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

Patient factors	Surgical Factors	Anesthetic factors	Other Acute Pain Strategies
2 sexes	21 specialties	5 classes anesthetic agents	2 psychological
X genders	2500 procedure codes	3 classes of analgesics	4 physical
4 age categories	20,000 procedures SK 2013	10 classes of adjuvants	
∞ physical health		100s local & regional techniques	
∞ mental health			
∞ genetics			
∞ previous expce			

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
    - **P**harmacology, **P**hysical, **P**sychological (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
  - Page et al J Pain Res. 2013;6:167-80
- 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

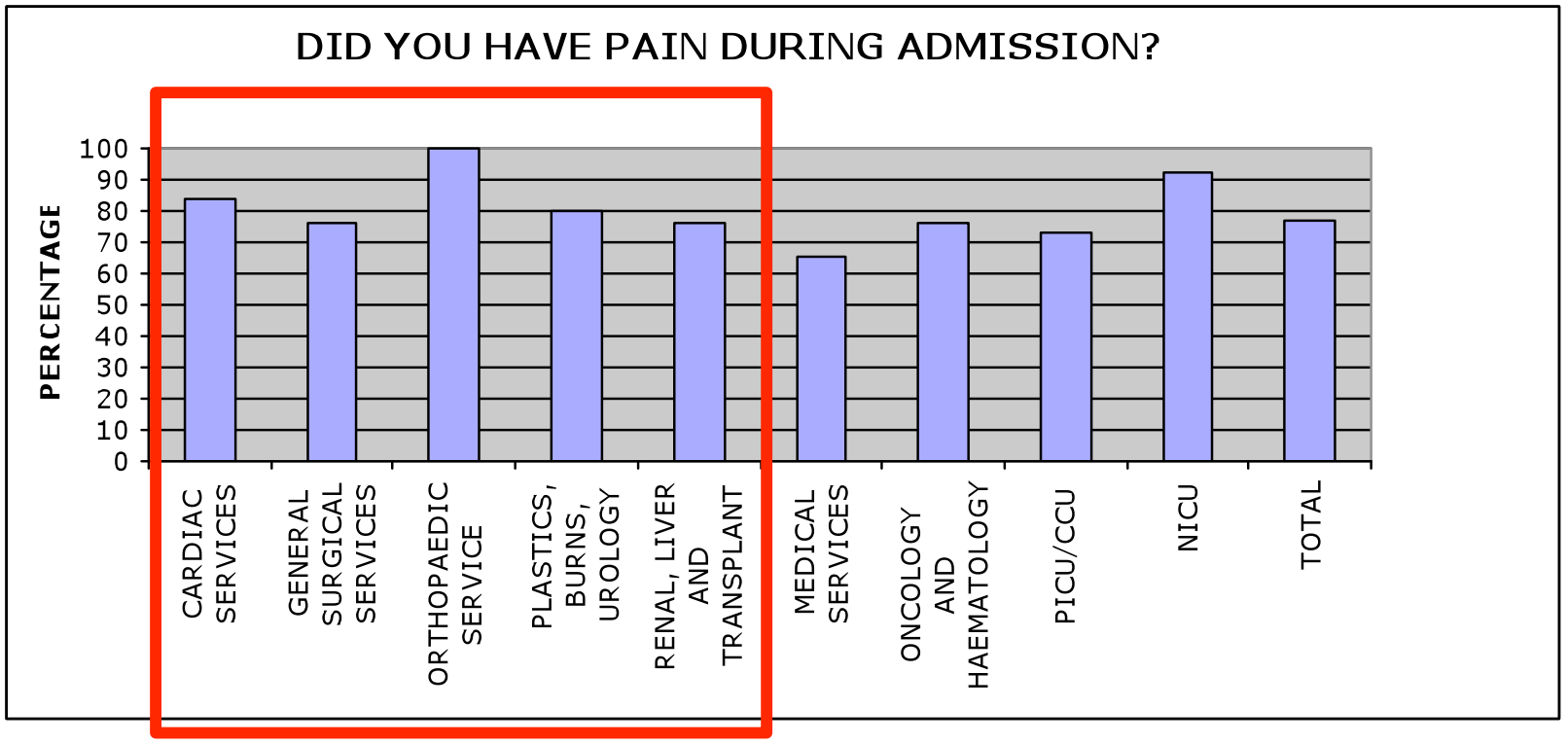
Groenewald et al., Pediatric Anesthesia, 2012; 22:661-8

- 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)

SickKids Inpatient Pain Audit

Taylor EM, Boyer K, Campbell FA. Pain Res Manag. 2008 Jan-Feb;13(1):25-32.

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…

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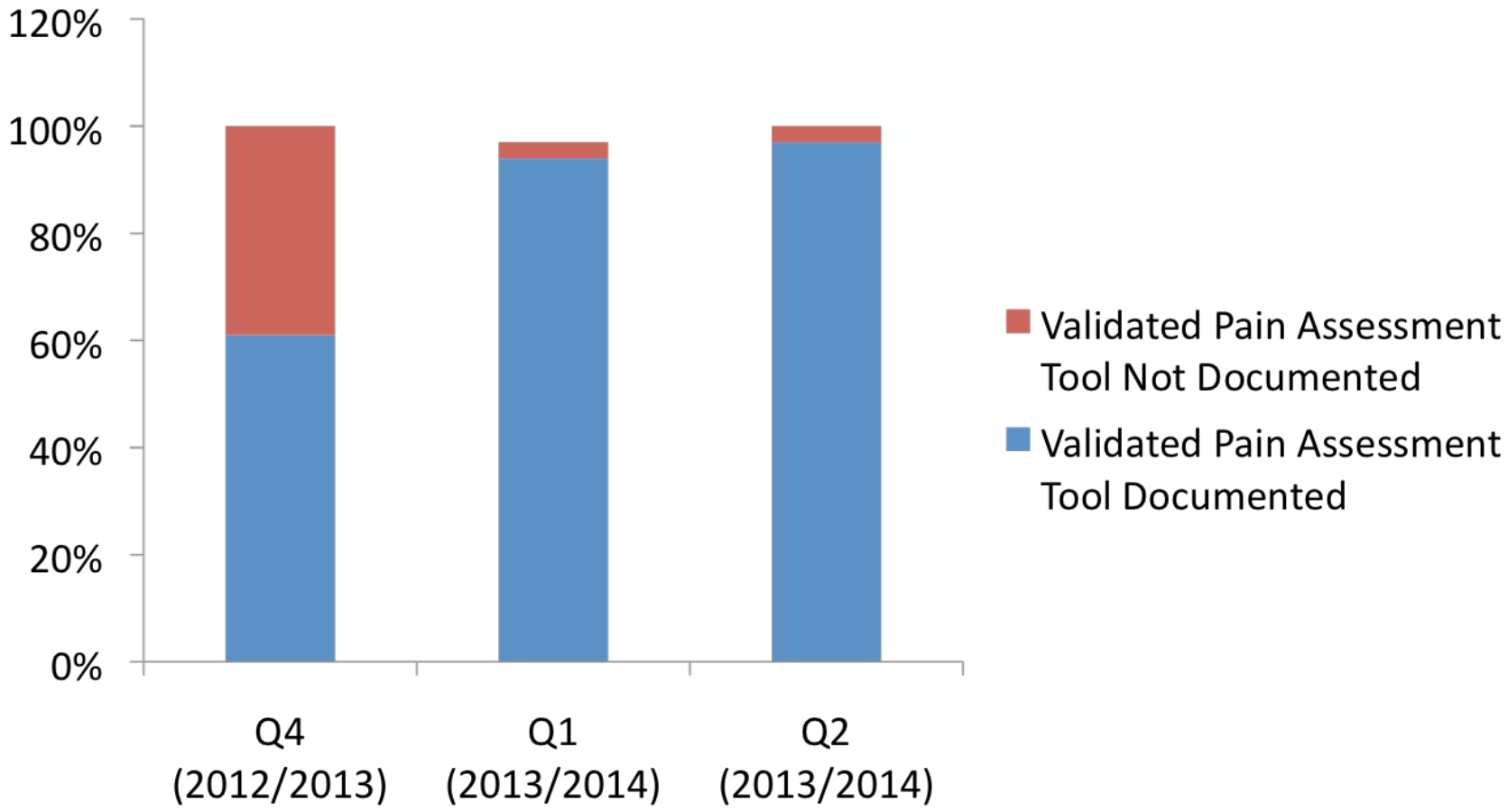
SK QIP – Surgical pain

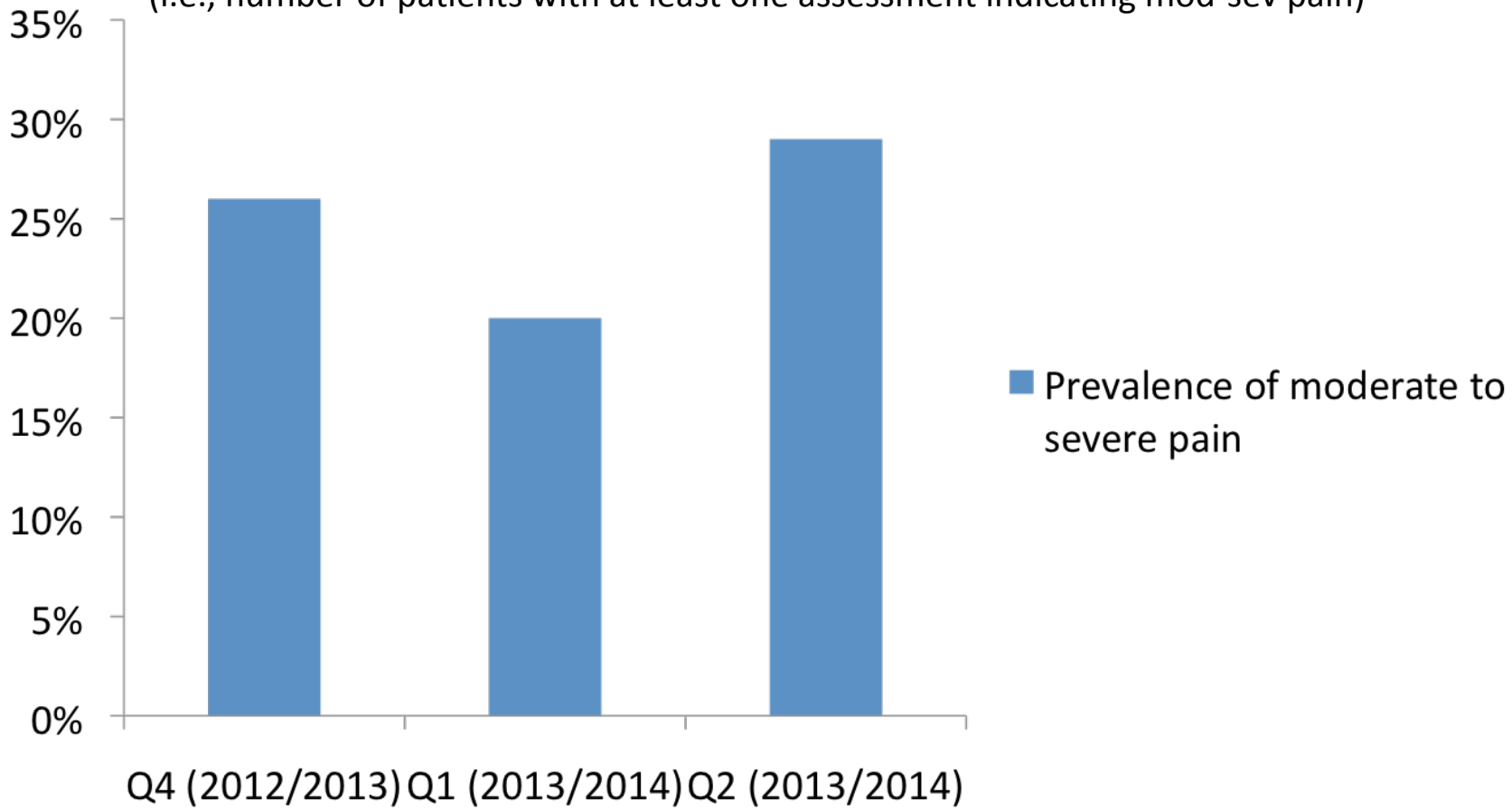
Pain Assessment Documentation



SK QIP – Surgical pain

Prevalence of moderate to severe pain

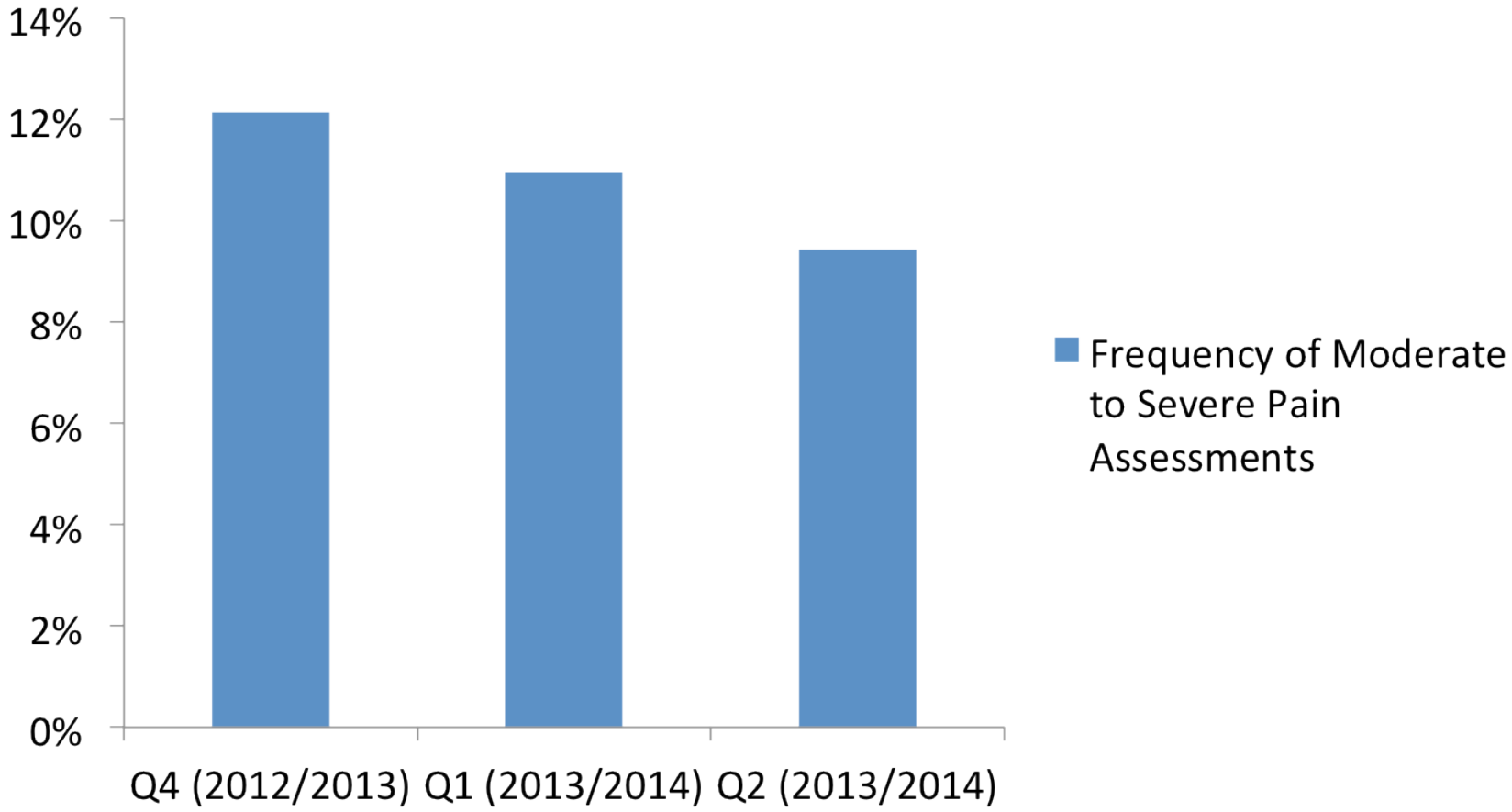
(i.e., number of patients with at least one assessment indicating mod-sev pain)



QIP – Surgical pain

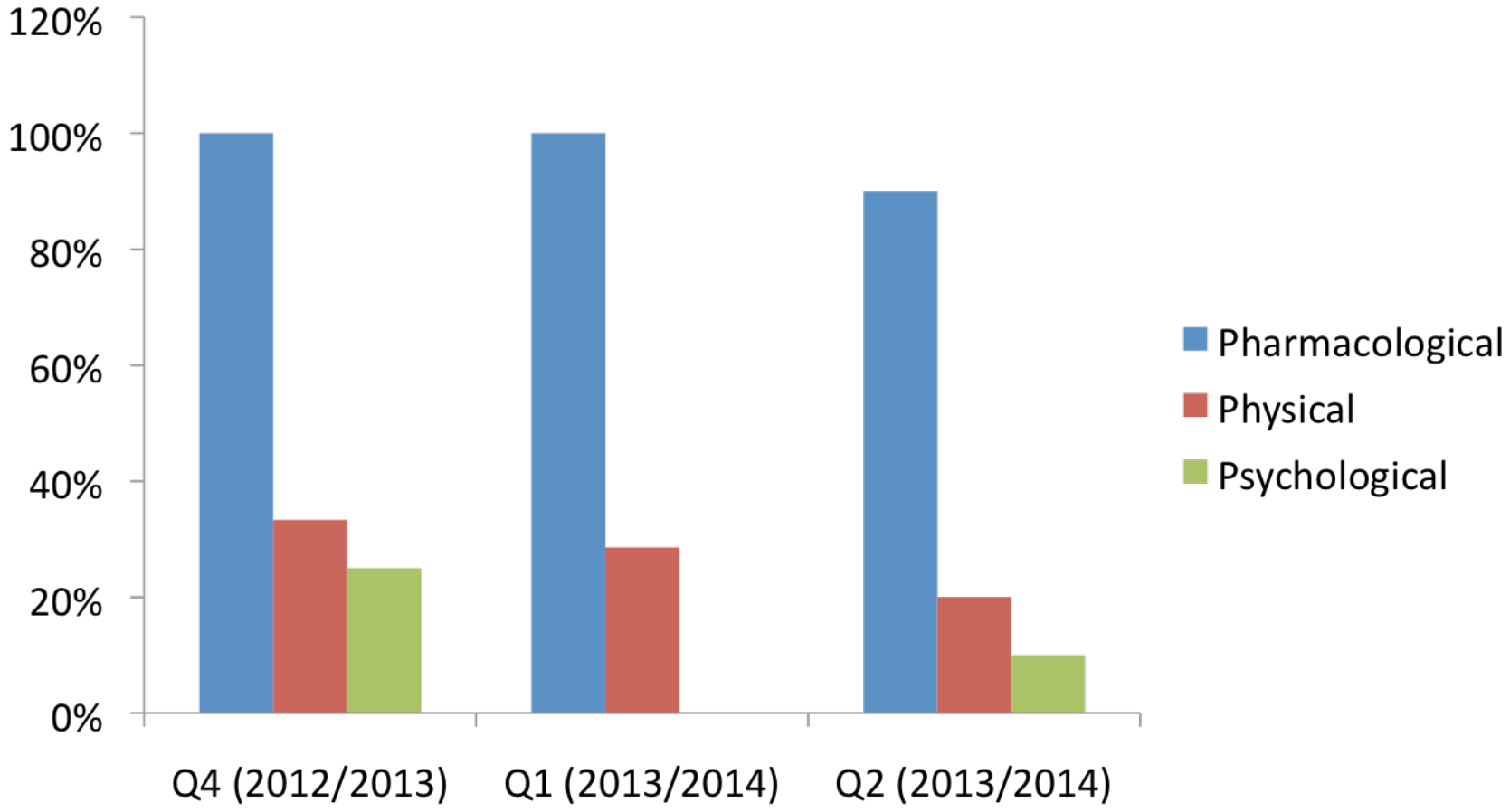
Frequency of Moderate to Severe Pain

(i.e. number of assessments indicating moderate to severe pain)



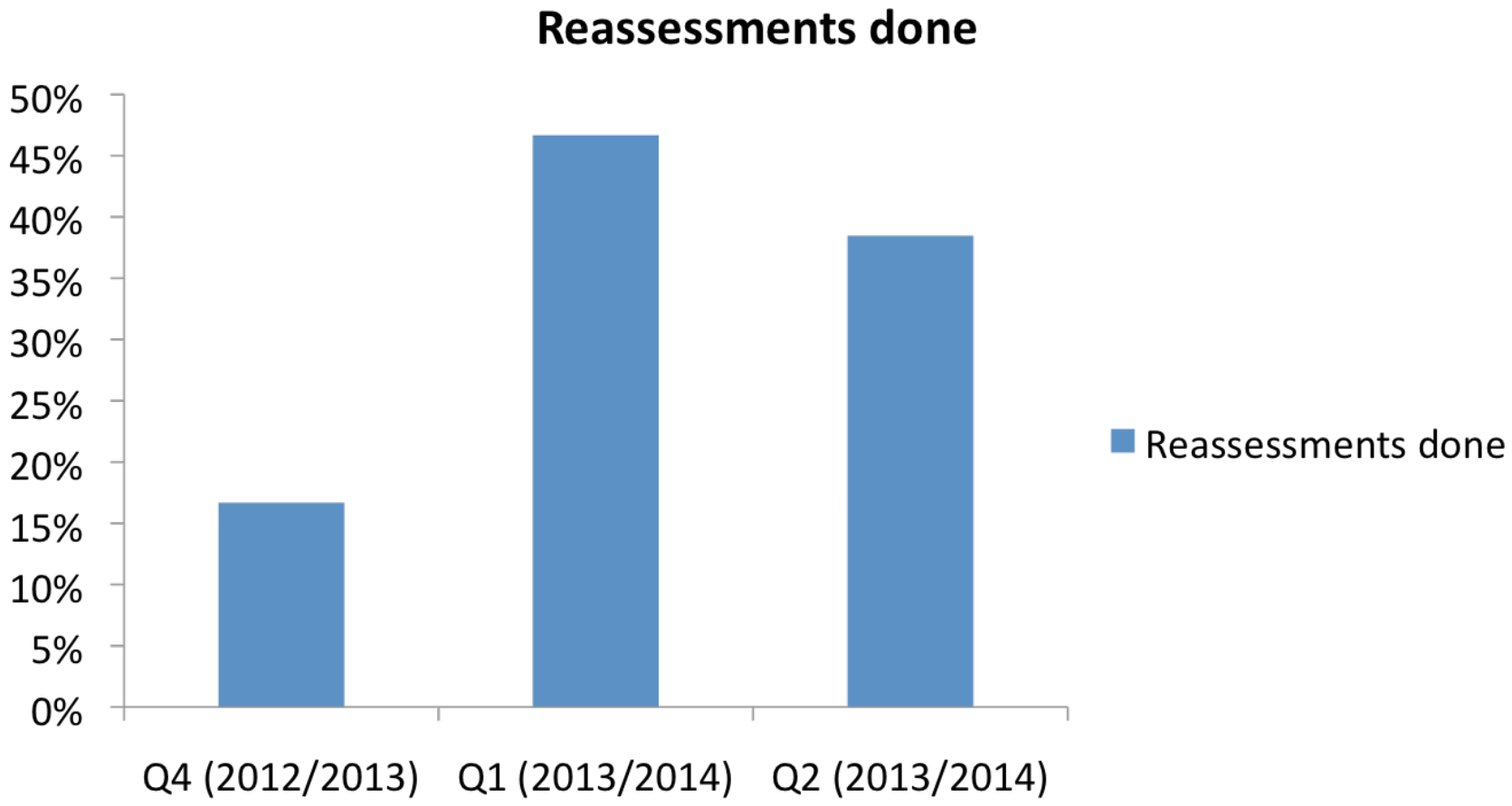
QIP – Surgical pain

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



QIP – Surgical pain

Reassessment Frequency



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

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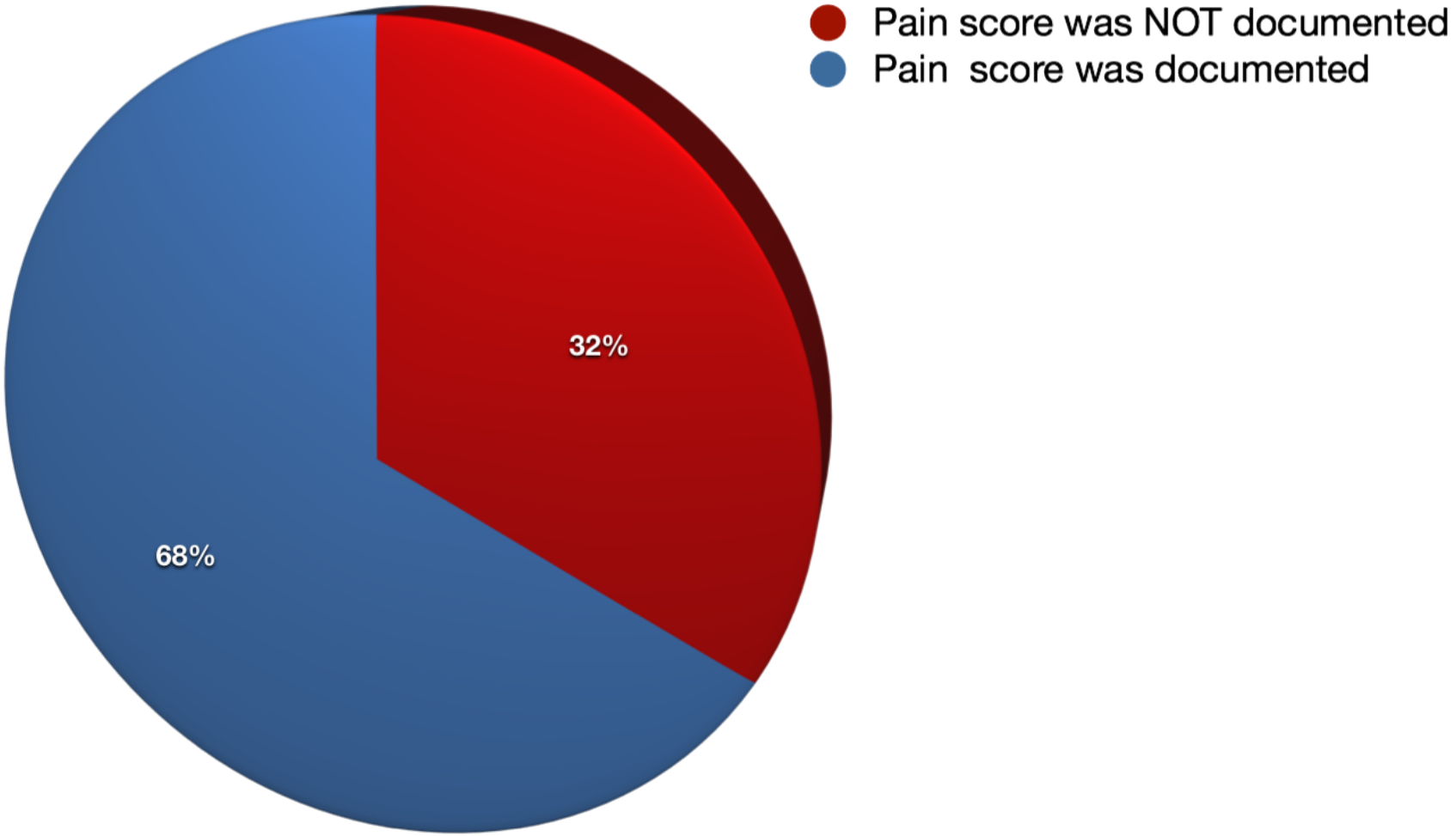
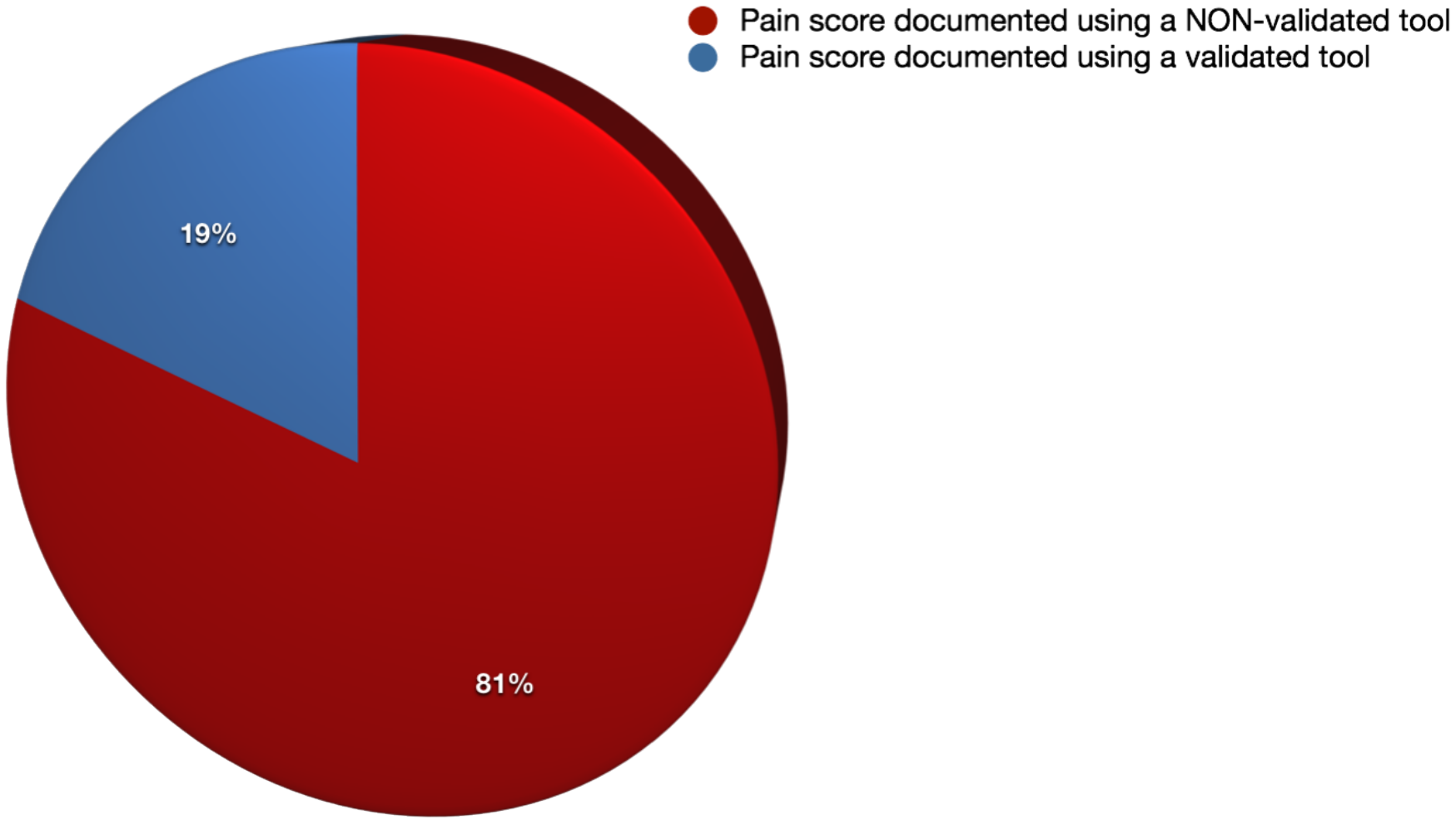
SickKids PACU Pain Audit
Pain assessment documentation
(N=99, 1 excluded)



SickKids PACU Pain Audit

Pain score documented using a validated tool?

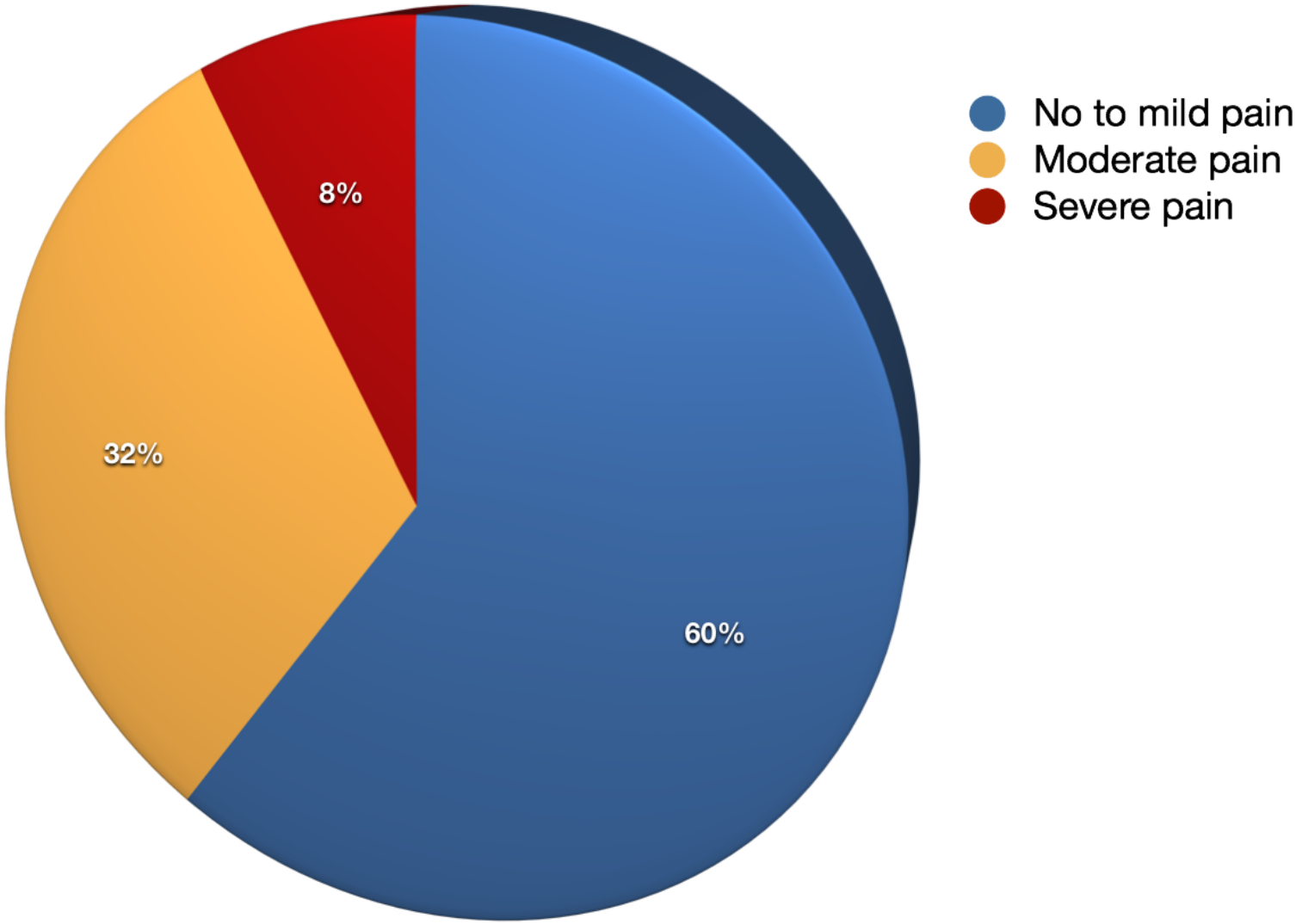
(N=67)



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

Power NM, Howard RF, Wade AM, Franck LS. Arch Dis Childhood. 97(10):879-84, 2012 Oct.

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

Shum S. Lim J. Page T. Lamb E. Gow J. Ansermino JM. Lauder G. Pain Res & Man 17(5):328-34, 2012 Sep-Oct.

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

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Pain Management – General Principles

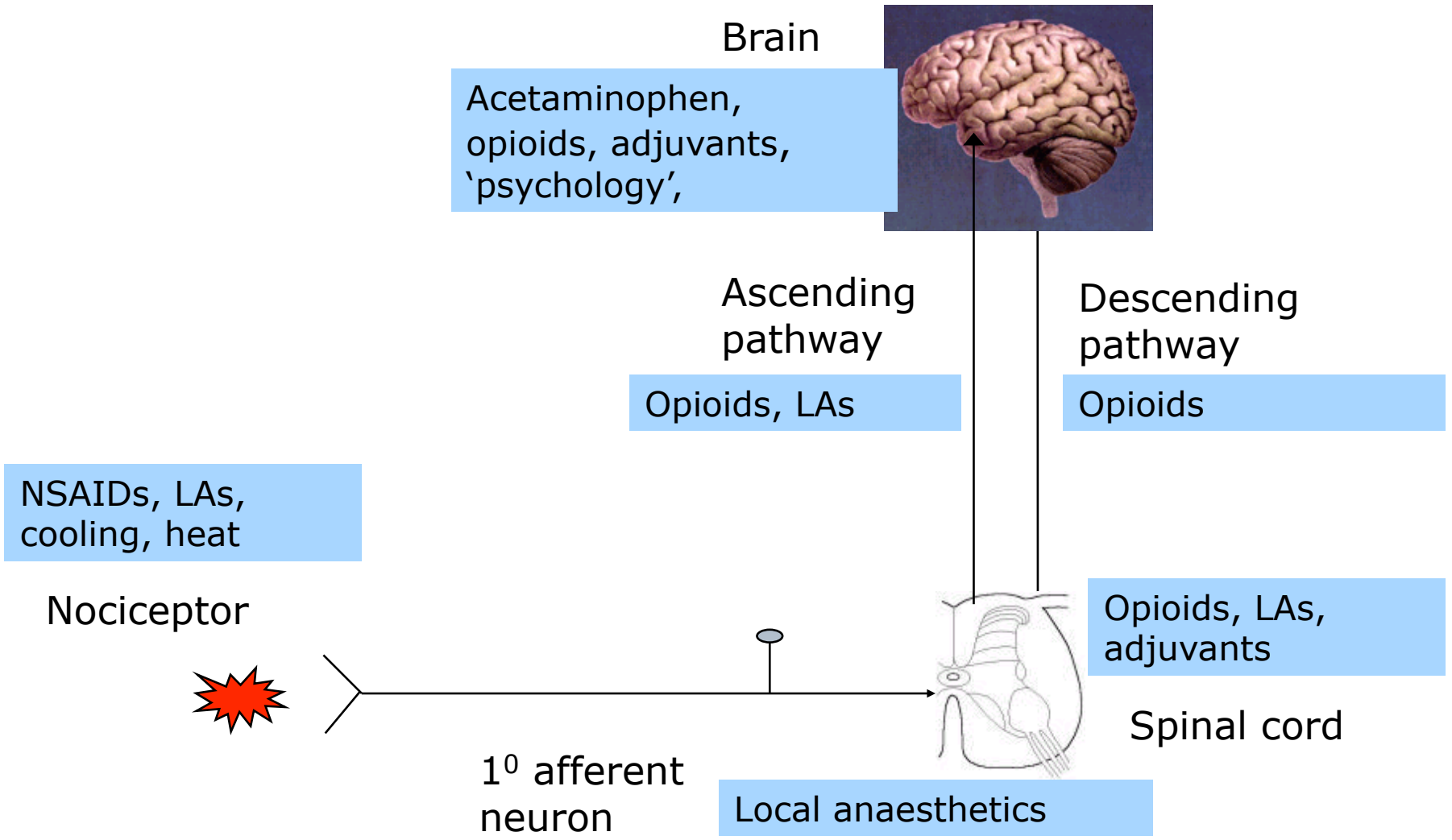
Planned and organized prior to surgery in consultation with patients & carers, other members of the perioperative team

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

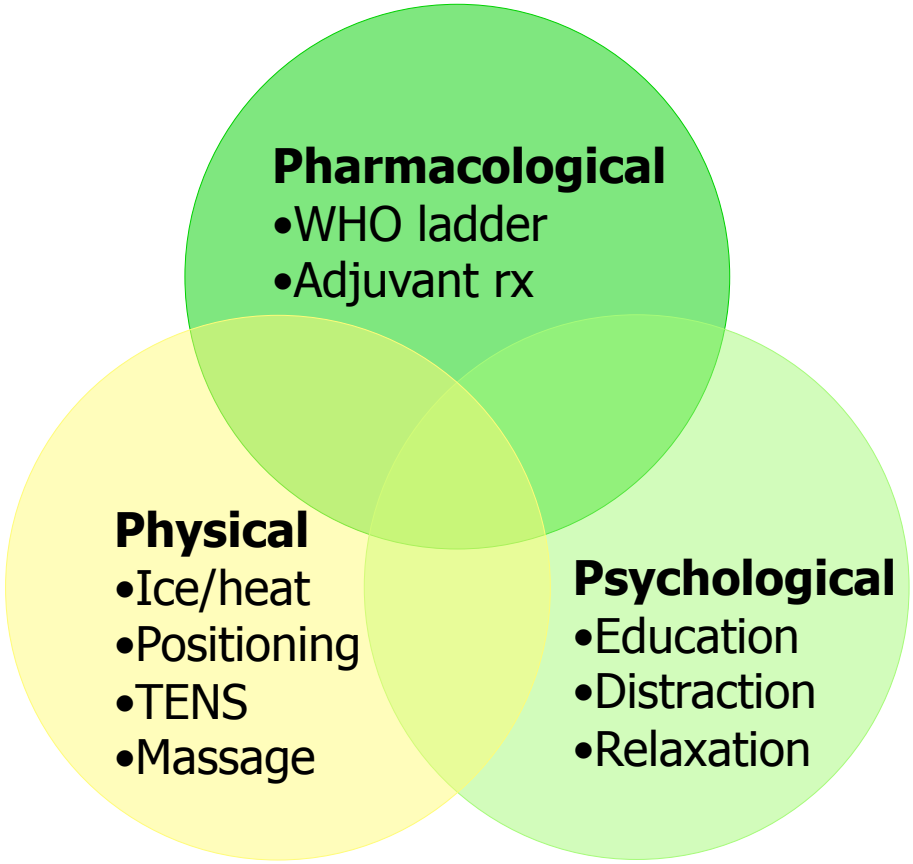
Pain must be assessed using validated tools, and documented; essential for preventing, diagnosing and treating pain

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



Pain prevention & intervention
The 3 'P's approach



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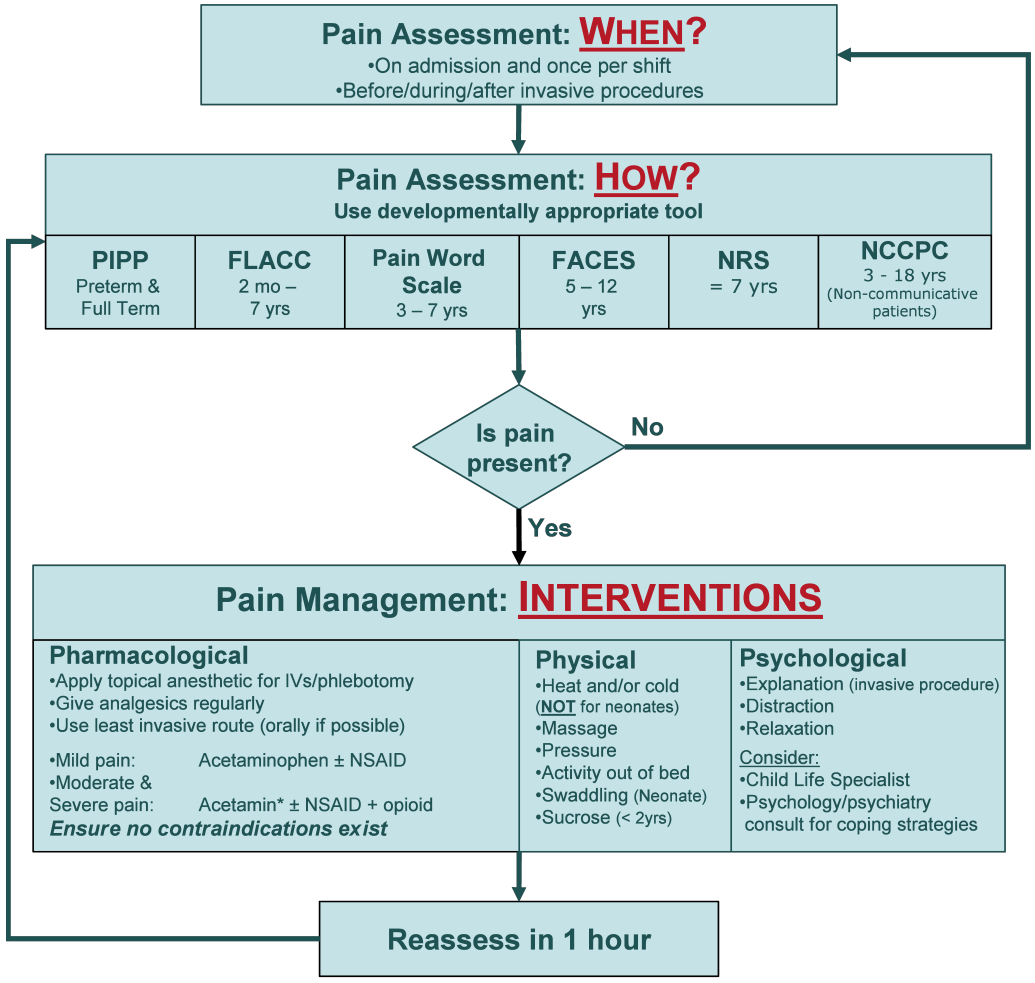
Pain Assessment and Management of the Child

Best Practice Spotlight



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

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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

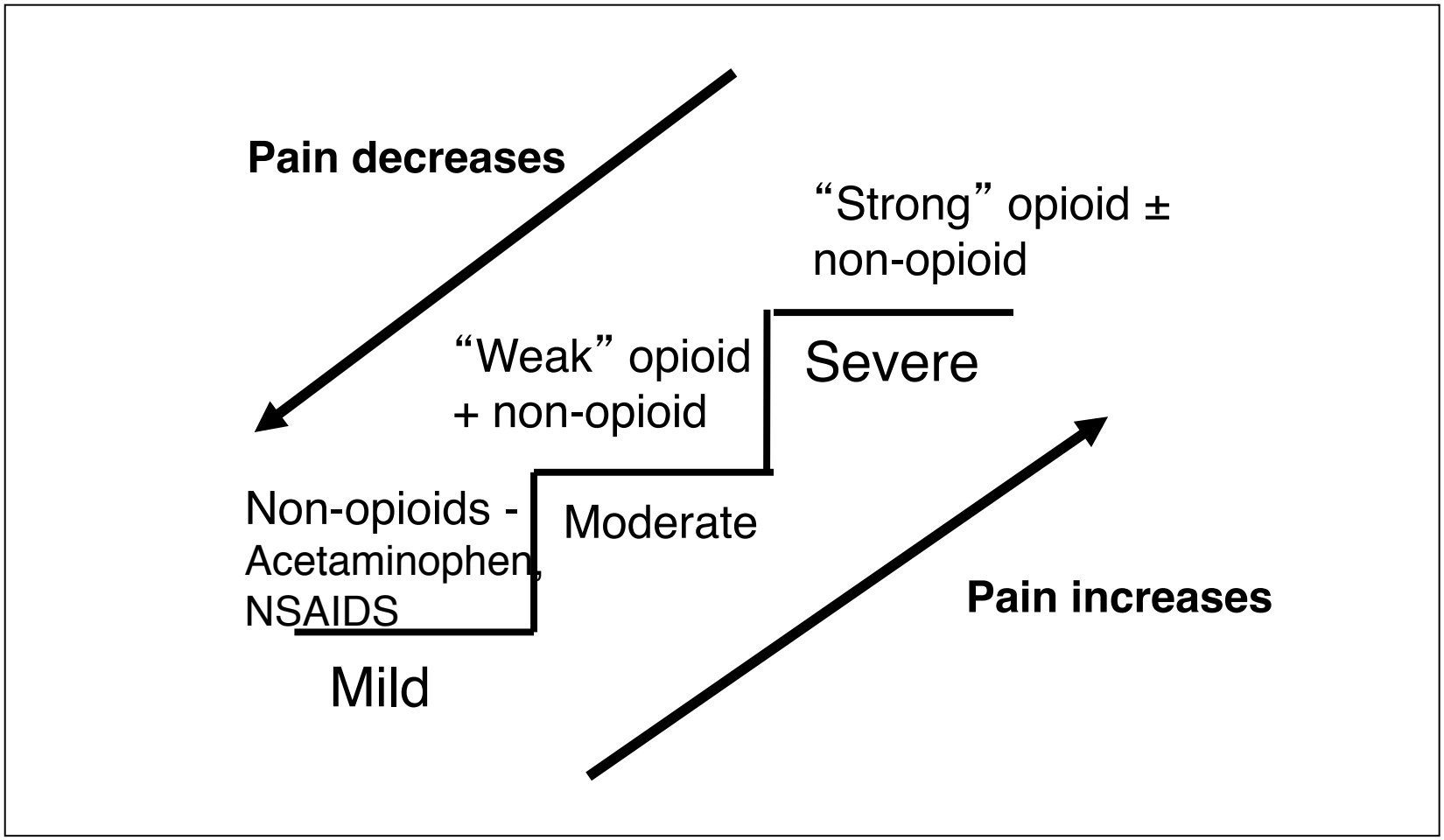
Balanced Analgesia

- 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-related psychological factors important in postoperative pain

Childrens anxiety is associated with increased postoperative pain and analgesic use

- Kain et al., Pediatrics. 2006 Aug;118(2):651-8.

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.

- Pagé MG, Stinson J, Campbell F, Isaac L, Katz J. Pain Res. 2012;5:547-58

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%)

- **Hasani A et al. Pain Med; 14(3):442-6, 2013 Mar**

Acetaminophen

Acetaminophen improves analgesia after minor and major surgery in children

- Hiller A, et al. Acetaminophen improves analgesia but does not reduce opioid requirement after major spine surgery in children and adolescents. Spine 2012; 37:E1225–E1231

May reduce opioid consumption and side-effects

- Korpela R, Korvenoja P, Meretoja OA. Morphine-sparing effect of acetaminophen in pediatric day-case surgery. Anesthesiology 1999; 91:442–447

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

- Ceelie I. et al.JAMA. 309(2):149-54, 2013 Jan

NSAIDs - *evidence*

Reduce opioid requirements

Improve postoperative pain intensity

Decrease PONV

- Michelet D. et al., A meta-analysis of the use of nonsteroidal antiinflammatory drugs for pediatric postoperative pain. Anesthesia & Analgesia.114(2):393-406, 2012 Feb.

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.

- Riggin L, Sommer D, Koren G, Ramakrishna J, Clin Otolaryngol 2013; 38:115–129.

NSAIDs and bone-fusion; *controversy*

No evidence of a deleterious effect

- two retrospective reviews looking at the use of NSAIDS following pedicatric spinal surgery
- no difference in incidence of nonunion in patients receiving ketorolac (221 patients) vs controls (306 patients)
  - Sucato DJ et al, Spine 2005; 30: 211–217
  - Vitale MG et al., Spine J 2003; 3: 55–62
- 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.

Morton NS, Errera A. Paediatr Anaesth. 2010 Feb;20(2):119-25.

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

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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 if appropriate
- Codeine should not be used for children with moderate to severe pain when alternative, more reliable medications are available

Recommendations

Drug	Dosing
Morphine	0.2-0.5mg/kg/dose po q4-6h, max 15mg/dose
Hydromorphone	0.04-0.08mg/kg/dose po q3-4h max 2-4mg/dose
Oxycodone	0.05-0.15mg/kg/dose po q4-6h, max 5-10mg/dose

Selected References:

Kelly L et al, More codeine fatalities after tonsillectomy in North American children. *Pediatrics* 2012; published online April 9. http://pediatrics.aappublications.org/content/early/2012/04/04/peds.2011-2538

Madadi P, Koren G. Pharmacogenetic insights into codeine analgesia: implications to pediatric codeine use. Pharmacogenomics 2008;9:1267-84.

Ciszkowski C et al. Codeine, Ultrarapid-Metabolism Genotype, and Postoperative Death. [Letter to the Editor]. NEJM 2009; 361;8: 827-8.

Gasche Y, Daali Y, Fathi M, et al. Codeine intoxication associated with ultrarapid CYP2D6 metabolism. *N Engl J Med* 2004;351;2827-31.

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.
    - Dahmani S. et al., Paediatric Anesthesia. 21(6):636-52, 2011

Ketamine and Neurotoxicity – *controversy*

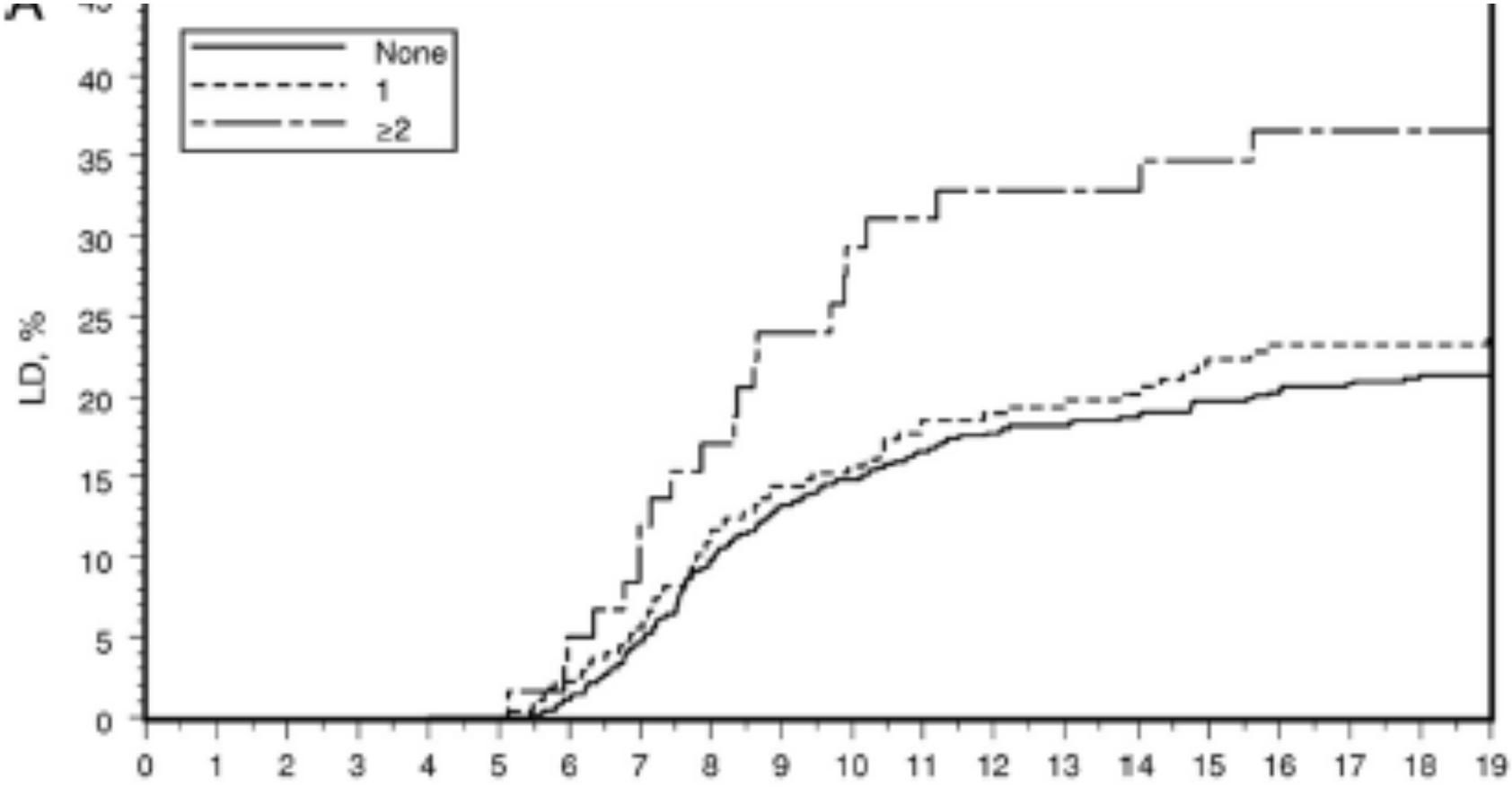
Nearly all anesthetic drugs (NMDA antagonists, GABA agonists) increase neuronal apoptosis (neurodegeneration) in young animals (rodents and primates)

- 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.
  - Hermans V. et al. BJA. 109(3):427-31, 2012 Sep.

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.
  - Hong JY et al., BJA. 105(4):506-10, 2010 Oct.

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
  - Rusy LM., Weisman SJ. et al, Anesthesia & Analgesia. 110(5):1393-8, 2010

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

Efficacy & safety of intraoperative dexmedetomidine for acute postop pain in children: a meta-analysis of RCTs.

Schnabel A. et al. Paediatric Anaesthesia. 23(2):170-9, 2013 Feb.

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.

- Na HS, et al. Br J Anaesth 2010; 104:344–350.

IV Lidocaine infusion – *adult study*

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

- Lauwick S. Canadian Journal of Anaesthesia. 55(11):754-60, 2008 Nov.

- 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

- Polaner DM et al. Pediatric Regional Anesthesia Network (PRAN): a multiinstitutional study of the use and incidence of complications of pediatric regional anesthesia. Anesth Analg 2012; 115:1353–1364.

Increasing use of peripheral nerve blockade

Lower incidence of complications than neuraxial techniques

- Ecoffey C, et al. Epidemiology and morbidity of regional anesthesia in children: a follow-up one-year prospective survey of the French-Language Society of Paediatric Anaesthesiologists (ADARPEF). Paediatr Anaesth 2010; 20:1061–1069.

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
    - Frigon C, et al Paediatric Anaesthesia. 19(12):1213-9, 2009 Dec

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

- Nilsson S. Paediatric Anaesthesia. 19(12):1184-90, 2009 Dec.

Parental postoperative pain management: attitudes, assessment, and management

Rony RY. Fortier MA. Chorney JM. Perret D. Kain ZN. Pediatrics. 125(6):e1372-8, 2010 Jun

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)

- Lin YC. Tassone RF, Jahng S. Rahbar R. Holzman RS. Zurakowski D. Sethna NF. Paediatric Anaesthesia. 19(11):1096-101, 2009 Nov.

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

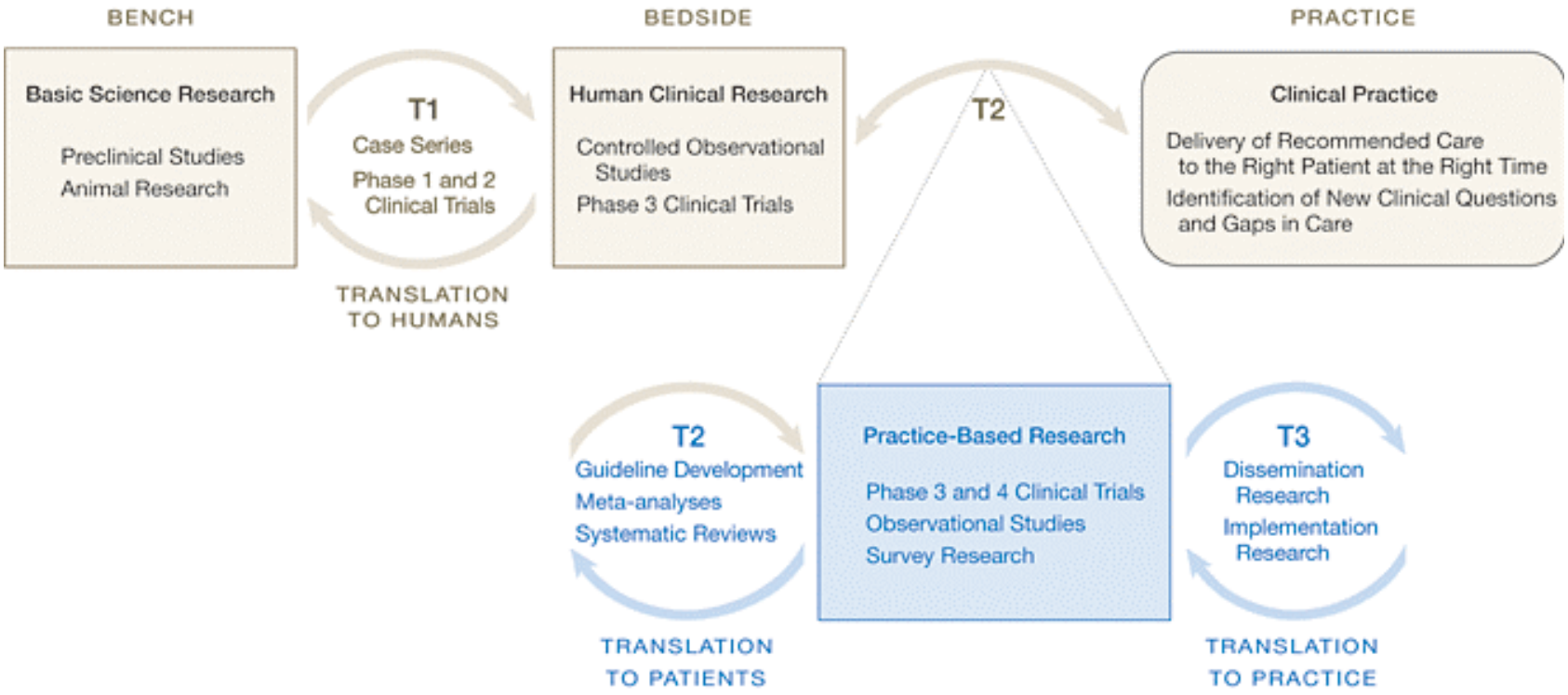
- Sylvester DC et al Clinical Otolaryngology. 36(6):566-70, 2011 Dec.

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



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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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