Acute Pain Management

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Introduction

- The need for pain management in children is now well accepted
- Children have frequently been under treated
- Education and research have lead to improved pain management

Assessment

- Pain is difficult to assess due to:
  - Age, developmental level, maturity
  - Fear, anxiety, depression
  - Behavioral problems, learning disabilities
- Multiple available pain scales

Management Principles

Preoperative

- Prepare child and family for surgery
- Discuss past pain experiences (child and parent's)
- Present pain treatment options
- Discuss pain assessment tools

Management Principles

Postoperative

- Maximize efficacy of technique(s)
  - Appropriate & frequent pain assessment
  - Allow parents to help assess preverbal children
  - Combine techniques

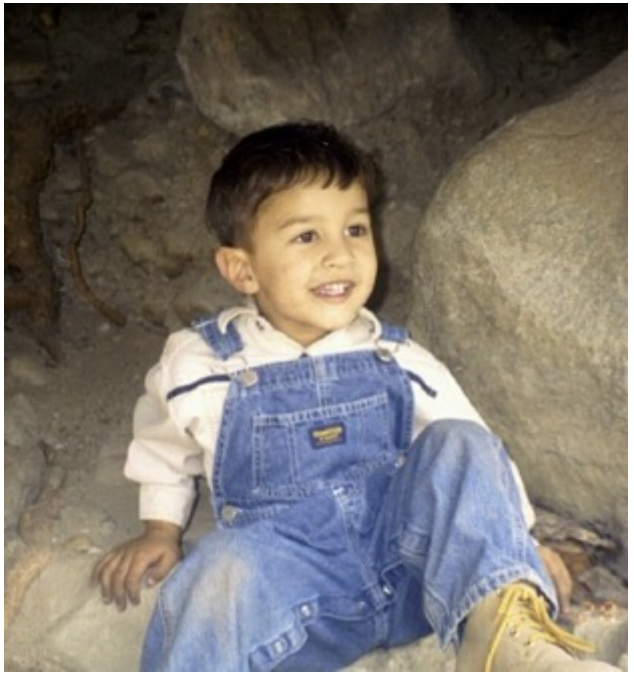
Introduction

- Regional anesthesia in children is practical, safe and effective
- Children tend to have easier anatomy

Introduction

- Most regional techniques are placed in an anesthetized patient
- Always cinsider risk/benefit
- Calculate toxic dose
- "Perfect" block is not mandatory
- Optimize use of other medications

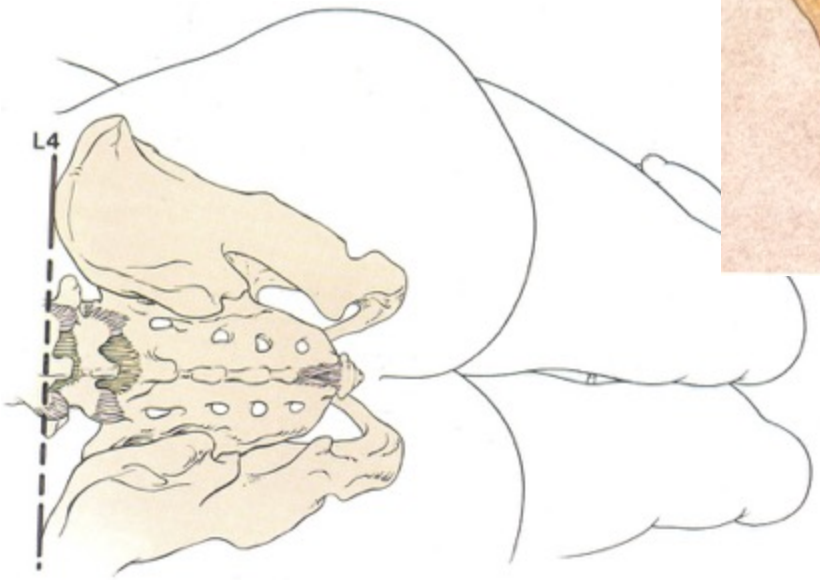
Neuraxial Blocks

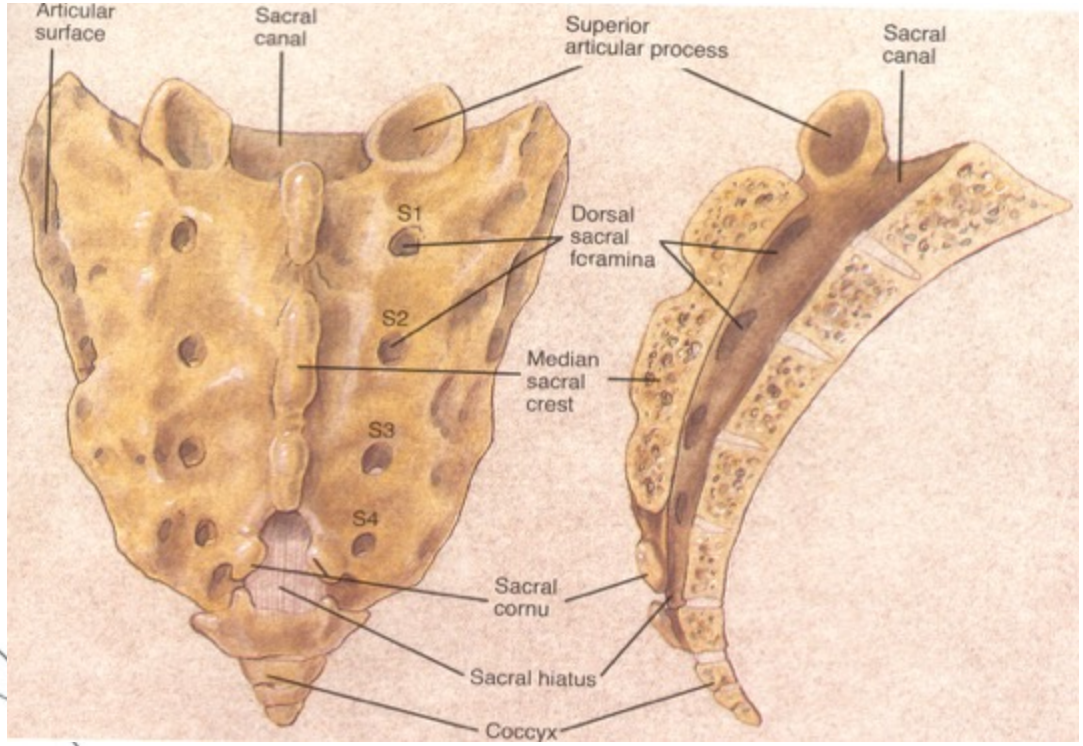


Caudal Analgesia

- One shot or continuous catheters
- The sacrum is cartilaginous in infants and children, ossification occurs between the ages of 20 and 30 years.
- Malformations of the sacrum occur in ~ 10% of the population.
- The sacral cornua marks lateral edges of the sacral hiatus
- Always above the gluteal crease

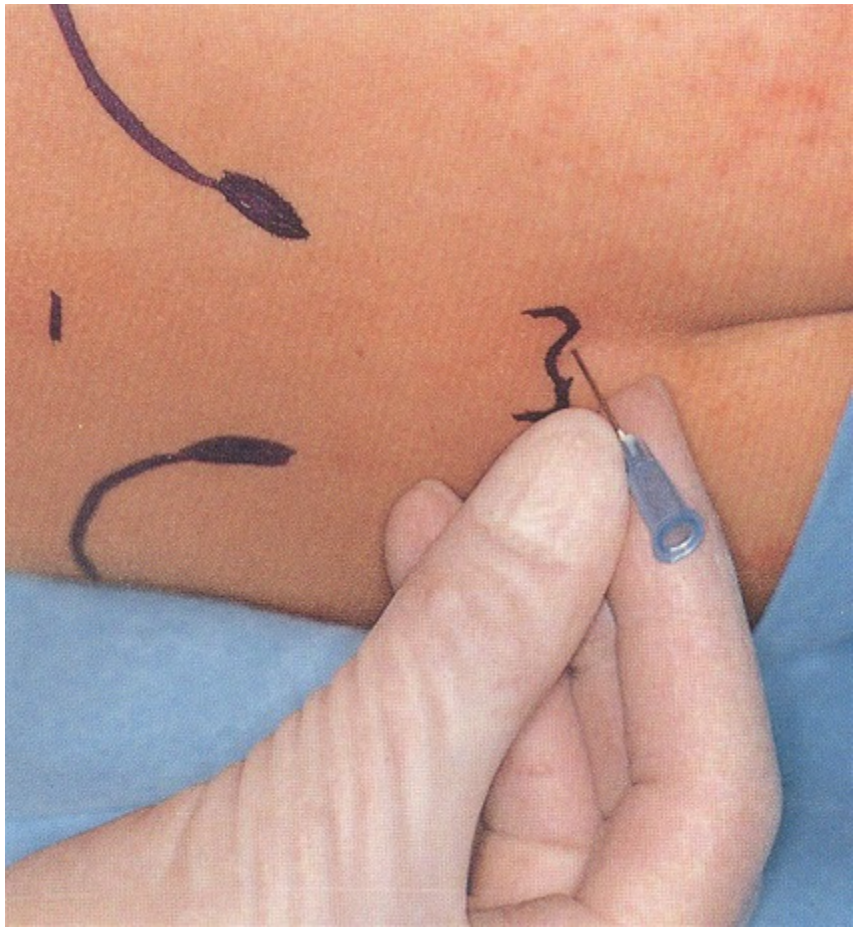
Caudal Anatomy





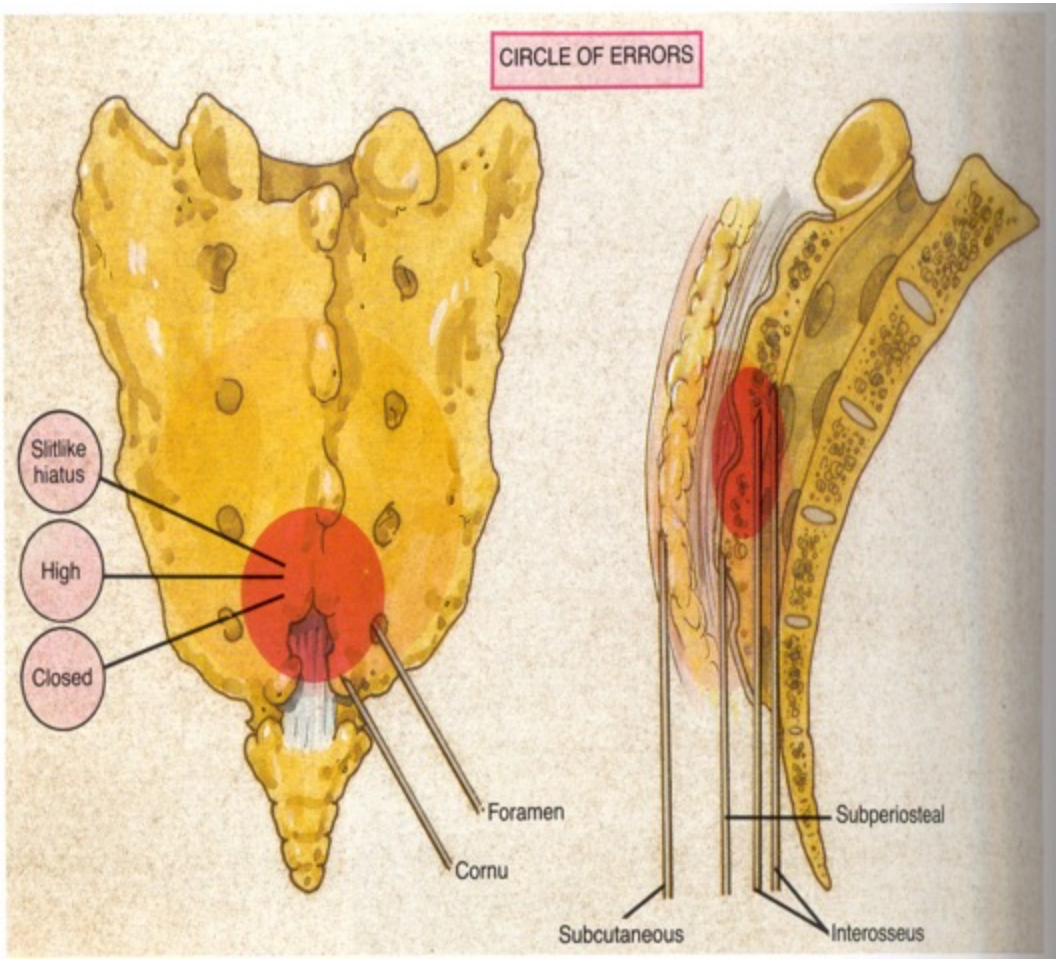
Caudal Analgesia

- Insert needle in sacral hiatus at ~ 60° angle until LOR as saccrococcygeal membrane is pierced
- Drop needle until it is perpendicular to back and advance a few mm
- Aspirate and inject LA



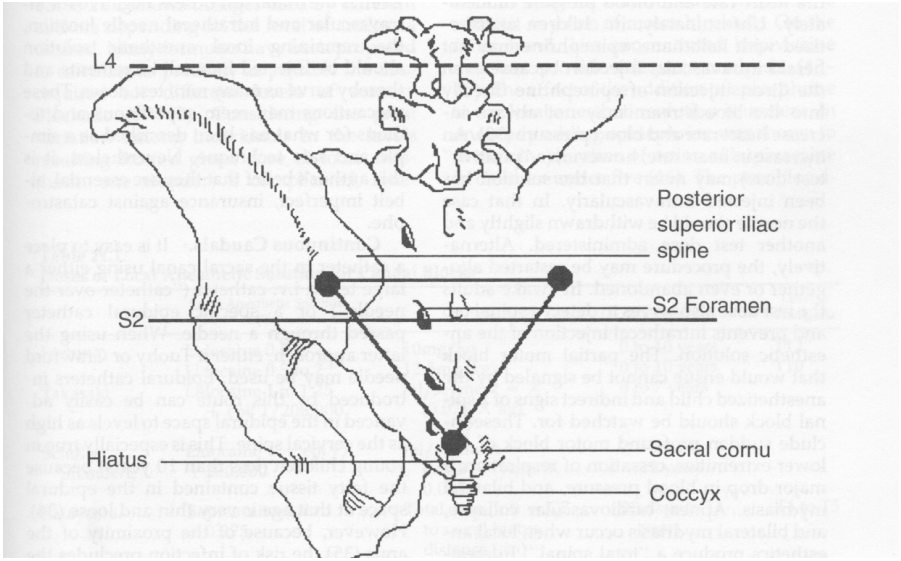
Complications

- Intraosseous, intravenous or subcutaneous injection
- Coccygeal cornua



S2 Approach

- Alternative to caudal approach
- S2-S3 interspace is ~0.5-1 cm below the inter-iliac line
- Epidural space is identified by LOR
- Same drugs & doses as for a caudal block



Suggested Dosing for Caudals

Armitage	ml/kg	Approx level
	0.5	sacrolumbar
	0.75	Lumbar-mid thoracic
	1	mid –high thoracic
	1.25	high thoracic
Takasaki	0.06ml/seg/kg	

Toxic dose for B and LB: 1.5 mg/kg for neonates

2.5 mg/kg for children

2-3 mg/kg for R

Test Dosing

- Although not 100% accurate
- Epinephrine 0.5 ug/kg should be used
- ST-T wave Δ's, HR ↑ by 10bpm, or increased BP are predicative of intravascular injections
- Isoproterenol and lower doses of epi do not seem to be effective

Tobias: Anesth Analg 2001

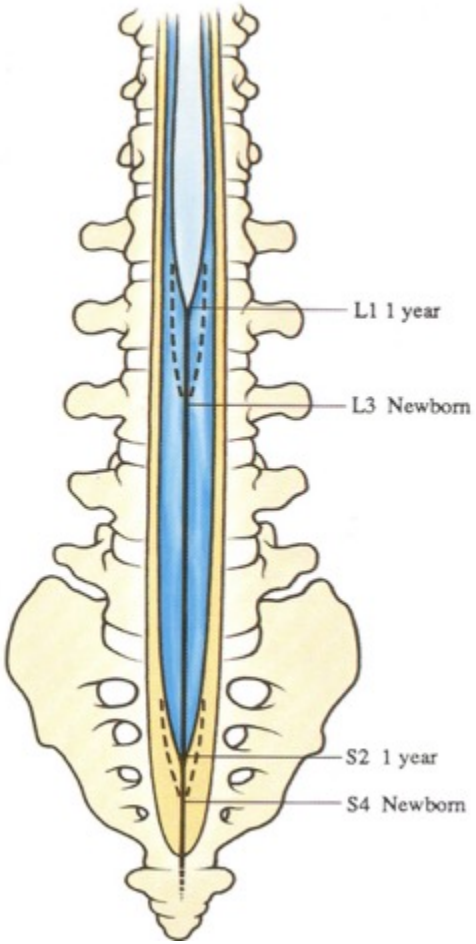
Table 1. Summary of Studies of a Simulated Test Dose (IV Administration) in Pediatric-Aged Patients

Reference	Anesthetic	Test drug (μg/kg)	Criteria evaluated	Findings
Desparmet et al. (7)	1 MAC halothane 50% nitrous oxide/oxygen Atropine—randomized	Epinephrine 0.5 in lidocaine 1 mg/kg	HR, % change in SBP	Positive HR response: ≥10 bpm. Atropine increases HR sensitivity.
Perillo et al. (11)	1.2 MAC halothane 50% nitrous oxide/oxygen No atropine	Isoproterenol 0.05, 0.075 in 0.5 mg/kg lidocaine	HR ≥10 bpm	Higher dose more sensitive; 17/21 with 0.05 μg/kg versus 22/23 with 0.075 μg/kg I.
Kozek-Langenecker et al. (12)	Anesthetized & awake state; 1.2 MAC halothane 70% nitrous oxide/oxygen No atropine	Isoproterenol 0.05, 0.075 or 0.1 in 0.25 mg/kg bupivacaine	HR ≥20 bpm	All 3 doses of I. effective in awake state. Higher dose more sensitive during anesthesia.
Tanaka and Nishikawa (14)	1 MAC sevoflurane 60% nitrous oxide/oxygen Atropine—randomized	Epinephrine 0.5 in 1 mg/kg lidocaine	HR ≥10 bpm SBP ≥15 mm Hg	HR: 100% sensitive (15/15) with and without atropine. SBP—100% sensitive with atropine and 10/15 without atropine.
Sethna et al. (15)	1 MAC isoflurane 100% oxygen Atropine	Epinephrine 0.5, 0.75 in 1 mg/kg lidocaine	HR ≥10 bpm SBP ≥15 mm Hg	HR: 19/21 with 0.5 μg/kg and 21/21 with 0.75 μg/kg. SBP: 17/21 with 0.5 μg/kg and 19/21 with 0.75 μg/kg.
Kozek-Langenecker et al. (16)	1 MAC sevoflurane or halothane 70% nitrous oxide/oxygen No atropine	Incremental doses of isoproterenol in saline	HR ≥20 bpm	Higher dose of isoproterenol (55 vs 32 ng/kg) needed with sevoflurane than with halothane.
Tanaka and Nishikawa (22)	1 MAC sevoflurane 67% nitrous oxide/oxygen Atropine	Epinephrine 0.5 in 1 mg/kg lidocaine	HR ≥10 bpm SBP ≥15 mm Hg T wave ≥25%	Positive response in 16/16, 13/16, 16/16 with HR, SBP, T-wave respectively. Increase in T-wave amplitude occurred earliest.
Kozek-Langenecker et al. (23)	1 MAC sevoflurane or halothane 70% nitrous oxide/oxygen No atropine	Epinephrine 0.5 in saline	HR ≥10 bpm SBP ≥15 mm Hg T wave ≥25%	T-wave more sensitive than HR or SBP. T wave, SBP more sensitive with sevoflurane than with halothane.
Tanaka et al. (25)	1 MAC sevoflurane 67% nitrous oxide/oxygen Atropine	Epinephrine 0.5 in bupivacaine 0.25 mg/kg or I. In lidocaine 1 mg/kg	HR ≥10 bpm T wave ≥25%	HR and T-wave 100% sensitive with epinephrine. HR 100% sensitive with I. No change in T-wave noted with I.
Tanaka and Nishikawa (26)	1 MAC sevoflurane 67% nitrous oxide/oxygen Atropine	Epinephrine 0.125, 0.25, 0.5 in 0.25, 0.5, and 1 mg/kg lidocaine	HR ≥10 bpm SBP ≥15 mm Hg T wave ≥25%	0.125 μg/kg not sensitive. 0.25, 0.5–100% sensitive for T-wave criteria. 0.5–100% for HR criteria.

IV = intravenous; I = isoproterenol; HR = heart rate; SBP = systolic blood pressure.

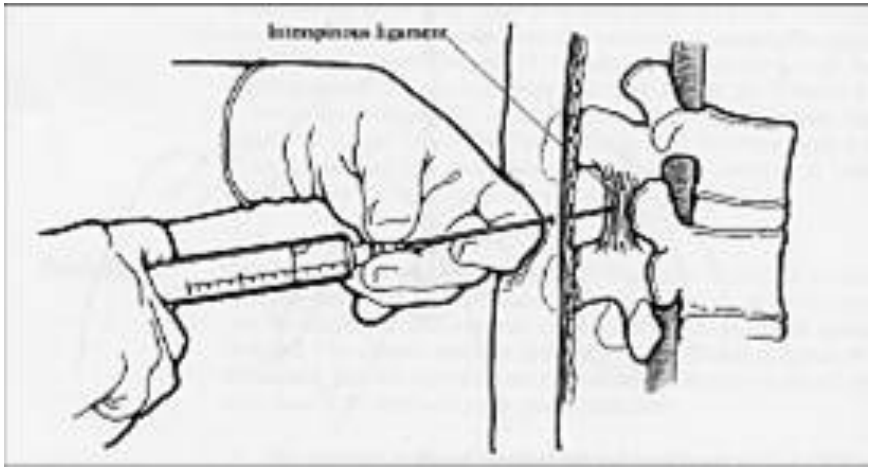
Lumbar and Thoracic Epidurals

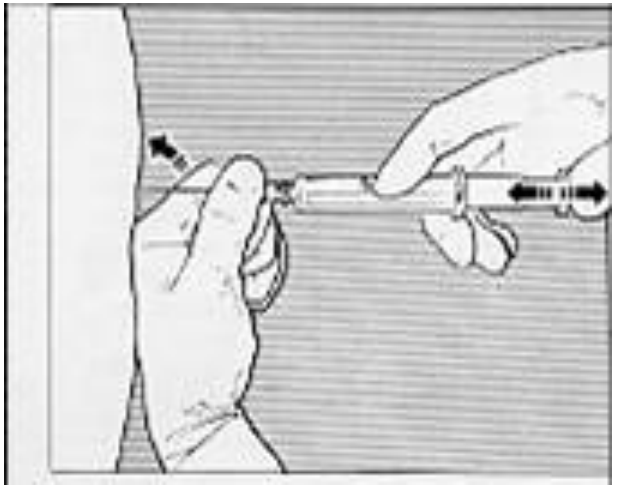
- ANATOMY
  - Dural sac extends to S_4 in the neonate
  - Spinal cord ends at L_{3-4}
  - Adult levels of S_3 & L_1 are reached by age 1 yr.
  - Epidural contents are less dense
  - Local anesthesia can spread easily



Lumbar and Thoracic Epidurals

- TECHNIQUE AND EQUIPMENT
  - Same as adults
  - Shorter, smaller needles and catheters are available
  - Bromage grip
  - Usually anesthetized child





Lumbar and Thoracic Epidurals

- DISTANCE TO EPIDURAL SPACE
  - 0.5 -1 cm neonates and infants
  - 1 - 2 cm 1 - 5 yr.
  - 2 - 3 cm 5 - 10 yr.
  - 3 - 5 cm 10 - 16 yr.

  Distance (mm) = (age (yrs) x 2) + 10

  Distance (mm) = (weight x 0.8)

Lumbar and Thoracic Epidurals

- DOSING
  - Toxic Dose of Bupivacaine
    - 0.5 mg/kg/hr in children
    - 0.2- 0.25 mg/kg/hr in neonates

Lumbar and Thoracic Epidurals

Agents	Bolus
Bupivacaine	2-2.5 mg/kg
Ropivacaine	3 mg/kg
Fentanyl	1-2 ug/kg
Morphine	20-50 ug/kg
Hydromorphone	10 ug/kg

Lumbar and Thoracic Epidurals

Agents	Conc	Infusion
Bupivacaine	0.08-0.125%	0.15-0.4 cc/kg/hr
Ropivacaine	0.08-0.2%	0.15-0.4cc/kg/hr
Fentanyl	2-5 ug/cc	0.5-1 ug/kg/hr
Morphine	50-100 ug/cc	2-10 ug/kg/hr
Hydromorph	3-5ug/cc	1-3 ug/kg/hr

What's in a Stereo-isomer?

- Ropivacaine (R) and levobupivacaine (LB) were introduced to ↓ cardiotoxicity
- R is less potent and the least toxic, it may have less motor block
- LB seems to have equipotent to B but is less toxic
- Ease of resuscitation after overdose: R > LB > B
- R and LB < arrythmogenic than B

R and LB in Children

- Ivani has shown 0.2% R to be ≈ 0.25% B in one shot caudals
- 0.1% R seems to be ineffective for one shot caudals
- There is less motor block at all concentrations
- One study on LB in children by Gunter et.al found it to be safe and effective in 39 children undergoing herniorrhaphy

Gunter JB et.al. Anesth Analg 89:647-9,1999.

Ivani Get.al. Comparison of Br J Anaesth 81: 247-8,1999

Why Use LB or R

- Neonates & young infants are more sensitive to the cardiotoxic effects of bupivacaine
- Peripheral nerve blocks require high volumes of LA $\Rightarrow\uparrow$ toxicity

A Pinch Of This …….

- Fentanyl
  - Safe, effective and popular in combination with local anesthetic in continuous epidural infusions
  - Most studies find no benefit to adding fentanyl to a one shot caudal for post-operative analgesia
  - Increased side effects

A Pinch of This…….

- Clonidine
  - Most studies show a prolongation of analgesia and increased sedation
  - Hypotension and bradycardia do not seem to occur as much in children
  - De Mey found no effect from either clonidine or sufentanil

De Mey JC et.al Eur J Anaesth 17: 379-82, 2000

A Pinch of This……

- De Negri and colleagues found the addition of ketamine 0.5mg/kg to be as effective as 2ug/kg clonidine when added to a 1 shot caudal
- Marhofer found ketamine 1mg/kg to provide equivalent analgesia to 0.25% bupivacaine

DeNegri et.al Paed Anaesth 11: 679-83,2001

Marhofer P et.al. Br J Anaesth 84: 341-5, 2000

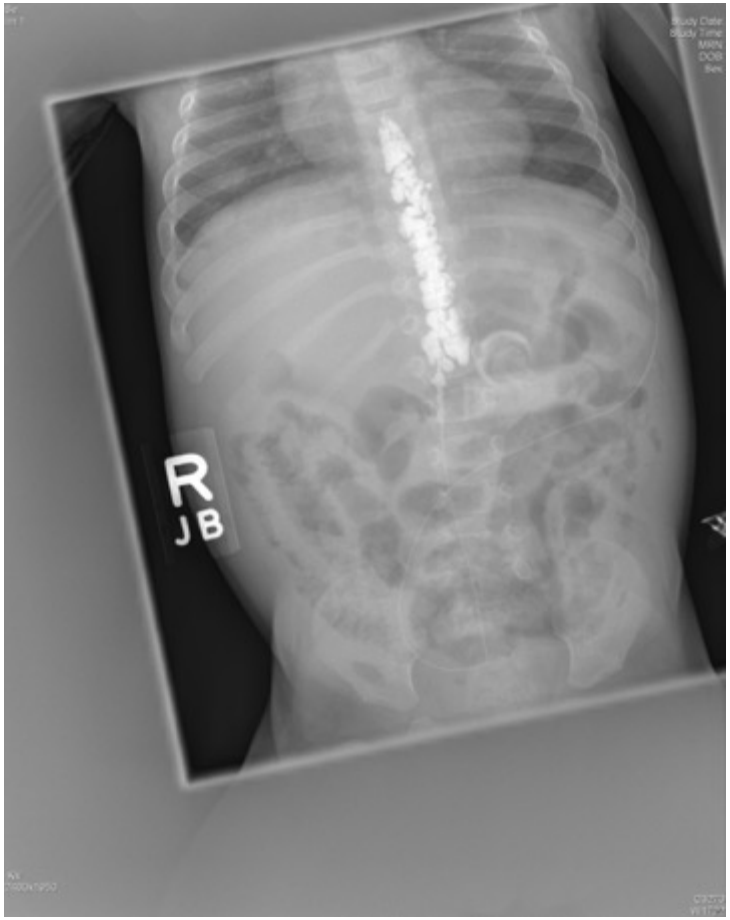
Threading catheters

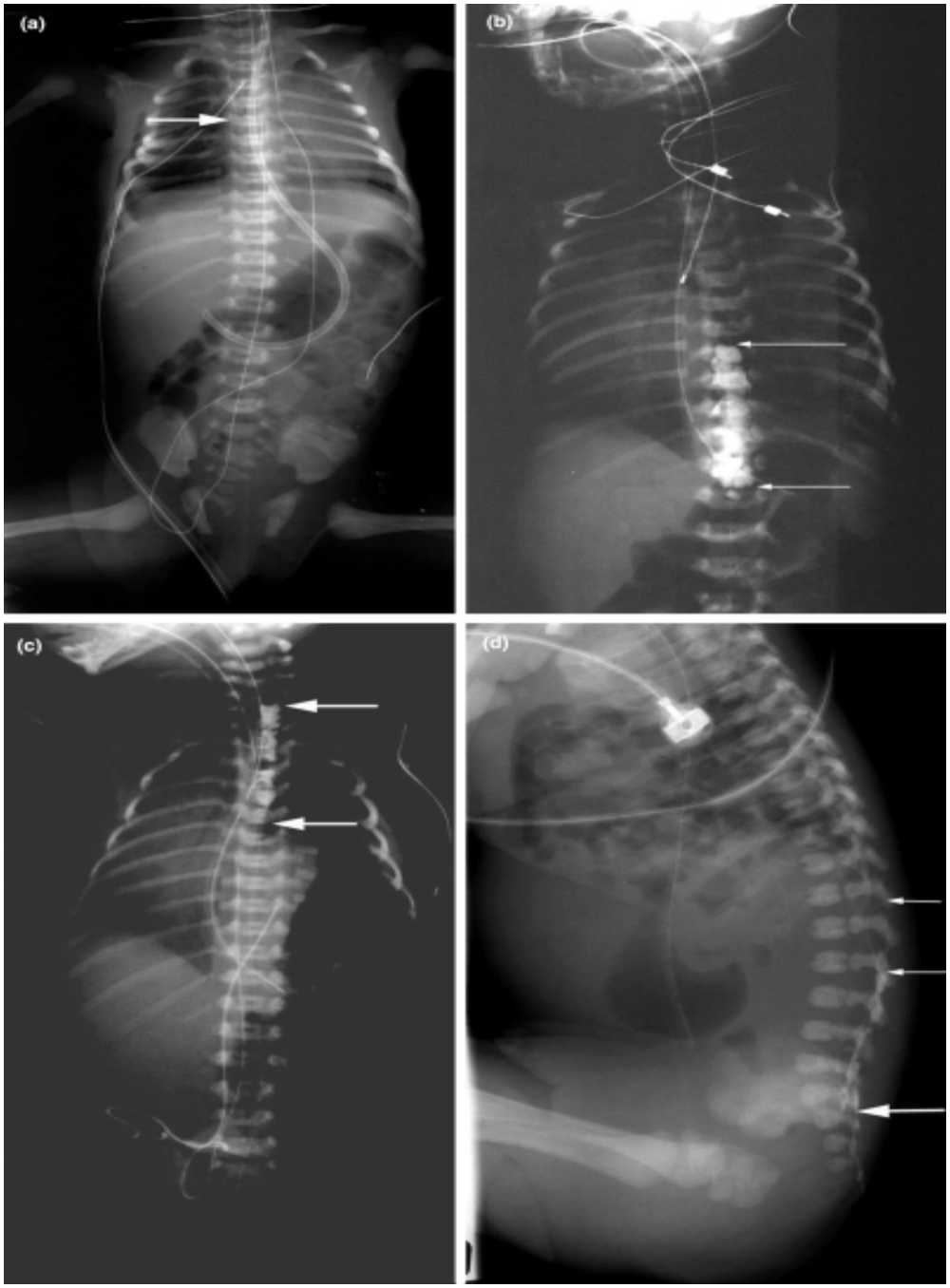
- In infants catheters can be threaded from the caudal space
- Coiling is more common with increasing age
- The usual complications can still occur

- Position should always be confirmed
- Houck found 32% malposition
  - 10/28--too high
  - 17/28 coiled in lumbosacral area
  - 1 outside of epidural space

Houck: Peds Anesth 2002

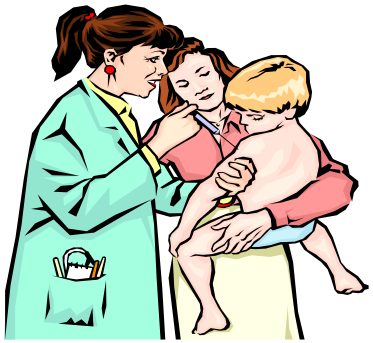
Epidurograms




(a)
(b)
(c)
(d)

Opioids

- The mainstay of pain medications
- A variety of routes are available—IM is avoided
- Intravenous opioids are used in doses similar to adults
- Intermittent administration is easy and allows for frequent dose and/or interval changes
- Meperidine is associated with ↑ neurologic symptoms



Opioid Analgesia

Constant Infusion

- Neonates, infants, developmentally delayed children
- Avoids peaks and troughs
- Useful for post-operative pain
- Morphine, hydromorphone or fentanyl are most commonly used

Opioid Analgesia

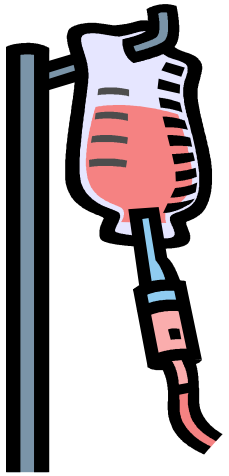
Patient Controlled Analgesia (PCA)

- Pts ~ 5 yr. and developmentally appropriate
- Parent and nurse controlled analgesia may be appropriate in selected cases
- With or without basal infusion ?
- Hydromorphone, morphine or fentanyl most commonly used
- May use Parent/Provider Controlled analgesia in selected patients

Patient Controlled Analgesia

Basal infusion

- Better pain control, improved sleep patterns for first 24 hr.
- Increased total narcotic usage
- increased reported side effects



PCA- Opioid Dosing

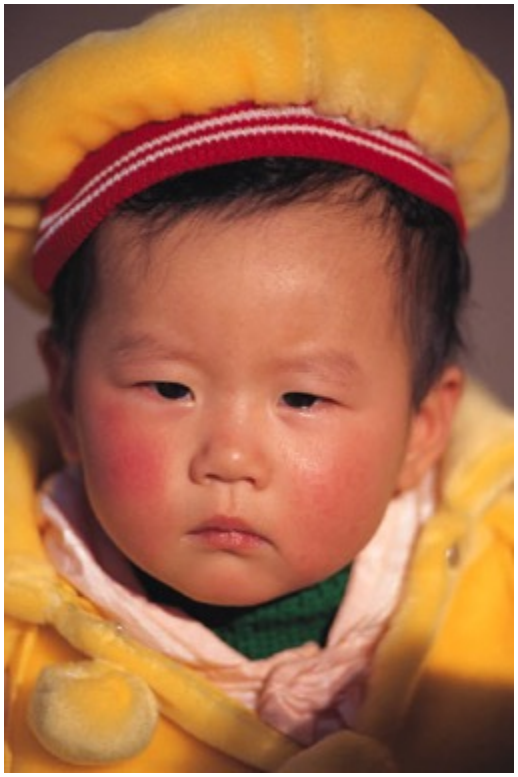
Drug	Bolus Dose (µg/kg)	Lockout Interval (min)	CBI (µg/kg/hour)	4-hr. limit (µg/kg)
Morphine	10-20	8-15	0-20	250-400
Hydromorphone	2-4	8-15	0-4	50-80
Fentanyl	0.5	5-10	0-0.5	7-10

Initial dosing recommendations in opioid-naïve children

Reproduced from Malviya S, Polaner DM, Berde CB. AcutePain in Cote CJ, Lerman J, Anderson B eds A Practice of Anesthesia for Infants and Children. Elsevier Inc 2013 pp 928-933

Opioids

- Intranasal (IN) fentanyl 2ug/kg improves emergence in children undergoing T&T
- ED now using IN sufentanil ?dose (0.7-2 ug/kg)
- IN butorphanol 25ug/kg
- IN remifentanil for intubation



Oral Opioids

- Codeine 1mg/kg q 3-4 hrs FDA warning
- Hydrocodone 0.1-0.2 mg/kg q 3-4 hrs FDA warning
- Oxycodone 0.1-0.15 mg/kg q 3-4 hrs
- Most preparations come in an elixir as well as tablets, +/- acetaminophen

- Oral opioids can be given prior to discharge from PACU or sent home with the patient.

Non-Opioid Analgesics

- Ibuprofen-5-10mg/kg po every 6-8 hours
- Ketorolac 0.5mg/kg IV every 8 hours up to 30mg
- Acetaminophen
  - Rectal 40mg/kg then 20mg/kg every 6 hrs
  - Oral 10-15mg/kg every 6 hours
  - IV 10-15 mg q 6 hours

How much opioid?

- 87% of pediatric patients received a prescription
- 60% used.
- Most families had NOT been counselled on safe disposal.
- Only 5% of families disposed of unused medications properly,
- 50% of families had teenagers in the house.
- After two weeks, families had on average 36 tablets (range 0-95) or 67 ml (range 0-567 ml) of prescription opioids left over.

How much opioid?

- Another study in children receiving morphine after surgery in Montreal noted that 1431 doses were ordered, and only 131 doses (9.2%) were administered
- Most were counselled, ~60% returned unused medication, ~25% disposed properly
- However, majority kept the medications out in the open

Opioid Prescribing for the Treatment of Acute Pain in Children on Hospital Discharge.

Figure 1

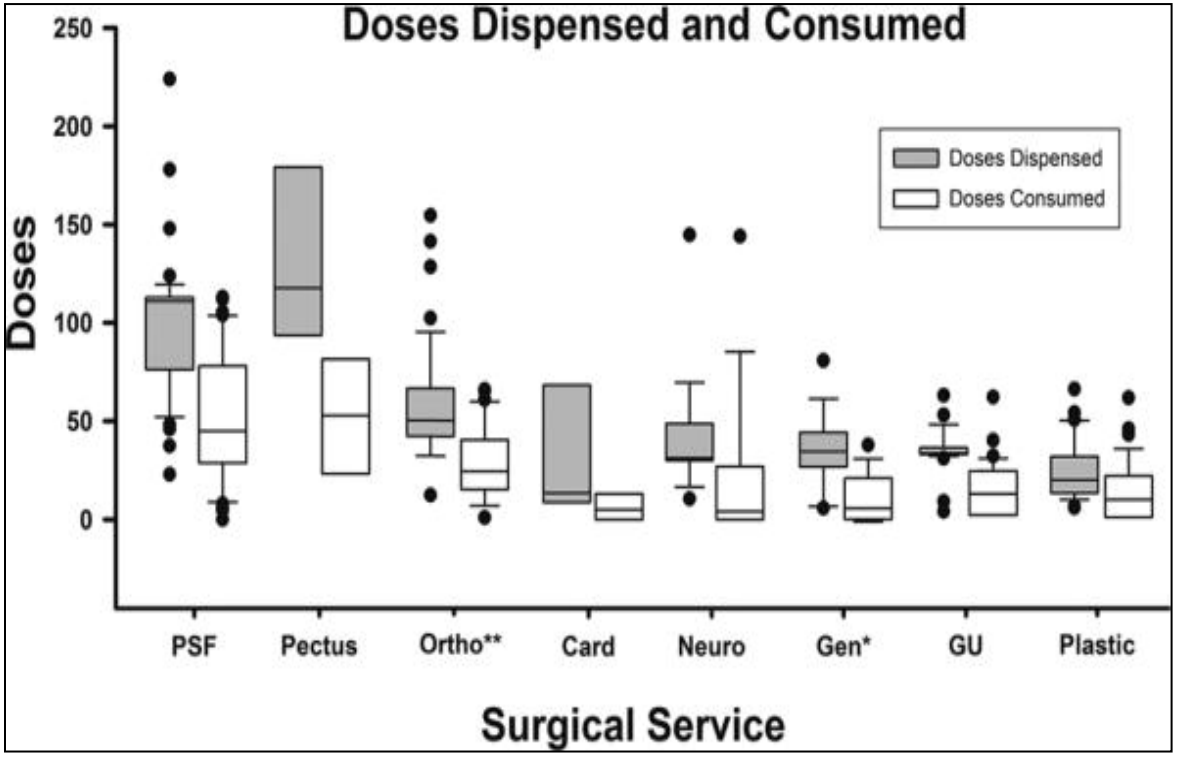


Figure 1 . Doses dispensed and consumed by surgical specialty.. *General pediatric surgery excluding Nuss procedure. **Orthopedic surgery excluding posterior spinal fusion. Card indicates cardiothoracic surgery; GU, genitourologic surgery; Neuro, neurosurgery; Pectus, Nuss procedure; Plastic, plastic surgery; PSF, posterior spinal fusion.


Almost 18 out of 100 Americans
have used illicit drugs or
misused Rx drugs.

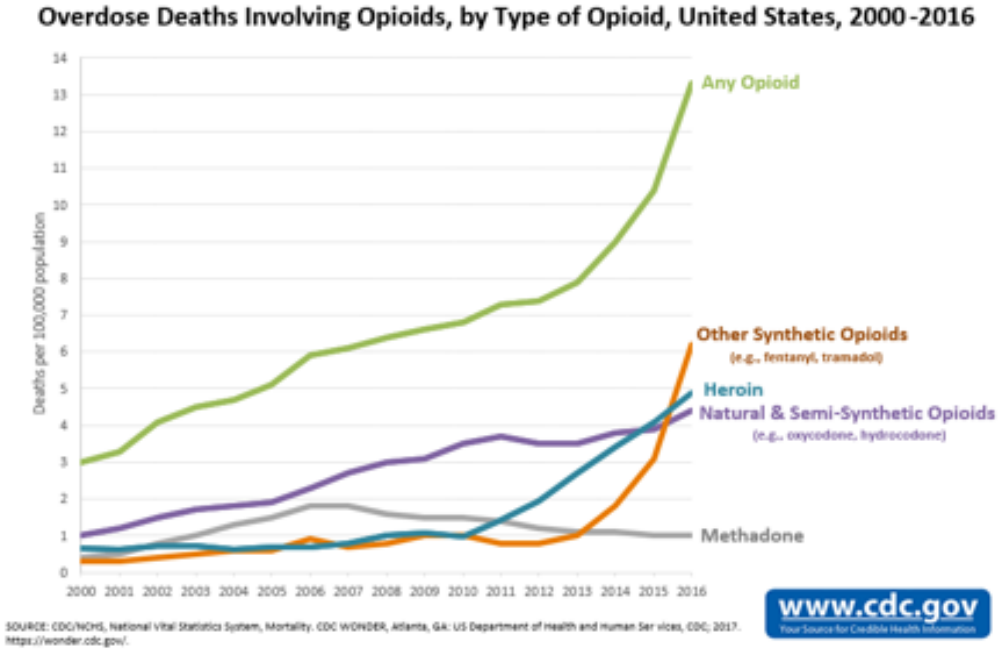
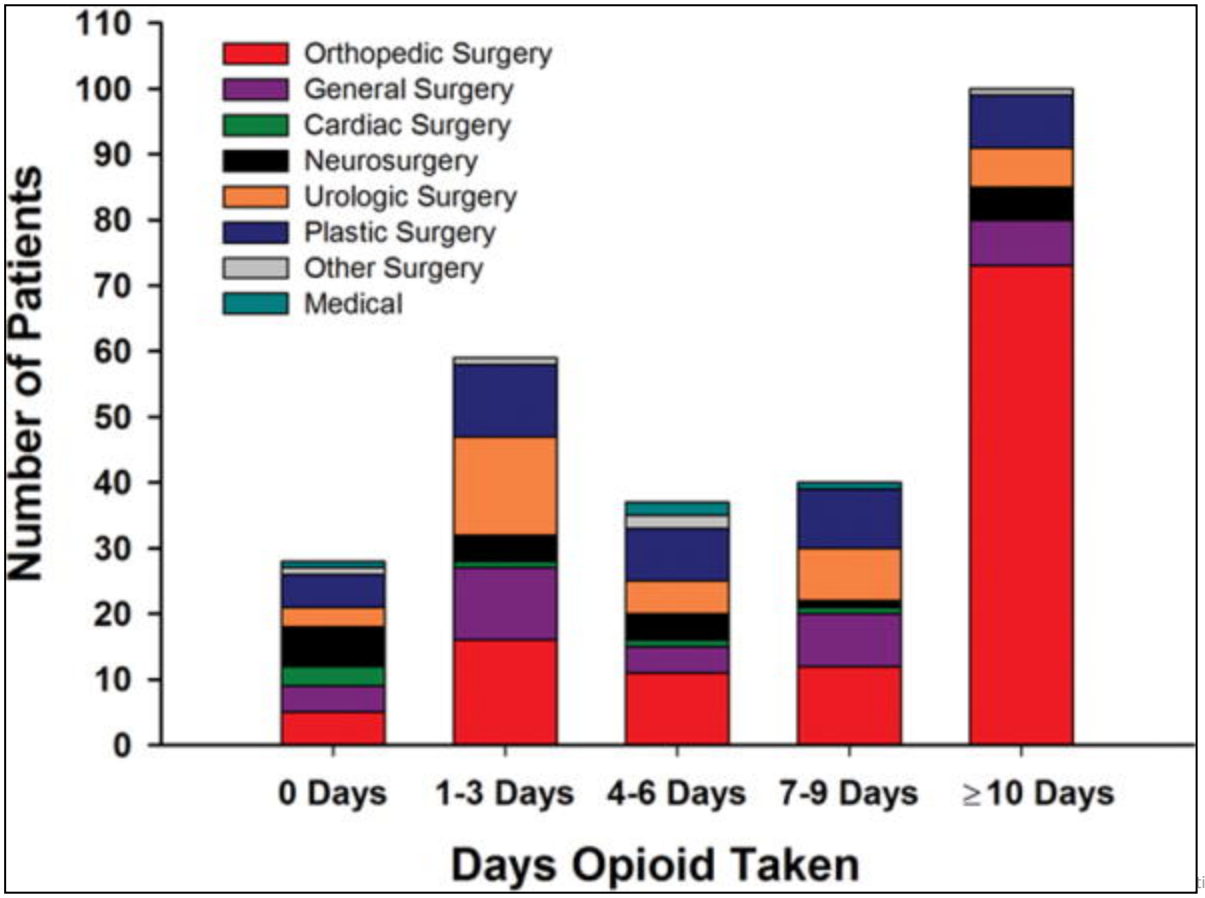

Overdose Deaths Involving Opioids, by Type of Opioid, United States, 2000-2016
Deaths per 100,000 population
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016
Any Opioid
Other Synthetic Opioids
(e.g., fentanyl, tramadol)
Heroin
Natural & Semi-Synthetic Opioids
(e.g., oxycodone, hydrocodone)
Methadone
www.cdc.gov
Your Source for Credible Health Information
SOURCE: CDC/NCHS, National Vital Statistics System, Mortality. CDC WONDER, Atlanta, GA: US Department of Health and Human Services, CDC; 2017.
https://wonder.cdc.gov/.

Figure 2



Opioid Prescribing for the Treatment of Acute Pain in Children on Hospital Discharge.
Monitto, Constance et. al Anesthesia &

Figure 2 . Duration of opioid use by specialty. Duration of opioid therapy reported by families after hospital discharge. Data are stratified by primary service.

Opioid Prescribing A&A Dec 2017

Calculating the cumulative amount of leftover opioid among

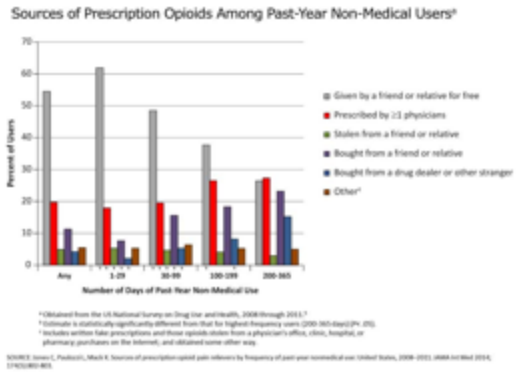
- 235 respondents:
  - 3110 oxycodone tabs
  - 7264 ml oxy elixir
  - Morphine, hydromorphone etc
  - 45,573 morphine mg equivalents
  - 19% advised on disposal
  - 4% disposed leftover opioids

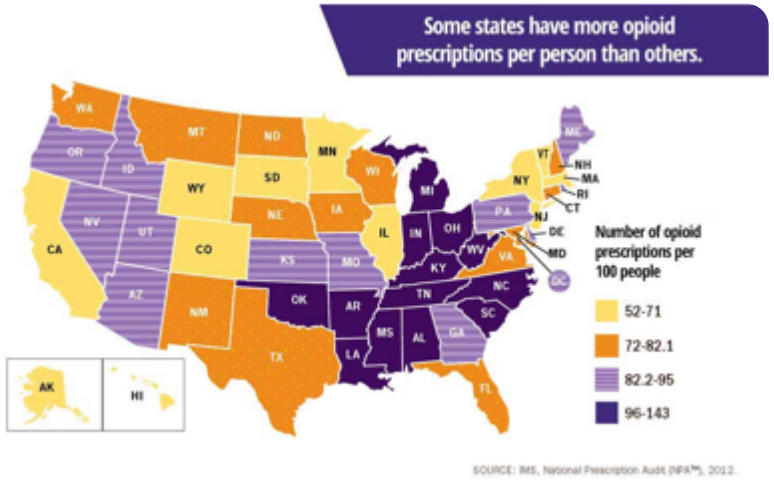
Opioid Prescribing A&A 2017

- Girls use 7.5 X more opioids
- Ortho and Nuss bar highest opioid use post surgery
- Patient with pain scores >5

Scope of the problem

- Opioid prescriptions are still high
- Rate is decreasing
- Overdose and death continues to increase



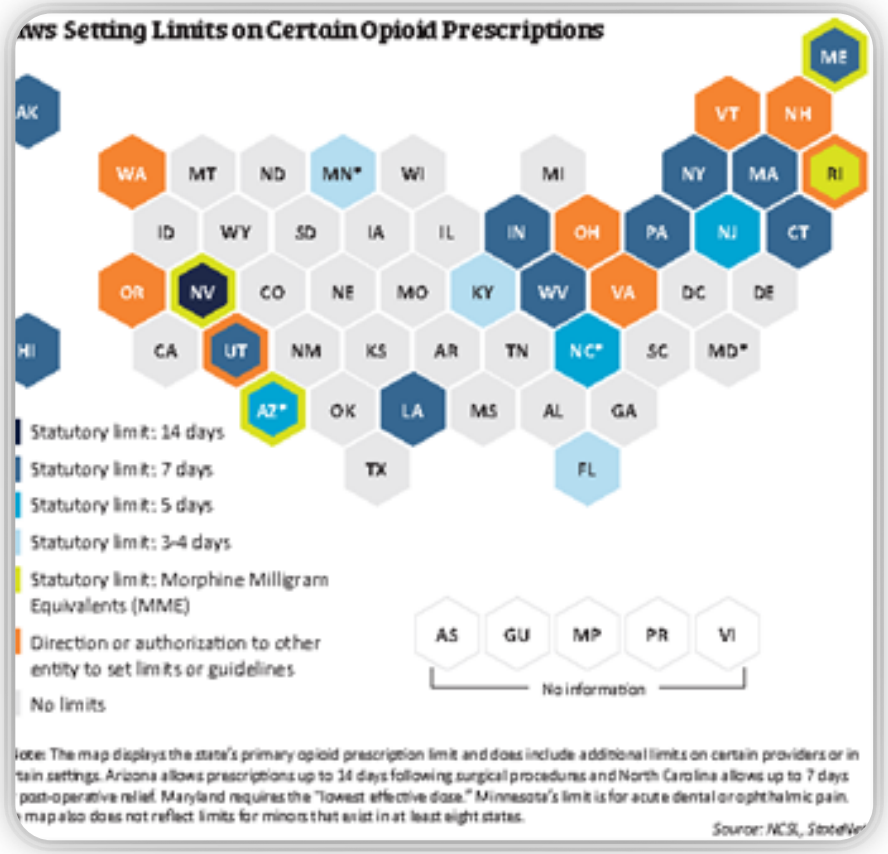


Who gets addicted?

- Anyone can get addicted
- Post surgery 0.9 -12% will become chronic opioid users
- H/o psychiatric disease, including ADHD, depression, anxiety
- Lives in rural area
- Low income

What can we do?

- Educate EVERYONE-physicians, patients, dentists, nurses, physician assistants
- Research-how much pain? For how long? What else can be used?
- Mental Health resources
- Recognize early-treat quickly
- Limit supply—but what about street drugs?
- Prescription Drug Monitoring Programs



Created posters for Practitioners

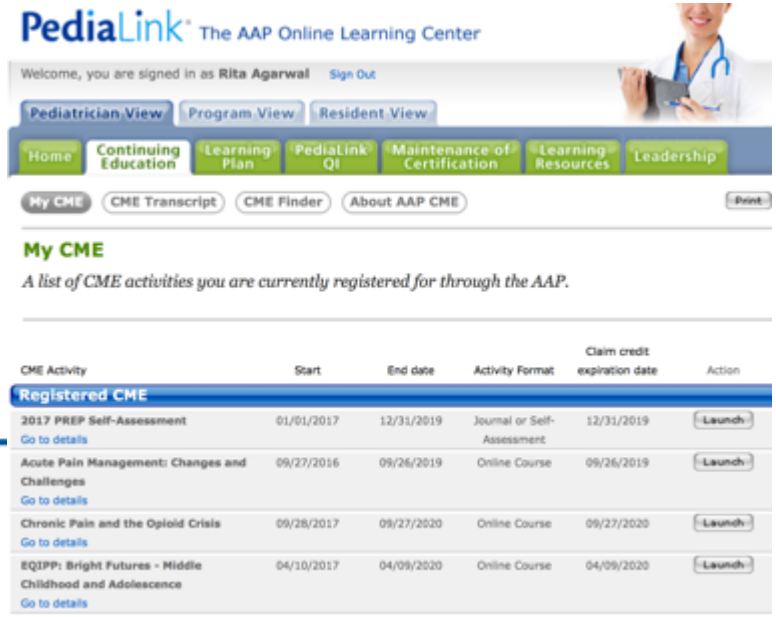
AAP News

October 20, 2017

Poster created to promote safe storage, disposal of Rx

Lucien Gonzalez, M.D., M.S., FAAP, Rita Agarwal, M.D., FAAP and Constance S. Houck, M.D., M.P.H., FAAP

Safe storage and disposal of controlled prescription drugs may save a young person's life. It's that simple.



PCSS-O

PCSS-O TRAINING

PROVIDERS' CLINICAL SUPPORT SYSTEM
For Opioid Therapies

Please Note: CME is only available for live events. CME is not available for recorded webinars.

Providers' Clinical Support System—Opioid Therapies (PCSS-O)
Start Date: September 2014
End Date: September 2017

Conclusions

- Need more resources for:
  - Mental health
  - Behavioral treatment
  - Alternative medications
  - Multimodal with non-addictive meds
  - Acknowledgement that addiction is a disease
  - Research-treatment, medications, approaches, techniques
  - Education

DO not Need

- MORE ONE SIZE FITS ALL LAWS
- Lawmakers practicing medicine and limiting access to medications
- Insurance companies making poorly thought out rules

Concluding Remarks

- Children are also very responsive to distraction
- Parents can be invaluable
- Assessment is difficult so it is more humane to assume pain
- Treatment and side effects similar to adults

Conclusion

- Peripheral nerve blocks and one shot caudal blocks are fast and simple
- They provide effective pain relief with minimal side effects
- Always calculate toxic LA dose