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Les meilleurs soins pour la vie
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Pediatric Trauma Rounds

Pain Management in Polytrauma

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Outline

- History
- MUHC Pediatric Opioid Therapy Guidelines
- Case studies
  - Opioid and non-opioid
  - Modes of administration
  - Regional analgesia
  - Compartment syndrome
- Non-pharmacological treatments

History

Explanations:

- ‘’Paediatric patients seldom need medication for the relief of pain.’’
- ‘’They tolerate discomfort well.’’
- ‘’The child will say he does not feel well or that he is uncomfortable, that he wants his parents but often he will not relate this unhappiness to pain’’

Swafford L, Allen D. Relief in Pediatric patients. *Med Clin North Am* 1968;52:131-136.

History

- 25 Charts of post-op children
  - 13 patients no analgesia
  - 12 patients received a total of 24 doses of analgesia
- 18 Charts of post-op adults
  - 626 doses of analgesia

Eland JM. Children's communication of pain (thesis). Iowa City, IA:University of Iowa, 1974.

History

- Premature babies → minimal anaesthesia
  - ↑ stress response
  - ↑ morbidity
  - ↑mortality

Anand KJS, Sippell WG, Aynsley Green A. Randomized trial of fentanyl anesthesia in preterm babies undergoing surgery: effects on stress response. *Lancet* 1987;8524:62-67.

Anand KJS, Aynsley Green A. Measuring the severity of surgical stress in newborn infants. *J Pediatr Surg* 1988;23:297-305.

Anand KJ, Hansen DD, Hickey PR. Hormonal metabolic stress response in neonates undergoing cardiac surgery. *Anesthesiology* 1990:73:661-670.

History

Reproduction of the study made by Eland and collaborators in the same institution 16 years earlier.

- 968 analgesic doses given in 1991
- 24 analgesic doses given in 1974

Asper JR. Postoperative analgesic prescription and administration in a pediatric population. *J Pediatr Nurs* 1994;9:150-157.

MUHC PEDIATRIC OPIOID THERAPY GUIDELINES

I- CHOOSING MEDICATION ACCORDING TO INTENSITY OF PAIN

- **Mild (Pain score 1-3)**

  eg. Superficial cuts, bruises, sprains

  1) Acetaminophen or Non-Steroidal Anti-Inflammatory (NSAIDs)

- **Moderate (Pain score 4-6)**

  eg. Significant cuts on the extremities, minor surgical procedures, chronic pain and cancer pain

  1) Regular dosing of acetaminophen **and/or** NSAIDs

  2) Consider adding opioids such as codeine or oxycodone

- **Severe (Pain score 7-10)**

  eg. Moderate to major surgical procedure, kidney stones, biliary colic, traumatic injuries, severe chronic pain and cancer pain, sickle cell crisis.

  1) Give regular dosing of acetaminophen **and/or** NSAIDs

  WITH

  2) Opioids PO or IV such as morphine, hydromorphone or oxycodone

II- PRESCRIBING OPIOIDS

A) Take into consideration:
1- RISK FACTORS that may increase predisposition to respiratory depression (refer to section IV)
2- ALLERGIES AND INTOLERANCES
3- Potential drug INTERACTIONS.

B) START WITH LOWER DOSES in patients with increased predisposition to respiratory depression (refer to section IV).

C) ADJUST REGULARLY the opioid dose according to intensity of pain and level of sedation. Progressive DOSE ESCALATION may be required. In some cases of severe pain, it should be done rapidly (minutes-hours).

D) PRESCRIBE ONLY ONE OPIOID and ONE ROUTE at a time. When two routes are necessary, prefer the use of the same opioid.

E) With a new prescription of opioids, DISCONTINUE OPIOIDS PREVIOUSLY ORDERED to avoid administration errors.

F) Prescribe EQUIANALGESIC DOSAGE when changing
1- from one opioid to another and
2- from one route to another.
Note that the equianalgesic table does not take into account incomplete cross-tolerance between opioids.

G) DO NOT ORDER DOSE RANGES (eg. avoid 2-4 mg every 4-6 hour as needed, prescribe 4 mg every 4 hours as needed).

H) WRITE CLEARLY. Avoid zeroes following a decimal (eg avoid morphine 5.0 mg, prescribe morphine 5 mg). Always write the zeroes preceding decimal (eg. avoid morphine .5mg, prescribe morphine 0.5 mg).

I) NEVER USE ABBREVIATIONS for medication name.

J) PREFER THE ORAL (PO) ROUTE. The second choice is intravenous (IV) route. Avoid SC/IM for the pediatric population (avoid trauma and pain from needles).

K) PREFER MORPHINE as first line for IV route. (Note that hydromorphone has been frequently implicated in respiratory depression in opioid-naive patients).

L) Prescribe appropriate medication to treat opioid SIDE EFFECTS (nausea/vomiting, pruritus) using the least sedating agent and dosage.

M) Prescribe stool softeners and/or laxatives to treat CONSTIPATION when opioids are administered regularly or for the post-operative period.

N) Attention should be paid to patients that are OBESE or OVERWEIGHT. Calculation of opioid dosage should be based on the lean weight.

Table 1. Starting dosage for opioid-naive pediatric patients (Older than 3 months old*)

Drugs	Risk Factors		No Risk Factors	
	P O (mg/kg)	IV (mg/kg)	PO (mg/kg)	I V (mg/kg)
Morphine	**0.15** max 5 mg/dose	**0.05** max 2.5 mg/dose	**0.3** max 10 mg/dose	**0.1** max 5 mg/dose
HYDROmorphone	**0.02** max 1 mg/dose	**0.01** max 0.5 mg/dose	**0.04** max 2 mg/dose	**0.02** max 1 mg/dose
Oxycodone	**0.05** max 2.5 mg/dose		**0.1** max 5 mg/dose	
Codeine	**0.5** max 30 mg/dose		**1** max 60 mg/dose	
Fentanyl injectable	Restricted use: refer to pharmacy manual and sedation protocols			

*For **infants ≤ 3 months** requiring opioids, doses should **0.02mg/kg/dose IV.**

Table 2. Opioids equianalgesic table for moderate to severe pain without hepatic or renal dysfunction

Drugs	Equianalgesic Dose		Onset of Action		Peak of Action		Duration of Action	
	IV/SC	PO	IV/SC	PO	IV/SC	PO	IV/SC	PO
Morphine	10 mg	30 mg	2-5 min.	15-60 min.	20 min.	60 min.	3-5 hr.	3-5 hr.
HYDROmorphone	2 mg	4 mg	5 min.	30 min.	15-30 min.	30-60 min.	3-6 hr.	3-6 hr.
Oxycodone		15 mg		15-30 min.		60 min.		4-6 hr.
Codeine		200 mg		30-60 min.		60-90 min.		4-6 hr.
Fentanyl injectable	100 mcg		< 5 min.		5-15 min.		20-60 min.	

IV- RISK FACTORS FOR RESPIRATORY DEPRESSION

A) Agents that may increase sedative effects of opioids (not exhaustive):

- **Anxiolytics/Sedative agents** (e.g. lorazepam, diazepam, clonazepam, oxazepam, midazolam)
- **Musculo-skeletal relaxants/Antispasmodic agents** (e.g. methocarbamol, baclofen, cyclobenzaprine)
- **Antipsychotics** (e.g. haloperidol, olanzapine, prochlorperazine)
- **Antidepressants** (e.g. amitriptyline, venlafaxine, citalopram, trazodone)
- **Anticonvulsants** (e.g. carbamazepine, phenytoin, valproic acid, phenobarbital, gabapentin)
- **Anti-histaminics** (e.g. diphenhydramir
- **Anti-nausea medication** (e.g. dimenhy metoclopramide)

B) Conditions that may increase predisposition to respiratory depression:

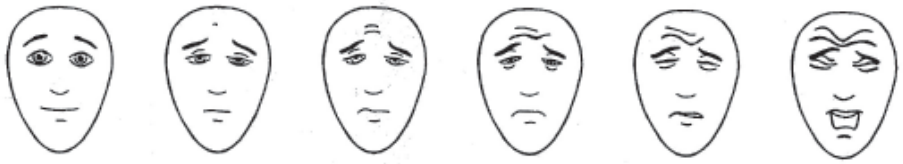
- Children less than 12 months old
- Renal or hepatic insufficiency
- Pulmonary disease or compromise
- Neuromuscular disease
- Obstructive sleep apnea – **Snoring**
- Obesity
- Polypharmacy with sedative effect (see A)
- Opioid-naive patients (Opioid response to be determined, no recent exposure to opioids)
- Head trauma / craniotomy
- Non-verbal patients / cognitive impairment
- Sudden cessation of the cause of pain

	Patient characteristics	Monitoring equipment	Surveillance & documentation
Intermittent IV bolus	Increased risk factors for respiratory depression	Continuous SpO_2 monitoring * RR monitoring non-obligatory	1- Q1 hour observation. 2- Routine vital sign with pain score and sedation score. 3- Sedation score, pain score, SpO_2 and RR before bolus administration **AND** 30 min after bolus completion.
		**Continuous respiratory rate and apnea monitoring should be considered for patients with increased risks of respiratory depression and for patients less than 12 months old.*	
	Low risk factors for respiratory depression	*Continuous SpO_2 monitoring non-obligatory	1- Q1 hour observation. 2- Routine vital signs with pain score and sedation score. 3- Sedation score, pain score and RR before bolus administration **AND** 30 min after bolus completion.
		**Opioid-naive patients may be on a continuous SpO_2 monitor during titration (especialy during sleep) or until response to opioids is determined for the first 24 hours.*	
Continuous IV infusion	All patients	Continuous SpO_2 **AND** RR monitoring	1- Q1 hour observation. 2- Routine vital signs with pain score. 3- Sedation score, SpO_2 and RR Q1hour. 4- Sedation score, pain score, SpO_2 and RR before bolus administration **AND** 30 min after bolus completion.
PO	All patients		1- Q1 hour observation. 2- Routine vital signs with pain score. 3- Sedation score, pain score and RR before the administration of medication **AND** 30-60 min after.

VI- PAIN MEASUREMENT TOOLS

A) Self Report (gold standard)

1- Faces Pain Scale-Revised Bieri
4 years and older



"These faces show how much something can hurt. This face (point to the left-most face) shows no pain. The faces show more and more pain (point to each from left to right) up to this one (point the right-most face), which shows the worst pain. Point to the face that shows how much you hurt right now ". Pain intensity is scored from left to right 0 – 2 – 4 – 6 – 8 – 10.

2- Numeric Rating Scale
8 years and older

"On a scale from 0 to 10 where 0 is no pain at all and 10 the worst possible pain, how much do you hurt right now?"

3- Visual Analogue Scale (10 cm scale or thermometer)

"On this scale the very bottom means no pain at all and the top means the worst possible pain. Show me how much you hurt right now."

B) Behavioral

1- FLACC scale:
For children 0-4 years and/or unable to self report pain

	0	1	2
Face	No particular expression or smile	Occasional grimace or frown, withdrawn, disinterested	Frequent to constant quivering chin, clenched jaw
Legs	Normal position or relaxed	Uneasy, restless, tense	Kicking, or legs drawn up
Activity	Lying quietly, normal position, moves easily	Squirming, shifting back & forth, tense	Arched, rigid or jerking
Cry	No cry (awake or asleep)	Moans or whimpers, occasional complaint	Crying steadily, screams or sobs frequent complaints
Consolability	Content, relaxed	Reassured by touching, hugging, or being talked to, distractable	Difficult to console or comfort

VII-GUIDELINES TO TREAT OPIOID-INDUCED RESPIRATORY DEPRESSION

A) Identification of opioid-induced respiratory depression:

Excessive sedation (sedation score of 3)
and/or
Respiratory rate falls bellow lower normal limit
and/or
Episodes of apnea over 10-15 seconds
and/or
$SpO_2 < 92\%$

**Consider general status of patient rather than one indicator*

B) Medical response for opioid-induced respiratory depression:

Stimulate the patient - Administer 100 % O_2 by face mask –
Contact treating physician

Good Patient Response (maintains airway and saturation, awakable with stimuli)	Patient not responsive and deteriorating (does not maintain patent airway and SpO_2 decreases)
• Maintains constant surveillance of patient – stimulation – until sedation score maintained at/or below 2;	• **Call a code – Start ABC for resuscitation** • Give **Naloxone** IV (SC if IV route is not available): **0.01 mg/kg**. Give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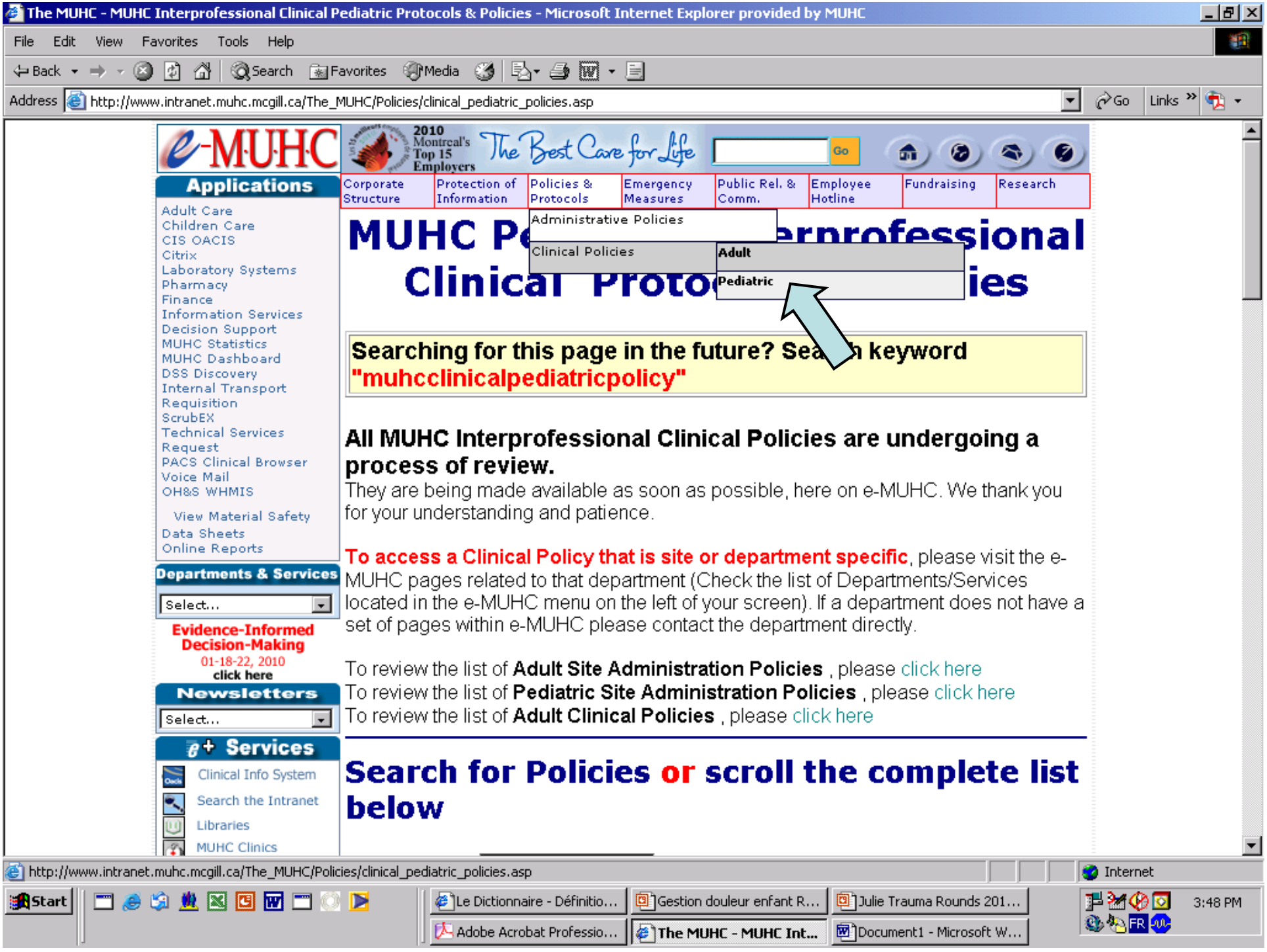
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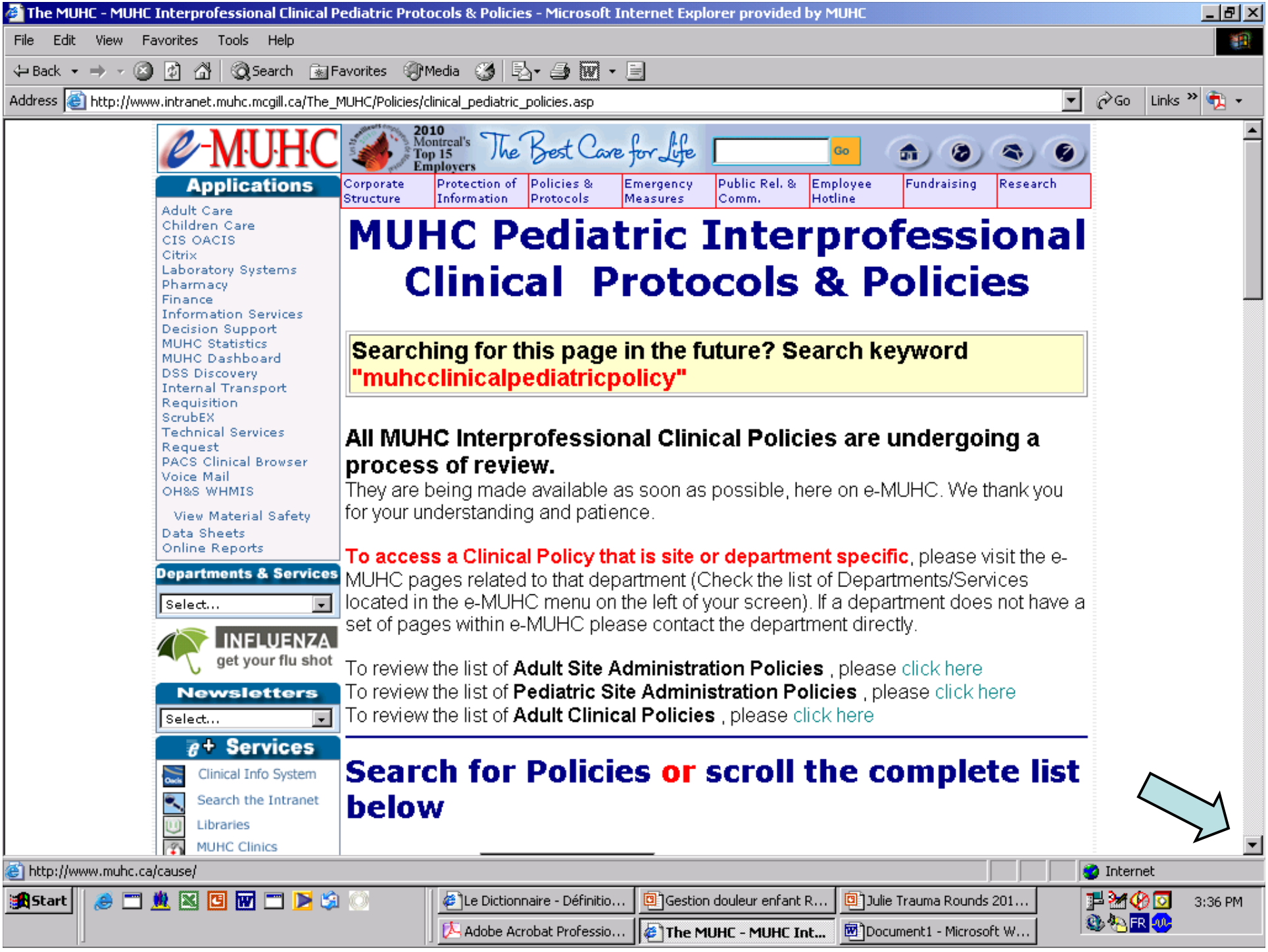
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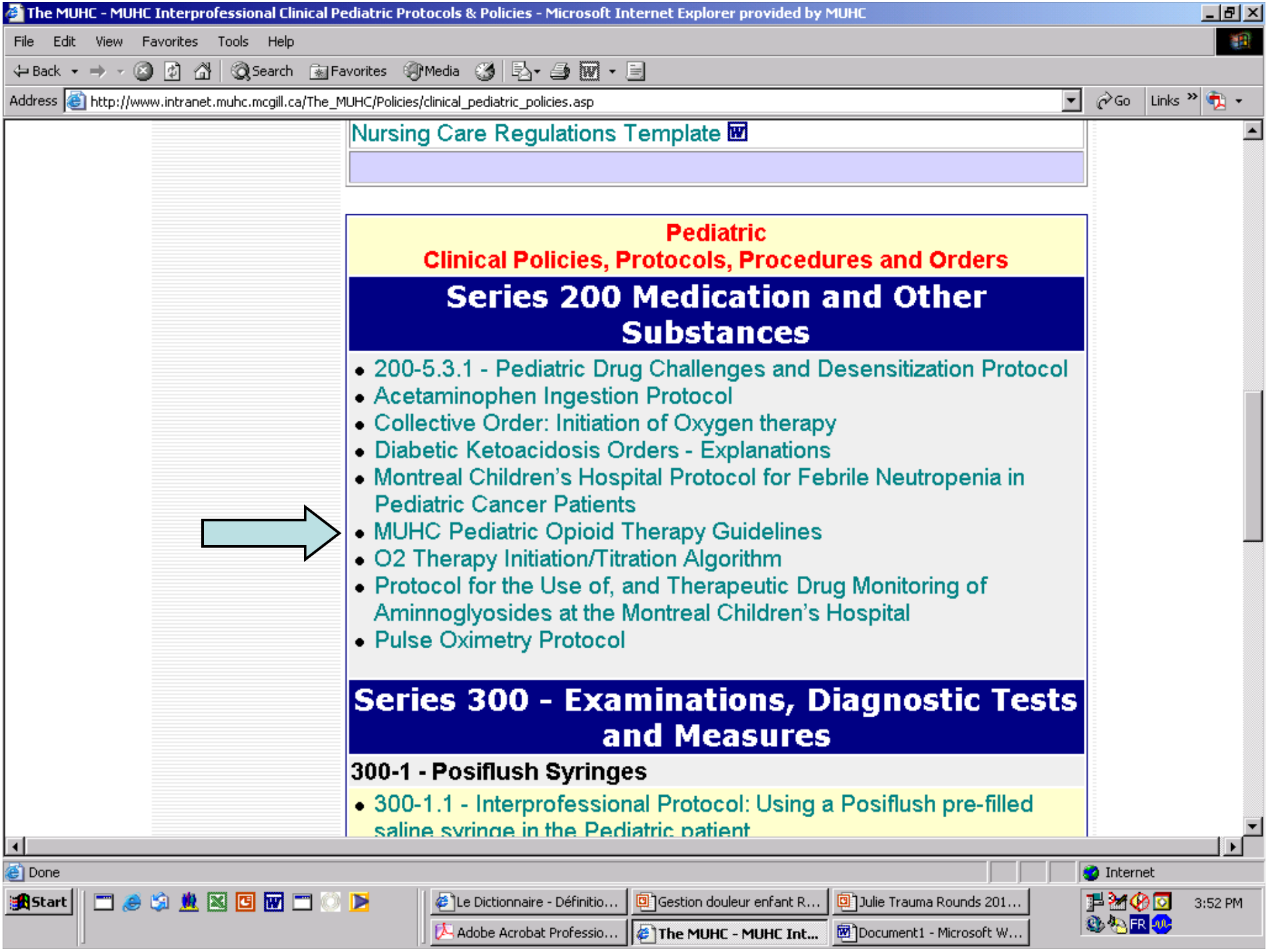
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Case Presentation #1

Patient: Polly Tromma

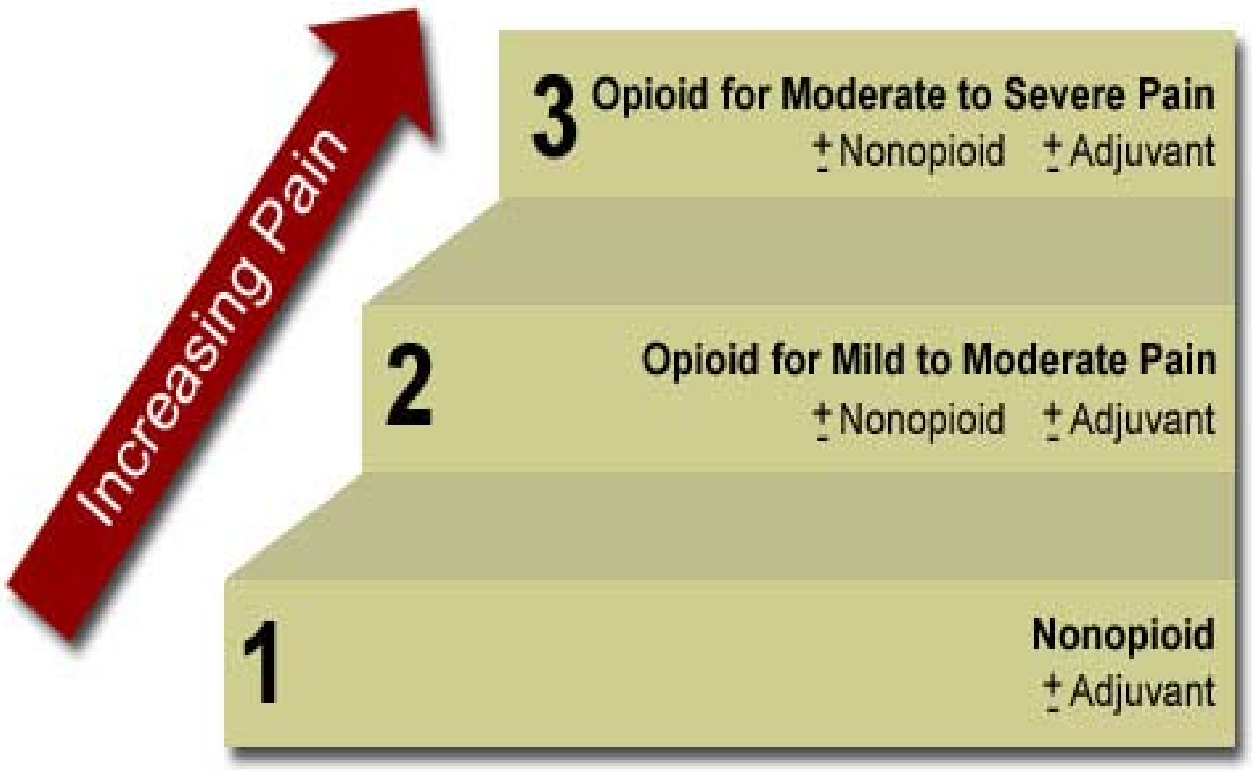
- 16 y.o. female, 57 kg, previously healthy
- Passenger in high-velocity MVC (100 km/hr), unbelted
- Intubated and stabilized at outlying hospital
- Presented with:
    - Bilateral hemopneumothorax
    - Multiple L rib fractures
    - L lung contusion
    - Grade IV splenic laceration
    - Grade III liver laceration
    - Grade II R kidney laceration
    - Bladder dome laceration
    - Unstable pelvic fractures

Polly

- Transferred to MCH; taken to CT, then to OR
  - Exploratory laparotomy
  - Chest tubes (x3) inserted
  - Pelvic external fixator applied by orthopedics
- Transferred to PICU intubated and ventilated

Pain Management in Trauma

- Multimodal approach, based on WHO analgesic ladder - helpful in **increasing pain control**, **decreasing opioid consumption**



WHO. 1996. Cancer Pain Relief, 2nd Ed.

WHO Analgesic Ladder

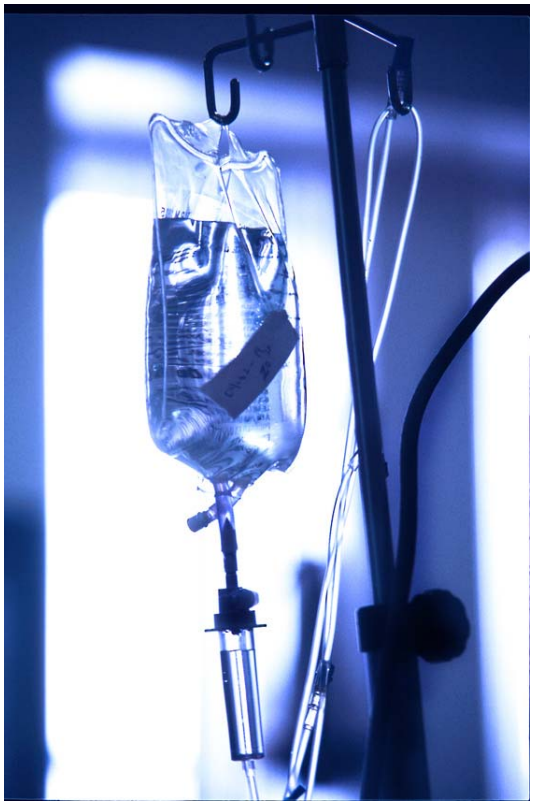
Key = MULTIMODAL APPROACH

Buvanendran et al. 2009. Curr Opin Anaesthesiol 22: 588-593.

- **Non-opioids**
  - Acetaminophen
  - NSAIDs
- **Opioids**
  - Morphine, hydromorphone, fentanyl …
- **Adjuncts**
  - Anti-convulsants, a-adrenergic agonists, ketamine, benzodiazepines, anti-depressants, etc.

Back to Polly

- No acetaminophen
- No NSAIDs
- Morphine:ketamine via PCA started on day 7 after MVC, once patient extubated



Opioids

- Morphine = **Gold Standard**; most studied, most utilized
- Minimum effective analgesic concentration (MEAC) – similar to analgesic corridor
- MEAC differs among patients
- For morphine: 12 ng/mL requires a loading dose of 0.05-0.1 mg/kg and an infusion rate of 10-30 mcg/kg/hr *(Lynn et al. 1984. Crit Care Med 12: 863-6).*

Opioids

- Other choices include **hydromorphone, nalbuphine, & fentanyl**

- **Hydromorphone**:
  - Also used in patients with renal failure; metabolites inactive analgesically but may be neurotoxic in accumulation *(Smith. 2000. Clin Exp Pharm & Phys 27: 524-528).*
  - To be avoided in opioid-naïve patients; linked to ↑ risk of respiratory depression *(Rapport du groupe de travail sur l'analyse de situations de décès reliés à l'utilisation d'analgésiques opiacés, MSSS Québec, 2006).*
  - Used as alternative to morphine if patient having excess pruritus and/or nausea

Modes of Administration of Opioids

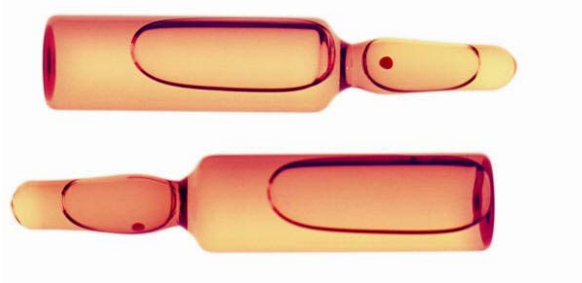
1. Intermittent IV boluses
2. PCA ± continuous infusion
3. Others (PO, PR, etc.)

1. Intermittent IV Boluses

- Opioid given at regular intervals by IV over 20 mins.

- **Advantages** compared to PCA/NCA
    - No need for advanced technology
    - No need for teaching, reinforcement

- **Disadvantages** compared to PCA/NCA
    - Plasma levels are more often supra and infra-therapeutic
    - No direct link between patient's level of pain and dosing



1. Intermittent IV Boluses

Analgesic Corridor

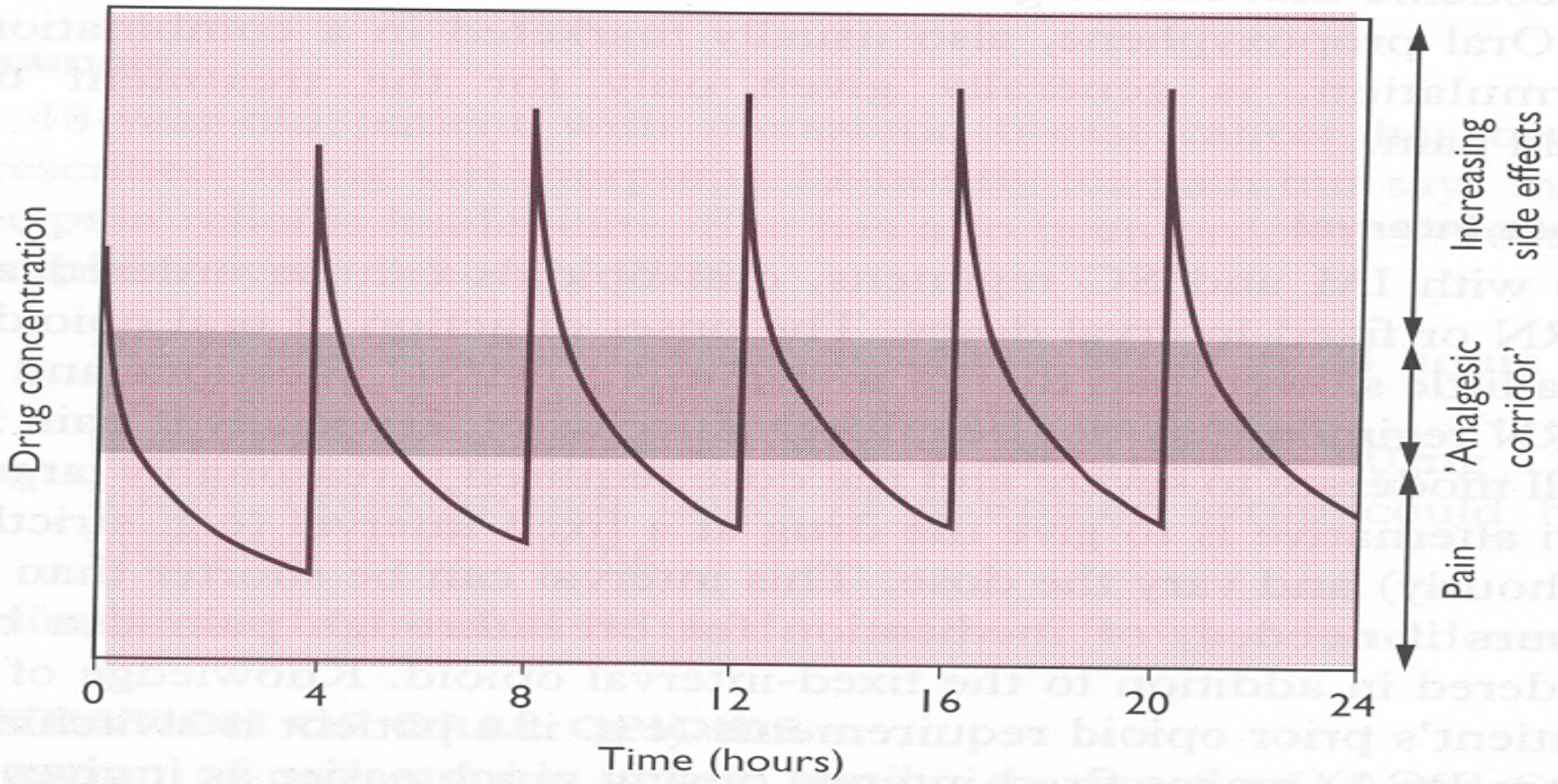


Figure 4.2 Intermittent intravenous opioid analgesia

2. PCA

- Patient-Controlled Analgesia
  - Allows for rapid titration of opioid based on patient's pain stimulus
  - Doses smaller but more frequent
  - Usually used in patients ≥ 6 y.o.
  - Requires teaching & reinforcement on part of RN

PCA

Analgesic Corridor

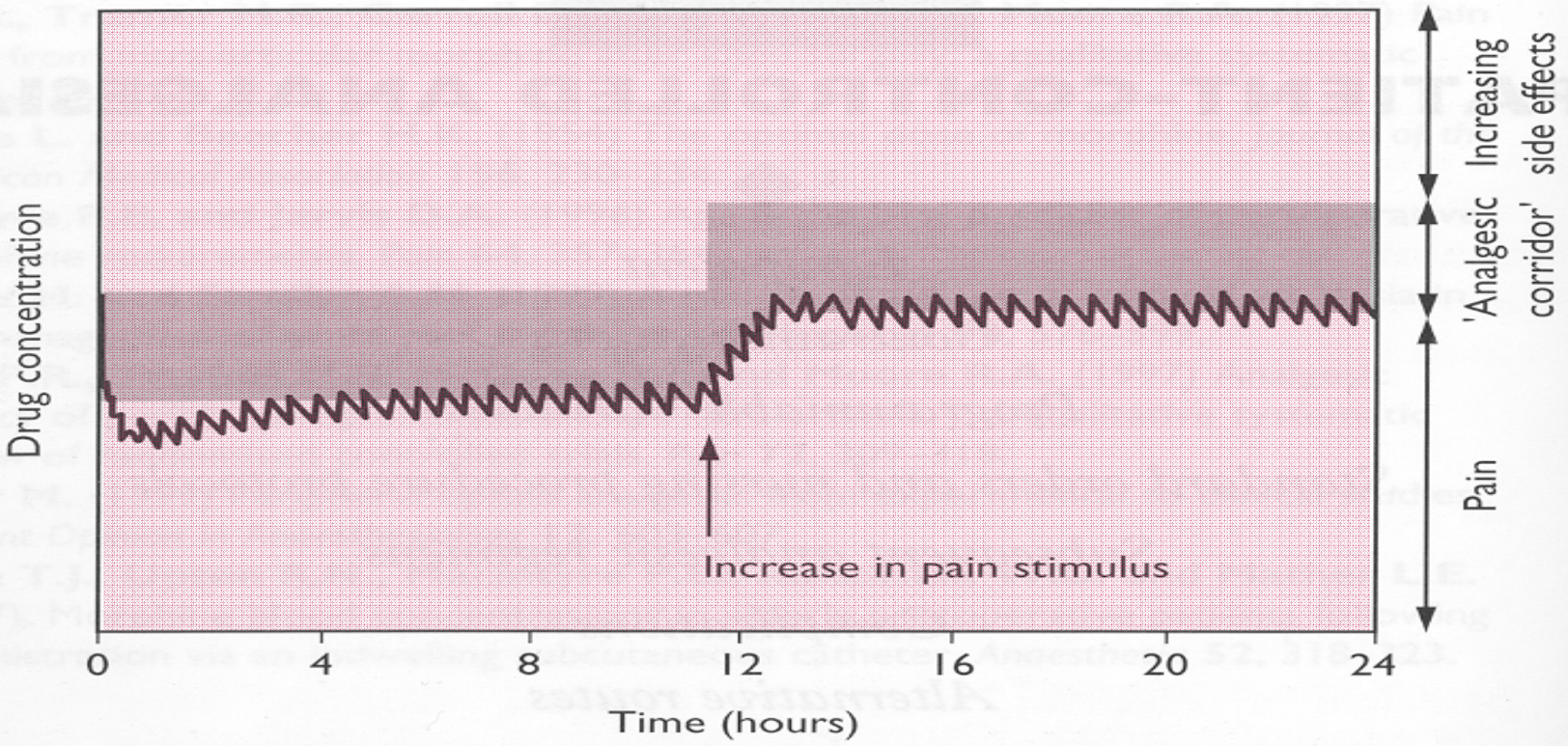


Figure 5.1 Patient-controlled analgesia is more likely to keep blood concentrations of opioid within the 'analgesic corridor' and allows rapid titration if there is an increase in pain stimulus, requiring higher blood levels of opioid in order to maintain analgesia

2. PCA

- **Advantages**
  - Better pain control, decreased stress response *(Hudcova et al. 2009. Cochrane DSR. Pp 1-84.)*
  - Gives patients sense of control $\Rightarrow$ high sense of satisfaction *(McDonald et al. 2001. Paediatr Drugs 3: 273-284.)*
  - Minimal delay between request for pain relief & analgesia

- **Disadvantages**
  - Slightly higher opioid consumption *(Hudcova et al. 2009. Cochrane DSR. Pp 1-84.)*
  - More pruritus *(Hudcova et al. 2009. Cochrane DSR. Pp 1-84.)*
  - Requires a certain level of comprehension

Background Infusions

- Generally used in cases of severe pain with high opioid intake (eg. Scoliosis surgery, sickle cell pain)

- **Advantages**
  - Increased sleep duration/quality *(Doyle et al. 1993. Br J Anaesth 71: 670-673 & McNeely et al. 1997. J Pain Symptom Manage 13: 268-273.)*

- **Disadvantages**
  - Higher opioid intake overall (*Doyle et al. 1993. Br J Anaesth 71: 670-673.)*
  - More side effects (higher risk of resp depression?) (*Looi-Lyons et al. 1996. J Clin Anesth 8: 151-156.)* >>> requires apnea monitoring

Safety of PCA

- PCA = very safe method of post-operative analgesia **when used in appropriate patients & with appropriate monitoring** *(Hudcova et al. 2009. Cochrane DSR. Pp 1-84.)*

- Average risk of respiratory depression (RR < 8-10) in adults using PCA = 1.2% *(Cashman et al. 2004. Br J Anaesth 93: 212-223.)*

- Here at MCH: 0% (0/187) in 2009
  1% (2/191) in 2008

Back to Polly

- Started on PCA
- Initial settings = **morphine/ketamine 1.5 mg Q10 mins**
- Also started on **clonidine 50 mcg PO BID** >>> adjunct

Adjuncts

- Ketamine
- Clonidine
- Gabapentin
- Others…

Ketamine [1,2,3]

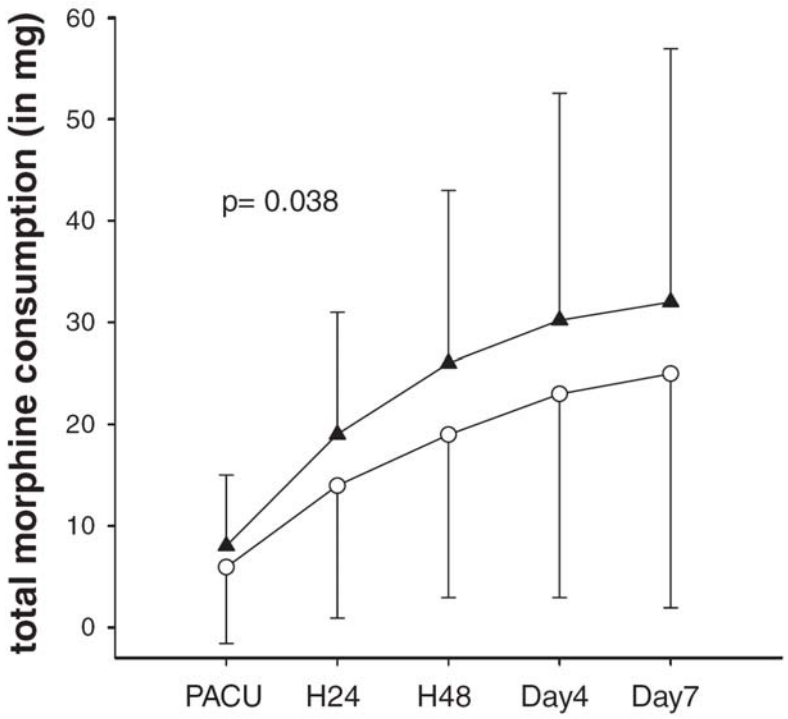
- Morphine-sparing effect
- ↓ post-operative nausea and vomiting in the first 24 h after surgery
- Adverse effects are mild or absent

1. Himmelseher S, Durieux ME. Ketamine for perioperative pain management. Anesthesiology 2005;102:211–20
2. Elia N, Tramer MR. Ketamine and postoperative pain—a quantitative systematic review of randomised trials. Pain 2005;113:61–70
3. Bell RF, Dahl JB, Moore RA, Kalso E. Peri-operative ketamine for acute post-operative pain: a quantitative and qualitative systematic review (Cochrane review). Acta Anaesthesiol Scand

Ketamine

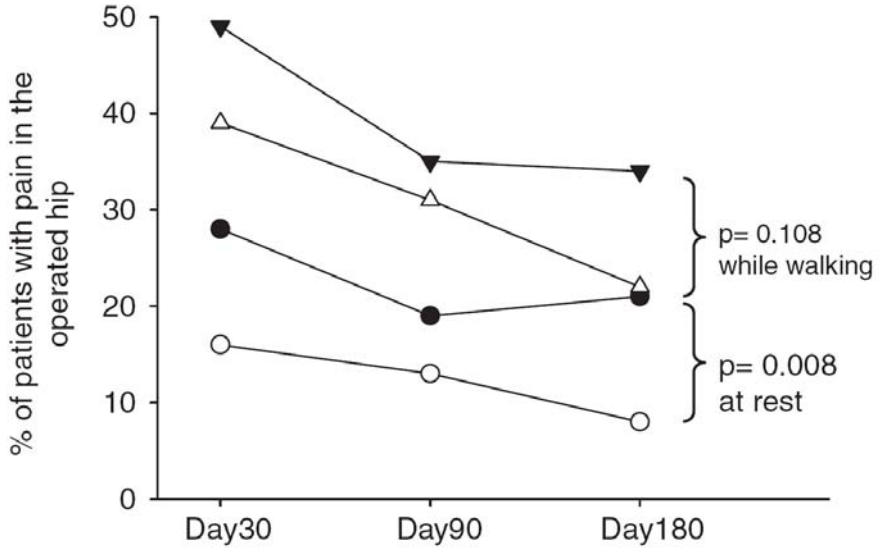
The Early and Delayed Analgesic Effects of Ketamine After Total Hip Arthroplasty: A Prospective, Randomized, Controlled, Double-Blind Study

- Perioperative 24-h low-dose ketamine infusion in adults for THA in the presence of other antihyperalgesic drugs
  - ↓ morphine consumption by 28% for the first 24 h and the first 7 days after.



Remerand F, Le Tendre C, Baud A, et al. Anesthesia & Analgesia. 109(6):1963-71, 2009.

Ketamine



Analgesic effects of ketamine were still present 6 months after surgery.

Remerand F, Le Tendre C, Baud A, et al. The early and delayed analgesic effects of ketamine after total hip arthroplasty: a prospective, randomized, controlled, double-blind study. Anesthesia & Analgesia. 109(6):1963-71, 2009.

Clonidine

- Alpha$_2$-adrenergic agonist
  - Alpha-2 receptors
    - located on the brain stem, spinal cord, and peripheral sensory nerves
  - Analgesic effects
    - Inhibition of the release of nociceptive neurotransmitters
    - ↓ neurotransmission of peripheral nerve fibers (Ad & C)

Clonidine

Indications

Premedication

Improvement of caudal / epidural analgesia

analgesia

Clonidine

- Routes of administration available in Canada
  - oral, transdermal (approved in Canada)
  - neuraxial, parenteral
- Advantages
  - Favorable pharmacokinetics
- Side effects
  - Sedation
  - ↓ Response to atropine
  - ↓ Hyperglycemic response to stress

Gabapentin

- Mechanism of action
– Reduces the hyperexcitability of dorsal horn neurons
    - alpha$_2$-delta subunit of presynaptic voltage-gated calcium channels is its main site of action
- Indications
– neuropathic pain
– postoperative pain[1]
    - ↓ early postoperative pain
    - ↓ opioid consumption over the first 24 h following surgery of 35%
    - ↓ opioid-induced side effects

1) Peng PW, Wijeysundera DN, Li CC: Use of gabapentin for perioperative pain control -- a meta-analysis. Pain Res Manag 2007; 12: 85-92

Gabapentin

Pain Medicine
Section Editor: **Spencer S. Liu**

A Comparison of Gabapentin and Ketamine in Acute and Chronic Pain After Hysterectomy

PCA morphine requirement was significantly reduced for the first 24 h with ketamine and gabapentin

Sen H. Sizlan A. Yanarates O. Emirkadi H. Ozkan S. Dagli G. Turan A. A comparison of gabapentin and ketamine in acute and chronic pain after hysterectomy. Anesthesia & Analgesia. 109(5):1645-50, 2009.

Gabapentin

Gabapentin prevented chronic pain in the first 6 postoperative months.

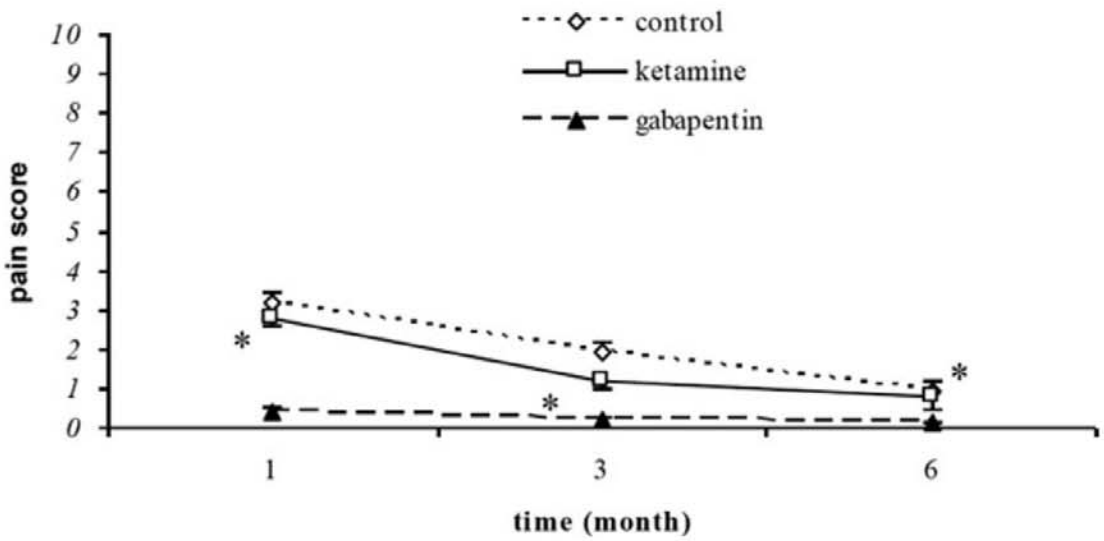


Figure 3. Verbal rating scores at the 1-, 3-, and 6-mo follow-up (mean ± SEM). *$P < 0.05$, group gabapentin compared with placebo and ketamine groups.

Sen H. Sizlan A. Yanarates O. Emirkadi H. Ozkan S. Dagli G. Turan A. A comparison of gabapentin and ketamine in acute and chronic pain after hysterectomy. Anesthesia & Analgesia. 109(5):1645-50, 2009.

Back to Polly

- To ward on post-MVC day 9 (day 2 after extubation) with PCA
- Multiple adjustments of PCA required
  - » Increased bolus dose
  - » Lockout decreased
  - » Continuous infusion started

- …Finally!! Patient reports feeling much better with new parameters on post-MVC day 10… however, **now c/o generalized, intolerable pruritus.**

Side-effect Management

"*Dosis facit venenum*"
The dose makes the poison

- The higher the dose of opioid ⇒ the higher the likelihood of opioid-related side effects

- Most common include:
  - Pruritus
  - Nausea/vomiting
  - Urinary retention
  - Constipation

- The only side-effect that will not decrease over time?

Side-effect Management

Choose least sedating agents to treat side-effects

- **Pruritus:**
  - Prefer naloxone over diphenhydramine
  - Low dose naloxone (1-2 mcg/kg/hr) = ↓ opioid-induced pruritus without reversing or diminishing analgesia *(Kjellberg et al. 2001. Eur J Anaesthesiol 18: 346-57.)*
- **Nausea/vomiting:**
  - Prefer ondansetron over dimenhydrinate
- **Urinary retention:**
  - Small boluses of naloxone or nalbuphine (1-2 mcg/kg) can help reverse this effect (briefly)

Back to Polly

- Started on naloxone infusion, 2 mcg/kg/hr, for pruritus
- Started on docusate sodium

- **Polly does relatively well for 3 days**
- Average IV morphine intake = **140 mg/24 hrs**

Back to Polly

- On post-MVC day 13, patient c/o of increasing pain to back, ribs (8/10)
- PCA and adjuncts adjusted

- Average IV morphine/ketamine intake over past 24 hrs increased to **164 mg**

What is causing Polly's increased opioid consumption??

Increasing Opioid Consumption as an Indicator

- Fear of “masking” ongoing process can lead to under-treatment
- More pain = poorer healing, slower recovery

By **treating pain** and **monitoring opioid consumption**, can follow any changes in patient’s status

- Polly’s CXR reveals large bilateral pleural effusions and L lung consolidation
- Taken back to OR for chest tube on post-MVC day 14

Back to Polly

- Post-op, requires same morphine-equivalent doses (140 mg/24hrs) as before pleural effusion
- Small adjustments to PCA settings made to ensure adequate pain control
- Pt discharged to rehab on post-MVC day 25

Case Presentation #2

Little Boy

- 22 month-old boy, 14 kg, previously healthy
- Farm accident, left forearm amputation with multi-level injury of left upper extremity.
- Stabilized at outlying hospital
- Operation under GA:
  - Reimplantation of forearm amputated left upper extremity
  - ORIF proximal humerus
  - Intraoperative brachial plexus nerve block via an infraclavicular approach with a catheter

Postoperative Course

- PICU
  - Sedated & ventilated
  - Continuous infusion via the PNB catheter with ropivacaine 0.1% at 3 mL/h
- Surgeries
  - POD 1: Thrombectomy vein graft anastamosis, artery microanastomosis
  - POD 2: Amputation left arm with skin graft
- Extubated POD 3
  - Withdrawal syndrome
- Gabapentin POD 4
  - To prevent neuropathic and/or phantom pain
- Continuous PNB infusion
  - D/C POD 6

Regional Anesthesia

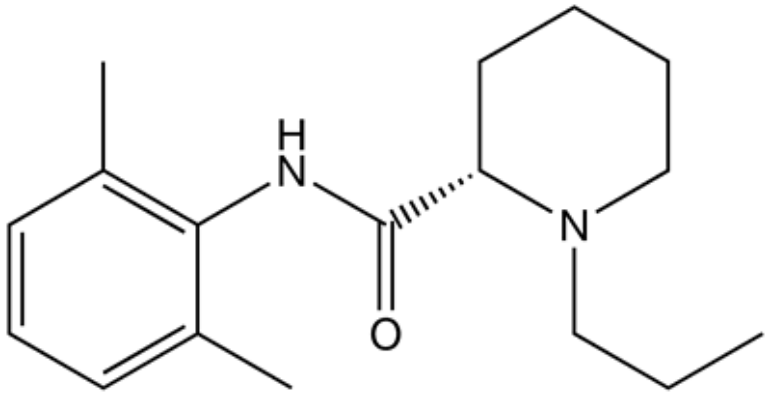
- Decreased requirements for
  - inhalational & iv anesthetic agents
  - opioids
- Decrease hormonal-metabolic stress response to surgery
- Earlier extubation
- Postoperative analgesia
- Provides sympathetic blockade

Regional Analgesia

Options

- Epidural (caudal, lumbar, thoracic)
- Spinal (single shot)
- Peripheral nerve blockade

Local Anesthetics



Ropivacaine

http://en.wikipedia.org

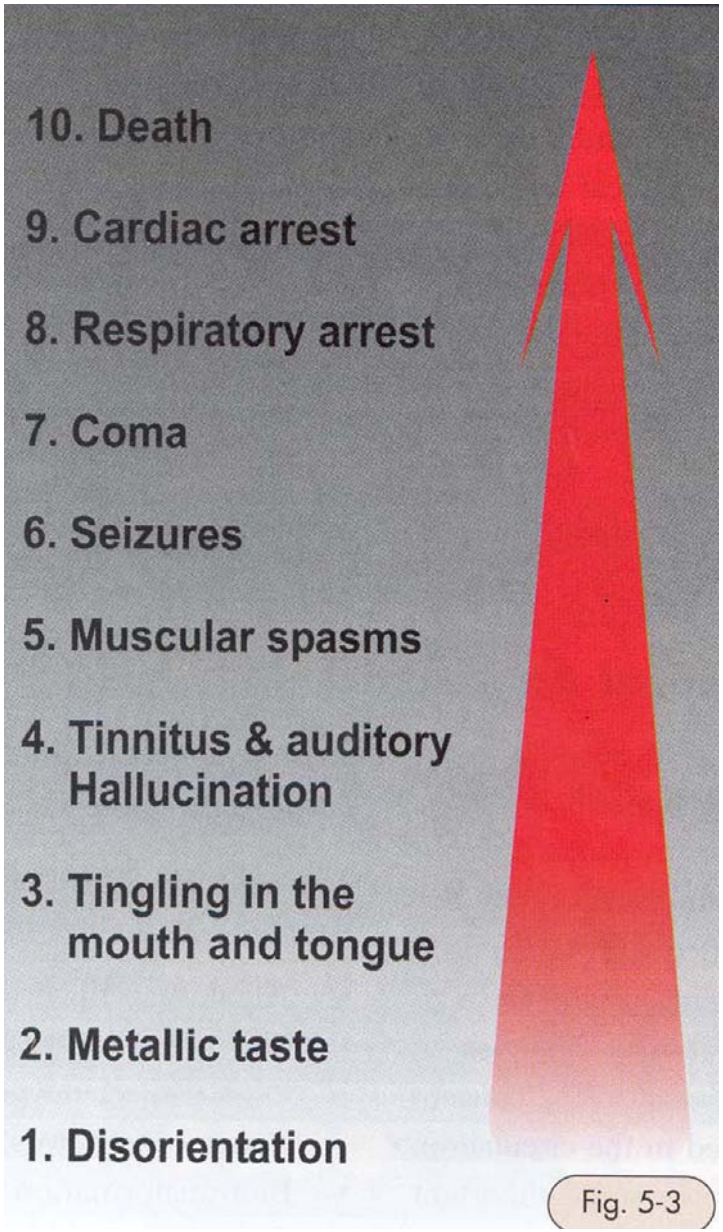
- Cause a reversible block to the conduction of impulses along nerve fibers
- Local concentration >>> plasma concentration after absorption.

Local Anesthetics - Mode of action

- Membrane of nerve fibers
  - Lipid bilayer
  - Proteins including the sodium channels
- Local anesthetics block the propagation of the nerve impulse by preventing the sodium channel from opening.

Local Anesthetics

Signs and symptoms of systemic toxicity



Hadzic A & Volka JD. Clinical pharmacology of local anesthetics. In: Peripheral Nerve Blocks Principles and Practice, 2004: p. 56.

Compartment Syndrome

The controversy of regional anesthesia in patients at risk of compartment syndrome

Dr. Mira Kapala

Compartment syndrome

- Trauma lesions and surgeries at greater risk
  - Displaced supracondylar fractures of the humerus
  - Tibial shaft fractures
  - Intramedullary fixation of pediatric arm fractures
- Complication
  - Volkmann’contracture
- Treatment
  - Decompression by fasciotomy

Orthopedic literature

“ All surgeons should be very suspicious of compartment syndrome, and we recommend that local anesthesia should not be used in trauma of the arm or the leg to avoid the possibility of conflicting opinion and diagnostic delay”

Eyres KS, Hill G, Magides A. Journal of Bone & Joint Surgery - British Volume. 78(6):996-7, 1996.

Anesthesia literature

Hazard of compartment syndrome: is the torture chamber the solution?

"The development of excruciating pain in a child deprived of any analgesic medication should no longer be considered the 'presenting' symptom of a compartment syndrome"

"Adequate pain management of children may even help when there is the suspicion of an early development of a compartment syndrome"

Dalens B. *Some current controversies in paediatric regional anaesthesia* Current Opinion in Anaesthesiology. 19:301-308, 2006.

Do epidurals mask compartment syndrome?

Yes

- Case reports
  - Hyder N, et al. *Compartment syndrome in tibial shaft fracture missed because of a local nerve block.* J Bone Joint Surg Br 1996 78-B: 499-500.
  - Price C, et al. *Compartment syndromes assocoated with postoperative analgesia –A Case Report.* J Bone Joint Surg Br 1996 78-A: 597-599.
  - Dunwoody JM, et al. Compartment Syndrome Associated with Bupivacaine and Fentanyl Epidural Analgesia in Pediatric Orthopaedics. Journal of Pediatric Ortho 1997 17(3): 285-288.

No

- Case reports
  - Montgomery CJ, Ready LB . *Epidural opioid analgesia does not obscure diagnosis of compartment syndrome resulting from prolonged lithotomy position.* Anesthesiology 1991 75(3):541-3.
  - Beerle BL, Rose Rl. *Lower extremity compartment syndrome from prolonged lithotomy position not masked by epidural bupivacaine and fentanyl.* Regional Anesthesia 1993 18(3):189-90.
- The national Pediatric Epidural Audit
  - Llewellyn N, et al. Pediatric Anesthesia 2007 17: 520-533.

Is Patient-Controlled Analgesia Safe?

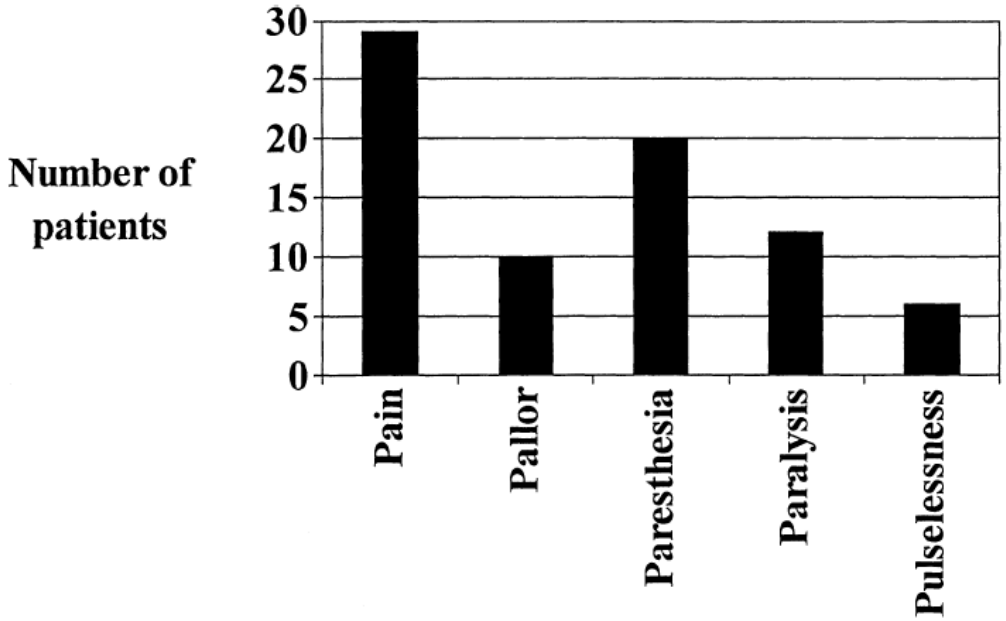
Acute compartment syndrome masked by intravenous morphine from a patient-controlled analgesia pump

P. Harrington[a,*], J. Bunola[b], A.J. Jennings[a], D.J. Bush[a], R.M. Smith[a]

Injury, Int. J. Care Injured 31 (2000) 387–389

Compartment syndrome

Clinical presentation



Bae D.S. et al. **Acute Compartment Syndrome in Children: Contemporary Diagnosis, Treatment and Outcome.** J Ped Orthop 2001; 21: 680-688

Compartment syndrome

TABLE 5. *Analgesic requirements*

Patient	Increasing dosage of analgesia (%)	Increasing frequency of analgesia (%)	Time from increasing analgesia to surgery (h)	Time from increasing symptoms to surgery (h)
7	1 → 2 mg methadone (100%)	q4h → q3h (25%)	96	96
11	30 mg ketorolac + 2 mg morphine	q6h → q3h (100%)	8	4
14	1 → 2 mg morphine PCA (100%)	q6h → q4h (50%)	16	5
15	4 → 5 mg morphine (25%)	q6h → q4h (50%)	16.5	2
16	2 → 4 mg morphine (100%)	q6h → q4h (50%)	24	24
18	1 → 2 mg morphine (100%)	q4h → q1h (400%)	20	20
24	2 → 3 mg morphine (50%)	q4h → q2h (100%)	8	1
29	5 mg Valium + 5 mg morphine	q6h → q3h (100%)	14	8
30	2 → 3 mg morphine (50%)	q5h → q3h (67%)	9	9
31	0.4 → 1.2 mg methadone (200%)	q6h → q4h (50%)	40	10
Average			25.2	17.9

- 10/33 children had PCA/NCA
- The onset of increasing analgesia requirement preceded that of other symptoms by an average of 7.3 hours.

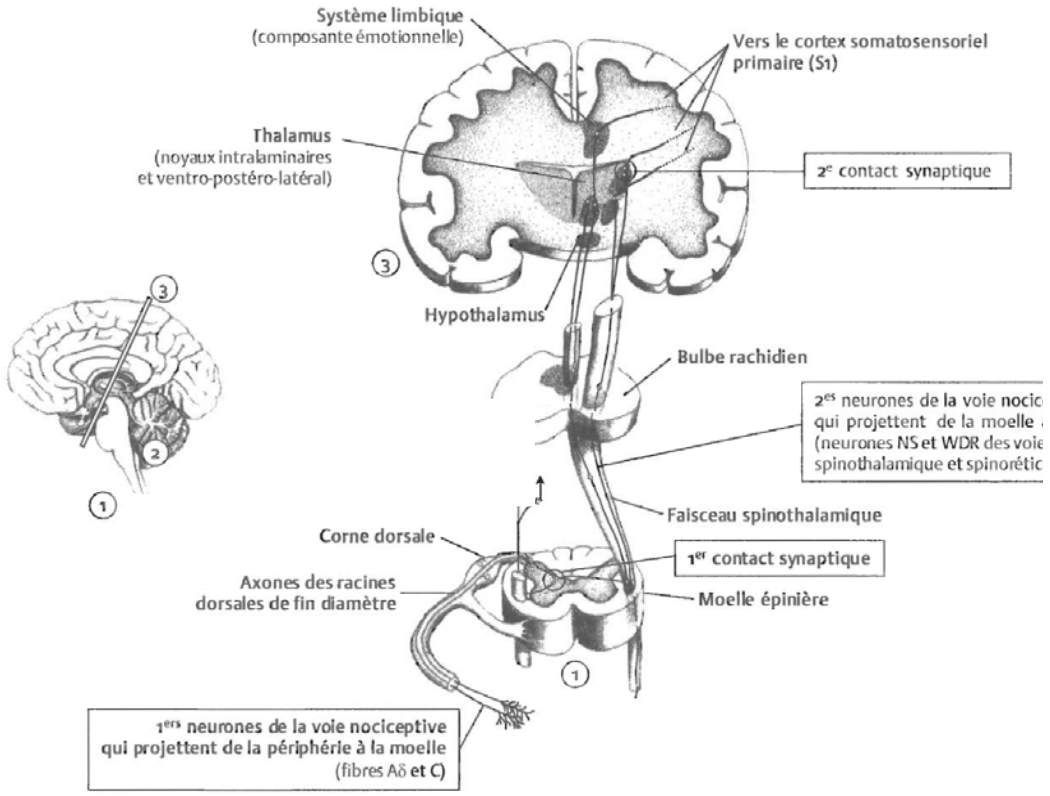
Bae D.S. et al. **Acute Compartment Syndrome in Children: Contemporary Diagnosis, Treatment and Outcome.** J Ped Orthop 2001; 21: 680-688

Compartment Syndrome Conclusions

- Diagnosis is difficult
- Adequate pain control should be offered to all patients
- No evidence that well conducted continous epidurals or nerve blocks with local anesthetics of low concentration can mask compartment syndrome
- Importance of regular monitoring
    - Pain, ↑ analgesics requirement, neuro/vascular, skin integrity
- Patient at risk should be identified

Main Pain Pathway

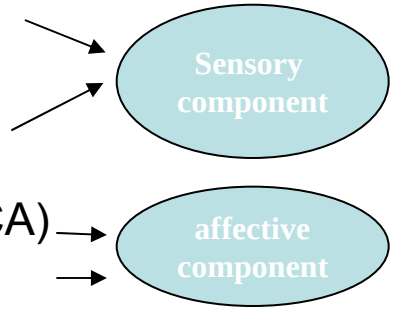
Figure 1.1 **Voies de la douleur : de la périphérie au cortex**



D'après Bear et coll., 1997[1]

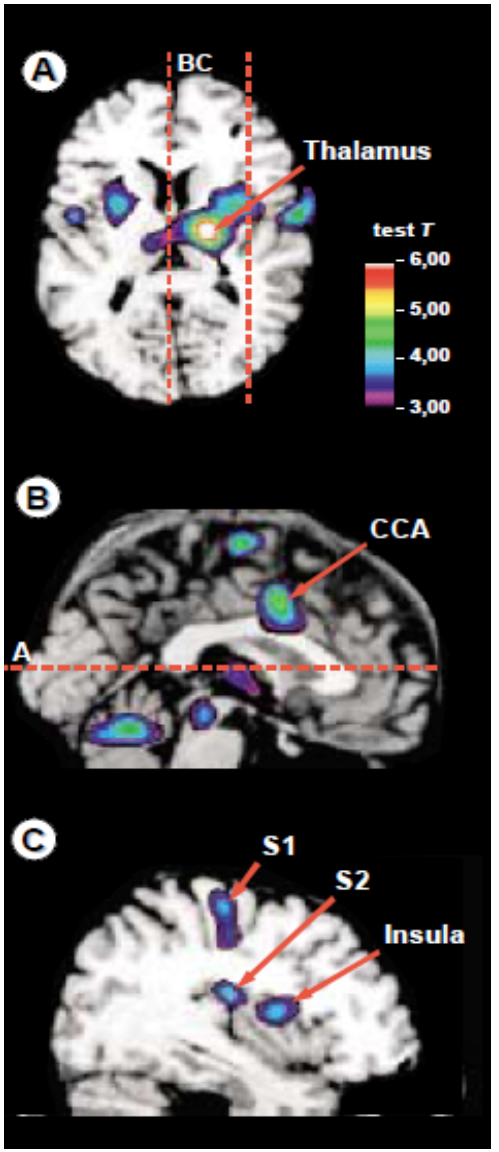
Figure modifiée d'après Bear et coll. 1997 et reproduite avec la permission des Presses de l'Université de Montréal. Marchand, S. Neurophysiologie de la douleur. Dans: Beaulieu P. ed. *Pharmacologie de la douleur*. Les Presses de l'Université de Montréal, 2005:p.6.

- Cortical areas involved in pain
  - –Primary somato-sensory cortex (S1)
  - –Secondary somato-sensory cortex(S2)
  - –Anterior cingular cortex (CCA)
  - –Insula



Determined with brain imaging studies with PET scan during painful stimulation in humans.

Interactions between emotions and sensations during the experience of pain



Rainville P. et associés. Médecine / sciences , 2000; 16: 519-27.

Hypnosis

1795-1860

James Braid and Alexandre Bertrand

‘’Subject’s suggestibility’’

‘’Hypnosis’’ Greek root ‘’Hypnos’’, sleep

Etienne Felix d’Henin de Cuvillers 1820

Hypnosis

1830s

Documentation of hypnosis as adjunct to surgical therapy

1845 to 1851

Scottish physician

James Esdaile

Hypnosis

Reintroduced in 1958

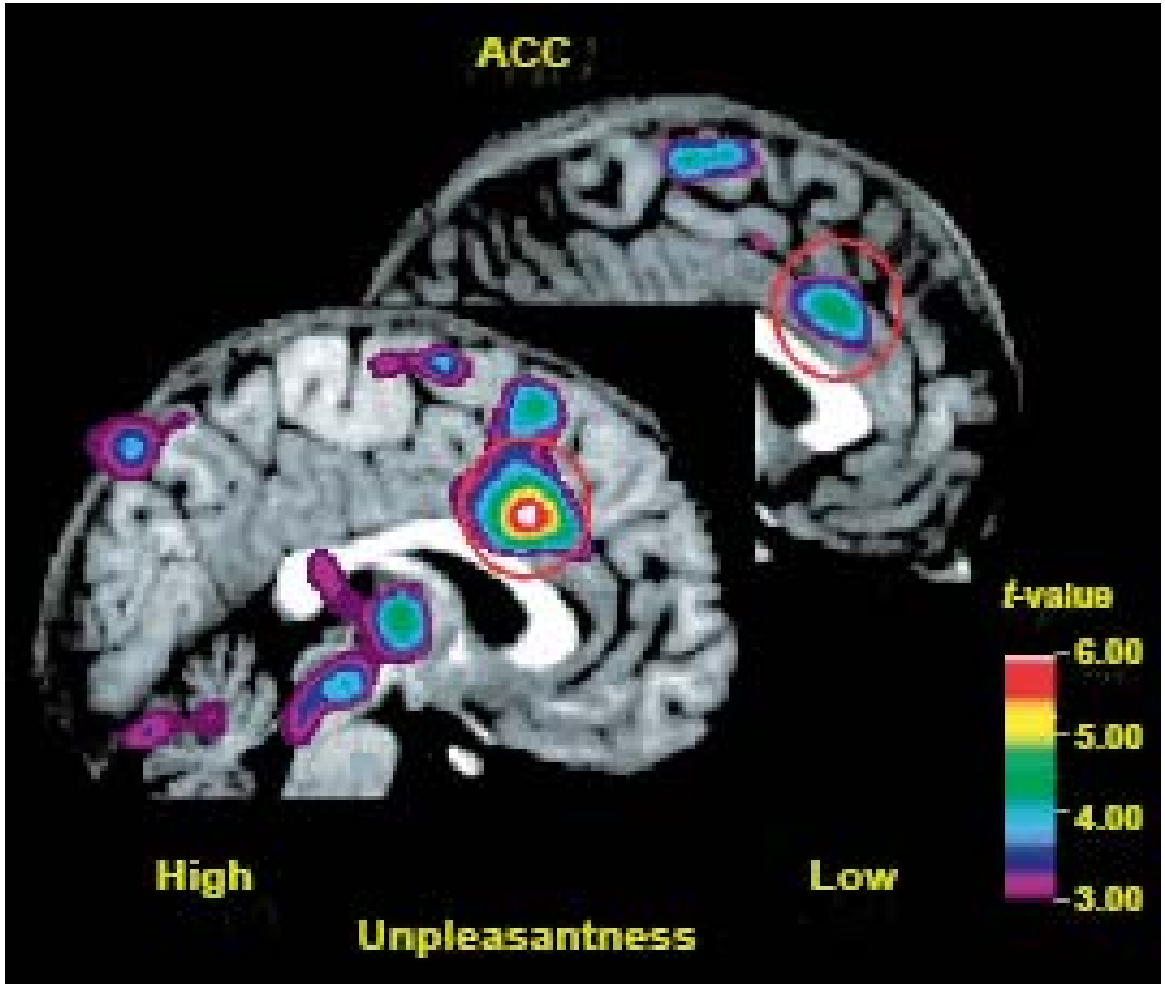
Experimental studies:

- Changes in the perception of experimental pain under hypnosis.
- Psychologic correlates of hypoanalgesia.

Clinical studies:

- Studies involving intraoperative suggestions to patients under general anesthesia.
- Perioperative hypnosis and general anesthesia.
- Hypnosis as part of conscious sedation and monitored anesthesia care.

How hypnosis can modify the pain experience!



Rainville P, Duncan GH, Price DD, Carrier, B & Bushnell MC. *Pain Affects Encoded in Human Anterior Cingulate But Not Somatosensory Cortex.* *www.sciencemag.org* 1997;277:968-971.

Self-hypnosis

Helping children help themselves

Hypnosis

Don’t move your arm.

↓

Keep you arm still or Relax your arm

Teaching Coping Skills

Understandable rational

Coaching

Relaxation

Practice makes perfect

Breathing Exercises

Model appropriate
breathing patterns
and
use their imagination

Distraction

- Watching a movie
- Counting, singing
- Listening to music
- Playing video games
- Telling or reading a story

Guided Imagery

Cognitive distraction technique

Control

- To decrease powerlessness
  - Amount of information
  - Power to make decisions
  - Choice of accompaniment

Sucrose

- < 18 months
- 24% sucrose solution prepared by the pharmacy
- Endorphins

Overgaard C & Knudsen A 1999
Johnston C et associés 1999
Gibbins S et associés 2002

Massage

Relaxes muscles

Positive association with touch sensation

Conclusion

- MUHC Pediatric Opioid Therapy Guidelines
- PCA is only a mode of administration of opioids
  - Patients need to be carefully selected
  - Teaching and surveillance is essential
- Multimodal analgesia is the key to success
- Use non-pharmacological approaches as often as possible!

More Bibliography

Wobst A.H.K. Hypnosis and Surgery:Past, Present, and Future. *International Anesthesia Research Society,* Vol.104, No.5, May 2007

Patterson K.L. & Ware L.L., Coping skills for children undergoing painful medical procedures. *Issues in Comprhensive Pediatric Nursing,* 11:113-143, 1988

Kuttner L. (1996) A Child in Pain, How to Help, What to do. U.S.A.:Hartley & Marks Publishers 271p.