# Pre-Test

A **88 lb**, 12 yo child is prescribed hydrocodone/ acetaminophen solution. The weight-based dose is **0.1mg/kg per dose**. Concentration of solution is **10mg/300mg per 15mL**. The medication can be taken **4** times a day.

1. How many mL per dose?

2. How much more total acetaminophen can be given to reach daily max of 3g?

# Pain Management in the Youth Athlete

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# Disclosures

- No Disclosures
- No Conflicts of Interest
- If brand name is used, only for purposes of public familiarity, not endorsement of that specific brand.

# Objectives

- Discuss pharmacologic interventions for sports-related pain and illness in youth athletes
- Address controlled substance use and safety in the youth athlete
- Review clinical pearls and pitfalls in the approach to pharmacologic interventions in youth athletes

# What is Pain?

- Pain is an unpleasant sensory or emotional experience associated with or without tissue damage.
- Pain is influenced by physiological, psychological, emotional and sociocultural elements.
- Pain is multi-faceted, highly subjective and unique to each person.

# Non-Pharmacologic

- Physical Therapy
  - TENS, Graston, ASTYM, Dry Needling
- Osteopathic Manipulation
- Chiropractic Manipulation
- Acupuncture
- Massage

# Inflammatory Response

# Cellular Injury

Cellular Injury – due to tissue damage (e.g. ankle sprain)

Arachidonic Acid is released from cell membrane

Arachidonic Acid is converted by Cyclooxygenase (COX-1 & COX-2)

Results in pro-inflammatory products (e.g. prostaglandins)

# Inflammatory Response

- **Prostaglandins ($PGE_2$ $PGF_2$)**
  - Vasodilation, ↑ Blood Flow
  - Sensitize peripheral nerves, ↑ Pain
  - Fever, ↑ Body Temperature
  - ↑ Leukocytes, (e.g. Neutrophils, Macrophages)
- **Thromboxane A2**
  - ↑ platelet aggregation and vasoconstriction
- **Prostacyclin**
  - ↓ platelet aggregation

# Inflammatory Response

- In addition, many chemicals facilitate a pain response when released as part of the inflammatory response:
  - Bradykinin
  - Histamine
  - Serotonin
- **Each person's response is specific to the individual**

# Cryotherapy

# Cryotherapy

- Immediately post-injury, ice  is believe to reduce tissue metabolism, thereby minimizing secondary hypoxic injury, cell debris, and edema.

- Adequate cooling can reduce pain, spasm, and neural inhibition, thereby allowing for earlier and more aggressive exercises.

# Cryotherapy

- Recommendations regarding cryotherapy protocol are by in large anecdotal and non-evidence based.
- Recommendations in review articles range from 10 to 20 minutes 2 to 4 times per day, up to 20 to 30 minutes, or 30 to 45 minutes every 2 hours.
- Practical approach: 5 – 7 minutes if ice bath is used or 10-15 minutes ice pack, 2 – 3 times per day.

# Cryotherapy

- Growing evidence suggests that cryotherapy may impede healing by delaying the inflammatory response.
- Inflammation is required for tissue healing after tissue damage via a series of cytokines released by the surrounding tissues and immune cells
- However, literature  is conflicting and lacks distinction between exercise induced injury and traumatic injury.

# NSAIDs

# Nonsteroidal Anti-inflammatory Drugs

- Inhibit COX pathway involved in the synthesis of prostaglandins
  - **COX-2** - pain and inflammation
  - **COX-1** – gastrointestinal, renal
- Modalities include oral, topical and injectable
- Vary in onset of action, duration & side effects

# Oral NSAIDS

- Ibuprofen
- Naproxen
- Ketorolac
- Meloxicam (Mobic)
- Diclofenac (Voltaren)

## Drug Profile

- Dose: 10mg/kg
- Max: 800 mg
- Liquid: 100 mg/5 mL
- Infant: 50 mg/1.25 mL
- Interval: Q8H

*Chewable option available

*mg and mL dosage w/ liquid

# Oral NSAIDS

- Ibuprofen
- Naproxen
- Ketorolac
- Meloxicam (Mobic)
- Diclofenac (Voltaren)

## Drug Profile

- Dose: 10-20mg/kg
- Max: 500 mg
- Liquid: 125 mg/5mL
- Interval: Q12H

*Liquid is difficult to find

*220 mg, 375mg, 500mg

# Oral NSAIDS

- Ibuprofen
- Naproxen
- Ketorolac
- Meloxicam (Mobic)
- Diclofenac (Voltaren)

## Drug Profile

- Generally do no prescribe oral ketorolac due to risk of gastrointestinal side effects (e.g. COX -1)

# Oral NSAIDS

- Ibuprofen
- Naproxen
- Ketorolac
- Meloxicam (Mobic)
- Diclofenac (Voltaren)

## Drug Profile

- Reported to have some selective COX-2 inhibition.

# Topical NSAIDS

- **Diclofenac (Voltaren) Gel, Patch**
  - Skin reactions most common
  - Bioavailability compared to oral is approximately 1%
- **Ketoprofen, Ibuprofen** – compounding pharmacy
- Zacher J. et al, Topical diclofenac and its role in inflammation: an evidenced base review.
  - Multiple RCT support use of topical diclofenac in pain related to acute pain. ↑ return to play unclear.

# Injectable NSAIDS

- **Ketorolac (Toradol) IV, IM**
  - IM onset 10 mins, peak effect 45 mins
  - Can be used for moderate to severe pain
  - No more than 5 days by any route
  - ↑ side effect profile due to strong COX-1 & COX-2 inhibition

- **Controversial use of Ketorolac in sports**

- **Multiple studies showing opioid sparing benefits post-operative in orthopedic surgeries**

# IM Ketorolac Versus Oral Ibuprofen in Acute Musculoskeletal Pain

Turturro (1995)

- ED patients received 60mg IM ketorolac and placebo capsule versus 800mg IBU and placebo IM saline injection.

- Mean pain scores improved in each group and did not differ significantly between groups at any interval.

- IM ketorolac and oral IBU provide comparable analgesia in ED patients with MSK pain

# Acetaminophen

# Acetaminophen

- Mechanism is not fully understood:
  - Inhibits COX-1 and COX-2
  - Limited anti-inflammatory effect, but less side effects.
- Modalities include oral, rectal and intravenous
- Multiple studies evaluating acetaminophen and NSAIDs. There **is** evidence to supports its use.

# Acetaminophen

- Dose: 15mg/kg
- Max Dose: 1000 mg (adult)
- Max Daily: 3000 mg (adult)
- Liquid: **160mg/5ml**;  Infant: 80mg/0.8ml (d/c)

*Metabolized by liver

# Corticosteroids

# Oral Corticosteroids

- Not aware of any studies looking at acute musculoskeletal injuries in pediatric patients treat with oral or IM corticosteroids

- Adult literature suggests therapeutic response for patients with sciatica and tenosynovitis

- **Prednisone** - 2mg/kg (max 60mg) x 5 days
- **Methylprednisolone** – 21 (4mg) tabs x 6 days

# Muscle Relaxers


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# “Muscle Relaxers”

- **Cyclobenzaprine (Flexerill)**
- **Diazepam (Valium)**

- Although evidence shows efficacy in back pain for short term use in adults, not appropriate in acute sports medicine injuries

- CNS depressive mechanism is centrally mediated therefore can not target specific muscles
  - ie side effects of dizziness, drowsiness, anticholinergic effect

# Opioids

# Opioids

- Opioids are not typically indicated in acute or chronic pediatric musculoskeletal injuries.
- If using for fracture management or post-surgical, do not use combination medications
- Prescribe with specific dose, interval and end date (max – 5 days).

# Opioids

- Oxycodone
- Hydrocodone/APAP
- Oxycodone/APAP

**Drug Profile**

- Dose: 0.1 mg/kg
- Max: 5 mg
- Liquid: 5 mg/5ml
- Interval: Q6H

# Opioids

- **Tramadol**
- **Codeine –** metabolized to morphine
- **Warning:** Some children have ultra-rapid metabolism, causing dangerously high levels of active drug, leading to respiratory depression

# Opioids

- Codeine is contraindicated to treat pain or cough, and Tramadol is contraindicated for treating pain in children under 12.

- Codeine and Tramadol are not recommended for use in adolescents ages 12-18 who are obese or have conditions such as obstructive sleep apnea or severe lung disease.

- 10-15% of population does not have enzyme to convert codeine to morphine, therefore useless

Arthroscopy. 2018 Dec;34(12):3236-3243. doi: 10.1016/j.arthro.2018.07.021. Epub 2018 Nov 2.

# Opioid Overprescription After Knee Arthroscopy and Related Surgery in Adolescents and Young Adults.

Tepolt FA[1], Bido J[2], Burgess S[1], Micheli LJ[3], Kocher MS[4].

Author information

## Abstract

**PURPOSE:** The purpose of this study was to compare the number of opioids prescribed with the amount of pain medication required after knee arthroscopy and related surgery in adolescent and young adult patients to determine the effectiveness of current pain-control practices at a single institution. The secondary purpose was to determine what demographic or surgical factors are associated with increased opioid intake.

**METHODS:** Adolescent and young adult patients who underwent knee arthroscopy and related surgery, including ligament reconstruction or tibial tubercle osteotomy, between May and August 2016 were provided pain-control logbooks in which they were asked to maintain a record of daily pain medication intake. The outcome of the study was defined as the total number of opioids consumed per patient.

**RESULTS:** One hundred patients returned completed logbooks, 56% of whom were female patients. The average age was 17.54 years (standard deviation [SD], 3.51 years). Most patients underwent an open procedure concurrent with knee arthroscopy (60%), underwent nerve block placement (51%), and underwent injection of local anesthesia (91%). Use of both intravenous acetaminophen and ketorolac during the perioperative period was also common (41%). Patients were prescribed an average of 50.98 oxycodone pills (SD, 12.50 pills) and reported consuming an average of 16.52 pills (SD, 13.94 pills), approximately 32.4% of those prescribed. Eleven percent never consumed opioids, and only 1 patient requested a refill during the 21-day postoperative period. Multivariate analysis showed that increased weight, longer surgery time, and increased diazepam use were most closely associated with increased opioid consumption.

**CONCLUSIONS:** After knee arthroscopy and related surgery, including ligament reconstruction or tibial tubercle osteotomy, adolescent and young adult patients are commonly overprescribed opioids, consuming on average only approximately one-third of those prescribed.

# Hot Topics

# NSAIDs & Bone Healing

- Prostaglandins play a major role in bone formation, resorption and bone repair.
- Any medication that blocks the formation of prostaglandins has the potential to impair fracture healing.
- Human studies have showed delay healing in tibia and humerus fractures, not pediatric.
- Difficult to draw conclusion as there are many different NSAIDS and durations of usage. However sensible to use lowest effective dose for shortest duration possible.

# Does the Use of Ibuprofen in Children with Extremity Fractures Increase their Risk for Bone Healing Complications?

DePeter KC[1], Blumberg SM[1], Dienstag Becker S[2], Meltzer JA[1].

Author information

## Abstract

**BACKGROUND:** Despite being an effective analgesic for children with fractures, some clinicians may avoid prescribing ibuprofen due to its potentially harmful effect on bone healing.

**OBJECTIVE:** To determine if exposure to ibuprofen is associated with an increased risk of bone healing complications in children with fractures.

**METHODS:** We performed a retrospective study of children aged 6 months to 17 years who presented to the pediatric emergency department (PED) with a fracture of the tibia, femur, humerus, scaphoid, or fifth metatarsus and who followed up with the orthopedic service. We chose these fractures due to their higher risk for complications. We classified patients as exposed if they received ibuprofen in the PED or during hospitalization or were prescribed ibuprofen at discharge. The main outcome was a bone healing complication as evidenced by nonunion, delayed union, or re-displacement on follow-up radiographs.

**RESULTS:** Of the 808 patients included in the final analysis, 338 (42%) were exposed to ibuprofen. Overall, 27 (3%) patients had a bone healing complication; 8 (1%) developed nonunion, 3 (0.4%) developed delayed union, and 16 (2%) developed re-displacement. Ten (3%) patients who were exposed to ibuprofen, and 17 (4%) who were not, developed a bone healing complication (odds ratio 0.8, 95% confidence interval 0.4-1.8; p = 0.61). There was no significant association between ibuprofen exposure and the development of a bone healing complication despite adjustment for potential confounders.

**CONCLUSION:** Children with extremity fractures who are exposed to ibuprofen do not seem to be at increased risk for clinically important bone healing complications.

# NSAIDs & Ligaments

- Ligament injury: inflammatory response, proliferative phase and remodeling phase.
- Conflicting animal data on NSAIDs and rat medial collateral ligament healing.
- Human studies have showed clear evidence of decreased pain and faster return to activity.
- However, the effect on joint stability is not known and may be negatively impacted with NSAID use.

# NSAIDs - DOMS

- NSAIDs are used post-workout or competition to treat delayed onset muscle soreness.
- The soreness is due to microtrauma, prostaglandins, and subsequent inflammation.
- Emerging evidence that the action of COX-2 in particular, is important to achieve maximal skeletal muscle hypertrophy in response to functional overload.

# NSAIDs - DOMS

- Despite the short-term analgesic effect provided by an NSAID after exercise, the desired training effects of the activity may be diminished

- Based on current evidence, there is little reason to believe that the occasional use of NSAIDs will negatively affect muscle growth

- Longer-term NSAID use may well be detrimental, particularly in those who possess
  greater growth potential, but more data needed

# Other

# Other Topicals

- Lidocaine (Gel, Patch)
- OTC
  - Tiger balm
  - Biofreeze
  - Icy Hot
  - Aspercreme
  - Salonpas
  - Capsaicin

# Topical Nonprescription Analgesics

- Menthol - cooling effect
- Camphor – cooling effect
  - Risk of toxicity with ingestion
- Trolamine salicylate – mild anti-inflammatory
- Methyl Salicylate – local vasodilation, ↑ skin temp
  - avoid in children and in individuals with aspirin sensitivity and asthma
- Capsaicin – warm, burning sensation

# Topical Nonprescription Analgesics

- Primary effect is counterirritant, which exerts effect by producing a less intense pain and distracts from the original pain
- Counterirritants are indicated for treatment of mild aches and pains related to acute injury.
- FDA has approved agents for minor aches and pain for adults and children 2 years and older.
- Often used in combination with other counterirritants and lidocaine

# Other Topicals

- Compound Formulations
  - Gabapentin 6%, Ibuprofen 5%, Lidocaine 5%
    - 3g apply topically large joint PRN TID

# Tumeric (Curcumin)

Orthop Surg. 2015 Aug;7(3):222-31. doi: 10.1111/os.12183.

**Role of Curcumin in Common Musculoskeletal Disorders: a Review of Current Laboratory, Translational, and Clinical Data.**

Peddada KV[1], Peddada KV[2], Shukla SK[3], Mishra A[3], Verma V[4].

- The Indian spice turmeric (curcumin) has been demonstrated to have significant medicinal properties, including anti-inflammatory effects

- It inhibits multiple processes in inflammatory cell proliferation, invasion, and angiogenesis, which gives it therapeutic potential in many musculoskeletal disorders

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# Questions?

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