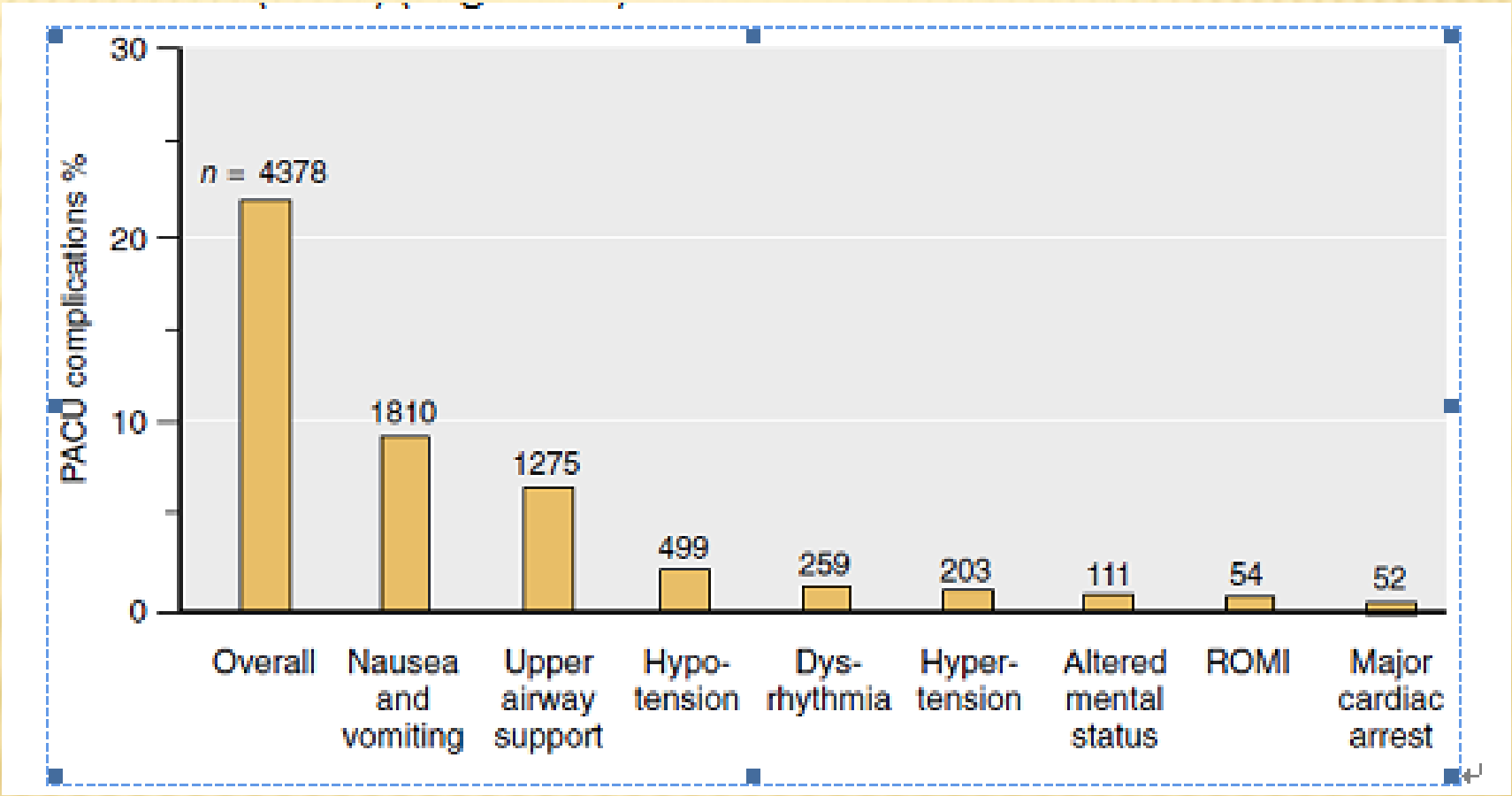
麻醉恢復期之評估及護理

POSTANESTHESIA CARE UNIT (PACU)

常見術後轉加護病房的適應症

- 重大手術 (心臟或大血管手術、開顱手術、肺部手術、長時間手術...等),需術後觀察者
- 病患有重大之疾病史 (心肌梗塞、腦中風、意識不清、腎臟衰竭...等)，且生活自主照顧能力嚴重受限者
- 術前或術中有嚴重之生命徵象不穩定、大出血、大量輸血、急救的情況
- 手術結束後，預期將延遲拔除呼吸管，而需呼吸器使用者


PACU complications %
30
20
10
0
n = 4378
1810
1275
499
259
203
111
54
52
Overall
Nausea and vomiting
Upper airway support
Hypo-tension
Dys-rhythmia
Hyper-tension
Altered mental status
ROMI
Major cardiac arrest

- Post-operative nausea and vomiting. (PONV)
- Respiratory complications
- Circulatory complications
- Failure to regain consciousness
- Postoperative pain

PONV

INCIDENCE

- PONV發生率約20~30%,
- 在術後僅次于痛的常見問題

RISK FACTORS AND INDEPENDENT PREDICTORS

- Patient-related.
- Anesthesia-related.
- Surgery-related.

PATIENT-RELATED

- **1. Female Gender:**最強的risk factor, 即使menopause後還是存在
- **2. Nonsmoker**
- **3. History of PONV, Motion Sickness, or Migraine**
- **4. Age**：The incidence of PONV decreases with age
- **5. Anxiety**：有相關,但是關連性不強

ANESTHESIA-RELATED

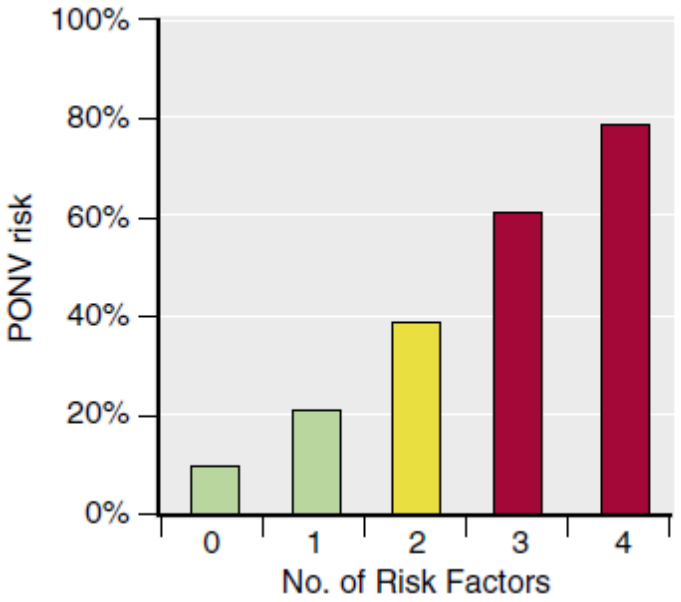
- **Postoperative Opioids:** 有使用的話發生PONV機率為兩倍,一樣哪種類沒差,主要是dose. 另外regional anesthesia 也可以減少PONV
- **Duration of Anesthesia:** longer and more invasive surgeries會有更多PONV
- **Propofol and Inhaled Anesthetics**

SURGERY-RELATED

1. Tympanoplasty and vestibular stimulation,
2. Adenotonsillectomy and swallowed blood,
3. Breast surgery and emotional load,
4. Laparoscopic surgery and peritoneal irritation,
5. Abdominal surgery and serotonin release,
6. Hysterectomy and vagal stimulation
7. Large abdominal and gynecologic surgeries have increased risk for PONV

ADULT

Risk factors	Points
Female gender	1
Nonsmoker	1
History of PONV	1
Postoperative opioids	1
Risk score =	0...4



PREVENTION

- Pain control.
- Regional anesthesia.
- Antiemetics.

ANTIEMETICS

- Dopamine Antagonists
- Histamine Antagonists
- Anticholinergics
- Serotonin Antagonists (5HT3 antagonists)
- Dexamethasone
- Others.

DOPAMINE ANTAGONISTS

1. Metoclopramide(Primperan)

- 作用 : D2-antagonist, prokinetic(促進腸胃蠕動來胃排空)
- 劑量：10mg
- Side effect: dyskinetic /EPS; hypotension and tachycardia.

2. Droperidol

- 作用 : D2-antagonist
- 劑量：0.625~1.25mg
- 副作用 : 使用會導致severe arrhythmias (torsades de pointes) and deaths, QT prolong
- black box: 有QT prolong疑慮的病人盡量不要使用,要使用也要有2~3小時的EKG monitor才行
- Prevent of PONV in PCA: 25 μg droperidol per mg of morphine.

HISTAMINE ANTAGONISTS

Dimenhydrinate (Dramamine) or Diphenhydramine (Benadryl)	H_1 (M)	31.25-62.5 mg IV, 50-mg suppository		0.61	0.71	Drowsiness RR = 9.0
Cyclizine (Marezine)	H_1 (M)	50 mg IV or IM	0.67	0.55	0.67	
Promethazine (Phenergan)	H_1 (M)	12.5-25 mg or 12.5-50 mg IM			0.46	Risk of vascular necrosis

OTHERS

Diazepam, Lorazepam (Ativan)	$GABA_A$, modulation	10 mg PO, 2-2.5 mg PO	0.50, 0.55			
Midazolam (Versed)	$GABA_A$, modulation	2-5 mg IV, 7.5-15 mg PO		0.73		
Dexamethasone (Decadron)	Unknown	4-8 mg	0.58	0.51	0.48	Slow onset, preferably after induction
Aprepitant	NK_1	40-mg PO capsule				Active control with ondansetron: Similarly effective against nausea but significantly more effective against vomiting: RR = 0.38 (0.13-0.64),[158] 0.55 (0.32-0.79)[159]

- Dexamethasone
- 作用機轉未明,推測是中樞的nucleus tractus solitarii
- Minimal effective dose: 2.5~5mg, slow onset of action

- Dormicum: 作用在GABA receptor, anxiolysis.

RESPIRATORY COMPLICATIONS

RESPIRATORY

- Upper airway obstruction.
- Hypoxemia
- Hypoventilation

RESPIRATORY

- Upper airway obstruction
- Laryngospasm
- Airway edema
- Hematoma.

UPPER AIRWAY OBSTRUCTION

- Loss of pharyngeal muscle tone: 麻藥未退或肌肉鬆弛劑效果還在
- Paradoxical breathing pattern: “ a rocking motion”
- Laryngospasm
- 堵塞物

Table 38–3 Factors Contributing to Prolonged Nondepolarizing Neuromuscular Blockade

Drugs
Inhaled anesthetic drugs
Local anesthetics (lidocaine)
Cardiac antidysrhythmics (procainamide)
Antibiotics (polymyxins, aminoglycosides, lincosamines [clindamycin], metronidazole [Flagyl), tetracyclines)
Corticosteroids
Calcium channel blockers
Dantrolene
Furosemide
Metabolic and Physiologic States
Hypermagnesemia
Hypocalcemia
Hypothermia
Respiratory acidosis
Hepatic/renal failure
Myasthenia syndromes

MANAGEMENT OF UPPER AIRWAY OBSTRUCTION

- 治療上以noninvasive優先選擇：jaw thrust with CPAP (5 to 15 cm H_2O)(前面講的laryngospasm可以到40cm H_2O)大多就可以打開, CPAP不行就放nasal, oral airway or laryngeal mask, or intubation.
- Opioids and benzodiazepines的作用：持續刺激或small titrated doses of naloxone (0.3 to 0.5 μg/kg IV) or flumazenil (0.2 mg IV to maximum dose of 1 mg)
- 殘存的肌肉鬆弛劑作用：使用acetylcholinesterase inhibitor (neostigmine) 或減少促進因子，像是低體溫

RESIDUAL NEUROMUSCULAR BLOCKADE

- Clinical assessment:

  a. Train-of-four (TOF)

  b. lift legs off the bed

  c. 頭抬高五秒是最標準的拔管criteria

* Most factors prolong MR : respiratory acidosis and hypothermia

AIRWAY EDEMA

- 手術時間過長或頭低腳高
- Surgical procedure : tongue, pharyngeal or neck,下腹腔達文西手術
- Important physical sign: facial & scleral edema
- Evaluate airway patency before extubation
- 小心拔管,leak test.

HEMATOMA

- Treatment hematoma:

  a. 打開傷口

  b. significant amount blood, difficult airway equipment, awake technique, surgical backup for tracheostomy

HYPOXEMIA

Table 38–4 Factors Leading to Postoperative Arterial Hypoxemia
Right-to-left intrapulmonary shunt (atelectasis)
Mismatching of ventilation to perfusion (decreased functional residual capacity)
Congestive heart failure
Pulmonary edema (fluid overload, postobstructive)
Alveolar hypoventilation (residual effects of anesthetics and/or neuromuscular blocking drugs)
Diffusion hypoxia (unlikely if receiving supplemental oxygen)
Inhalation of gastric contents (aspiration)
Pulmonary embolus
Pneumothorax
Posthyperventilation hypoxia
Increased oxygen consumption (shivering)
Sepsis
Transfusion-related lung injury
Adult respiratory distress syndrome
Advanced age
Obesity

- **Early signs :**

Restlessness, tachycardia & ventricular or atrial dysrhythmias

- **Late signs:**

Hypotension, bradycardia and cardiac arrest

RESPIRATORY

- Hypoventilation
- 呼吸功能沒完全恢復,吸的少吐的少

- decrease ventilatory drive, pulmonary & respiratory muscle insufficiency.
- sign prominent when $PaCO_2 > 60$ or $pH < 7.25$

Table 38–5 Factors Leading to Postoperative Hypoventilation

Drug-induced central nervous system depression (volatile anesthetics, opioids)
Residual effects of neuromuscular blocking drugs
Suboptimal ventilatory muscle mechanics
Increased production of carbon dioxide
Coexisting chronic obstructive pulmonary disease

CIRCULATORY COMPLICATIONS

CIRCULATORY COMPLICATIONS

- Hypotension
- Hypertension
- Dysrhythmias

Table 38–7 Causes of Hypotension in the Postanesthesia Care Unit
Intravascular Fluid Volume Depletion
Ongoing fluid losses (bowel preparation, gastrointestinal losses, surgical bleeding)
Increased capillary permeability (sepsis, burns, transfusion-related lung injury)
Decreased Cardiac Output
Myocardial ischemia/infarction
Cardiomyopathy
Valvular disease
Pericardial disease
Cardiac tamponade
Cardiac dysrhythmias
Pulmonary embolus
Tension pneumothorax
Drug induced (β-blockers, calcium channel blockers)
Decreased Vascular Tone
Sepsis
Allergic reactions (anaphylactic, anaphylactoid)
Spinal shock (cord injury, iatrogenic high spinal)
Adrenal insufficiency

BP= SV*HR*SVR = CO*SVR

Table 38–6 Factors Leading to Postoperative Hypertension

Arterial hypoxemia
Preoperative essential hypertension
Enhanced sympathetic nervous system activity (hypercapnia from hypoventilation, pain, gastric distention, bladder distention)
Hypervolemia
Emergence excitement
Shivering
Drug rebound
Increased intracranial pressure

Table 38–8 Factors Leading to Postoperative Cardiac Dysrhythmias
Hypoxemia
Hypercarbia
Volume shifts
Pain, aqitation
Hypothermia
Hyperthermia
Anticholinesterases
Anticholinergics
Myocardial ischemia
Electrolyte abnormalities
Respiratory acidosis
Hypertension
Digitalis intoxication
Preoperative cardiac dysrhythmias

- **Atrial Dysrhythmias：在重大非心臟手術後的發生率為10%**，若是cardiac and thoracic procedures機率更高。
- **Ventricular Dysrhythmias**：Premature ventricular contractions (PVCs) and ventricular bigeminy在恢復室是常見的。PVCs只要**交感刺激上升**就會發生

Delayed awakening

FAILURE TO REGAIN CONSCIOUSNESS

- 即使是在長時間手術或麻醉, 一般病人還是應該在結束後60~90分鐘對刺激有反應。當發生delay awakening後, 要注意病人的vital signs和做神經理學檢查. 驗gas data可以了解oxygenation和ventilation的情形，或是有其他electrolyte、metabolic disturbances (blood glucose concentration)的問題.

Table 38–14 Possible Explanations for Delayed Awakening in the Postanesthesia Care Unit

Residual drug effects (opioids, benzodiazepines, anticholinergics)
Hypothermia
Hypoglycemia
Electrolyte abnormalities
Arterial hypoxemia
Increased intracranial pressure (cerebral hemorrhage)
Air embolism

BODY TEMPERATURE AND SHIVERING

- General and regional anesthesia後都可能發生，Incidence: 5% to 65%.
- Mechanism：絕大多數還是因為hypothermia
- 因為brain和spinal cord並不是同時從全麻中恢復, 若是spinal太快恢復而大腦還沒恢復, 那大腦的抑制命令沒有下來, 就會出現uninhibited spinal reflexes manifested as clonic activity

TREATMENT

- 若是低溫就升溫
- Opioids, ondansetron, and clonidine : meperidine, 0.35 to 0.4 mg/kg (12.5 to 25 mg IV最常用)

POSTOPERATIVE PAIN

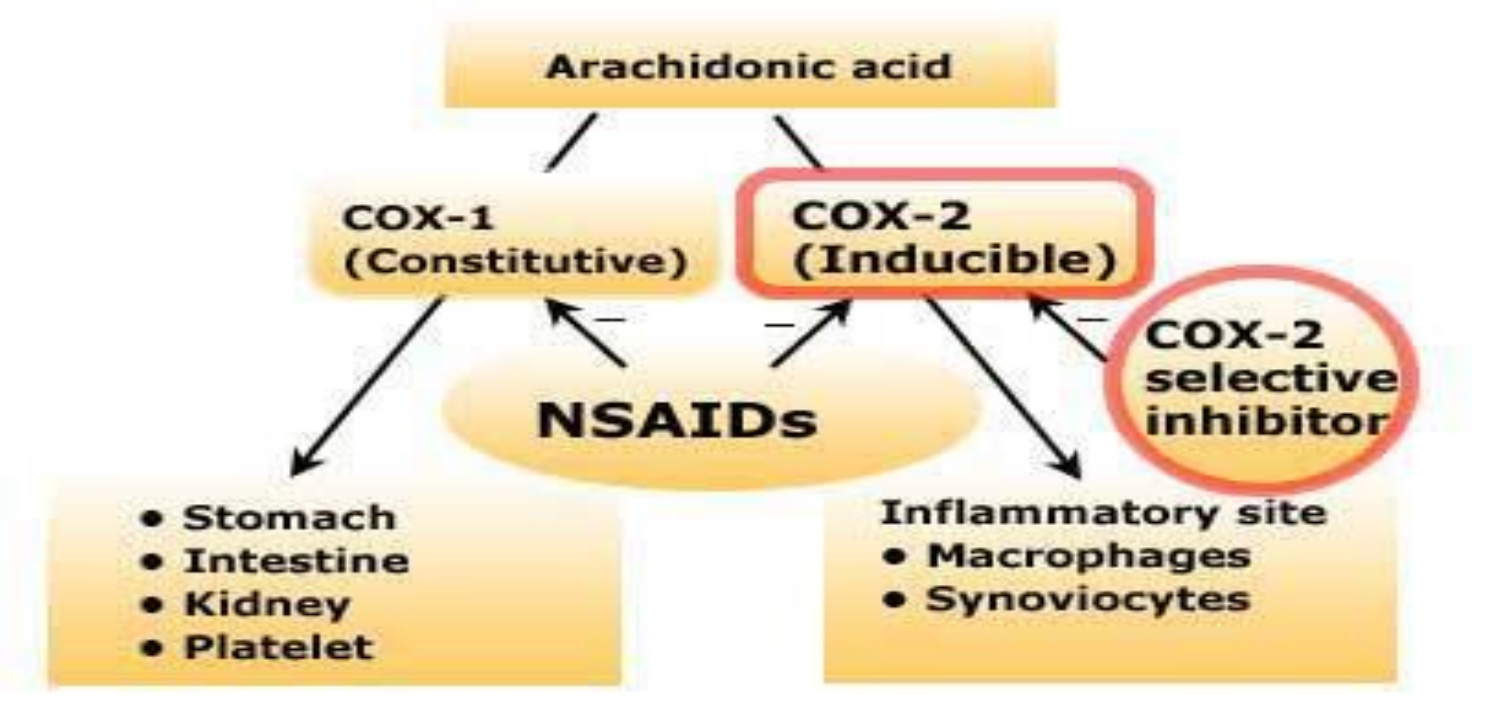
POSTOPERATIVE PAIN:

- 持續頓悶痛,主要在傷口和傷口周圍
- 活動時像翻身咳嗽更衣都會更痛
- 頭兩三天最痛,因為發炎反應,之後會慢慢緩和
- 隨著傷口癒合疼痛也會減少

- Morbidity and mortality ▲
- Ileus
- Hypercoagulability, DVT
- Myocardial ischemia.
- Immunosuppression and hyperglycemia cause poor healing.
- Lung complications
- Chronic postsurgical pain.

NONOPIOIDS

- 1.NSAIDS.



SIDE EFFECTS

- Decreased hemostasis,
- Renal dysfunction,
- Gastrointestinal hemorrhage,
- And deleterious effects on bone healing and osteogenesis.

OPIOIDS

- 由CNS內的μ-receptors來止痛,但是還是有周邊的peripheral opioid receptors
- No analgesic ceiling, 除非出現tolerance or opioid-related side effects,不然理論上劑量可以一直上升
- 多種途徑, IV, PO, IM, SC..等, intrathecal or epidural space也可以
- Moderate to severe postoperative pain 用IV or IM較好,因為onset快,效果也好
- 通常會等可以吃東西了而且用IV已經可以有效止痛了才會改口服opioid,不要IV都還沒辦法有效止痛就改口服

- 鴉片類止痛藥常見之副作用

  呼吸抑制 (respiratory depression)

  嗜睡 (excessive sedation)

  皮膚搔癢 (pruritus)

  尿液滯留 (urinary retention)

  噁心嘔吐 (nausea and vomiting)

  便秘 (constipation)：口服長期使用

- 使用鴉片類止痛藥之注意事項

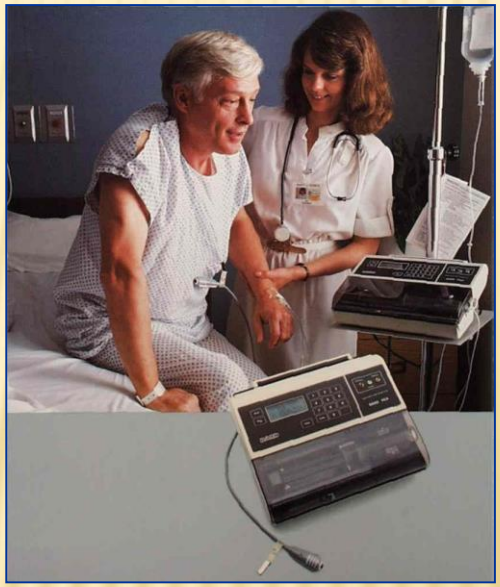
  隨時注意病患之生命徵象與意識狀況

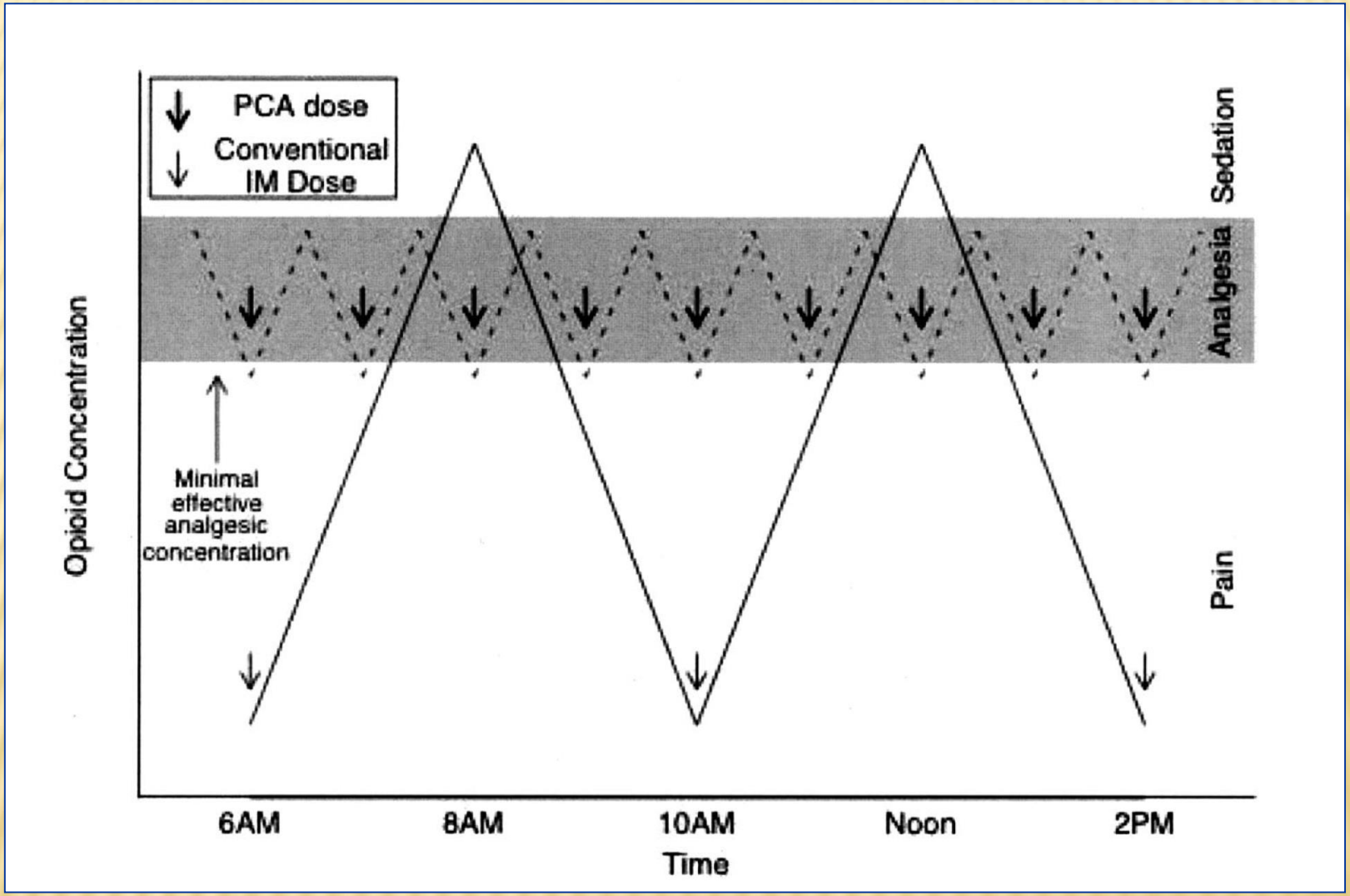
  給予氧氣與血氧濃度監測 (pulse oximeter)

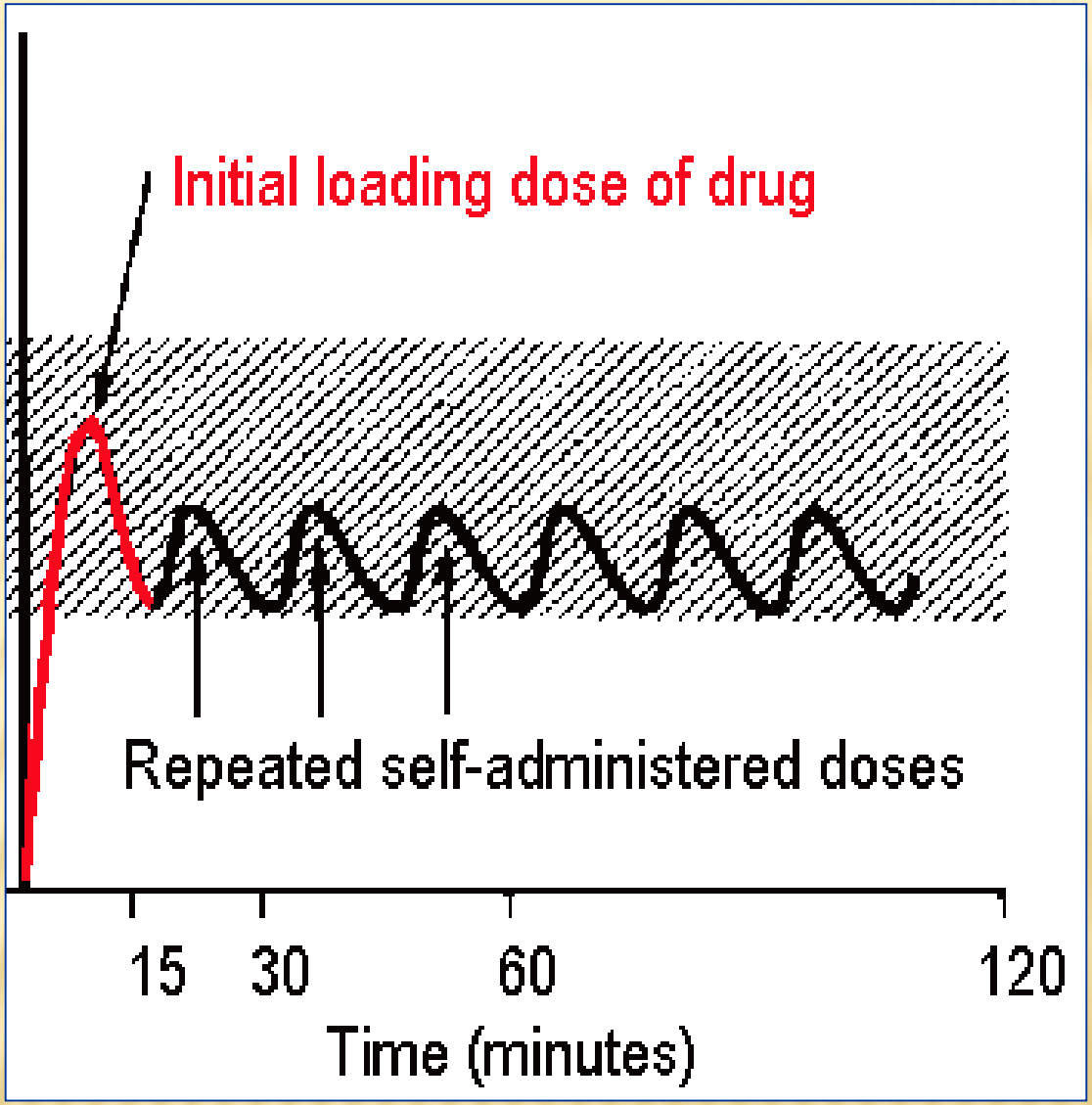
  肝腎功能障礙之患者須減量

病患自控式止痛裝置

Patient-Controlled Analgesia




PCA dose
Conventional IM Dose
Sedation
Analgesia
Pain
Opioid Concentration
Minimal effective analgesic concentration
6AM
8AM
10AM
Noon
2PM
Time


Initial loading dose of drug
Repeated self-administered doses
15
30
60
120
Time (minutes)

- **Intravenous Patient-Controlled Analgesia (IV PCA)：**
- 因為要根據每個人不同來調整劑量，所以PCA才產生, 是一種 **negative-feedback loop**, 大多數的PCA問題都是來自**user or operator error,** 機器本身很少有問題
- Setting有很多種, 主要是demand (bolus) dose, lockout interval, and background infusion：

Table 87-1 -- Intravenous Patient-Controlled Analgesia Regimens

Drug Concentration	Size of Bolus *	Lockout Interval (min)	Continuous Infusion
Agonists			
Morphine (1 mg/mL)			
Adult	0.5-2.5 mg	5-10	—
Pediatric	0.01-0.03 mg/kg (max, 0.15 mg/kg/hr)	5-10	0.01-0.03 mg/kg/hr
Fentanyl (0.01 mg/mL)			
Adult	10-20 µg	4-10	—
Pediatric	0.5-1 µg/kg (max, 4 µg/kg/hr)	5-10	0.5-1 µg/kg/hr
Hydromorphone (0.2 mg/mL)			
Adult	0.05-0.25 mg	5-10	—
Pediatric	0.003-0.005 mg/kg (max, 0.02 mg/kg/hr)	5-10	0.003-0.005 mg/kg/hr
Alfentanil (0.1 mg/mL)	0.1-0.2 mg	5-8	—
Methadone (1 mg/mL)	0.5-2.5 mg	8-20	—
Meperidine (10 mg/mL)	5-25 mg	5-10	—
Oxymorphone (0.25 mg/mL)	0.2-0.4 mg	8-10	—
Sufentanil (0.002 mg/mL)	2-5 µg	4-10	—
Agonist-Antagonists			
Buprenorphine (0.03 mg/mL)	0.03-0.1 mg	8-20	—
Nalbuphine (1 mg/mL)	1-5 mg	5-15	—
Pentazocine (10 mg/mL)	5-30 mg	5-15	—

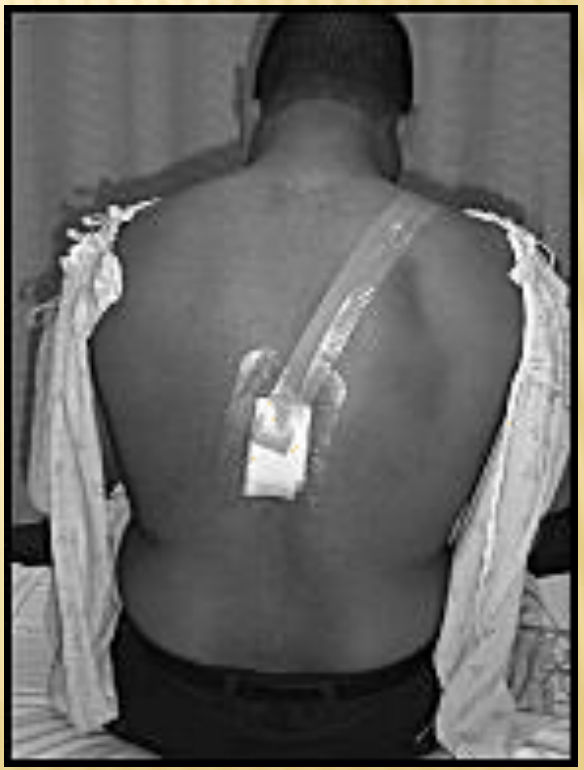
PCEA

- IV PCA – Morphine ± Ketorolac or Tramadol
- **Epidural PCA (PCEA)**

  (1) Local anesthetic

  Lidocaine, bupivacaine, levobupivacaine or ropivacaine

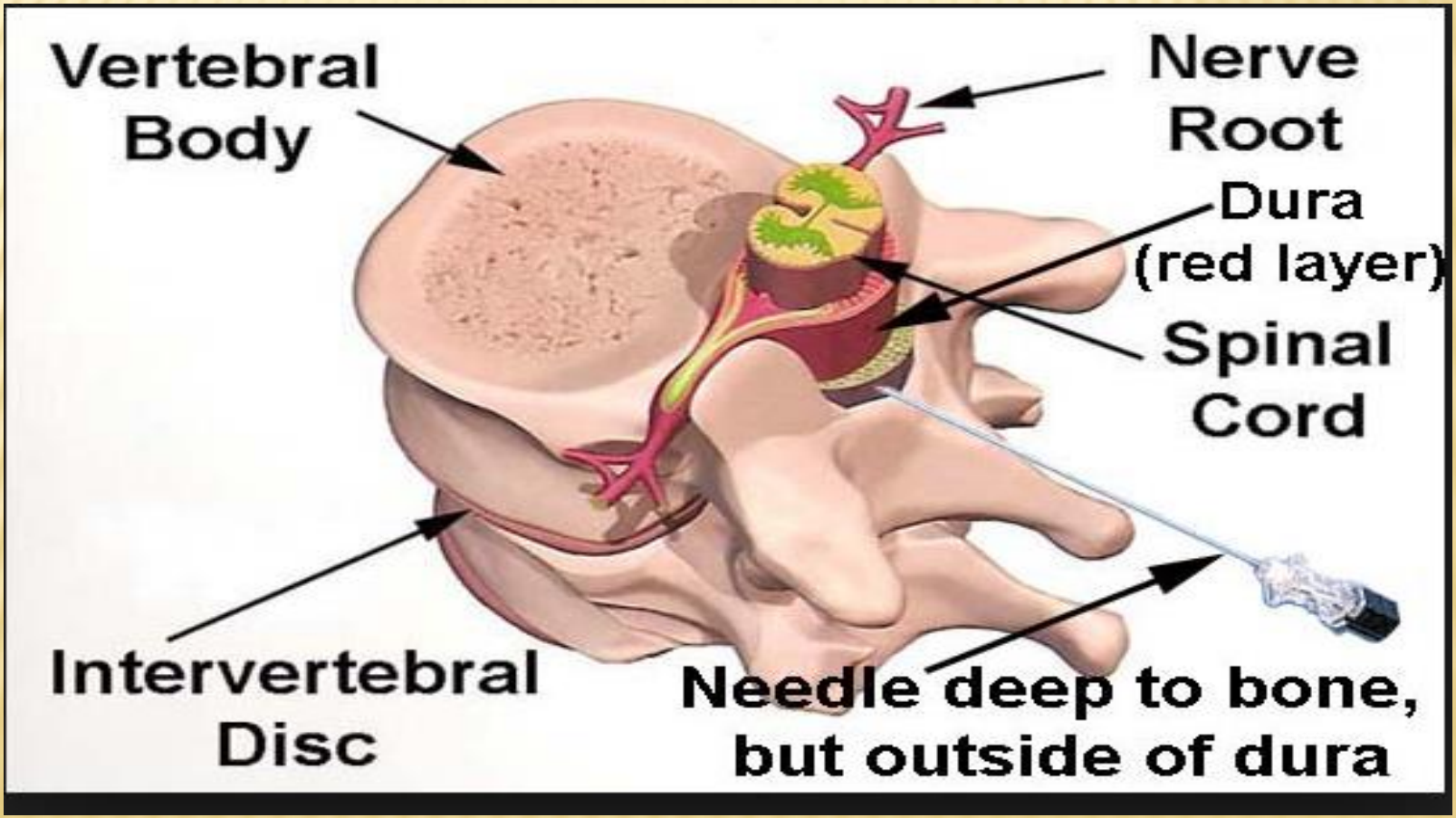
  (2) Opioid : Morphine, Fentanyl



- PCEA 不可接錯!!

CONTINUOUS EPIDURAL ANALGESIA

- Local anesthetics + opioids.



REGIONAL ANALGESIC TECHNIQUES

- 效果會比systemic opioids要來得好並且mortality and morbidity也更少
- 使用上的contraindication就和regional anesthesia的一樣.

SIDE EFFECTS OF NEURAXIAL ANALGESIC DRUGS

- Hypotension: block sympathetic fibers
- Motor block.
- Nausea and vomiting.
- Pruritus.
- Respiratory depression: reversible by naloxone
- Urinary retention: opioid receptors in spinal cord decreases the detrusor muscle's strength.

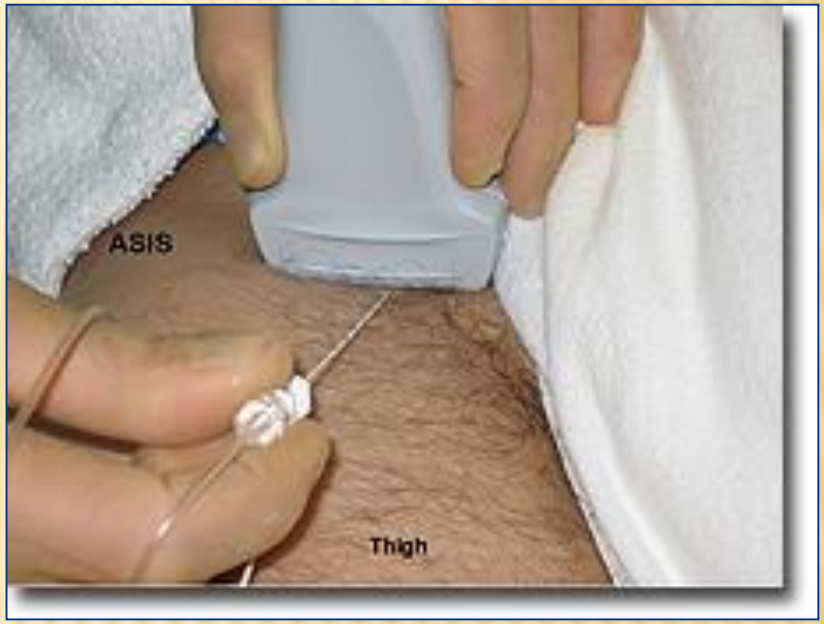
- Benefit: Reduced overall mortality, decrease the incidence of postoperative gastrointestinal, pulmonary, and possibly cardiac complications.
- Side effects: catheter related (placement, indwelling)

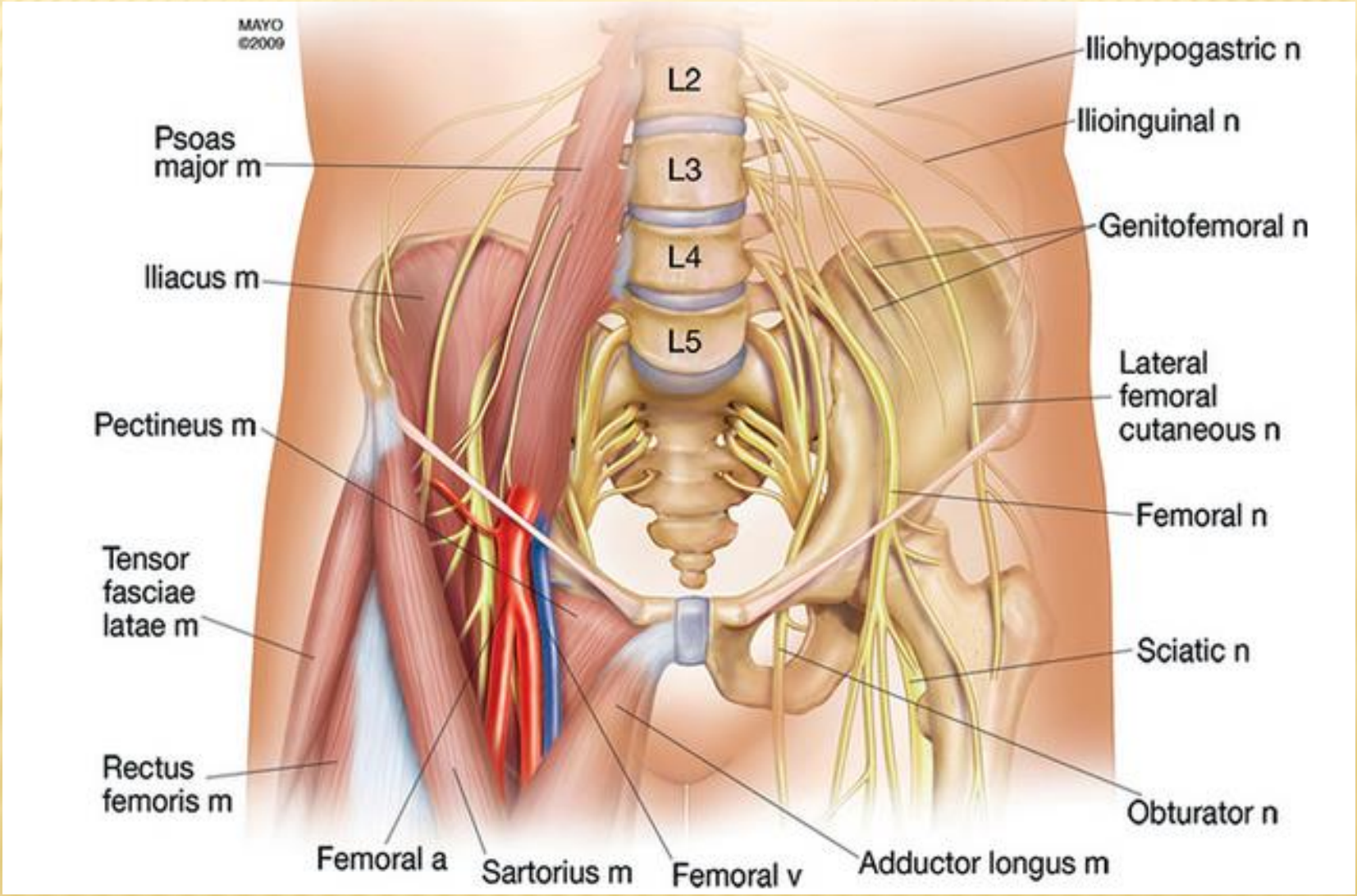
PERIPHERAL REGIONAL ANALGESIA

- Nerve blocks
- Interscalene nerve blocks
- Supraclavicular nerve blocks
- Femoral nerve blocks.

- Ultrasound guide.

NERVE BLOCK




MAYO
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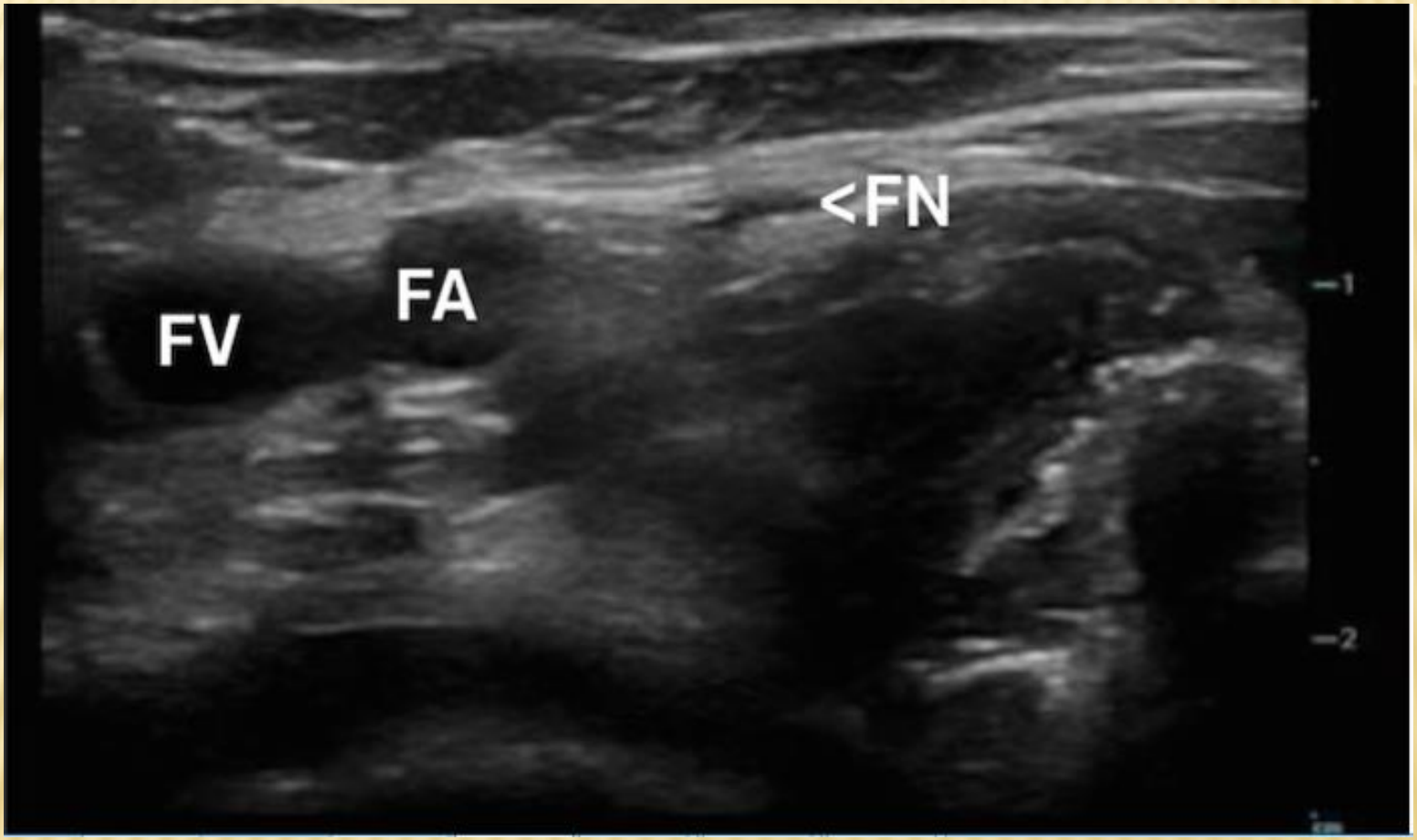
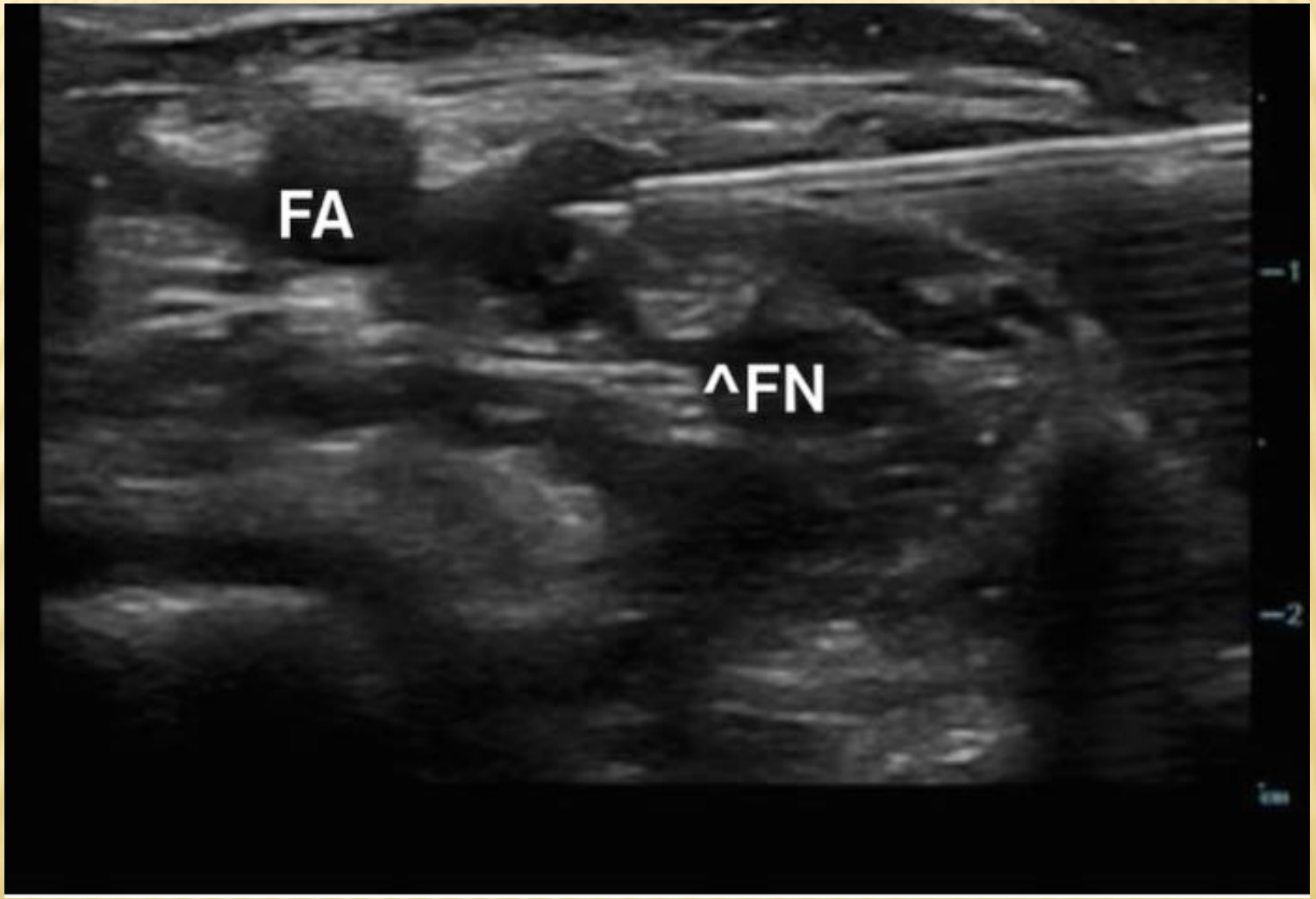
L2
L3
L4
L5
Psoas major m
Iliacus m
Pectineus m
Tensor fasciae latae m
Rectus femoris m
Femoral a
Sartorius m
Femoral v
Adductor longus m
Iliohypogastric n
Ilioinguinal n
Genitofemoral n
Lateral femoral cutaneous n
Femoral n
Sciatic n
Obturator n

NERVE BLOCK

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