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Pharmacology of Pain Medications

Ghana Emergency Nurses Collaborative
Michelle Munro, MS, CNM, FNP-BC
February 15, 2013
Critical Outcome

• Emergency nurse assesses, identifies, and manages acute and chronic pain within the emergency setting
Specific Outcomes

- Define the types of pain and complications of pain management
- Delineate pain physiology and mechanisms of addressing pain with medications
- Define the general assessment of the patient in pain
- Delineate the nursing process and role in the management of the patient with acute and chronic pain
- Apply the nursing process when analyzing a case scenario/patient simulation
- Predict differential diagnosis when presented with specific information regarding the history of a patient
- List and know the common drugs used in the emergency department to manage the painful conditions and conduct procedural sedation
- Consider age-specific factors
- Discuss medico-legal aspects of care of patients with pain related to emergencies
Medication Review

- Non-narcotic
- Narcotics
- Sedatives / anesthetics
- Local anesthetics
Non-Narcotic

- Acetaminophen
- Salicylates
- NSAIDs
Narcotic

- Codeine
- Fentanyl
- Hydromorphone
- Morphine sulfate
- Oxycodone
Sedatives / Anesthetics

- Diazepam
- Ketamine
- Lorazepam
- Midazolam
- Propofol
- Etomidate
Local Anesthetics

• Lidocaine
• Mepivacaine
• Procaine
• Tetracaine
• LET (lidocaine, epinephrine, tetracaine)
• EMLA cream
Considerations when deciding what type of pain therapy to choose?

• Pharmacological versus Non-pharmacological

• Curative relief or palliative relief

• Allergies

• Availability of medications
Methods of Controlling Pain

Pain Control

Non-Pharmacological
- Preoperative counseling
- TENS
- Acupuncture

Pharmacological
- Opioids
  - IM
  - IV infusion
  - IV PCA
- Local anesthetics
  - Local infiltration
  - Nerve blocks
  - Epidural blocks
- NSAIDS
  - IM
  - IV Infusion
  - IV PCA
Pharmacological Methods

• NSAIDS
  - Block synthesis of prostaglandins
  - Only suitable for mild to moderate pain
Pharmacological Methods

• Opioids:
  – Activate opioid receptors within the CNS
  – Reduce transmission of nerve impulses by modulation in the dorsal horn
Pharmacological Methods

• Local Anesthetics

  – Blocks the conduction of nerve impulses

  – Can be given with adrenaline because
    • Decreases absorption of local anesthetics allowing larger doses
    • Also acts on alpha 2 receptors which potentiates analgesic effect
Acute Pain Management

Start here (can take NSAIDs)

- **Mild**
  - 1 g paracetamol

- **Moderate**
  - 1 g paracetamol plus 30 mg codeine or 400 mg ibuprofen

- **Severe**
  - 1 g paracetamol plus 30 mg codeine or 400 mg ibuprofen

Start here (can’t take NSAIDs)

- **Mild**
  - 1 g paracetamol

- **Moderate**
  - 1 g paracetamol plus 30 mg codeine

- **Severe**
  - 1 g paracetamol plus 30 mg codeine

Wait at least 2 hours before repeating cycle

Acute pain management.

http://www.neuronarc.com/
## Pathophysiology & Analgesics

<table>
<thead>
<tr>
<th>Site of action</th>
<th>Analgesic/effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Nocioceptors in skin and subcutaneous tissues.</td>
<td>NSAIDS – block pathways involved in the formation of inflammatory agents.</td>
</tr>
<tr>
<td>- Stimulated by inflammatory substances (e.g., prostaglandins)</td>
<td></td>
</tr>
<tr>
<td>- Inhibits transmission of pain to higher centers.</td>
<td></td>
</tr>
<tr>
<td>3. Primary afferent neurons (A-delta, C fibers)</td>
<td>Local anesthetics – block transmission of impulses along neurons</td>
</tr>
<tr>
<td>- Transmit impulses from nociceptors to the spinal cord.</td>
<td></td>
</tr>
<tr>
<td>4. Dorsal horn of spinal cord and higher centers.</td>
<td>Opioids (morphine) – act as agonists at opioid receptors</td>
</tr>
<tr>
<td>- Further relay/transmission of painful stimuli to the cerebral cortex.</td>
<td></td>
</tr>
</tbody>
</table>
How They Work

Mechanism of Action, Side Effects, and Warnings
Mechanism of Action: NSAIDs

• NSAIDs

  – Traumatized cells release prostaglandins that sensitize primary afferent fibers

  – NSAIDs inhibit prostaglandin synthesis and interrupt the pain signal at the peripheral level

  • Ibuprofen
  • Ketorolac
  • Naproxen
  • Indomethacin
Adverse Effects: NSAIDs

- GI bleeding, ulceration
- Nephrotoxicity
- Blood dyscrasias
- Nausea
- Abdominal pain
- Dizziness
- Drowsiness
Warnings: NSAIDs

• Do NOT use with:
  – Third trimester of pregnancy
  – Hypersensitivity
  – Asthma
  – Severe renal/hepatic disease

• Maximum dose
  – Ibuprofen – max is 1200mg/day for adult and 40mg/kg/day for child
<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Adult Dose</th>
<th>Pediatric Dose</th>
<th>Toxic Dose</th>
<th>Maximum Dose</th>
</tr>
</thead>
</table>
| Acetaminophen (Paracetamol)| 325-650mg PO q 4-6 hours or 1000mg q 6-8 hours | >1 month: 10-15mg/kg PO q 4-6 hours >12 years: 325-650mg PO q 4-6 hours | - Loss of appetite  
- Nausea, vomiting, stomach pain  
- Sweating  
- Confusion  
- Weakness | 1gm/dose or 4gm/day for adults |
| Aspirin (ASA)             | 650-975mg PO q 4h                               | 10-15 mg/kg PO          | - Reye’s syndrome in children who then get flu or chickenpox.  
- Tinnitus  
- Toxic dose 150mg/kg | 60mg/kg/day                                      |
| Ibuprofen (Motrin)        | 600mg PO q6-8h                                  | 10 mg/kg PO q 6-8h      | - GI irritation  
- Platelet dysfunction  
- Renal dysfunction  
- Bronchospasm | 40mg/kg/day                                      |
| Tramadol (Ultram)         | 50-100mg PO                                     | Not approved            | - May precipitate serotonin syndrome in SSRI patients |                                                  |
| Ketorolac (Toradol)       | 60mg IM/dose  
30mg IV/dose | 0.5 mg/kg IV q 6h Max 120 mg/day | - Same as for Ibuprofen  
- Plus decrease dose by one-half in elderly |                                                  |
Mechanism of Action: Anesthetics

– General anesthetics: Act on the CNS to produce tranquility and sleep before invasive procedures
  • Propofol
  • Droperidol
  • Fospropofol
  • Fentanyl

– Local anesthetics: inhibit conduction of nerve impulses from sensory nerves
  • Lidocaine
  • Procaine
Adverse Effects: Anesthetics

- Dystonia
  - Sustained muscle contractions can cause twisting, repetitive motions, or abnormal postures
- Akathisia
  - Restless leg syndrome
- Flexion of arms
- Fine tremors
- Drowsiness
- Restlessness
- Hypotension
- Chills
- Respiratory Depression
- Laryngospasm
Warnings: Anesthetics

• General anesthetics should be used in caution with:
  – Elderly
  – Cardiovascular Disease (hypotension, bradydysrhythmia)
  – Renal/hepatic disease

• Local anesthetics should be used in caution during pregnancy

Steve A Johnson, flickr
Mechanism of Action: Opioids

- Opioids (systemic and intraspinal)
  - Bind to opioid receptors in the dorsal horn, inhibit release of neurotransmitters (such as substance P), and interfere with the relay of the pain signal across the neuronal synapse
Opioid Receptors

• Is a portion of a nerve cell to which an opioid or opioid-like substance can bind

  – Are located throughout the central nervous system at the spinal and supraspinal levels as well as in the periphery

  – Three receptor types
    • Mu
    • Kappa
    • Delta
Opioid Analgesic

• A morphine-like drug that attaches to an opioid receptor and produces analgesia by blocking substance P
Mu Receptor

– Mediates analgesia for most common opioid-agonist analgesics

– An **agonist analgesia** is an opioid that stimulates activity at an opioid receptor to produce analgesia but may also trigger physical dependence, tolerance, decreased GI motility, euphoria, sedation, and respiratory depression

• Codeine
• Fentanyl
• Hydrocodone (Vicodin)
• Hydromorphone (Dilaudid)
• Meperidine (Demerol)
• Methadone
• Morphine
• Oxycodone
Kappa Receptor

• Mediates analgesia and sedation but rarely affects respiratory drive or causes physical dependence
Delta Receptor

• Primarily mediates analgesia
Antagonist

• Blocks activity at mu and kappa opioid receptors by displacing opioid analgesics that are currently attached

• Most common antagonist is – naloxone (Narcan) – it is used to counteract the life-threatening side effects of the agonist opioids attached to the mu receptor sites
Mixed Agonist-Antagonist Analgesics

• Formulations that attach to both the kappa and mu receptor sites

• Provide analgesia at the kappa receptor site (agonist) but can simultaneously block activity (antagonist) at the mu receptor site
Endorphins

• A group of internally secreted opiate-like substances released by a signal from the cerebral cortex

• They attach to opioid receptors and block transmission of the pain signal

• Multiple factors affect their release, such as brief pain or stress, exercise, & massive trauma
Adverse Effects: Opioids

• GI symptoms (nausea, vomiting, anorexia, constipation, cramps)
• Light-headedness
• Dizziness
• Sedation
• Respiratory depression
Warnings: Opioids

• May worsen addiction
• Increase intracranial pressure
• Monitor patients with:
  – Severe heart disease
  – Hepatic/renal disease
  – Respiratory conditions
  – Seizure disorder
## Opioids

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Oral Dose</th>
<th>Duration (in hours)</th>
<th>Comments</th>
<th>Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morphine</td>
<td>30-60mg (0.5mg/kg)</td>
<td>3-5</td>
<td></td>
<td>-Respiratory depression</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Hypotension</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Sedation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Histamine Release</td>
</tr>
<tr>
<td>Codeine</td>
<td>30-100mg (2mg/kg)</td>
<td>4</td>
<td>-Poor analgesic</td>
<td>-Constipation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-Good cough suppressant</td>
<td>-Nausea &amp; vomiting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-Abuse potential</td>
</tr>
<tr>
<td>Hydromorphone</td>
<td>2-6mg (0.02 – 0.1mg/kg)</td>
<td>2-4</td>
<td>-Available as suppository</td>
<td>-Euphoria</td>
</tr>
<tr>
<td>(Dilaudid)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Opioids Continued....

<table>
<thead>
<tr>
<th>Drug Name</th>
<th>Oral Dose</th>
<th>Duration (in hours)</th>
<th>Comments</th>
<th>Precautions</th>
</tr>
</thead>
</table>
| Hydrocodone (Vicodin, Lortab)    | 5-10mg              | 3-4                 | -Good cough suppressant  
-Fewer side effects than codeine & greater potency                                                                                   | -Greater abuse potential     |
| Oxycodone (Percocet, Tylox)      | 5-10mg              | 3                   | -Euphoria  
-Abuse potential                                                                                                                       |                               |
| Meperidine (Demerol)             | 250-300mg (1.5-2.0mg/kg) | 2-3              | -Toxicity from metabolite normeperidine                                                                                                  | -Avoid with MAOI  
-Caution in renal & hepatic failure                                                                                                         |
Principles of Management of Pain

• Pre-emptive analgesia

• Balanced or combination analgesia

• Analgesia ladder
Pre-Emptive Analgesia

• Analgesia given prior to a procedure or problem to reduce pain

• Examples:
  – Procedural Sedation
  – Paracetamol and/or Ibuprofen (Motrin) given around the clock to reduce pain and swelling from an injury
Balanced Analgesia

- NSAIDS are used in conjunction with opioids
- Reduces amount of opioids
- Reduces side effects of opioids
Analgesia Ladder

STEP 1
Mild pain
Non-opioid agents
e.g. Paracetamol, NSAIDS

STEP 2
Moderate pain
Mild opioid
e.g. codeine phosphate + or – non-opioid

STEP 3
Severe pain
Opioid
e.g. Morphine sulphate + or – non-opioid
Route of Administration of Pharmacological Therapies for Pain
Oral

• Time to onset of analgesia is longer and titration is difficult
  – First-pass hepatic metabolism may inactivate as much as 80% of an oral opioid dose

• Patients who are vomiting will not be able to retain the drug long enough for absorption to occur
Injectable

- **IV**
  - Shortest time to onset of pain relief

- **IM**
  - Pain at injection site
  - Drug uptake is variable, depending on the patient’s peripheral circulation
Transmucosal

- Uniform absorption from the skin
- Usually well-tolerated by patients
- Not often used for acute pain – more for chronic pain management
Rectal

• Only available for hydromorphone (Dilaudid)

• Allows for transmucosal absorption without the first-pass effect

• However, absorption is variable

• Patients may object to this route
# Opioid Time to Peak Effect

<table>
<thead>
<tr>
<th>Route of Administration</th>
<th>Time to Peak Effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral</td>
<td>60 minutes</td>
</tr>
<tr>
<td>IM/SQ</td>
<td>30 minutes</td>
</tr>
<tr>
<td>IV</td>
<td>10 minutes</td>
</tr>
</tbody>
</table>
# Equianalgesic Chart for Commonly Prescribed Opioids

<table>
<thead>
<tr>
<th>Drug</th>
<th>Parenteral Dosage</th>
<th>Oral Dosage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Codeine</td>
<td>130 mg</td>
<td>200 mg</td>
</tr>
<tr>
<td>Fentanyl</td>
<td>100 µg</td>
<td>NA</td>
</tr>
<tr>
<td>Hydromorphone (Dilaudid)</td>
<td>2 mg</td>
<td>7.5 mg</td>
</tr>
<tr>
<td>Levorphanol (Levo-Dromoran)</td>
<td>2 mg</td>
<td>4 mg</td>
</tr>
<tr>
<td>Meperidine (Demerol)</td>
<td>100 mg</td>
<td>300 mg</td>
</tr>
<tr>
<td>Methadone (Dolophine)</td>
<td>10 mg</td>
<td>20 mg</td>
</tr>
<tr>
<td>Morphine</td>
<td>10 mg</td>
<td>30 mg</td>
</tr>
<tr>
<td>Oxycodone (OxyContin)</td>
<td>NA</td>
<td>15 mg</td>
</tr>
</tbody>
</table>
Patient-Controlled Analgesia (PCA)

• A pump used with an IV infusion to administer pain medications for patients with acute or chronic pain who are able to communicate, understand explanations, and follow directions

• Nurses Roles:
  – Assess vital signs and pain level
  – Explain the use of the pump
  – Collaborate with the physician, patient, and family about dosage, lockout interval, basal rate, and amount of dosage on demand
  – Assist the patient to use the PCA pump
A Quick Note on Some Chronic Pain Treatments
Mechanism of Action: Antidepressants

• Antidepressants

  – Inhibit reuptake of serotonin, a neurotransmitter, into neuronal fibers, which makes less serotonin available to relay the pain signal across the synapse; primarily indicated for neuropathic pain
Mechanism of Action: Noradrenergic Agonists

• Noradrenergic agonists

  – Attach to alpha\textsubscript{2} noradrenergic receptors in the dorsal horn of the spinal cord and modulate ascending pain signal
Review Question

- Decreased doses of opioids should be utilized in elderly patients because:
  a. They don’t eat as much so their medication needs are decreased
  b. They don’t feel pain
  c. They have slower metabolism of analgesics
Answer

• c. They have slower metabolism of analgesics

  – They also may have decreased sensation to pain because of changes associated with aging BUT they still feel pain
Review Question

• Describe the first step in pain management according to the WHO ladder and how the medication works to decrease pain.
Answer

• NSAIDs

– Traumatized cells release prostaglandins that sensitize primary afferent fibers; NSAIDs inhibit prostaglandin synthesis and interrupt the pain signal at the peripheral level
Review Question

• Describe the side effects of opioids and what should be monitored during therapy.
Answer

• Sedation
  – Monitor level of consciousness during treatment

• Respiratory Depression
  – Monitor respiratory rate and regularity during treatment
Review Question

• What is the best mode of delivery for pain medications (IV, PO, IM)?
Answer

• **Depends**

• Oral – longer time to onset but can be continued out of the hospital

• IV – shortest time to onset

• IM – pain at injection site and variable uptake but may be used for a patient without an IV site
Case Review

• Discuss a nursing care plan and appropriate pain management for the following scenario:

– An 88 year old man appears at the A & E with complaints of severe abdominal pain. He has not taken in anything by mouth for the last four hours due to the pain and is waiting for further evaluation as to what might be causing the pain. His temp is 38.0°C, Pulse is 105, Respirations are 24, B/P is 132/90.

• **Assessment:** General assessment for pain would include what indicators? What are some special considerations for this patient?
• **Nursing diagnosis:** What is your nursing diagnosis?
• **Plan/Intervention:** What type of nursing plan would you implement? What type of pain medications should be initiated at this time?
• **Evaluation:** How often would you follow-up with patient? What risks/complications would you be looking for?
Questions