PainWeek®

No Kidding Around: Pediatric Trauma Care

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Disclosure

- Dr. Krichbaum has nothing to disclose
- Dr. Miransky has nothing to disclose

Learning Objectives

- Discuss the differences in taking a history for a pediatric patient presenting with trauma related symptoms
- Summarize pain and symptom assessment tools for use in pediatric population
- Recommend safe and effective management of symptoms associated with trauma in the pediatric population

Pretest Question #1

- Which of the following is the least important to consider when taking a history of a pediatric trauma patient?

A. Their developmental stage
B. The concept of total pain
C. Their response to codeine analgesics
D. The patient's report of their symptoms

Pretest Question #2

- Which of the following pain assessment tools is based on the caregiver's perception?

A. FLACC
B. Wong-Baker Faces scale
C. INRS (Individualized numeric rating scale)
D. Pieces of Hurt Tool

Pretest Question #3

- BA is a 13 y/o male admitted to the PICU with a traumatic degloving injury of the left hand. He is currently on morphine 2 mg IV q 2h prn moderate pain or morphine 4mg IV q 2h prn severe pain. He is not scheduled for surgery for 10 days and is being treated with antibiotic therapy awaiting previous skin grafting to mature. In the last 24 hours, he has used 10 doses of morphine 4mg and expresses pain is uncontrolled. He is hesitant to allow wound care due to pain and is not eating or sleeping. Which would be the best method to improve this patient's pain control?
  A. Increase patient's doses to morphine 4 mg IV q 2h prn moderate pain and morphine 6mg IV q 2h prn severe pain
  B. Initiate morphine sulfate extended release 60mg PO q 12h and continue morphine 2 mg IV q 2h prn moderate pain or morphine 4mg IV q 2h PRN severe pain
  C. Initiate hydrocodone 5mg/acetaminophen 325mg PO q 6h and continue morphine 2 mg IV q 2h prn moderate pain or morphine 4mg IV q 2h PRN severe pain
  D. Initiate fentanyl 100mcg patch q 72 hours and continue morphine 2 mg IV q 2h prn moderate pain or morphine 4mg IV q 2h PRN severe pain

Background/Epidemiology

- Roughly one-fifth of ED visits involve pediatric patients in the USA
- Unintentional Injuries is the number one cause of death for ages 1-18 in the United States
  - Motor vehicle accidents account for just over half of unintentional injuries
- Higher chance of mortality and morbidity in rural, less populated areas
  - Presence of a pediatric trauma center within a state was associated with lower pediatric injury mortality rates
    - 80% of US children live within 50 miles of a level I or II trauma center
    - 17.4 million children do not have access to a pediatric trauma center within 60 minutes

Chua, W. J., Alpern, E. R., & Powell, E. C. (2021). Emergency Medical Services for Children: Pediatric Emergency Medicine Research. *Pediatr. Ann.*, *50*(4), e155-e159
AAP Committee On Pediatric Emergency Medicine. (2016). *Pediatrics,* 138(2):e20161569
Centers for Disease Control and Prevention. WISQARS Leading causes of death reports, 2010-2019. Available at: https://webappa.cdc.gov/sasweb/ncipc/leadcause.html. Accessed on July 13, 2021.

Remember: Children are NOT small adults!

Trauma: Pediatric vs Adult

- Pediatric patients have unique characteristics:
  - Physically/Anatomically
  - Physiologically
  - Psychologically
  - Cognitively
- Pediatric Trauma's routine workup of the patient includes assessing the potential for child abuse and/or neglect
- Medical providers often underestimate, underrecognize and under treat pain in pediatrics

AAP Committee On Pediatric Emergency Medicine. (2016). *Pediatrics,* 138(2):e20161569
Brudvik, C., et al. (2017). A comparison of pain assessment by physicians, parents and children in an outpatient setting. *Emerg Med J., 34*(3), 138–144.

Anatomical Differences

- Head is large and heavy, balanced on a neck poorly supported by weak muscles and ligaments
  - Head and cervical spine are easily injured
  - Pediatric spine starts to resemble the adult spine > 8 YO
- Sternum ossification and fusion are incomplete until early 20s
  - Underlying structures (lungs, heart, trachea etc) are less protected and can be damaged without significant signs of external injury
  - The liver and spleen are less protected by the rib cage and are thus at greater risk from blunt abdominal trauma
- Infants and small children have smaller airways
  - Minor injuries and slight swelling can rapidly compromise their ability to breath
- Thin abdominal wall with less fat and underdeveloped musculature
  - Abdominal contents are relatively vulnerable
- Children's bones are more cartilaginous
  - Tends to prevent fracture, however they can still have injury

Figaji, A. A. (2017). Anatomical and physiological differences between children and adults relevant to traumatic brain injury and the implications for clinical assessment and care. *Front Neurol*, *8*, 685
Harless, J., et al. (2014). Pediatric airway management. *Int J Crit Illn Inj Sci*, *4*(1), 65.
Royal Children's Hospital Melbourne. How are children different. Available at https://www.rch.org.au/trauma-service/manual/how-are-children-different. Accessed July 13, 2021
McFadyen, J. G., et al. (2012). Initial assessment and management of pediatric trauma patients. *Int J Crit Illn Inj Sci*, *2*(3), 121

Physiological Differences

- Children compensate for physiologic stress, maintain a near-normal blood pressure even in with 25% - 30% of blood volume loss, but a more precipitous collapse when compensation is overwhelmed.
  - Subtle changes in the heart rate and extremity perfusion may signal impending cardiorespiratory failure
- Larger surface area to volume ratio puts children at greater risk of hypothermia following trauma
- Nociceptive system starts developing as early as week 15 of gestation
- Heart Rate, Blood Pressure, or Respiratory Rate cannot be used independently to assess pain, particularly in infants
  - Lack reliability, sensitivity, and specificity

McFadyen, J. G., et al. (2012). Initial assessment and management of pediatric trauma patients. *Int J Crit Illn Inj Sci*, *2*(3), 121
Figaji, A. A. (2017). Anatomical and physiological differences between children and adults relevant to traumatic brain injury and the implications for clinical assessment and care. *Front Neurol*, *8*, 685
Pancekauskaitė, G., & Jankauskaitė, L. (2018). Paediatric pain medicine: pain differences, recognition and coping acute procedural pain in paediatric emergency room. *Medicina*, *54*(6), 94.
Royal Children's Hospital Melbourne. How are children different. Available at https://www.rch.org.au/trauma-service/manual/how-are-children-different. Accessed July 13, 2021

Psychologically Differences

- Anxiety and Pain commonly co-occur in pediatric populations
  - High levels of preoperative anxiety are associated with high levels of postoperative pain
  - Forceful immobilization can be frightening and can further escalate anxiety
- Young children have difficulty controlling their fear due to immature connectivity between frontal-lobe structures and the rest of the brain
- Children may not report pain
  - Avoid painful treatments
  - Fear of being sick
  - Fear of healthcare professionals
  - Protection of parents or caregiver
  - Desire to return to activities

Vagnoli, L., et al. (2019). Relaxation-guided imagery reduces perioperative anxiety and pain in children: a randomized study. *Eur J. Pediatr.*, *178*(6), 913-921.
Krauss, B. S., et al. (2016). Current concepts in management of pain in children in the emergency department. *The Lancet*, *387*(10013), 83-92.
Fein, J. A., et al. (2012). Relief of pain and anxiety in pediatric patients in emergency medical systems. *Pediatrics*, *130*(5), e1391-e1405.

Cognitive Differences

- Children have insufficient cognitive development to understand strangers trying to reassure them until the age of 5–7 years
  - –Physical comfort measures and distraction activities are more effective than verbal reasoning in helping to control distress
- Cognitive understanding of pain by age group

Age 1-3	Do not understand pain and why it occurs
Age 3-6	Understand pain, but cannot connect it with a disease or how a painful procedure may help
Age 7-9	May understand benefit of painful procedure
Age 10-12	May pretend to feel better to demonstrate bravery
Age 13-18	May try to "act like an adult" and under report pain

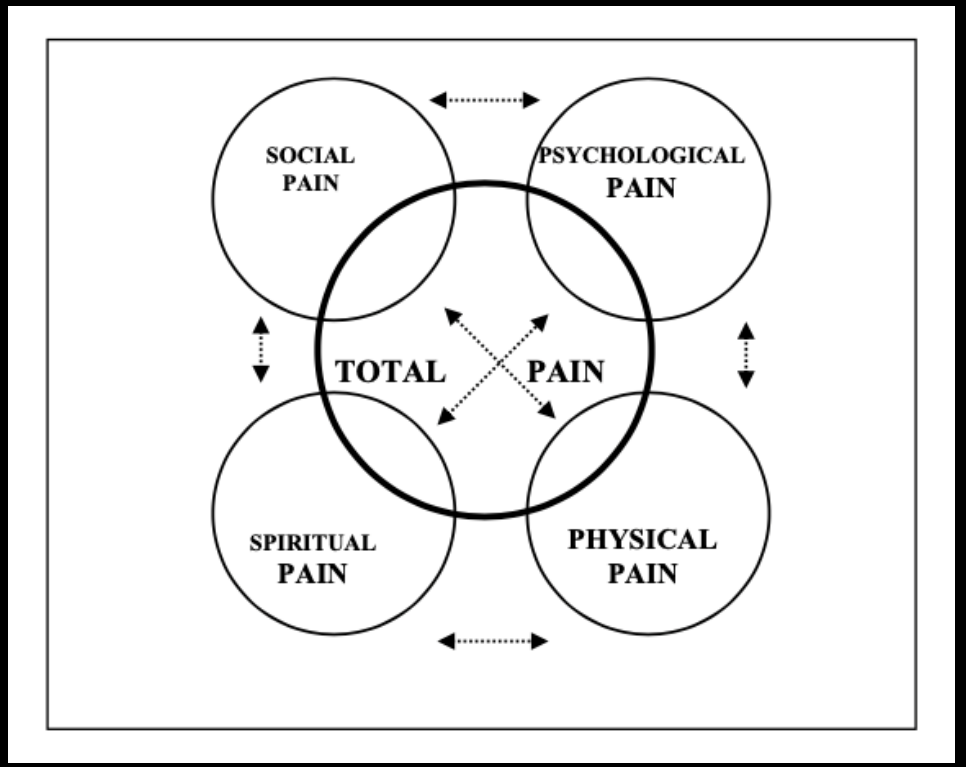
Pancekauskaitė, G., & Jankauskaitė, L. (2018). Paediatric pain medicine: pain differences, recognition and coping acute procedural pain in paediatric emergency room. *Medicina*, *54*(6), 94.

Pediatric Trauma

Pain Management Considerations

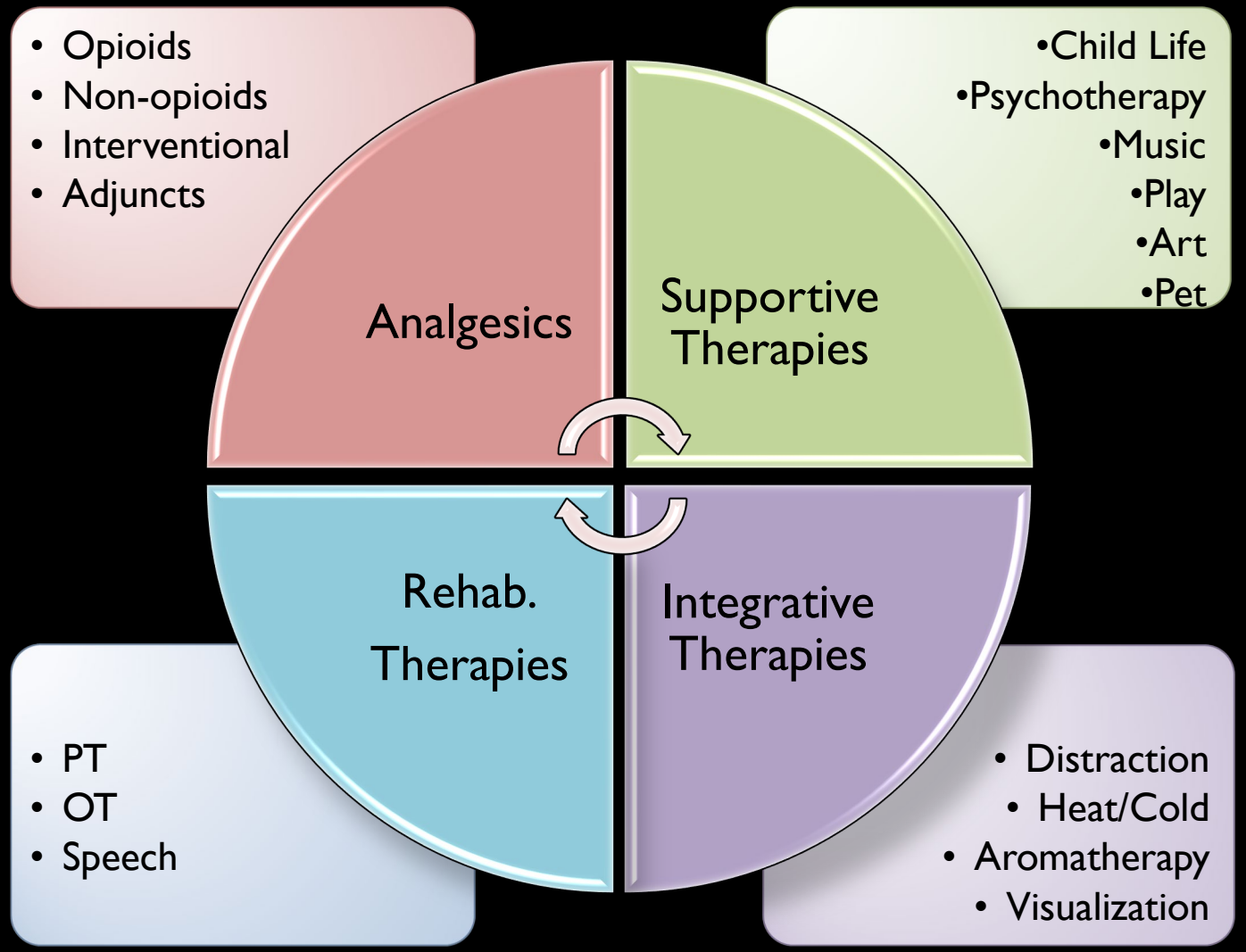
Types of Pediatric Pain

- Acute nociceptive
- Neuropathic pain
- Visceral pain
- Total pain
- Chronic pain



Mehta, A. and Chan, L. (2008). Understanding of the Concept of "Total Pain": A Prerequisite for Pain Control. *J Hosp. Palliat. Nurs.* 10:p.26-32
Friedrichsdorf, S. J., & Goubert, L. (2020). Pediatric pain treatment and prevention for hospitalized children. *Pain reports*, *5*(1). e804

Pediatric Multimodal Analgesia



Different responses to medications

- Larger brain/body weight ratio and higher blood–brain barrier permeability in younger children
- CYP dependent metabolism is ~50-70% of adult levels at birth, however by 2–3 years, enzymatic activity *exceeds* adult values
  - CYP enzymatic activity decreases to adult levels by puberty
- P-glycoprotein (P-gp) expression in human intestinal tissue increases with age to reach maximum levels in young adults (15–38 years of age)
- Gabapentin clearance is 33% higher in younger children (<5 years) than in older children (5–12 years) or adults due to immature L-amino transport activity resulting lower bioavailability

Lu, H., & Rosenbaum, S. (2014). Developmental pharmacokinetics in pediatric populations. J Pediatr Pharmacol Ther, 19(4), 262-276.
Anderson, G. D. (2002). Children versus adults: pharmacokinetic and adverse-effect differences. Epilepsia, 43, 53-59.

Mental Health Considerations (During and Post-Trauma)

- 20-30% of pediatric patients with traumatic injury report mental health symptoms and/or decreased quality of life up to 1 year post-injury
- Experiences with accidents, injuries, physical abuse, or hospitalization can leave a lasting impact
  - Untreated PTSD and depressions are major risk factors for deficits in physical recovery social functioning and quality of life
  - While some are able to cope with the experience and move on, some patients and their families may benefit from psychosocial support and intervention

Ridings, L. E., et al. (2019). Trauma resilience and recovery program: addressing mental health in pediatric trauma centers. J Pediatr psychol, 44(9), 1046-1056.
McFadyen, J. G., Ramaiah, R., & Bhananker, S. M. (2012). Initial assessment and management of pediatric trauma patients. Int J Crit Illn Inj Sci, 2(3), 121.

Pediatric History Taking

PainWeek®

Taking the History

- Gather as much data as possible by observation first
- Stay at the child's physical level if possible
- Order of exam: least distressing to most distressing
- Build rapport with child
  - Include child
    - Explain to the child's level
    - Children as young as 4 may be able to participate in giving history
    - Potential for inaccurate and unreliable transmission of information, concerns, and signs/symptoms from parent's interpretations
  - Distraction is a valuable tool (trusted care givers can be helpful)
- If something is going to hurt, tell the patient in a calm manner.
  - Don't lie or you lose credibility
- Watch for signs of potential child abuse

University of Utah Health Department of Pediatrics. Pediatric History and Physical Exam. Available: http://www.ped.med.utah.edu/cai/howto/H&P%20write-up.pdf Accessed July 7, 2021

Behavioral Indicators of Pain

- Vocalizations
  - Crying
  - Whining
- Facial expressions
  - Grimacing
  - Grinding or clenched teeth
  - Tightly closed eyelids
- Changes in sleep, appetite, social behavior
- Parents and Guardians may help provide insight as they are more familiar with assessing their child's behavior.

Manworren, R. C., & Stinson, J. (2016). Pediatric Pain Measurement, Assessment, and Evaluation. *Semin Pediatr Neurol*, *23*(3), 189–200.

Pain and Symptom

Assessment Tools

Observational Tools

- Face, Legs, Activity, Cry, Consolability Scale (FLACC)
  - Ages: 2 months and 7 years old
  - Can be used for non-verbal, GCS<15, or cognitive impairment
  - Scale: ranges from 0-10 with 0 representing “no pain”
- Pediatric Critical-Care Pain Observation Tool (P-CPOT)
  - Modified version of the adult CPOT assessment tool designed to assess pain in nonverbal critically-ill adults
  - 5 categories scored 0,1,or 2
  - May be more sensitive than FLACC for detecting pain in ventilated patients

Loizzo, A., Loizzo, S., & Capasso, A. (2009). Neurobiology of pain in children: an overview. *Open Biochem J*, *3*, 18.
Tao, H., & Galagarza, S. R. (2020). P-CPOT: An Adaptation of the Critical-Care Pain Observation Tool for Pediatric Intensive Care Unit Patients. *Pain Manag Nurs.*, *21*(2), 172-178.

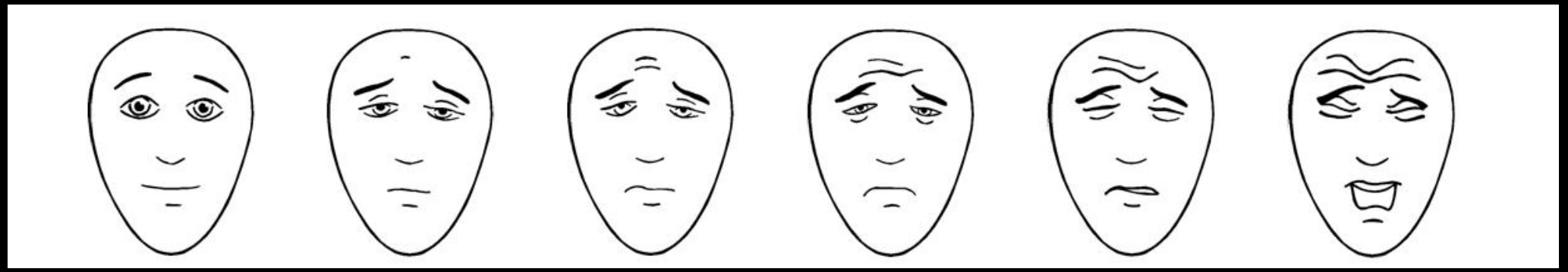
Self-Assessment Scales

- Reliable after age 6 due to need for cognitive and language skills
  - Judge adequacy of child's cognitive abilities appropriate use of a self-report measure included
  - If in doubt, consider a yes–no question about the presence of pain or hurt and supplement with observer/behavioral assessment of pain behaviors
- Recommend using more than one assessment tool in children <6

Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. *Pain*, *160*(1), 5-18..

Faces Pain Scale-Revised (FPS-R)

- Ages 3-18
- Children are asked to point to the face that shows how much hurt they have
- Faces scale with the largest support for its validity
- Systematic review of pediatric self-report pain measure tools for acute pain:
  - Strong recommendation for acute pain in ages 7 and older



Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. *Pain*, *160*(1), 5-18.
Image available at: www.iasp-pain.org/FPSR

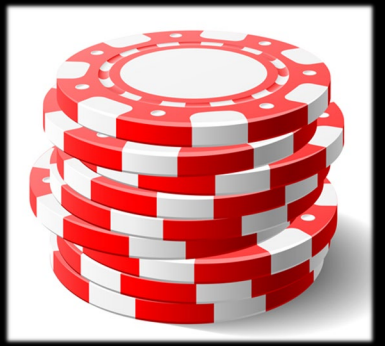
Wong-Baker FACES Pain Rating Scale

- Ages 3-18
  - Concerns with greater use of extreme scores and insufficient criterion validity in 4-5 year-olds
- Available in dozens of languages
- NOT to be used by a third person, parents, healthcare professionals, or caregivers, to assess the patient's pain
- Versions with the smiling face at the no-pain end of the spectrum may overestimate pain
  - Children without pain, but with distress from other sources, may be reluctant to choose the smiling face

Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. *Pain*, *160*(1), 5-18.
Walker, B. J., Polaner, D. M., & Berde, C. B. (2019). Acute pain. In *A practice of anesthesia for infants and children* (pp. 1023-1062). Elsevier.

Pieces of Hurt tool/Poker Chip Tool

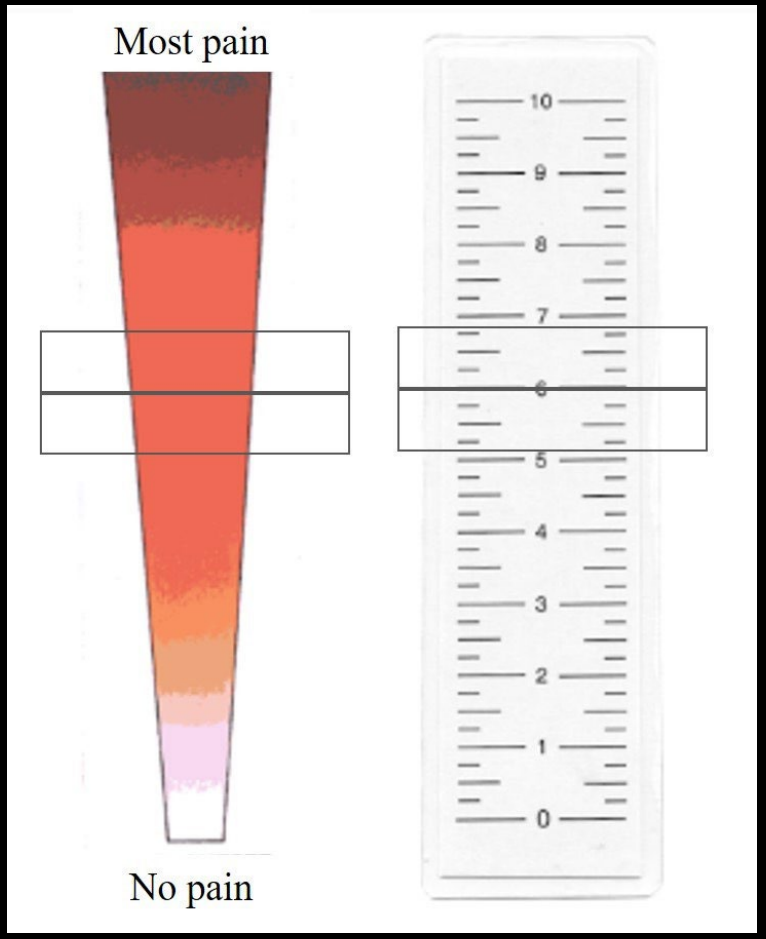
- Ages 3-18
- Quantifies pain intensity by using 4 poker chips to represent amounts of pain
  - Little bit of hurt
  - little more hurt
  - more yet
  - most hurt they could ever have
- Concerns with greater use of extreme measure scores in 4- and 5-year-olds with acute pain, and 4-year-olds with postoperative pain



Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. Pain, 160(1), 5-18.
Thirion, J., O'Riordan, M. A., & Stormorken, A. (2015). Revisiting the Pieces of Hurt pain assessment tool–do the pieces matter. Pediatr Pain Lett, 17(1), 1-4.

Color Analogue Scale (CAS)

- Ages 5-16
- Designed to use gradations of color, area, and length to enable children to concretely identify variations in pain intensity
- Systematic review of pediatric self-report pain measure tools for acute pain:
  - Strong recommendation for acute pain in ages 8 and older



Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. *Pain*, 160(1), 5-18.
Bulloch, B., Garcia-Filion, P., Notricia, D., Bryson, M., & McConahay, T. (2009). Reliability of the color analog scale: repeatability of scores in traumatic and nontraumatic injuries. *Acad Emerg Med*, *16*(5), 465-469.
Image Available from: https://www.researchgate.net/figure/Color-Analog-Scale-Adapted-from-McGrath-PA-et-al-A-New-Analogue-Scale-for-Assessing_fig2_329225062

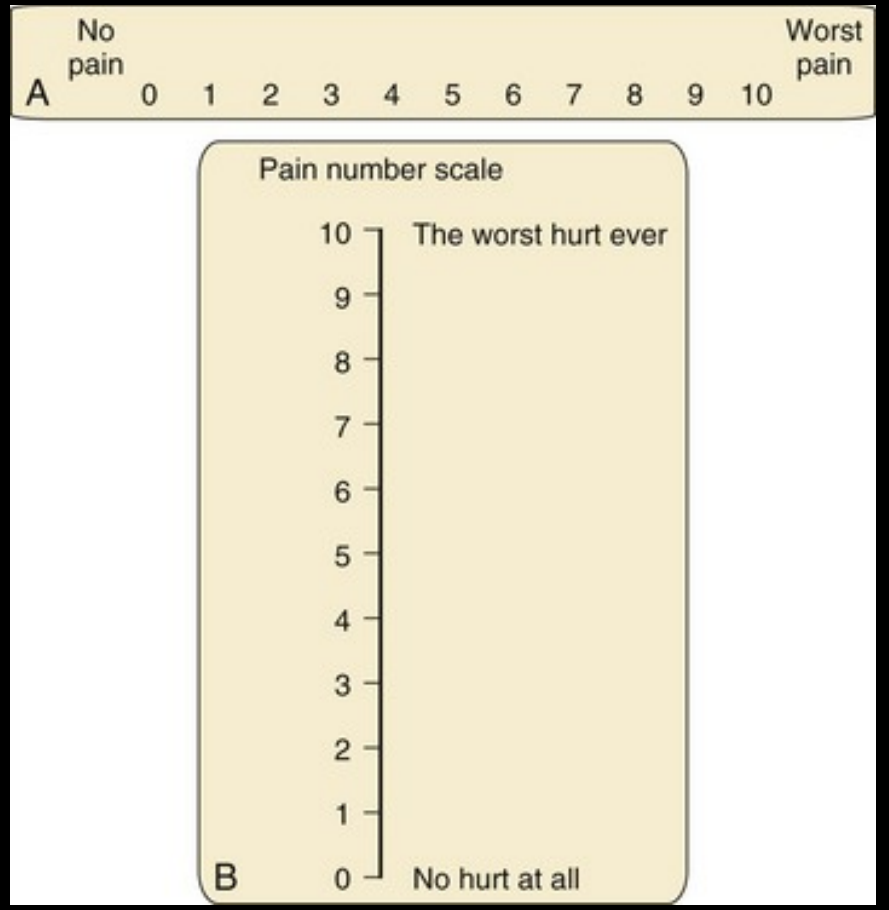
Numerical Rating Scale-11

- Ages 6 and up
- Rate pain intensity on 0-10 scale
- Verbal, Alert and Oriented, numeracy
- Systematic review of pediatric self-report pain measure tools for acute pain:
  - Strong recommendation for acute pain in ages 6 and older (demonstrating basic numerical competency

Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. Pain, 160(1), 5-18.

Visual Analogue Scale (VAS)

- Ages 6-18
- Patient marks their pain intensity on a line typically 100 mm in length with a corresponding scale score from 0 to 100 or 0 to 10
- Systematic review of pediatric self-report pain measure tools for acute pain:
  - Strong against in ages 3-5
  - Weak against in ages 5-8
  - Weak for in ages 8 and up



Birnie, K. A., et al. (2019). Recommendations for selection of self-report pain intensity measures in children and adolescents: a systematic review and quality assessment of measurement properties. Pain, 160(1), 5-18.
Image: https://clinicalgate.com/acute-pain/

Individualized Numeric Rating Scale (INRS)

- Used for children >8 years old who are cognitively impaired and/or critically ill and intubated
- Collects information regarding a pediatric patient's pain solely from a caregiver and/or parent
- Scale: 0-10 numeric rating, with 0 being "No Pain" and 10 being the "Worst Possible Pain"

Solodiuk, J., & Curley, M. A. (2003). Pain assessment in nonverbal children with severe cognitive impairments: the Individualized Numeric Rating Scale (INRS). *Journal of pediatric nursing*, *18*(4), 295-299.

Hugs and Drugs Recommendation

Ages	Recommended Scale
Alert and Oriented	
3 - 6	Use Multiple (Pieces of Hurt ± FPS-R ± Observation)
6 and up	Numerical rating Scale (if numerical competency) Color Analogue Scale (if no numerical competency)
Non-communicative	
2 months – 7 years	FLACC
8 years and up	INRS

Pediatric Trauma

Management and Treatment

Hugs and Drugs medication recommendations

- Analgesics to Avoid in Pediatrics
  - Codeine and tramadol
  - Topical lidocaine <2 yo
- Long-acting opioids are reasonable option if pain is expected to have an extended duration and constantly present in the absence of analgesics
- Blue Book – 2020 Pediatric Pain and Symptom Management by Dana-Farber Cancer Institute/ Brigham and Women's Hospital
  - https://pinkbook.dfci.org/
- Harriet Lane Handbook – 21nd ed.
  - 22ND Edition expected late 2021

Case #1

- Initial
  - SP is a 11 YO M who presented as a level II pediatric trauma patient. While trying to stop 2 boats from colliding and hitting the dock, the patient sustained an avulsion injury to his right posterior foot with tendons and bone exposed, along with an open calcaneal fracture. The injury was open with marked soft tissue loss along the periphery. Hemodynamically stable and lab results were unremarkable
  - No active bleeding was noted, and patient taken to OR for wound washout and orthopedic care.
  - PMH: ADHD and hyperglycemia
- Hospital Course
  - Patient returned to the OR on multiple occasions for washout and then plastics reconstruction.

Case #1

- Issues that came up
  - Hemoglobin 8.7 mg/dL from 11.6 mg/dL
    - Mother denied blood transfusions (Jehovah's Witness)
    - Patient asymptomatic
  - Pt noted altered sensation in right toes following surgery
    - Normal and expected per plastic surgery team due to nature of the surgery
  - Recurrent loss of IV access
    - Vascular consult for midline placement
- Support Services Involved
  - Child Life, Play Therapy, Art Therapy, Physical Therapy

Case #1 - Medications and Changes

- Initial
  - –Acetaminophen 650 mg PO Q4H, ibuprofen 400 mg PO Q6H, morphine 2 mg IV Q4H PRN pain scale
    - Morphine changed to 2.5 mg PO Q4H PRN moderate pain and 5 mg PO Q4H PRN severe pain while undergoing surgical interventions
    - Ondansetron 4 mg IV Q8H PRN nausea and vomiting
  - – Ketorolac 15 mg IVP Q6H added for first 24 hours after operations
  - – Ferrous sulfate 325 mg PO BID then decreased to daily after 1 week
  - – Gabapentin 100 mg PO Q8H titrated to 400 mg PO Q8H for neuropathic right foot pain
    - Patient developed increasing somnolence as dose increased
  - – Enoxaparin 25 mg SubQ BID started for DVT prophylaxis once cleared by surgical team
  - – Epoetin alfa 10,000 units daily recommended by Peds Hematology
  - – Senna-Docusate 8.6 mg-50 mg PO HS PRN constipation added
- Following Palliative Symptom Consult
  - –Nortriptyline 10 mg PO and then titrated to 20mg PO QHS mg for neuropathic pain
  - –Gabapentin weaned
  - –Stopped NSAIDS and started low dose oral opioid analgesics during hospital stay

Case #2

- 9 YO M presented as level 1 trauma following a penetrating head injury involving his left frontal lobe through right parietal lobe by the leg of a chair. He had been struck in the head with the chair by his stepparent. When patient presented, he was initially conscious, but his GCS deteriorated to 3 and patient was intubated. He suffered an intracerebral hemorrhage and underwent air decompressive hemicraniotomy.
- Patient had recurrent intercranial hemorrhages involving the right side of his brain. Ventriculostomy was placed for decompression. Patient required prolonged mechanical ventilation and so a tracheostomy and PEG where placed followed by VP shunt. Patient developed spasticity in his bilateral lower and left upper extremities. His mentation was grossly intact but had limited verbal abilities due to tracheostomy and used thumbs up/down to communicate.
- Reports pain in right arm and leg, constant nausea, and intermittent anxiety

Case #2

- Assessment tools used
  - Initially responsive but GCS deteriorated to 3
  - FLACC used when pt nonverbal
  - Numeric or faces score
- Social work. Behavioral health
- Neuro rehab
- Music therapy, Dance movement therapy, social services, chaplain, palliative care
- PT, OT, speech therapy, nutrition, respiratory

Case #2 - Medications and Changes

- Fentanyl 0.75mcg/kg/hr titrated 2mcg/kg/hr**
- Midazolam 0.1mg/kg/hr (weaned off 2.5 months later)**
- Acetaminophen 650mg IV q4H PRN fever changed to 500mg gtube Q4H prn mild pain
- Levetiracetam 500mg IV Q12h
- Dexmedetomidine 0.2mcg/kg/hr initiated on day 5**
- Methadone 4.8mg IV q4H (weaned off 2.5 months later)**
- Baclofen 5mg feeding tube q8h
- Nortriptyline 10mg vis PEG QHS
  - –EKG
  - –Pt reported benefit after 1 dose

Case #2 - Prior to discharge to rehabilitation facility

- Baclofen 10mg gtube Q8h
- Hydrodone/apap 7.5/325mg q4H prn severe pain
- Apap 500mg gtube q4h prn mild pain
- Ibuprofen 400mg gtube susp q6h prn moderate pain
- Nortriptyline 10mg qhs
- Methylphenidate 5mg daily increased to bid 8am and 2 pm

Non-pharmacologic Pain Interventions

- Child Life Specialist
  - Decrease anxiety and pain with developmentally appropriate education to patients and families
  - Help the child to develop and execute coping plans during difficult events
  - Support family involvement in the child's care
- Comforting/Positioning
- Distraction techniques
- Relaxation
- Guided Imagery
- Heat and Cold
- Buzzy® Device for painful procedures
- Massage
- Music Therapy
- Pet Therapy
- Aromatherapy

Fein, J. A., Zempsky, W. T., Cravero, J. P., & Committee on Pediatric Emergency Medicine. (2012). Relief of pain and anxiety in pediatric patients in emergency medical systems. *Pediatrics*, *130*(5), e1391-e1405.

https://www.stjude.org/treatment/patient-resources/caregiver-resources/patient-family-education-sheets/child-life/buzzy-device-for-pain-relief.html

Davis, K. (2017). National Hospice and Palliative Care Organization Palliative Care Resource Series Nonpharmacological Pain Management for Children. Available at :https://www.nhpco.org/wp-content/uploads/2019/04/PALLIATIVECARE_Nonpharmacological.pdf Accessed July 14, 2021.

Abrahm, J. (2014). Nonpharmacologic strategies for pain and symptom management. John Hopkins University Press: *A Physician's Guide to Pain and Symptom Management in Cancer Patients*.

Post Test Question #1

- Which of the following is the least important to consider when taking a history of a pediatric trauma patient?

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B. The concept of total pain
C. Their response to codeine analgesics
D. The patient's report of their symptoms

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- Which of the following pain assessment tools is based on the caregiver's perception?

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