Acute PostOperative Pain Management

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FUNDAMENTAL CONCEPTS

- Pain is an unpleasant sensory and emotional experience associated with, or resembling that associated with, actual or potential tissue damage (Jul 16, 2020).
- A revolution in the management of acute postoperative pain has occurred during the past four decades.
- Anesthesiologists are the best in managing perioperative conditions such as pain!

PAIN PATHWAYS AND THE NEUROBIOLOGY OF NOCICEPTION

Surgery → Tissue injury → Release of histamine & inflammatory mediators

Activation of peripheral nociceptors

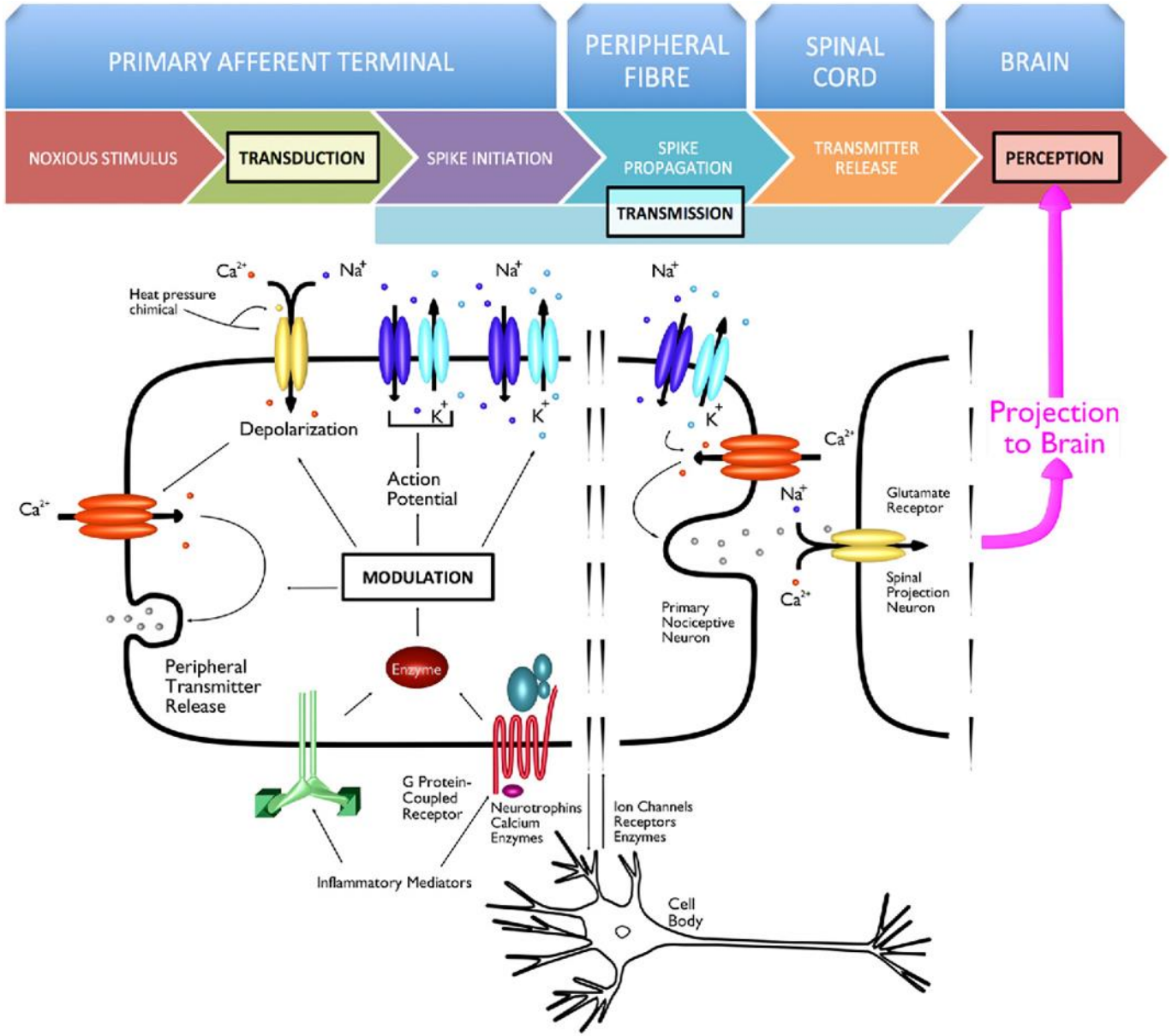
Neurogenic inflammation

- Peptides (e.g., bradykinin)
- Lipids (e.g., prostaglandins)
- Neurotransmitters (e.g., serotonin)
- Neurotrophins (e.g., nerve growth factor)
- Substance P
- Calcitonin gene-related peptide

→ vasodilatation & plasma extravasation

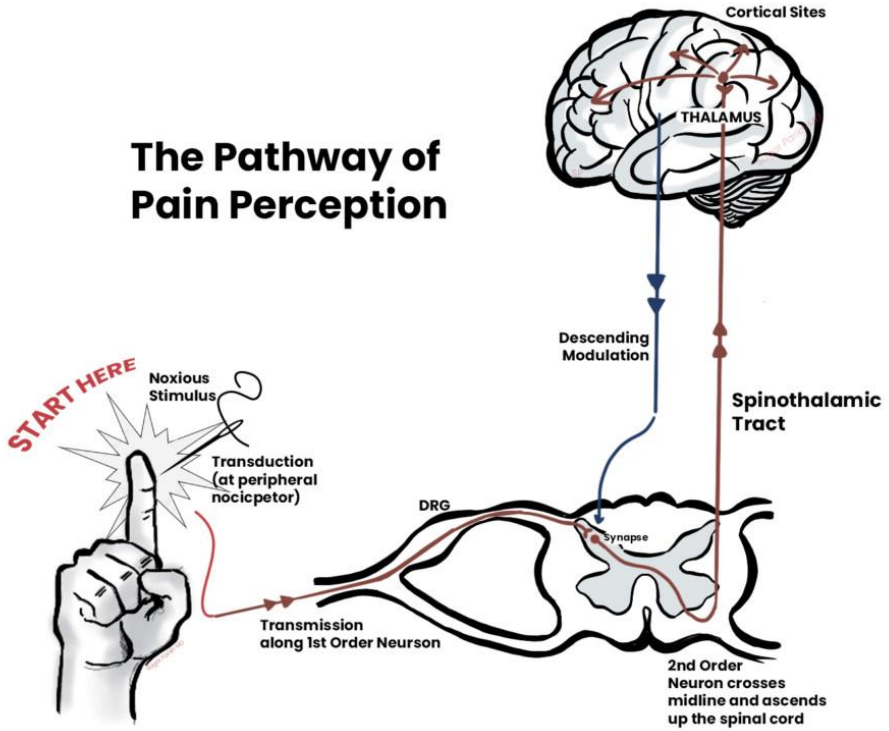
MAJOR CLASSES OF NOCICEPTORS

- Aδ mechanosensitive nociceptors
- Aδ mechanothermal nociceptors
- Polymodal nociceptors (being specifically associated with C fibers)


PRIMARY AFFERENT TERMINAL
PERIPHERAL FIBRE
SPINAL CORD
BRAIN
NOXIOUS STIMULUS
TRANSDUCTION
SPIKE INITIATION
SPIKE PROPAGATION
TRANSMITTER RELEASE
PERCEPTION
TRANSMISSION
Heat pressure chimical
Depolarization
Action Potential
MODULATION
Peripheral Transmitter Release
Enzyme
G Protein-Coupled Receptor
Neurotrophins Calcium Enzymes
Ion Channels Receptors Enzymes
Inflammatory Mediators
Primary Nociceptive Neuron
Glutamate Receptor
Spinal Projection Neuron
Projection to Brain
Cell Body

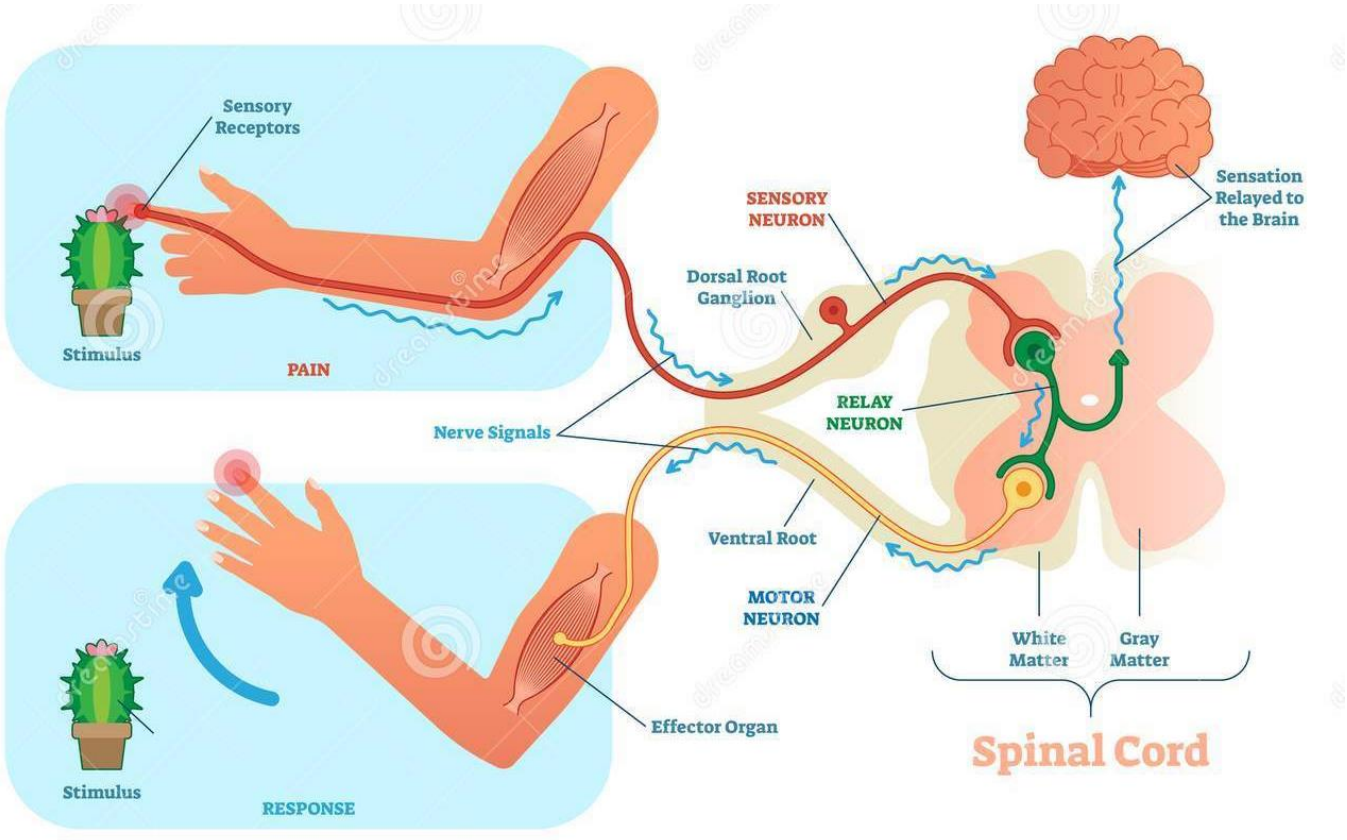
DESCENDING MODULATION (DORSAL HORN)

Serotonin
Norepinephrine
GABA



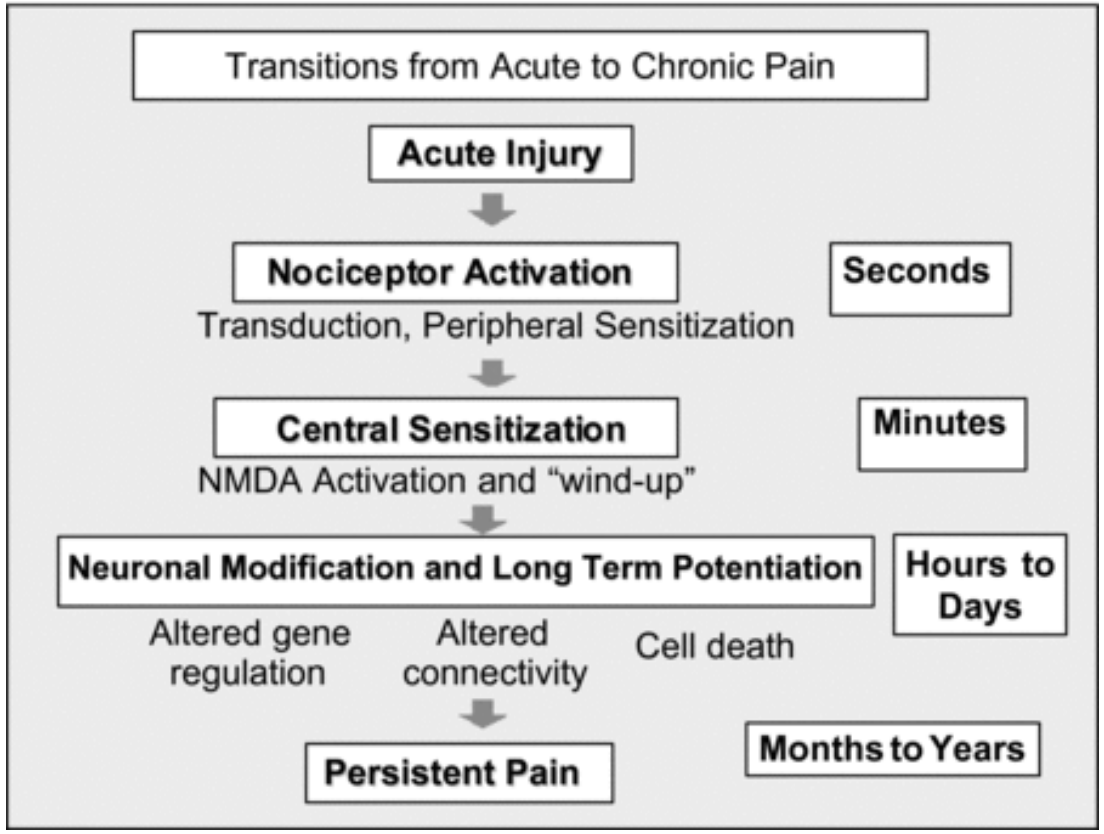
SPINAL REFLEX OF PAIN

- Increased skeletal muscle tone
- Inhibition of phrenic nerve function
- Decreased GI motility

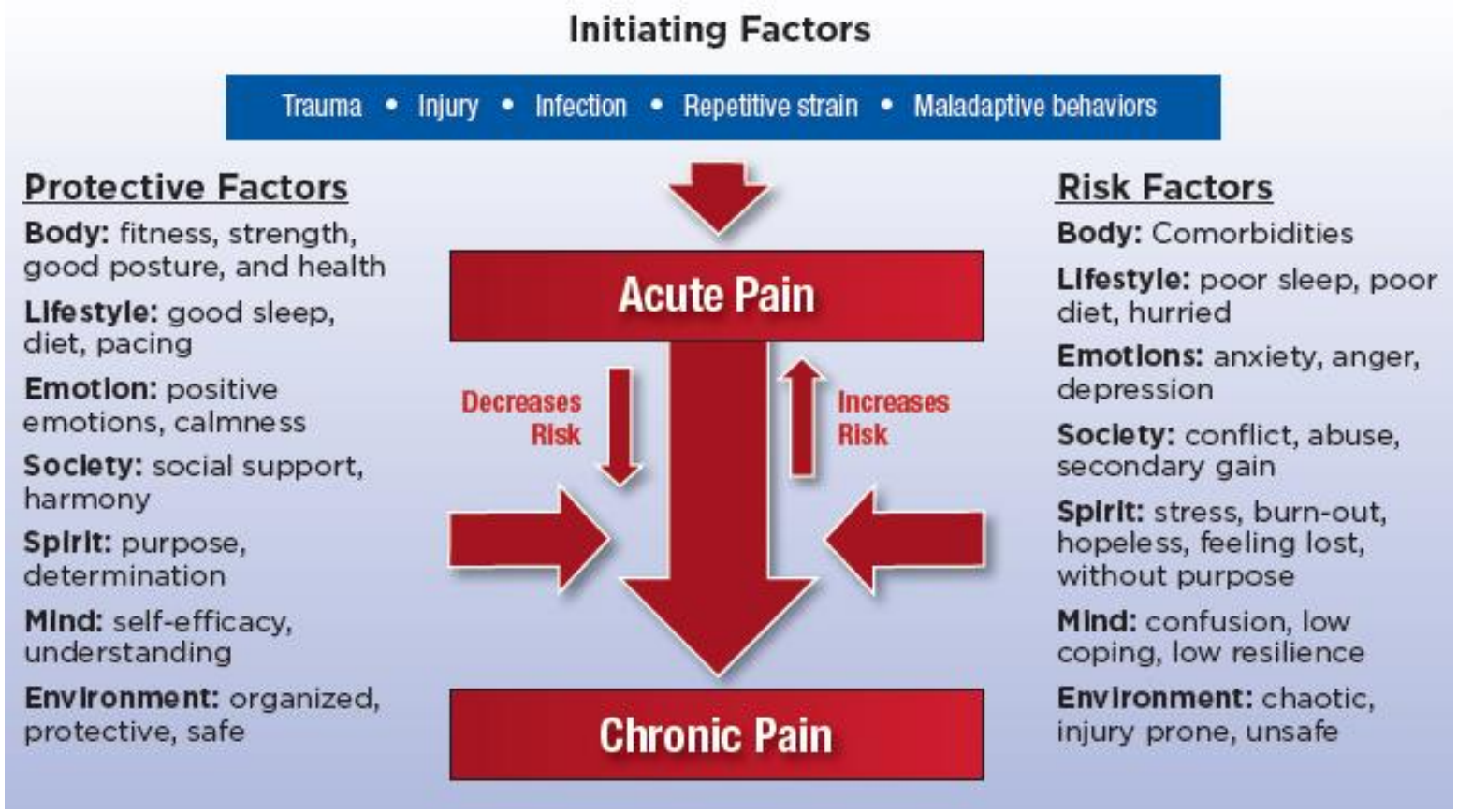


CENTRAL SENSITIZATION

- Central sensitization is equal to persistent postinjury changes in the CNS that result in pain hypersensitivity.
- Central sensitization is a condition of the nervous system that is associated with the development and maintenance of chronic pain. When central sensitization occurs, the nervous system goes through a process called wind-up and gets regulated in a persistent state of high reactivity.
- Wind-up phenomenon is repetitive stimulation of nociceptive C fibers leads to a disproportionate enhancement of dorsal horn noxious responses.
- Certain receptors (e.g., N-methyl-D-aspartate [NMDA]) may be especially important for the development of chronic pain after an acute injury.



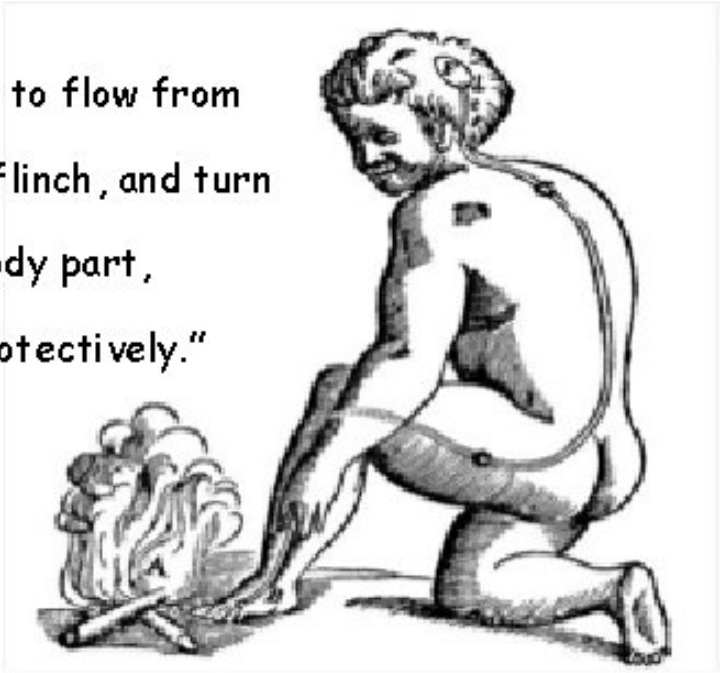
The traditional dichotomy between acute and chronic pain is arbitrary because acute pain may quickly transition into chronic pain.



The intensity of acute postoperative pain is a significant predictor of chronic postoperative pain.

DESCARTES' PAIN PATHWAY

"Particles of heat activate a spot of skin attached by a fine thread to a valve in the brain…
this opens the valve allowing animal spirits to flow from a cavity into the muscles causing them to flinch, and turn the head and eyes toward the affected body part,
also moving the hand and turn the body protectively."



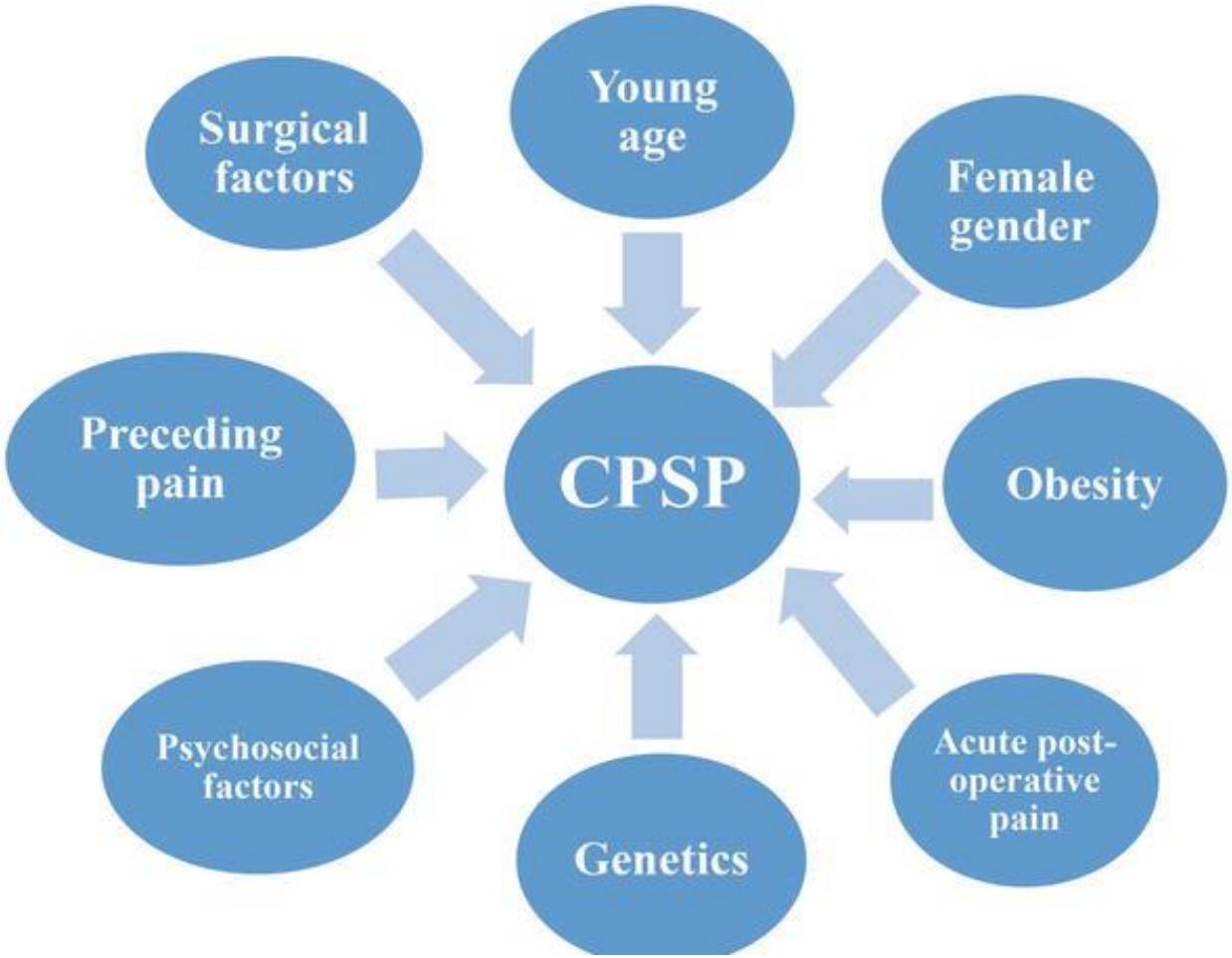
Attenuation Of Postoperative Pain, Especially with Certain Types of Analgesic Regimens, May Decrease Perioperative Morbidity and Mortality!

Acute effects of POP

- Neuroendocrine stress response: Release of cytokines, prostaglandins, leukotrienes, TNF-α
- Hypercoagulable state: DVT, vascular graft failure, and myocardial ischemia
- Immunosuppression
- Hyperglycemia: poor wound healing and depression of immune function
- Sympathetic activation: Morbidity & Mortality
- Decreased respiratory function (Spinal reflex inhibition of phrenic nerve activity)

Chronic effects of POP

- Chronic persistent postsurgical pain (CPSP): 10-65%
  - limb amputation (30%-83%)
  - thoracotomy (22%-67%)
  - sternotomy (27%)
  - breast surgery (11%-57%)
  - gallbladder surgery (up to 56%)



APS clinicians should understand chronic pain conditions and involve themselves in the patient's preoperative care.

PREVENTIVE ANALGESIA

- The rationale for preemptive analgesia was based on the inhibition of the development of central sensitization.
- A single analgesic treatment (either peripheral or neuraxial) before the incision does not reduce postoperative pain behaviors beyond the expected duration of the analgesic effect.
- This terminology has fallen out of favor!

PREVENTIVE ANALGESIA

any regimen given at any time during the perioperative period

MULTIMODAL APPROACH TO PERIOPERATIVE RECOVERY/ ENHANCED RECOVERY AFTER SURGERY (ERAS)

- Patient education
- Local anesthetic-based techniques (local infiltration, peripheral nerve blocks, and neuraxial analgesia)
- Combination of analgesic drugs that act via different mechanisms on different receptors within the pain transmission pathway
- Minimization of opioid use and side effects from opioids by utilizing nonopioid analgesics and techniques

ERAS will decrease perioperative morbidity, costs of care, decrease the length of hospital stay, and improve patient satisfaction without compromising safety.

TREATMENT METHODS

1. Systemic (i.e., opioid and non-opioid) analgesics
2. Regional (i.e., neuraxial and peripheral) analgesic techniques

MONITORING & DOCUMENTATION

Analgesic Medication*

Medication, concentration, and dose of drug
Settings of PCA device: demand dose, lockout interval, continuous basal infusion
Amount of drug administered (including number of unsuccessful and successful doses)
Limits set (e.g., 1- and 4-h limits on dose administered)
Supplemental or breakthrough analgesics

Routine Monitoring

Vital signs: temperature, heart rate, blood pressure, respiratory rate, average pain score
Pain score at rest and with activity, pain relief

Side Effects

Cardiovascular: hypotension, bradycardia, or tachycardia
Respiratory status: respiratory rate, level of sedation
Nausea and vomiting, pruritus, urinary retention

Neurologic Examination

Assessment of motor block or function and sensory level
Evidence of epidural hematoma

Instructions Provided

Treatment of side effects
Concurrent use of other CNS depressants
Parameters for triggering notification of the covering physician
Provision of contact information (24 hr/7 day per week) if problems occur
Emergency analgesic treatment if the PCA device fails

SYSTEMIC ANALGESIC TECHNIQUES

- Opioids
- NSAIDs
- Acetaminophen
- Gabapentinoids
- Ketamine
- Tramadol

PHARMACOLOGICAL TREATMENTS
WHO analgesic ladder (update maybe required)

The guidelines aimed to achieve ‘freedom from cancer pain’, and introduced five fundamental principles:

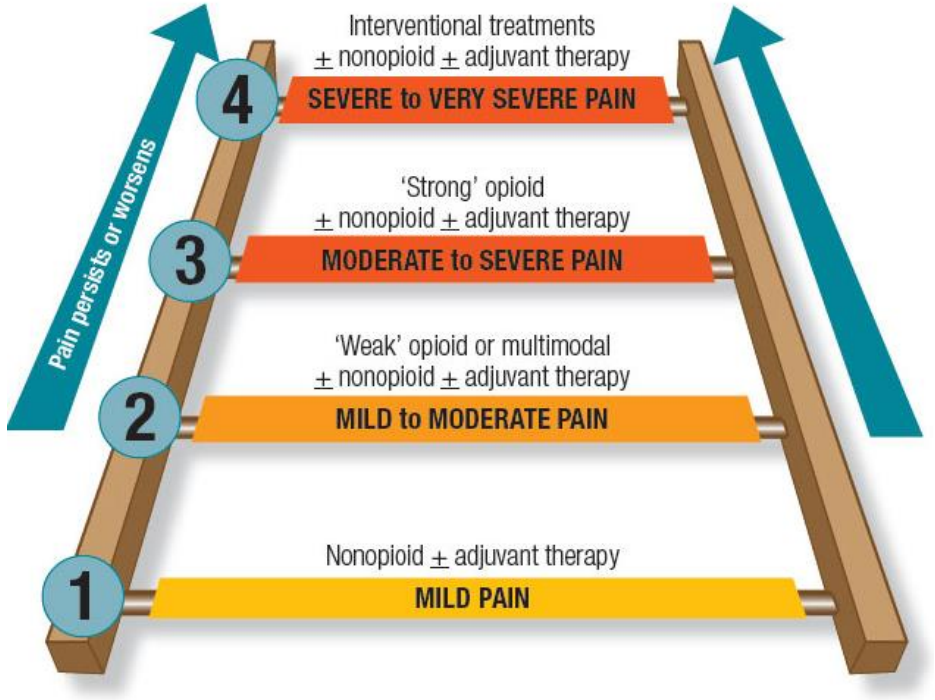
‘by mouth’,

‘by the clock’,

‘by the ladder’,

‘for the individual’

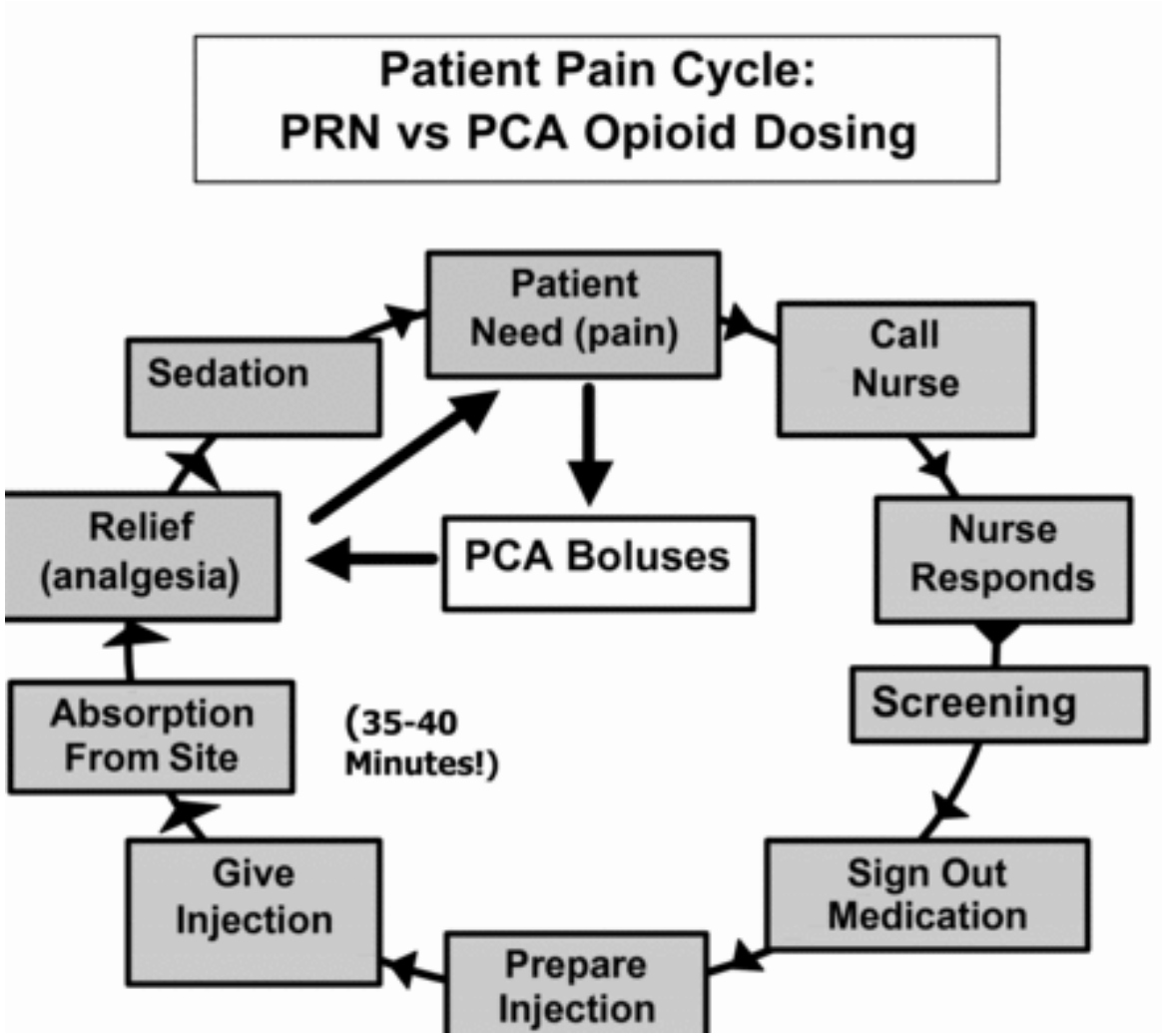
and ‘attention to detail’.



OPIOIDS

- A theoretical advantage of opioid analgesics is that there is no analgesic ceiling.
- The analgesic efficacy of opioids is typically limited by the development of tolerance or opioid-related side effects.
- Serum drug concentration may exhibit more variability with IM route of administration than with others.
- PRN: The worst method of opioid (analgesic) prescription!
- IV-PCA: Probably the most reliable method available

PCA vs PRN


Patient Pain Cycle:
PRN vs PCA Opioid Dosing
Patient Need (pain)
Call Nurse
Nurse Responds
Screening
Sign Out Medication
Prepare Injection
Give Injection
Absorption From Site
Relief (analgesia)
Sedation
PCA Boluses
(35-40 Minutes!)

IV PCA

- Most problems related to IV-PCA use result from user or operator error.
- Programable variables: demand (bolus) dose (integral to the efficacy), lockout interval, and background infusion
- Routine use of a background infusion predicted certain advantages, including improved analgesia, especially during sleep.
- Continuous infusions are not initially recommended for opioid-naïve adults.
- Use of a nighttime background infusion does not improve postoperative sleep patterns, analgesia, or recovery profiles in opioid-naïve adult patients.
- A background infusion in opioid-tolerant or pediatric patients maybe effective.
- The incidence of opioid-related adverse events from IV PCA is not different from that of PRN opioids administered intravenously, intramuscularly, or subcutaneously.

IV PCA REGIMENS

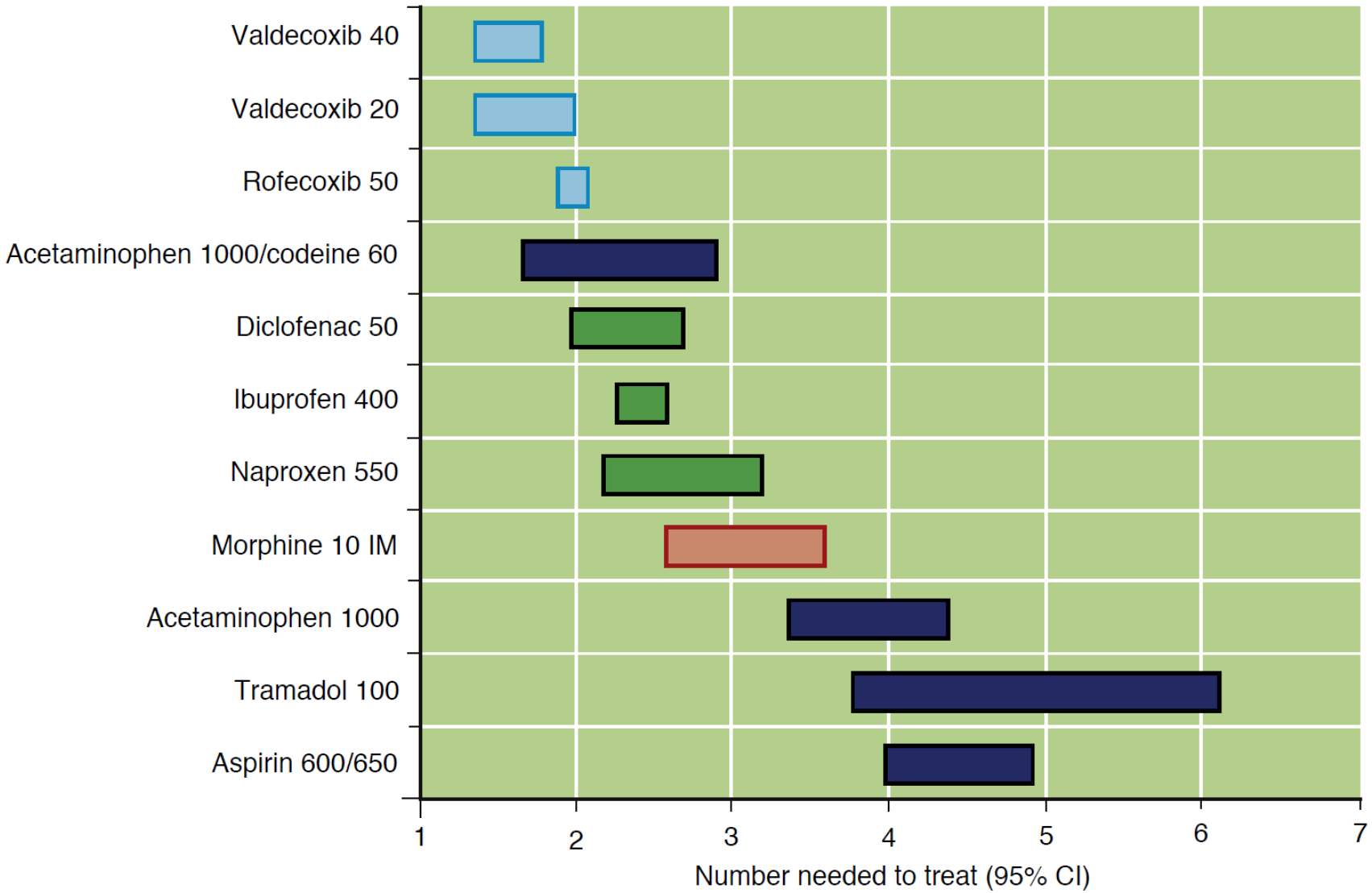
Drug Concentration	Size of Bolus*	Lockout Interval (min)	Continuous Infusion
AGONISTS			
Morphine (1 mg/mL)			
Adult	0.5-2.5 mg	5-10	—
Pediatric	0.01-0.03 mg/kg (max, 0.15 mg/kg/h)	5-10	0.01-0.03 mg/kg/h
Fentanyl (0.01 mg/mL)			
Adult	10-20 μg	4-10	—
Pediatric	0.5-1 μg/kg (max, 4 μg/kg/h)	5-10	0.5-1 μχg/kg/h
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/h)	5-10	0.003-0.005 mg/kg/h
Alfentanil (0.1 mg/mL)	0.1-0.2 mg	5-8	—
Methadone (1 mg/mL)	0.5-2.5 mg	8-20	—
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	—

NSAIDs

- Prostaglandins are important mediators of peripheral sensitization and hyperalgesia.
- NSAIDs can also exert their analgesic effects through inhibition of spinal COX.
- COX-1 (constitutive) participates in platelet aggregation, hemostasis, and gastric mucosal protection, whereas COX-2 (inducible) participates in pain, inflammation, and fever.
- The precise relationship between COX-3 and acetaminophen is still uncertain.
- Perioperative use of NSAIDs has several side effects, including decreased hemostasis, renal dysfunction, and gastrointestinal hemorrhage (Clinical significance is doubtful in many cases specially in brief exposures to normal doses!)
- Bronchospasm may be induced by NSAIDs (including aspirin).
- NNT refers to the number of patients who must be treated to obtain greater than 50% relief of moderate to severe postoperative pain. A lower mean NNT implies greater analgesic efficacy in this example.

Relative efficacy of single-dose analgesics in providing greater than 50% relief of moderate to severe postoperative pain

Drug*	Mean NNT†	95% CI
Acetaminophen (1000 mg PO)	3.8	3.4-4.4
Aspirin (600-650 mg PO)	4.4	4.0-4.9
Aspirin (1000 mg PO)	4.0	3.2-5.4
Diclofenac (50 mg PO)	2.3	2.0-2.7
Diclofenac (100 mg PO)	1.9	1.6-2.2
Ibuprofen (600 mg PO)	2.4	1.9-3.3
Ketorolac (10 mg PO)	2.6	2.3-3.1
Ketorolac (30 mg IM)	3.4	2.5-4.9
Naproxen (550 mg PO)	2.7	2.3-3.3
Celebrex (200 mg PO)	3.5	2.9-4.4
Celebrex (400mg PO)	2.1	1.8-2.5
Tramadol (100 mg PO)	4.8	3.8-6.1
Gabapentin (600 mg PO)	11	6.0-35
Codeine (60 mg) + acetaminophen (600-650 mg PO)	4.2	3.4-5.3
Oxycodone (5 mg) + acetaminophen (325 mg PO)	2.5	2.0-3.2
Codeine (60 mg PO)	16.7	11.0-48.0
Morphine (10 mg IM)	2.9	2.6-3.6
Oxycodone (15 mg PO)	2.4	1.5-4.9


Valdecoxib 40
Valdecoxib 20
Rofecoxib 50
Acetaminophen 1000/codeine 60
Diclofenac 50
Ibuprofen 400
Naproxen 550
Morphine 10 IM
Acetaminophen 1000
Tramadol 100
Aspirin 600/650
1
2
3
4
5
6
7
Number needed to treat (95% CI)

COX2 INHIBITORS

- The cardiovascular risks of COX-2 inhibitors are heterogeneous and influenced by many factors such as the specific medication, dosage, and patient characteristics.
- Celecoxib, a COX-2 inhibitor, has less COX-2 selectivity than other more potent COX-2 inhibitors (Rofecoxib) and is still clinically available.

ACETAMINOPHEN

- Its mechanism of action is through activation of descending serotonergic pathways in the CNS and via the inhibition of prostaglandin synthesis.
- In 2012, the FDA suggested, but did not mandate, a maximum daily dose for adults of 3 g, with no more than 650 mg every 6 hours, as needed (MedScape)

GABAPENTINOIDS

- Interaction with calcium channel α2-delta ligands to inhibit calcium influx and subsequent release of excitatory neurotransmitters
- Useful in multimodal analgesic regimens
- Problems with dizziness/light-headedness or visual disturbances
- Questioning the analgesic benefits of gabapentinoids in recent publications
- Costs more than benefits!

KETAMINE

- NMDA-antagonistic properties, which may be important in attenuating central sensitization and opioid tolerance
- PO, IV, IM, SC, ED, IT
- Useful in multimodal analgesic regimens
- Administrable for pediatric postoperative pain control
- Amnestic effects on the neuropharmacologic and cognitive level of patients with use of perioperative infusions is a concern.
- Contraindication of racemic forms for neuraxial uses

TRAMADOL

- A synthetic opioid that exhibits weak μ-agonist activity and inhibits reuptake of serotonin and norepinephrine
- Centrally acting analgesic and peripherally acting local anesthetic
- A relative lack of respiratory depression, major organ toxicity, depression of gastrointestinal motility, and a theoretically lower potential for abuse are advantages for postoperative analgesia.
- Should be used with caution in patients with seizures or increased ICP and is contraindicated in those taking MAOIs.

REGIONAL ANALGESIC TECHNIQUES

- Epidural A.
- Peripheral A.

superior to systemic opioids

reduce morbidity and mortality

SINGLE-DOSE NEURAXIAL OPIOIDS

- As a sole or adjuvant analgesic drug

Property	Lipophilic Opioids	Hydrophilic Opioids
Common drugs	Fentanyl, sufentanil	Morphine, hydromorphone
Onset of analgesia	Rapid onset (5-10 min)	Delayed onset (30-60 min)
Duration of analgesia*	Shorter duration (2-4 h)	Longer duration (6-24 h)
CSF spread	Minimal CSF spread	Extensive CSF spread
Site of action	Spinal ± systemic	Primarily spinal ± supraspinal
Side effects		
Nausea and vomiting	Lower incidence with lipophilic than with hydrophilic opioids	
Pruritus	Lower incidence with lipophilic than with hydrophilic opioids	
Respiratory depression	Primarily early; minimal delay	Both early (<6 h) and delayed (>6 h) possible

*The duration of analgesia varies. *CSF*, Cerebrospinal fluid.

Drug	Intrathecal or Subarachnoid Single Dose	Epidural Single Dose	Epidural Continuous Infusion
Fentanyl	5-25 μg	50-100 μg	25-100 μg/h
Sufentanil	2-10 μg	10-50 μg	10-20 μg/h
Alfentanil	—	0.5-1 mg	0.2 mg/h
Morphine	0.1-0.3 mg	1-5 mg	0.1-1 mg/h
Hydromorphone	—	0.5-1 mg	0.1-0.2 mg/h
Extended-release morphine*	Not recommended	5-15 mg	Not recommended

*See package insert for details on dosage and administration.

Doses are based on the use of a neuraxial opioid alone. No continuous intrathecal or subarachnoid infusions are provided. Lower doses may be effective when administered to the elderly or when injected in the cervical or thoracic region. Units vary across agents for single dose (mg vs. μg) and continuous infusion (mg/h vs. μg/h).

Smaller doses of epidural morphine may be required for elderly patients and thoracic catheter sites.

CONTINUOUS EPIDURAL ANALGESIA

- Postoperative epidural analgesia can provide analgesia superior to that of systemic opioids.
- CEA can be a part of ERAS.
- Local anesthetic-opioid epidural analgesic combinations are preferred.
- The overall advantage of administering CEI of lipophilic opioids alone is marginal.
- Continuous infusion of a hydrophilic opioid may be especially useful for providing postoperative analgesia when the site of catheter insertion is not congruent with the site of surgery or when side effects (e.g., hypotension, motor block) are attributed to the epidural local anesthetic.
- CEI of a local anesthetic-opioid combination also provides analgesia superior to that of IV PCA with opioids.
- Two adjuvants with more widespread acceptance are Clonidine (5 to 20 µg/h; hypotension, bradycardia, and sedation) and Epinephrine.

LOCATION OF CATHETER INSERTION

Location of Incision	Examples of Surgical Procedures	Congruent Epidural Catheter Placement
Thoracic	Lung reduction, radical mastectomy, thoracotomy, thymectomy	T4-8
Upper abdominal	Cholecystectomy, esophagectomy, gastrectomy, hepatic resection, Whipple procedure	T6-8
Middle abdominal	Cystoprostatectomy, nephrectomy	T7-10
Lower abdominal	Abdominal aortic aneurysm repair, colectomy, radical prostatectomy, total abdominal hysterectomy	T8-11
Lower extremity	Femoral-popliteal bypass, total hip or total knee replacement	L1-4

L, Lumbar level; *T*, thoracic level.

The benefits of epidural analgesia in decreasing morbidity in patients undergoing abdominal and thoracic surgery are seen only with thoracic (congruent), not lumbar (incongruent) epidural catheter placement

SIDE EFFECTS OF NEURAXIAL ANALGESIC DRUGS

- **Hypotension** (3.0%-10.2%): decreasing the overall dose of LA administered (by decreasing the rate or concentration), infusing an opioid epidural alone, and treating the underlying cause
- **Motor block** (2% to 3%): Resolves in most cases after stopping the epidural infusion for approximately 2 hours; In cases with persistent or increasing motor block spinal hematoma, spinal abscess, and intrathecal catheter migration should be considered.
- **Nausea and Vomiting** (50-80%): More prevalent in women; equal in epidural and systemic routes; naloxone, droperidol, metoclopramide, dexamethasone, ondansetron, and transdermal scopolamine have been used for treatment.
- **Pruritus** (60%): IV naloxone, naltrexone, nalbuphine, and droperidol appear to be efficacious for the pharmacologic control and ondansetron for prevention!
  - The use of epidural morphine is associated with postpartum reactivation of herpes simplex labialis.
- **Respiratory Depression** (0.1% to 0.9% & dose dependent): increasing dose, increasing age, concomitant use of systemic opioids or sedatives, possibility of prolonged or extensive surgery, and the presence of comorbid conditions (e.g., OSA) are RFs. Naloxone 0.1- to 0.4-mg then 0.5-5 µg/kg/h
- **Urinary retention** (23%): most frequent in those receiving epidural analgesia

PATIENT-CONTROLLED EPIDURAL ANALGESIA

- Lower drug use and better patient satisfaction with PCEA in comparison to CEA
- PCEA may also provide analgesia superior to that afforded by IV PCA.
- More than 90% of patients with PCEA receive adequate analgesia.
- Use of a continuous or background infusion in addition to the demand dose is more common with PCEA than with IV PCA.
- Combination of LA and opioids with the aim of reducing the incidence of motor block and respiratory depression

Analgesic Solution*	Continuous Rate (mL/h)	Demand Dose (mL)	Lockout Interval (min)
GENERAL REGIMENS			
0.05% bupivacaine + 4 μg/mL fentanyl	4	2	10-20
0.0625% bupivacaine + 5 μg/mL fentanyl†	4-6	3-4	10-20
0.1% bupivacaine + 5 μg/mL fentanyl	6	2	10-20
0.2% ropivacaine + 5 μg/mL fentanyl	5	2	20
THORACIC SURGERY			
0.0625%-0.125% bupivacaine + 5 μg/mL fentanyl†	3-4	2-3	10-20
ABDOMINAL SURGERY			
0.0625% bupivacaine + 5 μg/mL fentanyl†	4-6	3-4	10-20
0.125% bupivacaine + 0.5 μg/mL sufentanil	3-5	2-3	10-20
0.1%-0.2% ropivacaine + 2 μg/mL fentanyl	3-5	2-5	10-20
LOWER EXTREMITY SURGERY			
0.0625%-0.125% bupivacaine + 5 μg/mL fentanyl†	4-6	3-4	10-20

*Regimens listed are samples of local anesthetic-lipophilic opioid combinations from the literature.
†Patient-controlled epidural analgesic regimens commonly used at the Johns Hopkins Hospital.

BENEFITS OF EPIDURAL ANALGESIA

- Reduction of mortality & morbidity with a local anesthetic-based analgesic solution (30%)
- Decrease of the incidence of postoperative GI, pulmonary & possibly cardiac (**only** with thoracic EA) complications
- Earlier fulfillment of discharge criteria
- While the use of intraoperative RA decreases the incidence of hypercoagulable-related events (e.g., deep venous thrombosis, pulmonary embolism, vascular graft failure), postoperative EA does not obviously decrease the incidence of them!
- Maximal attenuation of perioperative pathophysiology occurs with the use of a local anesthetic-based epidural analgesic solution.
- Use of neuraxial anesthesia/analgesia for THA or TKA may decrease the risk of SSI.
- cancer recurrence?

Greater patient satisfaction & improved HRQL

RISKS WITH EPIDURAL ANALGESIA

- Neurologic complications after central neuraxial blockade (less than 4 in 10,000 (0.04%))
- Neuropathy after a peripheral nerve block (less than 3 in 100 (3%))
- The risk of epidural hematoma may be different for obstetric versus surgical patients.
- Serious infections (e.g., meningitis, spinal abscess) (<1 in 10,000)
- Superficial inflammation or cellulitis (4%-14%)
- Catheter colonization (20%-35%)
- Catheter failure rate (6-25%)
- Intrathecal and intravascular migration of the catheter (epinephrine-containing test dose, administration of LA in fractionated doses & aspiration before bolus administration)

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Guidelines

Responsible, Safe, and Effective Use of Antithrombotics and Anticoagulants in Patients Undergoing Interventional Techniques: American Society of Interventional Pain Physicians (ASIPP) Guidelines

Alan D. Kaye, MD, PhD[1], Laxmaiah Manchikanti, MD[2], Matthew B. Novitch[3], Imran N. Mungrue[4], Muhammad Anwar, MBBS[5], Mark R. Jones, MD[6], Erik M. Helander, MBBS[7], Elyse M. Cornett, PhD[8], Matthew R. Eng, MD[9], Jay S. Grider, DO, PhD[10], Michael E. Harned, MD[11], Ramsin M. Benyamin, MD[12], John R. Swicegood, MD[13], Thomas T. Simopoulos, MD[14], Salahadin Abdi, MD, PhD[15], Richard D. Urman, MD[16], Timothy R. Deer, MD[17], Cyrus Bakhit, MD[18], Mahendra Sanapati, MD[19], Sairam Atluri, MD[20], Ramarao Pasupuleti, MD[21], Amol Soin, MD[22], Sudhir Diwan, MD[23], Ricardo Vallejo, MD, PhD[24], Kenneth D. Candido, MD[25], Nebojsa Nick Knezevic, MD, PhD[26], Douglas Beall, MD[27], Sheri L. Albers, DO[28], Richard Latchaw, MD[29], Hari Prabhakar, MD[30] , and Joshua A. Hirsch, MD[31]

Table 13. *Classification of interventional techniques based on the potential risk for bleeding.*

Low-Risk Procedures	**Intermediate-Risk Procedures***	**High-Risk Procedures***
1. Trigger point and muscular injections (including piriformis injection) 2. Peripheral joints 3. Peripheral nerve blocks 4. Sacroiliac joint and ligament injections and nerve blocks 5. Caudal epidural injections 6. Ganglion impar blocks	1. Facet joint interventions (intraarticular injections, nerve blocks and radiofrequency neurotomy) 2. Lumbar transforaminal epidural injections at L4, L5, S1 3. Lumbar intradiscal procedures 4. Hypogastric plexus blocks 5. Lumbar sympathetic blocks 6. Peripheral nerve stimulation trial and implant 7. Pocket revision and implantable pulse regenerator/ intrathecal pump replacement 8. Caudal percutaneous adhesiolysis 9. Lumbar percutaneous disc decompression (L4/5 or below) 10. Lumbar vertebral augmentation (below L4) 11. Intervertebral spinous prosthesis 12. Lumbar discography 13. Lumbar interlaminar epidural injections at L5-S1	1. Cervical, thoracic, and high lumbar (above L4-L5) interlaminar epidurals 2. Cervical, thoracic and lumbar above L3 transforaminal epidural injections 3. Spinal cord stimulator trial and implant 4. Percutaneous adhesiolysis with interlaminar or transforaminal approach 5. Percutaneous disc decompression (above L4/5) 6. Sympathetic blocks (stellate ganglion; thoracic splanchnic, celiac plexus) 7. Thoracic and cervical intradiscal procedures 8. Vertebral augmentation, lumbar (above L4), thoracic and cervical 9. Intrathecal catheter and pump implant 10. Interspinous prosthesis and MILD®

*Patients with high risk of bleeding (e.g., old age, history of bleeding tendency, concurrent uses of other anticoagulants/antiplatelets, liver cirrhosis or advanced liver disease, and advanced renal disease) undergoing low or intermediate-risk procedures should be treated as intermediate or high risk, respectively.

Medication	Time to Wait After Last Dose of Medication Before Low Risk Interventional Techniques Are Performed		Time to Wait After Last Dose of Medication Before Moderate Risk Interventional Techniques Are Performed		Time to Wait After Last Dose of Medication Before High Risk Interventional Techniques Are Performed		Timing of Therapy restoration or Restarting	
	ASIPP	ASRA (40)	ASIPP	ASRA (40)	ASIPP	ASRA (40)	ASIPP	ASRA (40)
NSAIDS (COX 1) (COX 2)	May continue or stop 1-10 days due to lack of protective effect	Stop 1-10 days due to lack of protective effect	May continue or stop 1-10 days due to lack of protective effect	Stop 1-10 days due to lack of protective effect	May continue or stop 1-10 days due to lack of protective effect	Stop 1-10 days due to lack of protective effect	24 hours	24 hours
Aspirin								
Low-Dose Aspirin	Continue or may stop for 3 days	Stop for 4 days	Continue or may stop for 3 days	Stop for 4 days	Stop for 5 days	Stop for 6 days	24 hours	24 hours
High Dose Aspirin	Continue or may stop for 3 days	Stop for 4 days	Continue or may stop for 3 days	Stop for 4 days	Stop for 5 days	Stop for 6 days	24 hours	24 hours
Antiplatelet Agents (Phosphodiesterase Inhibitors)								
Dipyridamole (Persantine)	May continue	May continue	May continue	May continue	May continue or stop for 2 days	Stop for 2 days	12 hours	12 hours
Cilostazol (Pletal)	May continue	May continue	May continue	May continue	May continue or stop for 2 days	Stop for 2 days	12 hours	12 hours
Aggrenox (dipyridamole plus aspirin)	May continue	Stop for 4 days	May continue	Stop for 4 days	Stop for 5 days	Stop for 6 days	24 hours	24 hours
Platelet Aggregation Inhibitors								
Clopidogrel (Plavix)	May continue	May continue	May continue or stop for 3 days	Stop for 7 days	Stop for 5 days	Stop for 7 days	12 hours	12 hours
Prasugrel (Effient)	May continue	May continue	May continue or stop for 6 days	Stop for 7-10 days	Stop for 6 days	Stop for 7-10 days	24 hours	24 hours
Ticlopidine (Ticlid)	May continue	NA	May continue or stop for 7 days	NA	Stop for 7-10 days	NA	24 hours	24 hours
Ticagrelor (Brilinta)	May continue	Continue	May continue or stop for 3 days	NA	Stop for 3-5 days	Stop for 5-10 days	24 hours	24 hours
Vitamin K Antagonists								
Warfarin	May stop for 2 days INR ≤ 3.0	INR < 3.0	Stop for 2-5 days INR ≤ 1.5	Stop for 5 days INR normalize	Stop for 2-5 days INR ≤ 1.5	Stop for 5 days INR normalize	24 hours	24 hours
Thrombin Inhibitors								
Dabigatran (Pradaxa)	May continue or stop for 2 days	May continue or stop for 2 days	Stop for 4-5 days 6 days - renal	Stop for 4-5 days 6 days - renal	Stop for 4-5 days 6 days - renal	Stop for 4-5 days 6 days - renal	24 hours	24 hours

Medication	Time to Wait After Last Dose of Medication Before Low Risk Interventional Techniques Are Performed		Time to Wait After Last Dose of Medication Before Moderate Risk Interventional Techniques Are Performed		Time to Wait After Last Dose of Medication Before High Risk Interventional Techniques Are Performed		Timing of Therapy restoration or Restarting	
	ASIPP	ASRA (40)	ASIPP	ASRA (40)	ASIPP	ASRA (40)	ASIPP	ASRA (40)
Anti-Xa Agents								
Apixaban (Eliquis)	May continue or stop for 2 days	May continue or stop for 2 days	Stop for 3-5 days	Stop for 3-5 days	Stop for 3-5 days	Stop for 3-5 days	24 hours	24 hours
Rivaroxaban (Xarelto)	May continue or stop for 1 day	May continue or stop for 1 day	Stop for 2 days	Stop for 3 days	Stop for 2 days	Stop for 3 days	24 hours	24 hours
Edoxaban (Savaysa, Lixiana)	May continue or stop for 1 day	NA	Stop for 3 days	NA	Stop for 3 days	NA	24 hours	24 hours
Heparins								
Heparin (treatment) - IV	Discontinue for 4 hours	Discontinue for 4 hours	Discontinue for 4 hours	Discontinue for 4 hours	Discontinue for 4 hours	Discontinue for 4 hours	24 hours	24 hours
Heparin (treatment) - SC	Discontinue for 8-10 hours	Discontinue for 8-10 hours	Discontinue for 8-10 hours	Discontinue for 8-10 hours	Discontinue for 8-10 hours	Discontinue for 8-10 hours	24 hours	24 hours
Low Molecular Weight Heparin	Discontinue for 24 hours	Discontinue for 24 hours	Discontinue for 24 hours	Discontinue for 24 hours	Discontinue for 24 hours	Discontinue for 24 hours	24 hours	24 hours
Thrombolytic Agents								
TPA, Streptokinase, Alteplase, Reteplase	May continue	May continue	Stop for 2 days	Stop for 2 days	Stop for 2 days	Stop for 2 days	24 hours	24 hours
GPIIb/IIIa Inhibitors								
Abciximab (ReoPro)	May continue	May continue	Stop for 1-2 days	Stop for 2-5 days	Stop for 1-2 days	Stop for 2-5 days	8-12 hours	8-12 hours
Eptifibatide (Integrilin)	May continue	May continue	Stop for 8 hours	Stop for 8-24 hours	Stop for 8 hours	Stop for 8-24 hours	8-12 hours	8-12 hours
Tirofiban (Aggrastat)	May continue	May continue	Stop for 8 hours	Stop for 8-24 hours	Stop for 8 hours	Stop for 8-24 hours	8-12 hours	8-12 hours
Miscellaneous								
Fondaparinux (Arixtra)	May continue	May continue	Stop for 4 days	Stop for 4 days	Stop for 4 days	Stop for 4 days	8-12 hours	8-12 hours

PERIPHERAL REGIONAL ANALGESIA

- Site-specific analgesia superior to that with systemic opioids
- Dexamethasone, clonidine, and dexmedetomidine are frequently added adjuvants.
- Facilitation of postoperative rehabilitation as evidenced by accelerated resumption of passive joint range-of-motion, decrease in time until discharge readiness, and earlier actual discharge from the hospital or rehabilitation center are some benefits.
- Peripheral nerve blocks are now more integrated into new clinical pathways.

TRUNCAL BLOCKS

- Paravertebral blocks
  - Thoracic PVB for thoracic, breast, and upper abdominal surgery and for the treatment of rib fracture pain
  - Lower incidence of hypotension and also lower the risk of postoperative pulmonary complications (vs EA)
- Intercostal blocks (the incidence of pneumothorax increases with each intercostal nerve blocked (1.4% per nerve, with an overall incidence of 8.7% per patient))
- Transversus abdominis plane (TAP) blocks
- Quadratus lumborum blocks
- Erector spinae plane blocks
- Interpleural (intrapleural) analgesia, and cryoanalgesia (inferior to epidural and paravertebral analgesia)

INTRAARTICULAR AND LOCAL INFILTRATION ANALGESIA

- There is no evidence for analgesic effect of intraarticular morphine after knee arthroscopy.
- Intraarticular administration of NSAIDs may provide clinically relevant peripheral analgesia.
- The clinical benefit from intraarticular injection of local anesthetics is unclear.
- Concerns regarding glenohumeral chondrolysis reported in association with postarthroscopy infusion of local anesthetic.

OTHER TECHNIQUES

- Transcutaneous electrical nerve stimulation (TENS)
- Acupuncture
- Exercise/activity
- Psychological approaches (Cognitive therapy and behavior therapy)

POSTOPERATIVE ANALGESIA IN SPECIAL POPULATIONS

DR. REZA AMINNEJAD

OPIOID-TOLERANT PATIENTS: PATIENTS WITH PREEXISTING PAIN

Patients considered opioid-tolerant are those who are regularly taking at least:

60 mg oral morphine per day;

25 µg transdermal fentanyl per hour;

30 mg oral oxycodone per day;

8 mg oral hydromorphone per day;

25 mg oral oxymorphone per day; or an equianalgesic dose of another opioid for one week or longer.

TOLERANCE, PHYSICAL DEPENDENCE, ADDICTION

- Addiction is a chronic disorder characterized by the compulsive use of a substance resulting in physical, psychological, or social harm to the user, and continued use despite that harm.
- Tolerance and physical dependence are pharmacologic properties of opioids and are not synonymous with the aberrant psychological state or behavior associated with addiction.

STRATEGY & TREATMENT PLAN

- Base treatment decisions on objective pain assessment (e.g., ability to breathe deeply, cough, ambulate) in conjunction with patients' self-reported pain scores.
- Recognize the need to identify and treat two major problems, maintenance of a basal opioid requirement and control of incisional pain.
- Recognize that detoxification is not usually an appropriate goal in the perioperative period.
- Remember you have limited time to make a substantial positive difference!
- Replace the patient's baseline or basal opioid requirements postoperatively
- Anticipate an increase in postoperative analgesic requirements
- Maximize the use of adjuvant drugs
- Consider the use of regional analgesic techniques
- Plan for the transition to an oral regimen

- Adjuvant drugs such as NSAIDs should be administered on a regularly scheduled basis.
- Use of RA techniques with neuraxial opioids may provide excellent analgesia in opioid-tolerant patients while theoretically preventing withdrawal symptoms.
- Prepare for discharge home by a combination of a regularly administered, controlled-release formulation of opioid (i.e., sustained-release morphine) and short-acting, immediate release opioid on a PRN basis.
- Conversion of approximately 50% to 75% of the equianalgesic dose to a sustained-release preparation of opioid or a transdermal fentanyl patch, with the remainder converted to a short-acting opioid delivered on a PRN basis is an appropriate starting point.
- Consider ketamine PCA or a combination ketamine and opioid PCA, subcutaneously or orally
- Challenges of Buprenorphine!

  It is ideal to not take buprenorphine 3 days in advance of surgery but …

GUIDELINES FOR EQUIANALGESIC DOSING OF OPIOID AGONISTS

	RELATIVE STRENGTH COMPARED	EQUIANALGESIC DOSE (MG)	
Drug	**With Morphine**	**Oral**	**Parenteral**
Morphine	–	30	10
Buprenorphine	Much, much stronger	N/A	0.4 (7.5 μg/h TD)
Butorphanol	Much stronger	N/A	2
Codeine	Weaker	200	125
Fentanyl	Much, much stronger	N/A	0.1 (16.5 μg/h TD)
Hydrocodone	Equivalent to mildly weaker	30	N/A
Hydromorphone	Much stronger	7.5	1.5
Levophanol	Much stronger	4	N/A
Methadone	Stronger	10	5
Nalbuphine	Equivalent	N/A	10
Oxycodone	Stronger	20	N/A
Oxymorphone	Stronger	10	1
Pentazocine	Weaker	150	60
Tapentadol	Weaker	100	N/A
Tramadol	Much weaker	300	N/A

Equianalgesic doses are approximate and intended to serve only as an estimate of opioid requirements. Actual doses may vary, in part because of wide interpatient variability in response to opioids. Doses should be individualized and gradually titrated to effect. *TD*, Transdermal.

PEDIATRIC PATIENTS

- Undertreatment is a great issue.
- Poor pain control may result in increased morbidity or mortality.
- Wrong beliefs are that …
  - Children and infants do not feel pain
  - Pain is not remembered
  - There is no untoward consequence of experiencing pain
- Assessing pain is challenging (NRS, VRS, VAS, FPS-R, & ect).
- Oral route is preferred for mild to moderate pain & IV or RA is appropriate for moderate to severe one.

  Children as young as 4 years have the cognitive and physical capability to appropriately use an IV PCA device.
- Unlike adults, neuraxial, IV, or IM opioids such as background or continuous infusion of them do not result in respiratory events in pediatric patients.

- Peripheral and neuraxial regional analgesic techniques are commonly used and effective

  Although epidural (caudal) analgesia may be safely administered to neonates, the clinician should recognize that the maximal continuous infusion dose is probably smaller than that in older children because of lower levels of α1-acid glycoprotein (which binds LAs) and diminished ability of the relatively immature liver to metabolize amide LAs.

- The use of EA is associated with improvement in some outcomes such as earlier tracheal extubation, return of gastrointestinal function, and length of hospital stay.

- Acupuncture may be a potentially useful adjunct for the treatment of pediatric postoperative pain.

OBESITY, OBSTRUCTIVE SLEEP APNEA, AND SLEEP

- Obesity is defined as a body mass index (BMI) of greater than 30 kg/m2, with morbid and supermorbid obesity defined as a BMI of greater than 40 and 60 kg/m2, respectively.
- Patients with OSA may be at an increased risk for respiratory arrest.
- Use of sedative doses of benzodiazepines and opioids may be dangerous.
- Avoiding respiratory depressants is highly recommended (non-opioids & regional techniques).

INPATIENT PAIN SERVICES

- Whether inpatient pain services actually improve outcomes is unclear.
- Use of postoperative epidural analgesia in the context of APS may decrease the cost of patient care through shorter intensive care unit stays and a decreased rate of complications.
- With skills in regional anesthetic techniques and knowledge of the neurobiology of nociception and the pharmacology of analgesics and local anesthetics, as well as specialty education in the treatment of acute and chronic pain conditions, **Anesthesiologists are recognized leaders in perioperative pain relief and the development of APS**.

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THANKS FOR YOUR ATTENTION