Improving postoperative pain outcomes for children

International Forum on Pediatric Pain

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Declaration of Disclosure

I have no actual or potential conflict of interest in relation to this presentation.
Preamble

Despite substantial evidence to guide practice, children continue to have significant pain after surgery.

The challenge is to implement knowledge to provide safe effective pain management to all children in the right place at the right time.
By the Numbers

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<th>Patient factors</th>
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<th>Anesthetic factors</th>
<th>Other Acute Pain Strategies</th>
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Objectives

After this presentation you will be able to:

- Explain the importance of optimizing pain outcomes after surgery
- Describe what is known about pain outcomes after surgery
- Apply evidence to prevent and manage surgical pain in children more effectively
Outline

Context
- Why is good postoperative pain prevention & management important?
- How well is surgical pain managed in children?

Pain Management strategies; *evidence & controversies*
- General principles
  - Pharmacology, Physical, Psychological (the 3’P’s)
  - What’s Trending…

How can we do better?
Postoperative pain is risky

Children & families
- Suffering – physical, psychological
- Poorly controlled postoperative pain
  - Longer recovery
  - ↑ risk of complications e.g. infection
  - Longer hospitalization
  - Unplanned re-admissions
  - Chronic Post Surgical Pain (12-80% incidence 1 yr post surgery)

Clinicians
- Fail in ethical responsibility to ‘do no harm’ (Walco et al NEJM 1994)
- Violation of hospital policy, failure to meet accreditation standards

Society
- Expensive
Chronic postsurgical pain (CPSP)

Definition

- Persists > 2 months after a surgical procedure
- Other causes ruled out

Incidence of CPSP in adolescents

- 13.5% - 15 yrs after hernia repair
- 22% - 1 year post scoliosis surgery
- 38-92% of child and adolescent amputees

Risk factors

- acute post-surgical pain intensity
  - NRS ≥ 3/10; 3x risk mod-sev CPSP at 6 months, 2x risk at 1 yr
Prevalence of mod-sev pain in hospitalized children
Groenewald et al., Pediatric Anesthesia, 2012; 22:661-8

- Audit - hospitalized children over 1 month period (N=390)
  - Mayo Eugenia Litta Childrens Hospital, 2009

- Prevalence of moderate to severe pain
  - 27% overall
  - Risk factors – age (infants, teens), surgical service
    - 44% - surgical patients had moderate to severe pain
      - 75% received - acetaminophen
      - 21% - NSAID
      - 76% - opioid (36% scheduled, 40% PRN)
77% of inpatients have pain during admission
44% - moderate-severe in previous 24h
SickKids Quality Improvement Plan - Pain
Surgical Outcomes

METHOD
• Chart Audit; Quarterly
• Capturing all inpatients in hospital ≥ 24 hours

OUTCOMES
• Pain Practices
  • (pain assessment documentation, interventions mod-sev pain)
  • Prevalence of moderate to severe pain

FEEDBACK
• Provided to all inpatient units + interprofessional groups, leadership, Quality leaders, educators...
SK QIP – Surgical pain

Prevalence of moderate to severe pain
(i.e., number of patients with at least one assessment indicating mod-sev pain)
QIP – Surgical pain

Frequency of Moderate to Severe Pain
(i.e. number of assessments indicating moderate to severe pain)

- Q4 (2012/2013): 12%
- Q1 (2013/2014): 10%
- Q2 (2013/2014): 8%

Frequency of Moderate to Severe Pain Assessments
QIP – Surgical pain

Percentage of Patients with Moderate to Severe Pain who receive at least one of the following interventions
QIP – Surgical pain

Reassessment Frequency

Reassessments done

- Q4 (2012/2013): 15%
- Q1 (2013/2014): 45%
- Q2 (2013/2014): 35%

Reassessments done
SickKids PACU Pain Audit (Pilot)

METHOD
- Retrospective chart review
- One month - 100 patients

OUTCOMES
- Pain assessment documentation
- Prevalence of moderate to severe pain

FEEDBACK
- PACU CIP Committee
- PACU Rounds
SickKids PACU Pain Audit
Pain assessment documentation
(N=99, 1 excluded)

- Pain score was NOT documented: 32%
- Pain score was documented: 68%
SickKids PACU Pain Audit

Pain score documented using a validated tool? (N=67)

- Pain score documented using a NON-validated tool: 19%
- Pain score documented using a validated tool: 81%
SickKids PACU Pain Audit
Prevalence of moderate to severe pain
in patients with documented pain scores (n=67)
Pain and behaviour changes in children following surgery

Descriptive study - direct observation, self-report questionnaires (n=131) parents /children (2-12 years)

- High incidence pain & PB for several weeks
  - 93% had pain, 73% exhibited PB - day 2 after discharge
  - 25% still had pain and 32% PB at week 4

- Factors associated with PB
  - child's previous pain experience
  - parent and child anxiety
  - parent's level of education
An audit of pain management following pediatric day surgery at BC Children's Hospital


Prospective audit - 225 children

- Medical records - in-hospital data.
- Telephone questionnaire 48 h post discharge - at home data.

Pain reports and scores worse at home than in-hospital

Children undergoing certain procedures - more likely to experience significant pain.

Improvements may be possible by

- increasing the use of multimodal analgesia
- providing standardized written discharge instructions
- using surgery-specific pediatric analgesia guidelines
Postoperative Pain Management

General principles
What’s trending?
Pharmacological, Physical, Psychological strategies

Pain Management – General Principles

Planned and organized prior to surgery in consultation with patients & carers, other members of the perioperative team

Discharge instructions should be clear to facilitate good pain management at home

Pain must be assessed using validated tools, and documented; essential for preventing, diagnosing and treating pain

Postoperative pain management should be appropriate to developmental age, surgical procedure, & clinical setting to provide safe, effective pain relief with few side effects
Pain management interventions

- **Nociceptor**: NSAIDs, LAs, cooling, heat
- **1<sup>st</sup> afferent neuron**
- **Ascending pathway**: Opioids, LAs
- **Brain**: Acetaminophen, opioids, adjuvants, ‘psychology’
- **Descending pathway**: Opioids, LAs, adjuvants
- **Spinal cord**: Local anaesthetics
Pain prevention & intervention
The 3 ‘P’ s approach

Pharmacological
• WHO ladder
• Adjuvant rx

Physical
• Ice/heat
• Positioning
• TENS
• Massage

Psychological
• Education
• Distraction
• Relaxation
Pain Assessment and Management of the Child

Pain Assessment: **WHEN?**
- On admission and once per shift
- Before/during/after invasive procedures

Pain Assessment: **HOW?**
Use developmentally appropriate tool

- PIPP
  - Preterm & Full Term
- FLACC
  - 2 mo – 7 yrs
- Pain Word Scale
  - 3 – 7 yrs
- FACES
  - 5 – 12 yrs
- NRS
  - = 7 yrs
- NCCPC
  - 3 – 18 yrs (Non-communicative patients)

Is pain present?
- No
- Yes

Pain Management: **INTERVENTIONS**

Pharmacological
- Apply topical anesthetic for IVs/phlebotomy
- Give analgesics regularly
- Use least invasive route (orally if possible)
- Mild pain: Acetaminophen ± NSAID
- Moderate & Severe pain: Acetamin* ± NSAID ± opioid
*Ensure no contraindications exist*

Physical
- Heat and/or cold (NOT for neonates)
- Massage
- Pressure
- Activity out of bed
- Swaddling (Neonate)
- Sucrose (< 2 yrs)

Psychological
- Explanation (invasive procedure)
- Distraction
- Relaxation

Consider:
- Child Life Specialist
- Psychology/psychiatry
- Consult for coping strategies

Reassess in 1 hour

*Algorithm based on the Hospital for Sick Children’s Pain Assessment Policy and Pain Management Clinical Practice Guideline.*
Pain Management – who is responsible?

Operating room
- **Anesthesiologist & Interprofessional Team**
  - Balanced multi-modal analgesia
    - Acetaminophen, NSAID, opioid, +/- adjuvants
  - Regional anesthetic techniques
    - Local infiltration, peripheral & central nerve blocks

Postoperative
- **Generic Pain Management (inpatient & ambulatory)**
  - Responsible Physicians interprofessional team
- **Specialist Pain Management**
  - Acute Pain Service
“I attribute my success to this - I never gave or took any excuse.”

Florence Nightingale
Pharmacological strategies

evidence & controversies

The perfect analgesic

Effective
Safe / no side-effects:
  ▪ No CNS or cardiorespiratory depression
  ▪ No constipation
  ▪ No nausea

Easy to order, easy to administer, easy to take
No drug interactions

Cheap
No withdrawal, dependence, tolerance, addiction
Useful in all patient populations
Reversible effect
Quick onset
Acceptable duration of effect (long, short)
Different preparations (liquid, sublingual, injectable, transdermal)
Better than currently available analgesic of the same class!
WHO Recommendations on Pain Relief

Balanced Analgesia

- More than one class of analgesic or adjuvant each working in a different way = better pain relief with fewer side effects

Medications should be taken

- By the clock: SCHEDULED
- By the mouth: USE LEAST INVASIVE ROUTE
- By the ladder
Analgesia Ladder

- Pain decreases
  - "Weak" opioid + non-opioid
  - Non-opioids - Acetaminophen, NSAIDS

- "Strong" opioid ± non-opioid
  - Severe
  - Moderate
  - Mild

- Pain increases
Pain-related psychological factors important in postoperative pain

Childrens anxiety is associated with increased postoperative pain and analgesic use

Pain anxiety significantly associated with pain intensity and functional disability 2 weeks after discharge
Pain catastrophizing - associated with pain unpleasantness
Girls - higher levels of acute postoperative anxiety & pain unpleasantness.
Does targeting preoperative anxiety have an impact on postoperative pain?

Impact of usual anxiety reduction strategies on pain is relatively unknown:

- Midazolam
- Psychological strategies
  - Education/explanation
  - Parental presence at induction of anesthesia (PPIA)
  - Presence of Child Life
Does choice of anesthetic agent affect postoperative pain?

RCT, DB. N=88 3-6 years, ASA I-II hernia repair
Sevoflurane - higher % postoperative pain than propofol
(24.3% vs 4.5%)

Acetaminophen

Acetaminophen improves analgesia after minor and major surgery in children


May reduce opioid consumption and side-effects


IV paracetamol reduces postop morphine requirements in neonates & infants undergoing major noncardiac surgery.

NSAIDs - evidence

Reduce opioid requirements
Improve postoperative pain intensity
Decrease PONV

NSAIDs and bleeding; controversy

A 2013 updated systematic review and meta-analysis of 36 randomized controlled trials; No apparent effects of nonsteroidal anti-inflammatory agents on the risk of bleeding after tonsillectomy.

NSAIDs and bone-fusion; *controversy*

No evidence of a deleterious effect

- two retrospective reviews looking at the use of NSAIDS following pediatric spinal surgery
- no difference in incidence of nonunion in patients receiving ketorolac (221 patients) vs controls (306 patients)
- Use remains controversial - prospective data required
Opioids

Morphine

- Most widely used and studied opioid in children
- Safe and effective in all ages
- Can be given by the oral, subcutaneous, intramuscular, intravenous, epidural, intraspinal, & rectal routes
- Continuous or intermittent infusion of the dose is adjusted according to individual analgesic requirements
- Beware opioid induced hyperalgesia
  - sensitization of pronociceptive mechanisms
  - mechanism poorly understood (NMDA receptors, C-fibre activation)
  - Rx - NMDA antagonists
PCA

- Established in children as young as age 5
- Criteria for selection: age and understanding, ability to use PCA, trained staff, educated families, monitoring
- Use of background infusion more common in children, efficacy and side effects vary according to dose
A national audit of pediatric opioid infusions.

Serious clinical incidents associated with continuous infusion, PCA, NCA in patients aged 0-18

- 1:10,000 serious harm - comparable to pediatric epidural infusions
- Avoidable factors
  - Prescription and pump programming errors,
  - Concurrent sedatives or opioids by different routes and overgenerous dosing in infants.
  - Early respiratory depression in patients with specific risk factors, receiving NCA or continuous opioid infusion suggests that closer monitoring for at least 2 h is needed for these cases.

Provides information to help process of informed consent.
Opioids; controversy

Opioids for pain relief rarely cause addiction

Codeine
- Requires metabolism (CYP2D6) to morphine
- Polymorphic metabolism
  - <30% of population lack enzymatic pathway
  - Ultra-rapid metabolism – NEJM 2009
- HAS BEEN REMOVED FROM SK FORMULARY

Meperidine (Demerol) – ISMP Canada
- Discourage use & remove oral formulation from formulary
  - active metabolite is neurotoxic
Summary Statement of Evidence on Codeine

Use of oral analgesia for the management of moderate to severe pain in children

Issue

- Codeine and codeine products have not been available on SickKids hospital formulary since July 1, 2010

Context

- Pain management is a high priority at SickKids
- The SickKids Pain Management Clinical Practice Guideline states that oral morphine is preferred to codeine for the management of moderate to severe pain

Summary of the Literature

- Codeine is dependent on hepatic metabolism (CYP2D6) for conversion to its active form, morphine
- This metabolism is subject to genetic variability such that analgesic and adverse effects of codeine are unpredictable in a significant proportion of the population
- The genetic polymorphism of this metabolic pathway results in:
  - Slow metabolizers (insufficient morphine resulting in ineffective analgesia in up to 10% of population)
  - Ultra-rapid metabolizers (excessive morphine resulting in toxicity in 10-30% of population)

Implications for Practice for the Treatment of Moderate to Severe Pain

- Scheduled acetaminophen and non-steroidal anti-inflammatory drugs are recommended if no contraindications exist
- Use physical (ice/heat) and psychological (distraction/relaxation) techniques of pain control as appropriate
- Codeine should not be used for children with moderate to severe pain when alternative, more reliable medications are available

Recommendations

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<th>Drug</th>
<th>Dosing</th>
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<tr>
<td>Morphine</td>
<td>0.2-0.5mg/kg/dose q6-8h, max 15mg/dose</td>
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<tr>
<td>Hydromorphone</td>
<td>0.04-0.08mg/kg/dose q3-4h max 2.4mg/dose</td>
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<tr>
<td>Oxycodone</td>
<td>0.05-0.15mg/kg/dose q4-6h, max 5-10mg/dose</td>
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Selected References:


FOR FURTHER INFORMATION PLEASE CONTACT
Drug Information: 416-813-6703 or druginfo@sickkids.ca
**Ketamine - evidence**

NMDA antagonist - well tolerated in children at low doses

Meta-analysis – 35 RCTs

- **Perioperative IV ketamine**
  - Overall decreased PACU pain intensity and analgesic requirement; but not for subsequent 24h.
  - Not opioid-sparing
- **Locally administration - tonsillectomy**
  - decreased PACU and early (6-24 h) pain intensity
  - PACU analgesic requirements.

Ketamine and Neurotoxicity – *controversy*

Nearly all anesthetic drugs (NMDA antagonists, GABA agonists) increase neuronal apoptosis (neurodegeneration) in young animals (rodents and primates)

- Alters structure and function of the brain

Cognitive and Behavioral Outcomes After Early Exposure to Anesthesia and Surgery (children)

- Matched design - adjustment for comorbidities
- Repeated exposure to anesthesia and surgery before 2yrs:
  - Significant risk factor for development of learning disabilities
  - No increase in educational interventions for emotion/behavior

  • Flick RP et al., Pediatrics 2011;128:e1053–e1061
Percentage of learning disabilities after early exposure to GA before age 2
Dexamethasone improves pain & PONV

Pediatric tonsillectomy
- RCT DB placebo controlled, N= 147
- Single IV dexamethasone 0.15 mg/kg or 0.5 mg/kg Reduced PONV and severe pain intensity on second postoperative day.

Day-case paediatric orchiopexy.
- RCT DB, placebo controlled N=77
- IV dexamethasone 0.5 mg kg(-1) + caudal block augmented the intensity and duration of postoperative analgesia without adverse effects.
Gabapentin (alpha-2-delta modulators)

Gabapentin (oral pre-op & continued post-op)
- RCT DB, placebo controlled, N=57
- Improved analgesia and reduced morphine use in pediatric spinal fusion patients; no decrease in opioid side-effects

Gabapentin – single pre-op dose
- RCT DB, placebo controlled, N=37
- No difference on any outcome measure: prevalence mod-sev pain, opioid requirements, side effects
  - Mayell A, Campbell F et al, in preparation
Dexmedetomidine

Alpha-2-receptor agonist

Sedative, analgesic, sympatholytic, and anxiolytic effects; no/little respiratory depression

Administration

- Boluses cause hypotension
- IV infusion
  - 1 µg/kg loading dose, over 10 minutes
  - maintenance infusion of 0.2–1.0 µg/kg/hour

Dexmedetomidine vs placebo or opioids

- 11 RCTs - 434 children received dexmedetomidine, 440 received control
- Dexmedetomidine
  - Lower risk for postoperative pain
  - Reduced postoperative opioid requirements
  - Further studies required - procedure specific dexmedetomidine dosing and adverse events
IV Magnesium

Meta-analysis, perioperative IV magnesium in adults reduced opioid consumption and pain scores in first 24h post-op
  • Albrecht E, et al., Anaesthesia 2013; 68:79–90.

Perioperative magnesium may reduce analgesia requirement in children undergoing orthopedic surgery – further research required.
IV Lidocaine infusion – adult study

Intraoperative infusion of lidocaine reduces postoperative (PACU) fentanyl requirements in patients undergoing laparoscopic cholecystectomy.


- RCT; N=50
- Lidocaine 1.5 mg/kg followed by a continuous infusion of lidocaine 2 mg.kg.hr
- Reduced opioid requirements in PACU
Regional and Local anesthesia

Routes of administration

- **Local**
  - Infiltration of skin and subcutaneous tissues

- **Regional**
  - Peripheral nerve(s); e.g., femoral nerve
  - Plexus – brachial (arms), lumbar (legs)
  - (Nerve roots) – not often used
  - Central neural blockade – epidural, caudal, spinal
**Regional Anesthesia - safety**

Large multicenter prospective audit of regional anesthesia in children.

Very low rate of serious complications


Increasing use of peripheral nerve blockade

Lower incidence of complications than neuraxial techniques

Regional anesthesia - *controversies*

Do they work (according to surgeons!)?

Do additives help?

Should RA be used in the presence of infection?

Does compartment syndrome get masked by regional anesthesia?
What’s trending…

TAP for Appy
- Transversus abdominis plane block effective analgesia after appendectomy: RCT. (Carney et al 2010)

Caudal
- For circumcision equivalent to US guided penile block (Sandeman DJ. 2010)
- Addition of dexmedetomidine or clonidine to caudal bupivacaine significantly improves analgesia for abdominal surgery. (El-Hennawy AM BJA 2009)
- Transient self-limiting back pain after caudals.

Epidural
- Epidural analgesia improves pain control and reduces side effects in scoliosis sx (Taenzer AH. Ped Anesth 2010)
- PCEA excellent pain relief and few adverse events Saudan S et al Ped Anesthesia 2008)
Acute Pain Service

Role

- Clinical
  - Optimize pain assessment and pain management for children with complex acute pain
  - Special techniques: PCA, NCA, PCEA, NCEA, nerve sheath infusions

- Education

- Research and QI

Evidence for Effectiveness

- Introduction of an organized APS
  - Improved pain assessment practices
  - Decrease in postoperative oxygen desaturation
  - Reduced length of stay by 1 day
Psychological strategies
Psychological strategies for PACU

Adults can influence children's distress and coping in PACU

- Empathy, distraction, and assurance talk may be helpful in keeping a child from becoming distressed, and nonprocedural talk and distraction may cue children to cope.
- Reassurance should be avoided when a child is already distressed.
  - Chorney JM, Tan ET, Kain ZN, Anesthesiology. 2013 Apr;118(4):834-41
Music therapy in PACU

Music medicine reduced the requirement of morphine and decreased the distress after minor surgery

Parents detected pain in their children yet provided few doses of analgesics.

Parents may benefit from interventions that provide them with information that addresses individual barriers regarding assessing and treating pain.
Physical strategies
Acupuncture for postoperative pain and agitation

Acupuncture improves pain and emergence agitation in children after bilateral myringotomy and tube insertion. (Prospective RCT N=80)


Ice-lollies - cheap, effective and safe method of reducing postoperative pain up to one hour following paediatric tonsillectomy (single-blinded, RCT).

And finally...
How can we do better?
Translational Research

**T1 Bench to Bedside** - process of transferring basic science knowledge into new drugs and technologies

**T2 Translational Research** - process of taking current scientific knowledge and ensuring it is applied in routine [clinical] care

Common to all procedures - what do I do…

Preoperative Discussion
- Discussion - importance of pain control – options
- Anxiety:
  - Acknowledge the emotional response’
  - Give choice, - anxiolytic +/- PPIA

Intraoperative
- Systemic analgesia: Balanced multimodal
  - aceta/nsaid/opioid
  - Consider lidocaine, gabapentin, ketamine, dexmedetomidine, dexamethasone
- Local or Regional technique

Postoperative
- PACU – always travel with opioid and propofol
- Under care of surgical teams – regular systemic analgesia – WHO principles
- APS for selective cases
Summary

Context
- Poorly managed postoperative pain in children is common and harmful

Pain Management strategies
- Mitigate anxiety if possible
- Use 3’P’s approach - Local / regional anesthesia should be used + multimodal pharmacological strategies
- Discharge instructions – to improve pain mx at home

What do we need to improve postoperative pain outcomes?
- More evidence
- Get evidence into practice
- Embed QI initiatives into practice
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References


