

Anaesthesia and Sedation

Dr Reham Ragab · CoNNect International Academy · source deck: "Lecture 9 — Anaesthesia & Sedation" (29 slides)

EXAM-DAY SUMMARY

everything on this page → detail in \$\$ overleaf

ESTERS VS AMIDES → §1

- Ring (lipophilic) — chain — amino group (hydrophilic); **linkage names the class**: ester —COO—, amide —NHCO—
- Amide → liver; slow onset; long 2–16 hrs; low allergy
- Ester → plasma; fast onset; short 30–45 min; high allergy (PABA)
- Esters only for: amide allergy · liver failure · cirrhosis · topical pre-puncture
- Amides: lidocaine, mepivacaine, bupivacaine, ropivacaine (+ articaine, prilocaine). Esters: benzocaine, procaine

THE TWO "UNUSUAL AMIDES" → §2

- Articaine: plasma → **safe in liver failure**; high diffusion → buccal only, no palatal injection; avoids IAN injury at implants; 4–6 hrs; ✗ children (traumatic ulcers)
- Prilocaine/felypressin: liver + plasma + kidney + lung + sweat glands → low toxicity; latex-free cartridge; safe in HTN/CVD; ✗ pregnancy (premature labour)

TOPICAL → §2

- Benzocaine: ester; fast onset, short; flavoured; **before needle puncture**
- Lidocaine: amide; slow onset, strong + long; primary-tooth extraction · incision of abscess/eruption cyst · ulcers with Orabase
- Procaine = ester, injection only

DURATION → §3

- Short 2–4 hrs: lidocaine, mepivacaine
- Moderate 4–6 hrs: articaine
- Long > 6 hrs: bupivacaine, ropivacaine → **post-op analgesia when morphine CI**

DRUG OF CHOICE → §3

- Default, no CI: lidocaine
- Best plain: mepivacaine = **least vasodilator**
- Fears palatal injection: articaine
- Latex allergy · CVD · HTN: prilocaine/felypressin
- Pregnant + HTN, or **uncontrolled** hyperthyroidism, or phaeochromocytoma: plain mepivacaine
- **Controlled** hyperthyroidism: lidocaine

VASOCONSTRICTORS → §4

- Adrenaline = alpha-1 → VC; delays absorption · prolongs duration · haemostasis · **reduces systemic toxicity**
- Cost: cardiac stimulation via beta-1
- Felypressin (octapressin): no beta-1 → HTN/CVD safe; ✗ pregnancy

ALLERGY VS TOXICITY → §5

- Allergy (esters ≫ amides, PABA): urticaria/flushing · **↑ heart rate** · facial oedema → cortisone; all together = anaphylaxis → adrenaline
- Toxicity (IV/IA injection or overdose): ↓ heart rate · pale · tinnitus · anxiety · metallic taste · tongue + perioral numbness
- Severe: seizures · methaemoglobinaemia (prilocaine → IV methylene blue) · late arrhythmias · cardiac arrest
- Emergency: stop work → oxygen → ambulance → CPR if coma/LOC
- Avoid toxicity: aspiration · slow injection · dose limitation

THE ARITHMETIC → §6

- 2% = 2 g/100 ml = **20 mg/ml**; cartridge 1.8 ml = 36 mg
- 300 mg ÷ 36 = 8.3 cartridges (MRD, plain)
- 1:100 000 = 1 g/100 000 ml = 0.01 mg/ml → 18 µg per 1.8 ml cartridge

LIDOCAINE MAX DOSES → §6

- Plain: 4.4 mg/kg, ceiling 300 mg · 1 cartridge/10 kg · 2.2 ml/10 kg
- + epinephrine: **7 mg/kg, ceiling 500 mg** · 1.4 cartridge/10 kg · 3.08 ml/10 kg
- Liver disease: 0.5 × healthy max
- No weight given: adult 70 kg · child 20 kg
- 30 kg + epi = 210 mg; 30 kg plain = 3 cartridges = 6.6 ml

CONSCIOUS SEDATION → §7

- CNS depression, **verbal contact maintained**; not anaesthesia → still needs LA
- Happiness · hallucination · amnesia → chaperone a must
- Routes: inhalation · oral · IV. Oral not used in UK — less controlled

INHALATION VS IV → §7

- N₂O: superficial; children 5–16, adults restorative; **titrate 10% → 70%**; scavenging; chronic exposure → female infertility + B12 anaemia
- N₂O ✗: 1st trimester · B12 anaemia · COPD/deviated septum/ common cold
- IV: deep; >16 yrs, adults for surgery; oximeter + escort
- IV ✗: resp/CV depression · 3rd trimester · opioids · hypothyroidism

BENZODIAZEPINES → §7

- Diazepam: long acting · active metabolites · rebound sedation
- Midazolam: short · inactive metabolites · no rebound; 10 mg in 5 ml (better titration) or 10 mg in 2 ml
- Reversal: **flumazenil — emergency only**

SEDATION / GA BY PATIENT → §8

- Children: <5 GA · **5–16 inhalation** · >16 IV; uncooperative child or adult → GA
- Pregnancy: 1st IV · 2nd both · 3rd inhalation
- GA gate: complex/>40 min · non-compliant · LA failed or CI
- Inpatient GA if: >1 hr · travel >2 hrs · no escort · medical constraint (CVS, resp, GI, renal, endocrine, meds, pregnancy)

§1 Structure and classification

KEY POINTS

Every local anaesthetic (LA) = lipophilic aromatic ring + intermediate chain + hydrophilic amino group. The **linkage inside the chain names the class** → linkage sets metabolism → metabolism sets allergy risk and which patients you may use it in.

- **Three parts:** aromatic ring (lipophilic) · intermediate chain · amino group, NH^+ (hydrophilic)
- **Linkage = the classifier:** ester = $-\text{COO}-$ · amide = $-\text{NHCO}-$
- **Esters** → **plasma:** hydrolysed in plasma → fast onset · short duration ★30–45 min · high allergy rate
- **Amides** → **liver:** hepatic metabolism → slow onset · long duration ★2–16 hrs · low allergy rate

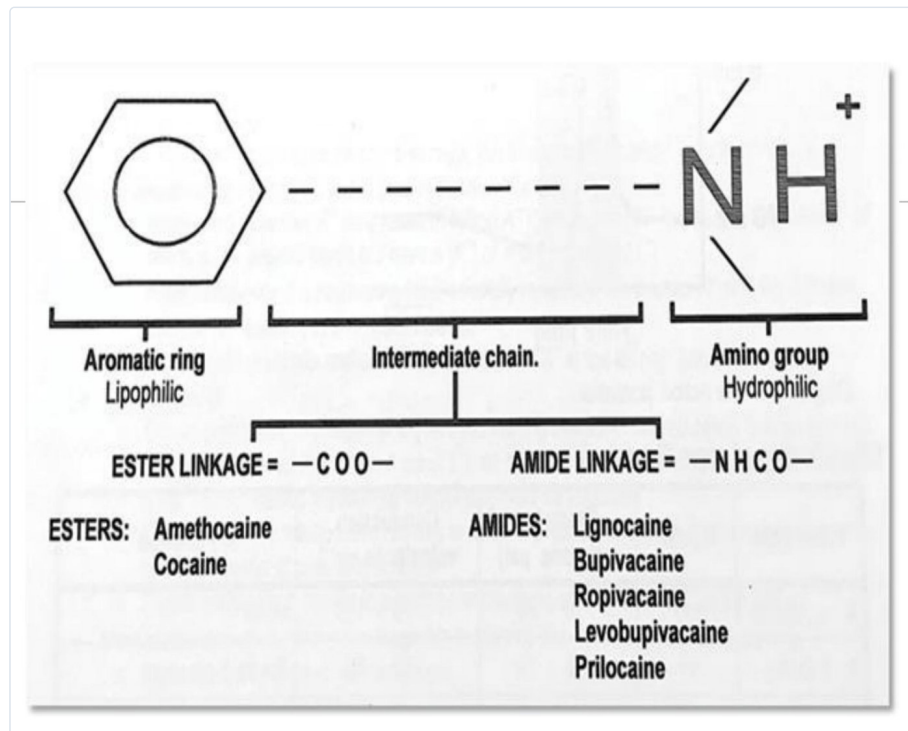


Fig. 1 — LA molecule: lipophilic aromatic ring → intermediate chain (ester $-\text{COO}-$ or amide $-\text{NHCO}-$) → hydrophilic amino group. Deck lists esters amethocaine · cocaine; amides lignocaine (= lidocaine) · bupivacaine · ropivacaine · levobupivacaine · prilocaine.

Table 1 — Amides vs esters

	Amino amides	Amino esters
Metabolism	Liver	Plasma
Allergy	Low rate	High rate
Onset	Slow	Fast
Duration	Long (2–16 hrs)	Short (30–45 min)
Used for	All cases except those opposite	Amide allergy · liver failure · liver cirrhosis · topical before needle puncture
Agents	Lidocaine · mepivacaine · bupivacaine · ropivacaine “Unusual amides”: articaine · prilocaine	Benzocaine · procaine

MNEMONIC

Two i's = amide: lidocaine · mepivacaine · prilocaine · articaine · bupivacaine · ropivacaine. Esters carry one: procaine · benzocaine · cocaine · amethocaine.

★ EXAM PEARL

The whole ester indication list is one idea: **use an ester when the amide route is blocked** — allergy to amides, or a liver that cannot metabolise them (failure, cirrhosis) — plus topical use before needle puncture.

§2 The agents in detail

2.1 Articaine — the “unusual amide” that behaves like an ester

- **Metabolised in plasma:** unlike other amides → ★**safe in liver failure**
- **High power of diffusion:** crosses bone/soft tissue readily
 - no painful palatal injection needed → **buccal infiltration alone is enough**
 - avoids inferior alveolar nerve (IAN) injury during dental implant placement — infiltrate rather than block
- **Moderate acting:** 4–6 hrs

CAUTION

Articaine **contraindicated in children** — long soft-tissue numbness → self-biting → traumatic ulcers.

2.2 Prilocaine with felypressin

- **Multi-organ metabolism:** liver · plasma · kidney · lung · sweat glands → **low toxicity rate**
- **Latex-free cartridge:** → totally safe in ★**latex-allergic patients**
- **Vasoconstrictor = felypressin (octapressin):** not a catecholamine → no beta-1 cardiac stimulation
 - safe in **hypertension and cardiovascular disease (CVD)**
 - ✗ pregnancy — oxytocic → **premature labour**
- **Signature toxicity:** methaemoglobinaemia → see §5

2.3 Topical anaesthesia

Table 2 — Topical agents: benzocaine vs lidocaine

	Benzocaine	Lidocaine
Class	Ester	Amide
Onset / duration	Fast onset · short duration	Slow onset · strong and long duration
Used for	Before needle puncture · flavoured (child-friendly)	Extraction of primary teeth · incision of abscess or eruption cyst · topical analgesic for mouth ulcers (mixed with Orabase)

- **Procaine:** the other ester → **injection** only, not a topical agent

★ EXAM PEARL

Topical is the one place an ester is routine in a healthy patient. If the stem says “**before needle puncture**” → benzocaine; if it says definitive soft-tissue procedure without a needle (primary tooth extraction, abscess incision) → **topical lidocaine**.

§3 Duration and drug of choice

Table 3 — Duration bands

Band	Duration	Agents
Short acting	2–4 hrs	Lidocaine · mepivacaine
Moderate acting	4–6 hrs	Articaine
Long acting	> 6 hrs	Bupivacaine · ropivacaine

- **Why long-acting matters:** bupivacaine/ropivacaine → ★**post-operative analgesia when morphine is contraindicated**
- **Mepivacaine = least vasodilator:** → the **best plain (VC-free) anaesthetic**

Table 4 — Drug of choice by clinical situation

Situation	Agent of choice	Because
No contraindication	Lidocaine	Default first choice
Plain anaesthesia wanted	Mepivacaine (plain)	Least vasodilator
Fears painful palatal injection	Articaine	Diffusion → buccal only
Latex allergy · CVD · hypertension	Prilocaine (felypressin)	Latex-free · non-catecholamine VC
Pregnant + hypertension, or uncontrolled hyperthyroidism	Plain mepivacaine	No adrenaline load
Controlled hyperthyroidism	Lidocaine	Adrenaline tolerated
Phaeochromocytoma (adrenal gland tumour)	Plain mepivacaine	Catecholamine-secreting tumour
Amide allergy · liver failure · cirrhosis	Ester (or articaine)	Metabolised in plasma

★ EXAM PEARL

Controlled vs uncontrolled hyperthyroidism is the discriminator: controlled → lidocaine (with adrenaline) is fine; uncontrolled → plain mepivacaine. Same split logic for phaeochromocytoma and pregnancy-with-hypertension — anything that already floods the patient with catecholamines gets a **plain** agent.

§4 Vasoconstrictors

- **Adrenaline = alpha-1 agonist:** activates alpha-1 adrenergic receptors → vasoconstriction (VC)
- **Four gains from VC:** delays absorption of LA from the site · prolongs duration of action · aids haemostasis in the operative field · reduces systemic toxicity
- **The cost:** ★ **cardiac stimulation via beta-1 agonist effect** → the reason plain agents exist
- **Felypressin (octapressin):** the alternative VC, in prilocaine → no beta-1 effect → hypertension/CVD safe, but ✗ pregnancy (premature labour)
- **Strength expressed as a ratio:** 1:100 000 → arithmetic in §6

★ EXAM PEARL

Adrenaline **reduces** systemic LA toxicity (slower absorption) while **adding** its own cardiac risk — two different toxicities. Exam stems exploit the confusion: “which reduces the risk of LA overdose?” → the vasoconstrictor.

§5 Allergy, toxicity and emergencies

5.1 Allergy

- **Esters >> amides:** ★ **para-amino benzoic acid (PABA)** = allergic byproduct of ester metabolism
- **Signs and symptoms:** urticaria (skin rashes and flushing) · **increased heart rate** · facial oedema
- **Management:** cortisone
- **All signs together = anaphylaxis:** → managed by **adrenaline**

5.2 Toxicity

- **Cause:** venous or arterial injection · or too high a dose
- **Early signs and symptoms:** **decreased heart rate** · pale face · tinnitus · anxiety · metallic taste · tongue and perioral numbness
- **More severe toxicity:** seizures → methaemoglobinaemia → late-effect arrhythmias → cardiac arrest
- **Methaemoglobinaemia:** rare fatal side effect of **prilocaine** → reversed by ★ **IV methylene blue**

Table 5 — Allergy vs toxicity: the bedside discriminator

	Allergy	Toxicity
Heart rate	↑ increased	↓ decreased
Skin	Urticaria, flushing, facial oedema	Pale face
Neuro / sensory	—	Tinnitus · anxiety · metallic taste · tongue and perioral numbness
First drug	Cortisone (adrenaline if anaphylaxis)	No antidote — supportive; methylene blue for methaemoglobinaemia
Worst case	Anaphylaxis	Seizures · arrhythmias · cardiac arrest

5.3 Emergency management and prevention

1. **Stop** dental work
2. **Oxygen**
3. **Call ambulance**
4. **CPR**: if coma or loss of consciousness

CAUTION

Three ways to avoid toxicity: aspiration before injecting (excludes intravascular placement) · **slow injection** · **dose limitation** (§6).

★ EXAM PEARL

Heart rate splits the two emergencies: rash + tachycardia = allergy; pale + bradycardia + tinnitus + metallic taste = toxicity. Methaemoglobinaemia sits under toxicity and names one drug — prilocaine.

§6 Dose calculation



Diagram 1 — Percentage → mg/ml → mg per cartridge → maximum recommended dose (MRD) in cartridges, worked for 2% plain lidocaine (300 mg ceiling).

- **Percentage → mg/ml**: 2% = 2 g per 100 ml → 0.02 g/ml = ★ **20 mg/ml**
- **Cartridge = 1.8 ml**: → $1.8 \times 20 = 36$ **mg per dental cartridge** (2% solution)
- **Ratio → mg/ml**: $1:100\,000 = 1\text{ g in }100\,000\text{ ml} = 1000\text{ mg in }100\,000\text{ ml} = 0.01\text{ mg/ml}$
 ◦ per 1.8 ml cartridge → $0.018\text{ mg} = \star 18\text{ }\mu\text{g adrenaline}$

Table 6 — Maximum recommended dose, lidocaine

	Without epinephrine	With epinephrine
Per kg	4.4 mg/kg until 300 mg	7 mg/kg until 500 mg
Cartridges	1 cartridge / 10 kg	1.4 cartridge / 10 kg
Volume	2.2 ml / 10 kg	3.08 ml / 10 kg

- **Liver disease**: maximum dose = ★ **0.5 × the healthy maximum**
- **No weight in the stem**: assume adult = **70 kg** · child = **20 kg**

Worked examples from the lecture:

1. **30 kg, lidocaine with epinephrine, in mg**: $30 \times 7 = 210\text{ mg}$
2. **30 kg, lidocaine without epinephrine, in ml**: $30 \div 10 = 3$ cartridges → $3 \times 2.2 = 6.6\text{ ml}$

★ EXAM PEARL

Work from mg/kg, then convert. The per-10-kg cartridge and millilitre shortcuts in the deck do not reconcile exactly with the mg/kg rule ($70\text{ mg} \div 36\text{ mg} = 1.9$ cartridges, not 1.4; $7\text{ mg/kg} \div 20\text{ mg/ml} = 3.5\text{ ml/10 kg}$, not 3.08). The mg/kg figures and the ceilings are what is examined — derive volume as $\text{mg} \div 20\text{ mg/ml}$, cartridges as $\text{mg} \div 36\text{ mg}$.

§7 Conscious sedation

KEY POINTS

Conscious sedation = CNS depression with **verbal contact maintained** throughout. It is **not anaesthesia** → local anaesthesia is still required. Three routes: inhalation · oral · IV.

- **Effects:** happiness · hallucination · amnesia
 - hallucination + amnesia → risk of false allegation → **chaperone is a must**

Table 7 — Inhalation vs IV sedation

	Inhalation	Intravenous
Agent	N ₂ O (“happiness gas”)	Midazolam or diazepam
Depth	Superficial sedation	Deep sedation
Who	Children 5–16 yrs · adults for restorative work	Adults above 16 yrs · adults for surgeries
Contraindications	Pregnancy 1st trimester · vit B12 deficiency anaemia · obstructive disease (COPD, deviated septum, common cold)	Respiratory or cardiovascular depression history · pregnancy 3rd trimester · opioid users · hypothyroidism
Hazards / requirements	Chronic exposure → female infertility + vit B12 deficiency anaemia · needs special scavenging systems	Causes respiratory and CV depression · oximeter monitoring · escort
Technique	Titration starts at 10% , up to 70%	Titrate to verbal contact

Table 8 — Diazepam vs midazolam

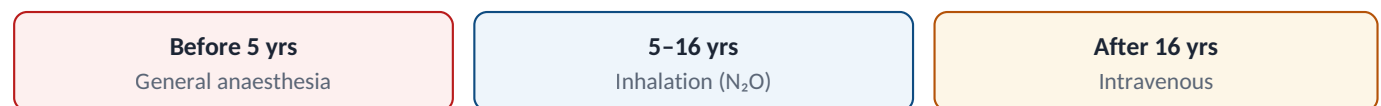
	Diazepam	Midazolam
Duration	Long acting	Short acting
Metabolites	Active	Inactive
Rebound sedation	Yes	None
Presentation	—	10 mg in 5 ml (better titration) · 10 mg in 2 ml

- **Reversal agent of midazolam:** ★ **flumazenil** — **emergency use only**
- **Oral sedation:** not used in the UK → **less controlled manner** (no titration, unpredictable absorption)

★ EXAM PEARL

Midazolam wins on every column that matters — short acting, inactive metabolites, no rebound sedation, and **10 mg in 5 ml titrates better** than 10 mg in 2 ml. Flumazenil is **not** routine reversal at the end of a case.

§8 Choosing sedation or GA by patient



Uncooperative child **or** adult at any age → general anaesthesia

Diagram 2 — Sedation route by age, with the cooperation override.

- **Pregnancy:** 1st trimester → **IV** · 2nd trimester → **both safe** · 3rd trimester → **inhalation**
 - mirror image of the contraindications in Table 7 — N₂O out in the 1st, IV benzodiazepine out in the 3rd
- **Uncooperative:** child or adult → ★ **general anaesthesia (GA)**, regardless of age

8.1 Selecting patients for general anaesthesia

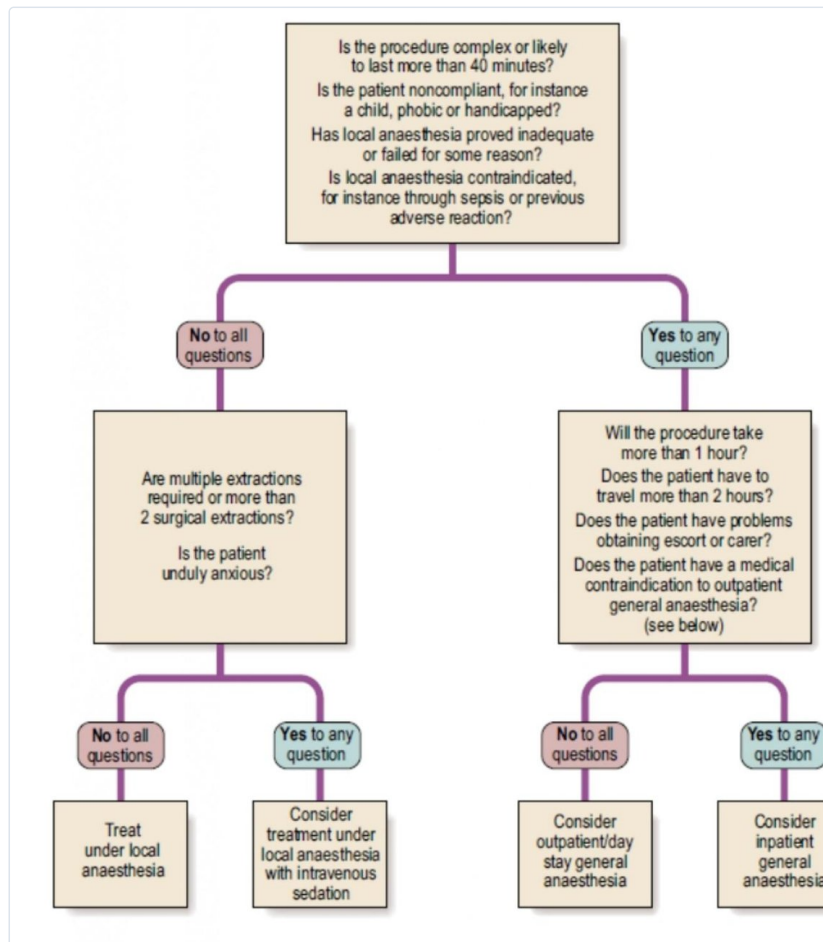


Fig. 2 — GA selection (Fig. 25.4). Gate 1: complex / > 40 min · non-compliant (child, phobic, handicapped) · LA inadequate or failed · LA contraindicated (sepsis, previous adverse reaction). **No to all** → second gate: multiple extractions or > 2 surgical extractions, unduly anxious → no = LA alone; yes = LA + IV sedation. **Yes to any** → second gate: > 1 hr · travel > 2 hrs · escort/carer problems · medical contraindication to outpatient GA → no = outpatient/day-stay GA; yes = inpatient GA.

Table 9 — Medical constraints to *outpatient* general anaesthesia

System	Constraint
Cardiovascular	Myocardial infarct · angina · hypertension · anaemia · deep vein thrombosis · stroke
Respiratory	Severe asthma · chronic obstructive airway disease
Gastrointestinal	Hiatus hernia · hepatitis · obesity
Genitourinary	Renal failure
Endocrine	Diabetes · thyroid disease
Medication	Antihypertensives · anticoagulants · corticosteroids
Also	Pregnancy · family history of adverse reactions to a general anaesthetic

★ EXAM PEARL

The constraints list does not forbid GA — it forbids **outpatient** GA, pushing the patient to **inpatient**. Stems that pile on comorbidity are usually testing that step, not asking you to abandon GA.