0.5g/kg q2h*

Urinary Alkalisation

Indications

- *Salicylates:* mild/mod only
- *Phenobarbitone:* MDAC better

Technique

- Bolus: 1-2mmol/kg *$NaHCO_3$* IV bolus
- Infusion: 150ml in 850ml 5%D at 250ml/hr
- Monitor K
- *Aim urine pH > 7.5*

CVVHD/F

- *CBZP, Li, Salicylates, K, Alcohols, Valproic acid, Theophylline, Metformin*

ANTIDOTES

High Dose Insulin (HDI)

- Indications CCB or β-blocker OD
- Bolus 1u/kg + 50ml 50%D
- Infusion 0.5-2u/kg/hr

Naloxone

- Opiates 0.01 mg/kg
- 100mcg adults 400mcg kids q1min max 2g
- Infusion = 2/3 dose per hour (2mg in 100ml NS)

Flumazenil

- BZDP
- 0.2mg q1min, 0.01mg/kg Paed max 1mg

$NaHCO_3$

- Indications: TCA, Propranolol, Salicylates, Alcohols, CPR++
- Bolus 2 mmol/kg
- Infusion 150 mmol in 850ml NS @ 250ml/hr
- TCA 2 mmol/kg q2min until pH 7.5-7.55, QRS < 100ms

Calcium

10% CaCl 10ml = 6.8 mmol
10% CaGlu 10ml = 2.2 mmol

- Indications: CCB, HFA, ↑ K, ↑ Mg, ethylene glycol
- CCB: 20ml *CaCl* or 60ml *CaGlu* x3
- All else: 5-10 ml *CaCl*, 10-20ml *CaGlu*
- HFA skin is *CaGlu*
  - topical/neb 2.5%
  - sub/cut 0.5 ml/cm²
  - Biers 10ml in 40ml NS min 20min
  - Arterial 10ml in 40ml NS over 4hrs
- HFA inhalation 2.5% CaGlu solution

Digoxin Immune Fab

- 20 amps arrest
- 10 amps unstable
- 05 amps stable but lethal
- Acute = 1.6 x mg
- Chronic = 0.01 x lv x kg

NAC

150mg/kg 100ml 5%D over 15min
050mg/kg 500ml 5%D over 4hrs
100mg/kg 1L 5%D over 16hrs (100mg/kg if > 50g OD)

Atropine

- OP, carbamate, digoxin, β-blockers, CCB
- OP 1.2mg, double q2min until dry
  - use *pralidoxime* too 2g
- All else: 0.61.21.8 q15min (0.02mg/kg)

Cyproheptadine

- Serotonin syndrome
- 8mg q8h + BZDP

Physostigmine

- 2nd line anticholinergic (BZDP 1st)
- *Atropine, antihistamines, TCAs*
- 0.5-1mg (0.02mg/kg)

$MgSO_4$

10mmol = 2.47g
- Eclampsia = 40mmol
- Everything else = 10mmol

Desferoxamine

- Indications
  1. **Fe > 90 umol/L @ 4h**
  2. **Clin feat eg GIT, MA, ALOC, Shock**
  3. **Chronic overload**
- 15mg/kg/hr (watch for ↓ BP)
- Stop when pt stable or Fe < 60 umol/L

Antidotes: Less Common

Octreotide

- Sulfonylurea, Quinine
- Inhibits release of endogenous insulin
- Bolus 50 µg
- Infusion 25 µg/hr

10% Ethanol

- Methanol, ethylene glycol
- Bolus 8ml
- Infusion 1-2ml/kg/hr

Lipid Emulsion

- Local anaesthetic arrest, last line TCA, CCB
- Bolus 1-1.5ml/kg x2-3 q3-5min
- Infusion 0.25-8ml/kg/min
- SE: ARDS, pancreatitis

Methylene Blue

- MetHb > 20%, 3rd line anaphylaxis, TSS
- Bolus 1-2mg/kg

Folinic Acid

- Methotrexate, Trimethoprim
- 15mg q6h 3d

Hydroxycobalamin

- CN suspected (burns, high lactate, CV instability)
- 2.5g x2

TOXIDROMES

Opioid

- Feat: Miosis, ↓HR, ↓RR
- Mx supportive incl ***NalOxone***

Cholinergic

- Cause: ***organophosphates, carbamates, bioterrorism***

Features

DUMBELLS (red = muscurinic effects)

- ***Diarrhoea***, Diaphoresis
- ***U***rination
- ***Meiosis*** (muscurinic) > Mydriasis (sympathomimetic)
    - ***Meiosis common in chemical warfare***
- ***Bronchospasm, bronchorrhoea***
- ***Emesis***
- ***Lacrimation***
- ***L***ethargy
- ***Salivation***, Seizures
- ***O***ther
    - Weakness
    - Fasciculations
    - ***↓HR*** (muscurinic)
    - Confusion/coma
    - ***↑ HR (sympathomimetic) - common from 2ry cause***

Management

- ***Atropine*** for muscurinic effects: 1.2mg – x2 q2min until dry
- ***Pralidoxime(controversial)***

Anticholinergic

Cause

- ***Antihistamines***
- Antimuscarinics
    - ***Atropine***
    - ***Hyoscine***
    - ***Glycopyrrolate***
- ***Antipsychotics***
- Plants
    - mushrooms
    - datura
- ***BZDP***
- ***TCAs***
- ***CBZP***
- Ophthalmic
    - ***Cyclopentolate***
    - ***Homatropine***
    - ***Tropicamide***

Features

Mad as a hatter, Blind as a bat, hot as a hare, dry as a bone, the heart runs alone

Central	**Peripheral**
- ***Agitated delirium***	- Mydriasis
- Tremor	- ↑HR
- Myoclonus	- ↑T
- Coma	- Dry mouth
- Seizure (rare)	- Dry skin
- ↓ Glc	- Flushing
	- Absent bowel sounds
	- Urinary retention

Management

- Fluids/Cool/IDC for retention
- ***BZDP*** 1st line for delirium
- ***Physostigmine*** 2nd line for delirium ± diagnostic
- Avoid anticholinergics
- Agitated delirium can last days

Sympathomimetics

- Cause: ***cocaine, amphetamines***
- Feat: ↑HR, BP, sweating, tremor, seizures, hallucinations

Management

- Cooling
- BZDP
- Hydration

Toxidrome	Pupils	HR	BP	T	RR	GI	Sweat	Other	Causes
Opiod	••	↓	↓	-	↓	↓	-	-	Opiates
Cholinergic	••	-	-	-	-	↑	↑	DUMBELLS[1]	Organophosphates, Carabamates
Anticholinergic	●●	↑	-	↑	-	↓	↓	Blind as a bat…[2]	Antihistamines, BZDP, CBZP, TCAs, phenothiazines, plants
Hallucinogenic	●●	↑	↑	↑	↑	↑	-	Hallucinations, anxiety, dysphoria, seizures	LSD, PCP, Ketamine
Sympathomimetic	●●	↑	↑	↑	↑	↑	↑	↓ K, ↑ Glc	Amphetamines, cocaine, caffeine, salbutamol, theophylline
Seratonin	●●	↑	↑	↑	↑	↑	↑	ALOC, hyper-reflexive, clonus	Amphetamines, antihistamines, MAOIs, SNRIs, SSRIs, TCAs, Li, Tramadol, Fentynl, Ondansetron, LSD
NMS	●●	↑	↑	↑↑	↑	-	↑	Lead-pipe rigidity, mutism, bradykinesia, dystonia, catatonia	Antipsychotics
MH	●●	↑	↑	↑↑	↑	-	↑	Generalised rigitidty, ↑ $ETCO_2$	Inhalational anaethetics, Sux
Sedative-hypnotic	-	↓	-	-	↓	-	-	Sedation, confusion, delirium, ataxia, coma	BZDP

[1] Diorrhea, urination, mydriasis, bronchospasm, emesis, lacrimation, lethargy, salivation, seizures; bronchial secretions, weakness, fasciculations
2 Blind as a bat, hot as a hare, dry as a bone, mad as a hatter, the heart runs alone; agitated delerium, retention, ileus

Serotonin Syndrome

Causes

- New single serotonergic drug
- Δ of serotonergic drug (without washout period)
- Drug interaction: 2 agents or illicit/herbal
- Deliberate self harm

Implicated Drugs

- Amphetamines/LSD
- Analgesics: tramadol, fentynl
- ***AAAnti-PHED***
- Antipsychotics: lithium
- Antihistamines
- Anti-emetics: ondansetron
- Anti-depressents: TCAs, SSRIs, SNRIs, MAOIs

Features

Triad of

1. Autonomic signs: Mydriasis, ***Diaphoresis***, ***↑T***
2. Neuromuscular: ***Hypertonic, Hyper-reflexia,*** tremor, ***Clonus*** (spont, inducible, ocular)
3. Mental state: ***Agitation***, delirium, seizure, coma
4. ***Life-threatening: T>38.5C + ↑ truncal rigidity + peripheral hypertonia***

Hunter Serotonin Toxicity Criteria

1. Spont clonus
2. Inducible clonus & agitation or diaphoresis
3. Ocular clonus & agitation or diaphoresis
4. Tremor & hyper-reflexia
5. Hypertonic and ↑T & ocular or inducible clonus

Management

- ***BZDP*** for neuro, ↑HR, ↑BP
- ***GTN*** 2nd line ↑BP
- Anticholinergic effects (not useful if intubated)
    - PO ***Cyproheptadine*** 8mg q8h
    - SL ***Olanzapine*** 5-10mg
    - IV ***Chlorpromazine*** 25-100mg in 100ml NS
- Fever control

Sedative-Hypnotics

- Cause: ***Benzodiazepines***
- Feat: ↓HR, ↓RR, sedation/coma, confusion/delirium, ataxia

Management

- I&V
- ***FlumaZenil***

Methaemoglobinaemia

Causes

- ***Metoclopramide***
- ***Nitrates eg SNP, GTN***
- ***Napthalene/Camphor***

ABx

- ***Trimethoprim***
- ***Sulphonamides***
- ***Dapsone***

Local Anaesthetics

- ***Benzocaine***
- ***Prilocaine***

Features

- Low SaO_2 ~ 80%
- High PaO_2
- ***Chocolate blood***

Management

- Level < 20% - watch
- Level > 20% - ***methylene blue*** 1-2 mg/kg
- Consider HBOT, exchange transfusion

Tardive Dyskinesia

Clinical Features

- Tongue protrusion/rolling
- Lip smacking/sucking
- Chewing motion
- Facial dyskinesia
- Involuntary movt of body/extremities

Causes (Antipsychotics)

- Typicals (30%): ***haloperidol, droperidol, chlorpromazine***
- Atypicals (20%): ***clozapine, respiridone, quetiapine, olanz***
- ***Metoclopramide***

Drug Withdrawal

- ***Diazepam*** 20mg q2h max 100mg/d
- ***Thiamine*** 300mg IM/IV
- Haloperidol 0.5-2mg
- Droperidol 5mg IM
- Hydration & Electrolytes

Malignant Hyperthermia (MH)

- Cause: Inhalational agents, ***Suxamethonium***
- Feat: ↑ $ETCO_2$, rigidity, high HR, BP, RR

Management

- Stop agent
- 100% O_2 & Hyperventilate
- BP control
- ***$NaHCO_3$***
- ***Dantrolene*** 2.5mg/kg

Neuroleptic Malignant Syndrome (NMS)

Cause

- antipsychotics (0.02-2.5%)
- no less with introduction of atypical

Clinical Features

- Triad of ***rigidity, ALOC, autonomic instability***
- Onset 24-72 hrs, offset days - months

CNS	*Autonomic*	*Neuromuscular*
- Confusion	- ***↑T***	- ***Lead-pipe rigidity***
- ***Delirium***	- ↑HR	- Brady/akinesia
- Stupor	- ↑BP	- Mutism/staring
- Coma	- Δ Resp	- Dysarthria
	- Arrythmia	- Dystonia/abnormal posture
		- Invol movt
		- Incontinence

Suggested Criteria

- Recent exposure to dopamine antagonists (or r/o agonist)
- ↑ T
- Rigidity
- ALOC
- ↑ CK ≥ 4x normal
- Symph lability ie 2 of:
    - ↑ BP
    - BP↑↓
    - Diaphoresis
    - Urinary incontinence
    - ↑ HR + RR
- No other cause

Risk factors

- High dose
- Large ↑
- Genetics
- Parenteral
- ≥ 2
- Young male
- Dehydration
- Organic

Management

- ***BZDP*** controversial since part of aetiology of NMS
    - use in mild/moderated for ***delirium & rigidity***
    - not 1st line for autonomic instability or ↑BP (use ***GTN***)
- ***Bromocriptine*** 2.5mg NG/PO q8h
    - 1st line in ***autonomic instability***
    - Resolution within 24hrs (delirium takes longer)
    - Use for at least 1-2 wks
- ***Dantrolene*** IV 2-3mg/kg/day
    - 1st line in severe ***rigidity or fever***
- ECT considered for fever, sweating, ALOC

PERSONAL DRUG TRAFFICKING

- Body packer: for transport, well packaged
- Body stuffer: unplanned concealment, more likely to leak

Challenges

- Many times lethal dose
- Inaccurate history
- Pt not consenting
- Few prospective studies

Management

- Treat toxicity
- CT to confirm
- Give ***AC*** 50g
- Admit until expected number passed or 3x normal stool
- Normal diet and gentle laxatives
- Endoscopy/colonoscopy ↑ risk of package rupture

ANALGESICS

Paracetamol

Risk Assessment

NB severe = > 50g or 1g/kg or x2 nomogram line or ALT > 1000

Indications for AC

< 2hrs	single large
< 4hrs	MR or > 30g
> 4hrs	MR > 30g

Acute Rpt	> 200mg/kg or 10g over < 8hrs
	> 200mg/kg or 10g over 24-hr
	> 150mg/kg or 6g per 24hr in 48hr
	> 100mg/kg or 4g per 24hr > 48hr + ***sx liver inj***
	NB for all, choose whichever is lower, use IBW

Single Large

< 2hr	***AC*** + 4hr level (NB ***AC*** up to 4hrs if ***SR or > 30g***)
2-8hr	Level ± Treat - no further Ix when finished
> 8hr	Treat + Level + ALT ± stop treatment

Level interpretation
- ***Para Tx threshold: 4hr = 1000 µmol/l or 150mg/l***
- Over = Tx, **ALT** at end, if ≥ 50 cont NAC
- Under + ALT < 50 = stop
- ***Under + ALT > 50 = Tx as over***

Repeated Supra-therapeutic

- Don't give NAC straight up
- Check level + ALT → recheck 8hr → recheck q12h until normal (see below)

Level interpretation
- 1st test: BOTH ***ALT < 50 AND Para < 20mg/L*** = stop
- Sub: If ***ALT static or < 50 & para < 10*** = stop

Modified Release

- Start NAC if > 200 mg/kg or 10g
- Level 4hrs post ingestion & 4 hrs after 1st level
- If ↓ level then stop NAC
- Otherwise cont NAC and rpt level 2hr before NAC finishes
- If ALT > 50 or Para > 10 mg/L then cont

Large or Massive

- x2 dose for 16hr bag of ***NAC***
- Ongoing mx as per MR
- Causers lactic acidosis

Referral to Transplant Hospital

- INR > 3 at 48hrs or > 4.5 anytime
- Crea > 200 or anuric
- pH < 7.3 or lactate > 3 persistently
- ↓ BP, Glc, Plt
- Encephalopathy

Phases of OD

< 24hrs	N&V
1-3d	↑ LFTs, RUQ PAIN
3-4d	Liver failure, death
> 4d	Recovery (if alive)

NSAIDs

< 100 mg/kg	ASx
100-300 mg/kg	GIT & CNS
> 300 mg/kg	Multi-organ failure

Management

- Supportive

Diphenoxylate-Atropine

Aka ***Loperamide***
- Tx: ***Naloxone***

Salicylates

*Includes **wintergreen oil***

Features

- ***Salicylism***: vomiting, tinnitus, resp alkalosis

Risk

< 150 mg/kg	ASx
150-300 mg/kg	Salicylism
> 300 mg/kg	ALOC, seizures
> 500 mg/kg	Lethal

Acid-Base

- Resp alk from direct
- HAGMA
- Met Alk from vomiting
- Resp acidosis from coma

Management

- ***AC*** < 8hrs
- **Anticipate ↓ K^+**
- Alk urine with ***$NaHCO_3$*** 1-2mmol/Kg
- Alk blood by RR & ***$NaHCO_3$***
- ***BZDP*** for seizures
- Dialysis if level > 7.2 (acute), 4.4 (chronic)

Colchicine

- Sx: gastritis, multi-organ failure
- > 0.8mg/kg lethal
- Mx: ***AC*** anytime, supportive otherwise

Opiates

- ***Naloxone*** 100 µg IV q1min to RR
- **If from *Dextroproxyphene* (digesic) treat as *TCA***

ABX

Macrolides:	TdP = ***$MgSO_4$***
Sulphonamides:	MetHb = ***Methylene blue***
Vancomycin:	Erythroderma = stop infusion
Isoniazid:	Seizures = ***Pyridoxine*** 5g + ***BZDP***
Quinine:	MDAC, $NaHCO_3$, 5%Dex, Octreotide

AUTONOMIC

Antihistamines

- Effect: Anticholinergic
- Mx: ***BZDP***, ***Physostigmine*** 0.5-1.0mg max 4mg

Cholinergic

- Main one is OG
- ***Atropine*** 1.2mg – x2 q2min until dry
- ***Pralidoxime***

Theophylline

- Narrow TI ∴ all acute ingestions are bad!
- Sx: dysrhythmias & seizures
- Lethal > 50mg/kg

Level

mg/L		mg/L	
10-20	Therapeutic	80-100	Severe
20-40	Minor	> 100	Lethal
40-80	Moderate		

Mx

- ***AC***
- ***Propanolol*** for SVT/***BZDP*** for seizures
- ***MDAC***
- ***CVVHD*** (level > 100 acute or > 60 chronic)

CNS

Ethylene Glycol

- > 1ml/kg lethal
- Ix: ***↑OG, RAGMA, lactic acidosis***

Management

- Hyperventilate
- ***$NaHCO_3$*** 1-2mmol/kg
- ***BZDP***
- ***Ethanol*** temporising
- CVVHD/F
- ***Ca Gluconate*** 10ml if ↓ Ca

Methanol

- > 0.5 ml/kg lethal
- Feat: ***blindness***
- Ix: ***↑OG, RAGMA***

Management

- Same as ***ethylene glycol*** + ***folinic acid*** 50mg

CBZP

Levels

> 40mg/L Coma
> 50mg/L TCA-like Na block

Mx

- ***MDAC***
- ***$NaHCO_3$*** for TCA-like syndrome
- Dialysis

Phenytoin

Levels

> 20mg/kg	Ataxia
>100mg/kg	Coma/Seizures

Mx

- ***AC***

Valproate

Risk

400-1g/kg	Coma (can be delayed 12hr)
> 1g	Multi-organ failure

Level Mx

> 500mg/L	Coma
> 2000	Dialysis

Antipsychotics

- Supportive Mx
- ***Quetiapine*** may req ***noradrenaline***
- TdP rare

SSRIs

- Supportive Mx
- ***Citalopram*** & ***Escitalopram*** **prolong QT**

SNRIs

- ***Venlafaxine***, ***Desvenlafaxine***
- ***High Risk Serotonin syndrome & Seizures*** (vs SSRIs)

Risk

> 3g	30% risk seizure
> 4.5g	100% risk seizure, ↓BP, long QT
> 7g	LV dysfunction

Mx

- Supportive
- ***Adrenaline*** for LV dysfunction, ECMO
- Titrate ***BZDP*** to HR

TCAs

Dothiepin, doxepin, amitriptyline, nortriptyline

Risk

5-10mg/kg	antichol	QRS > 100	seizure
> 10mg/kg	serious	QRS > 160	VT
> 30mg/kg	lethal		

Features

- Coma (< 2hrs with > 30mg/kg)
- ***Large terminal R wave aVR > 3mm, R/S > 0.7 aVR***
- QT prolonged

DDx for ECG

- Antiarrythmics Type Ia (procainmide), Ic (flecainide)
- LA
- Propanolol
- CBZP
- Quinine
- Chloroquine
- Dextropropoxyphene

Mx

- ***$NaHCO_3$*** 2mmol/kg q2m (50 or 100 mmol in reality)
  NB comes in 50 or 100 mmol vials
  End points - ***pH 7.5*** (stabilise cardiac membrane)
  - QRS < 100 ms
- ***Lignocaine*** 1.5mg/kg if pH > 7.5
- ***Norad*** for BP
- ***BZDP*** for seizures
- ***Hyperventilate*** to ↑ pH 7.5-7.55
- Prolong CPR

Lithium

- Acute = GIT Sx; Chronic= Neuro Sx

Acute

- ***< 25g benign*** (NB level does not correlate well)
- Feat: GIT Sx, Coma
- Mx: fluids++, replace Na, CVVHD (if AKI or Lv > 2.5 mmol/l)

Chronic

- Neurotoxic
- Usually a precipitant eg infection
- ***Dialysis if Li > 2.5 mmol/L or AKI***

Hansen & Amdisen Chronic Li Severity

1. Mild	Tremor, hypereflexive, agitation, ataxia
2. Moderate	Stupor, rigidity, hypertonia, hypotension
3. Severe	Coma, seizure, myoclonus

CARDIOVASCULAR

Digoxin: ACUTE

Risk (lethal dose)

- ***K > 5.5*** mmol (100% mort without ***digoxin immune fab***)
- > 10mg (adults) 4mg (kids)
- ***Digoxin*** > 15 nmol/L any time

Features

- Early:	N&V
- Late:	↓HR, ↑ automaticity, delirium
- ECG	- ↑ automaticity
	- ***Reverse tick***: ↓ sloping ST
	- U waves
	- T waves either flat, inverted, biphasic
	- Short QT

Management

- ***AC*** < 1hr
- ***Digoxin immune fab***
  - Lethal dose or arrest
    - #amp — dose (mg) x 1.6
    - unknown stable — 5 amps → 5 amps q30m
      - > 10mg (adults) > 4mg (kids)
      - K > 5
      - dig > 15 nmol/L
    - unknown unstable — 10 amps → 5 amps q30m
    - arrest — 20 amps + CPR > 30min
- For complications
  - ↑ K: ***$NaHCO_3$*** 1-2mmol/kg + ***Insulin/D*** ***NOT Ca***
  - AV block: ***atropine***
  - Vent arrhythmia: ***lignocaine*** 1mg/kg bolus
- Disposition: ***clear if no sx, no K for 6hrs***

Digoxin: CHRONIC

Features same as acute plus
- Syncope
- Eye: ↓ VA, chromatopsia, xanthopsia
- Levels - Normal 0.5-1.0
  - ***Near normal can be toxic eg 1.5***

Management
- Arrest = ***5 amp*** (vs 20 in acute)
- Otherwise level x weight ÷ 100

ACE-I

- Supportive

Amiodarone

- Any acute dose ok
- Chronic complications
  - ***Pulmonary toxicity*** (fibrosis)
  - CVS: brady, AV block, TdP
  - Thyroid dysfunction ↑ or ↓
  - Hepatotoxicity
  - Corneal deposits

Management
- Supportive
- ↓ BP = ***adrenaline*** (***~~atropine~~*** doesn't work)

Clonidine

- Supportive ***(2 can kill kids)***
- > 20mg/kg = coma
- Triad of drowsy, meiosis, bradycardia
- Can trial ***naloxone*** 0.1mg for ↓ GCS

β-blocker

Sotalol & ***Propranolol*** fatal, others benign
- dose not related to tox
- prolonged PR = early sign of tox

Propranolol
- **1g can kill**
- β , ***Na block*** & lipid soluble
- Features
  - β-block: ↓HR, ↓BP, bronchospasm
  - ECG same as ***TCA*** OD but ***slower rate***
  - lipid sol: coma
- Manage
  - Treat as per ***TCA*** OD 1st
  - ***Atropine ± Iso ± Adr ± HDI***
  - ***$NaHCO_3$*** for QRS

Sotalol
- β, K block
- Features
  - β-block: ↓ HR, ↓ BP, bronchospasm
  - K block: ***Long QT, TdP***
- Mx
  - ***Atropine ± Iso ± Adr ± HDI***
  - ***$MgSO_4$*** 10mmol, ***overdrive pacing***

CCB
Verapamil & ***Diltiazem*** fatal, others benign

- ≥ 10 fatal (can be delayed up to 4-16hrs)
- Features
  - CVS: ↓HR ± block, ↓BP
  - CNS: seizure, coma
  - Met: ↑ Glc, ***HAGMA***
- Manage
  - AC
  - WBI
  - ***CaCl***
  - Fluids & ***HDI***
  - Vent pacing
  - ECMO

METALS

As

- industrial accident, contaminated water
- ***Urine*** (not serum) levels ***> 1mg/kg lethal***

Features
Predictable, stepwise

1. Rice water diarrhoea
2. GI haemorrhage
3. Encephalopathy, coma (hours)
4. Bone marrow suppression
5. Peripheral neuropathy like GBS (if survive)

Mx
- Supportive (mainly hypovolaemia)
- WBI, Antidotes: ***Succimer***

Pb

- Usually occupational, shrapnel

Risk (μg/dl)

< 10	IQ
> 10	developmental, learning abnormalities
> 30	fertility, constitutional, peripheral n
> 100	GIT, encephalopathy, seizures

Mx
- Cerebral oedema: mannitol 1g/kg, dex 10mg
- Endoscopic decontamination, WBI
- Chelation *well* ***Succimer*** if well
  unwell ***EDTA*** + ***Dimercaprol***

Hg

- Seafood most common

Features
- inhaled: Pneumonitis
- ingested: GI upset
- injected: PE, cerebral emboli

Risk
- Blood > 200 μg/L Sx
- ***Urine*** > 100 μg/L Neuropsych
- XR can find

Mx
- ***Succimer*** 10mg/kg PO BD 14d
- Penicillamine 4-7mg/kg
- ***Dimercaprol*** if mercury salt

TOXIC GASES

- CO
- CN
- H_2S
- Hydrocarbons: pneumonitis, coma
- Phosgene: APO

For CO & CN see Burns

H_2S

- Most common cause of fatal inhalation
- Smells like ***rotten eggs***
- Similar to CN effects + Airway irritation
- Mx: 100% O_2, decontamination

Hydrocarbons

- includes ***'oils' eg eucalyptus oil***
- Risk: 5ml in kids = coma
- Seizure < 2 hrs - can discharge after 2hrs
- Sensitises catecholamines ∴ if arrest give ***propranolol*** **NOT** catecholamines!

PESTICIDES, HERBICIDES, RODENTICIDES

- OG & Carbamates
- Glyphosate
- Paraquat
- Napthalene/Camphor
- Strychnine
- Phosphine
- Super warfarin

Napthalene/Camphor

- Moth balls
- Feat: haemolytic anaemia, ***MetHb***, haemolysis
- Mx: ***AC, polyethylene glycol***

OG & Carbamates

- Cholinergic (***DUMBBELLS***) via AChE inhibition
- Delayed effects: neuropathy, neuropsychiatric, paralysis

Management
- ***Atropine*** 1.2mg, double q2-3min until dry (***HR not good end-point***) has been up to 100mg!
- Ageing = ***atropine*** doesn't work, ***carbamates*** dont age
- ***BZDP***
- ***Pralidoxime*** 2g, 0.5g/hr (not for ***carbamates***)

Glyphosphate

- In herbicides
- GI corrosive → Sx Mx only

Paraquat

- Herbicide
- Creates reactive O_2 species ∴ ***Aim Sat 91% only***
- GI corrosive → lungs/kidneys→ MA → multi organ failure
- Ix: urinary paraquat, serum paraquat (prognosticate)
- Mx: NG before too much mucosal ulceration
  Decontaminate: AC, ***Fullers earth***
  Dialysis mainstay
  Palliate if > 250ml 20%
  Last ditch: plasma exchange, methylprednisolone

Strychnine

- Rodenticide: paralysis < 30m
- Supportive

HYPOGLYCEMICS

Insulin

- Bolus: adults 50ml ***50%D***, kids 2ml/kg ***10%D***
- Infusion: ***10%D*** 100ml/hr to BSL > 4
  CVL if need > 10%D

Metformin

- Life threatening ***HAGMA***: lactic acidosis - main toxic effect
- > 10g = Sx
- Mx ***$NaHCO_3$***
  AC < 2hrs
  Dialysis for pH & clear ***metformin***

Sulfonylureas

- ***lethal with 1 tab if not diabetic***
- stimulates endogenous insulin production

Management
- ***AC***
- ***Octreotide***: Bolus 50 μg → 25 μg/hr if persistent ↓ BSL
- ***Dextrose***: Adults 50% 50ml, Kids 10% 5ml/kg

VITAMINS & MINERALS

Potassium

Slow K, Chlorvescent
- Mx for trending or established ↑K
- Usual Tx for ↑K + WBI ± Dialysis

Fe

Features
- GI corrosion
- Direct cellular toxicity
- RAGMA
- Liver failure
- Multi organ failure

Risk *mg/kg*		***Stages***	
< 20	Asx	0-6hr	GIT
20-60	GI Sx	6-12hr	Quiescence
60-120	Sys tox	12-48hr	Cellular tox (RAGMA)
> 120	Lethal	2-5d	Acute Liver Failure
		2-6wk	Cirrhosis, GI strictures

Ix
- Fe levels peak 4-6hr, ***HCO_3 good surrogate***
- XR shows tablets

Mx
- Decontamination: WBI, endoscopy, surgery
- ***Desferrioxamine***: 15-40mg/kg/hr

Disposition
- kids home if < 40mg/kg, 6hr obs, ***-ve XR***
- adults home if < 60mg/kg, 6hr obs

BIOTERRORISM

Chemical

- **Cyanide**
- **Phosgene**: inhaled → pneumonitis
- **Mustard gas**: blistered skin, occular damage
- Nerve Agents (**Saron**): Organophosphate ∴ ***atropine***+++

Biological Weapons

- **Anthrax**: Haemorraghe, Tx with ***cipro & clindamycin***
- **Plague**: bubonic/septic/pneumonitic, Tx with ***Streptomycin***
- **Tularaemia**: Most infectious, haemorraghe, live vaccination
- **Botulism**: flaccid paralysis, tx with equine antitoxin
- **Small Pox**: DNA virus, supportive only
- **Viral haemorrhage fever**: ***ebola, lyssa, yellow fever***