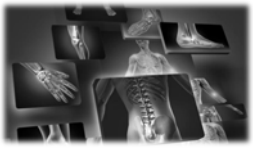


Opioid-Sparing Anesthesia:
What Can We Learn from the Opioid Crisis?

Garry Brydges DNP, MBA, CRNA, ACNP-BC, FAAN
2019 WVANA Spring Meeting

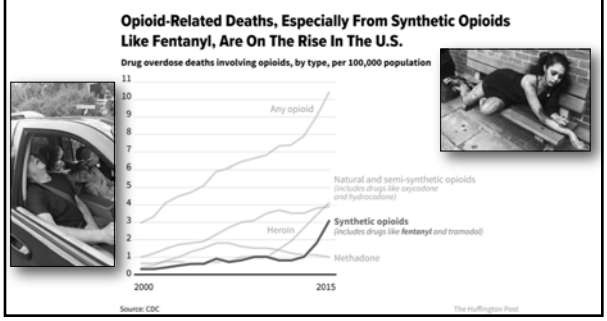
Objectives

The learner will be able to:

- Describe the role of Opioid-Sparing Techniques in Anesthesia.
- Describe the outcomes achieved with opioid-sparing compared to traditional techniques.
- Differentiate the value of quality versus quantity of anesthesia through Opioid-Sparing Strategies

Opioids: Public Health Issue

Opioids: Public Health Issue

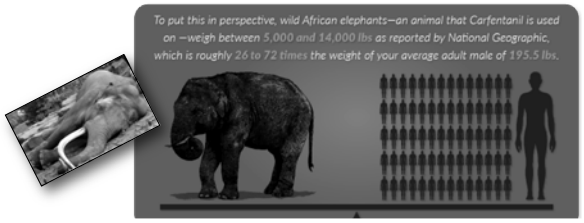


Opioids: Public Health Issue

Opioids: Public Health Issue

3,000 X more potent than Morphine

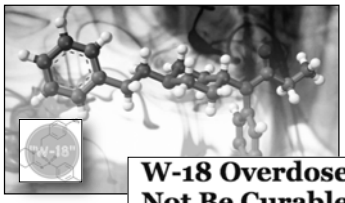
Opioids: Public Health Issue



3 Marylanders die from carfentanil overdoses

WBALTV | Updated: 4:47 PM EDT Apr 24, 2017

Opioids: Public Health Issue



This new street drug is 10,000 times more potent than morphine, and now it's showing up in Canada and the U.S.

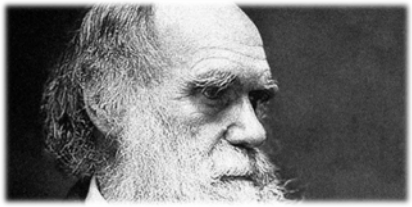
W-18 Overdoses In Alberta May Not Be Curable With Naloxone Kits

The Huffington Post Alberta | By Sarah Rieger

Posted: 05/24/2016 5:53 pm EDT | Updated: 05/24/2016 5:59 pm EDT

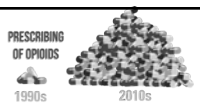
Philosophically

Dr. Charles Darwin



Is this … "Social" Natural Selection?

Ethics versus Economics

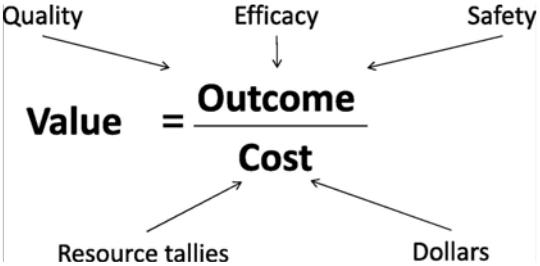


DID THE **FDA** PLAY A ROLE IN THE **OPIOID** EPIDEMIC?

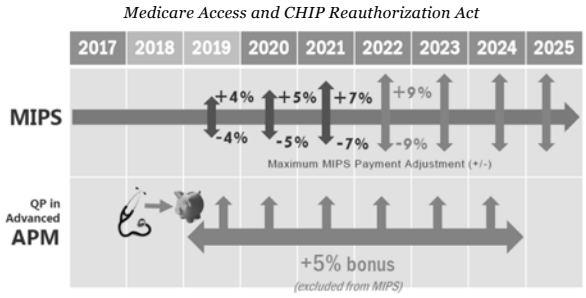
"**Value**" Based Healthcare Delivery

(Not Volume Based)

Quality (MACRA) NOT Quantity (FFS)

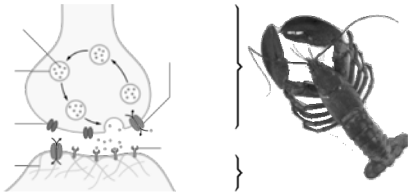


Why is this Important? . . . Economists = MACRA



Opioids: Public Health Issue

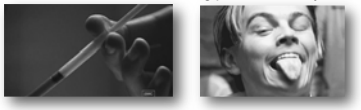
- How did we get here?
  - Imbalance Serotonin - Octopamine



Peterson, J. (2018) 12-Rules For Life: An Antidote to Chaos

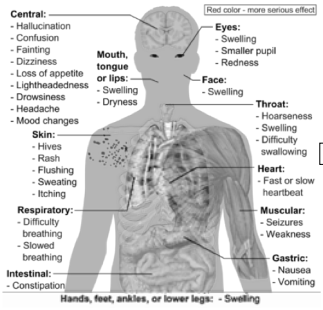
Opioids: Public Health Issue

- Addiction: disrupting the positive feedback loop
  - Initial dose: exhilarating, but only with drug level threshold
  - Stopping:
    - Drug level drops
    - Toxins rise
    - Anxiety Centers: HYPER-RESPOND
    - Human Behavior …. Fixing problem is easy



Peterson, J. (2018) 12-Rules For Life: An Antidote to Chaos

Opioids: Why Avoid?



1. Tolerance
2. Dependence
3. Addiction

What Can You Do?

Goal: Opioid-Sparing

- Reduce Stress & Inflammation
  - Cortisol & Catecholamine release
- Optimize Immune Function
  - Natural Killer & T-Cell Function
- **Spare Opioids maximally**
- Reduce Symptom Burden
  - Rapid Rescue where prudent

The Evidence

Opioid-induced hyperalgesia: Cellular and molecular mechanisms

Laurie-Anne Roeckel, Glenn-Marie Le Coz, Claire Gavériaux-Ruff and Frédéric Simonin
Neuroscience, 2016-12-03, Volume 338, Pages 160-182, Copyright © 2016 IBRO

The Evidence

Opioid-induced hyperalgesia: Cellular and molecular mechanisms

The Mechanism of **Hyperalgesia** and Anxiety Induced by Remifentanil: Phosphorylation of GluR1 Receptors in the Anterior Cingulate Cortex
by Jie Zeng; Sisi Li; Chao Zhang; See more...

Journal of Molecular Neuroscience, 05/2018

The Evidence

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by Chang, Lu; Ye, Fang; Luo, Quehua; See more...

The Evidence

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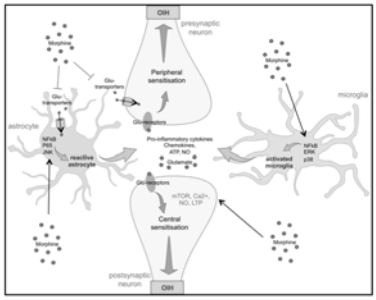
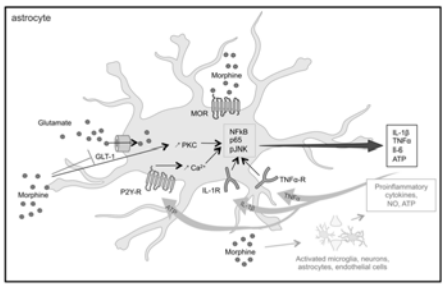
Remifentanil-induced postoperative hyperalgesia: current perspectives on mechanisms and therapeutic strategies
Local and Regional Anesthesia. 2018;Volume 11:15-23

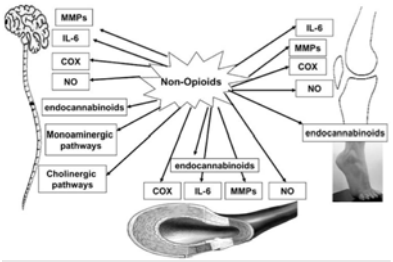


Yi, P., & Pryzbylkowski, P. (2015). Opioid induced hyperalgesia. *Pain Medicine, 16*(S1), S32-S36. doi:10.1111/pme.12914



Yi, P., & Pryzbylkowski, P. (2015). Opioid induced hyperalgesia. *Pain Medicine, 16*(S1), S32-S36. doi:10.1111/pme.12914

Opioid-Sparing: **Underlying Premise**



Hamza, M., & Dionne, R. A. (2009). Mechanisms of Non-Opioid Analgesics Beyond Cyclooxygenase Enzyme Inhibition. *Current Molecular Pharmacology*, *2*(1), 1–14.

Opioid-Sparing: **Underlying Premise**

Endogenous Chemicals Causing Pain

5-HT = 5-hydroxytryptamine
5-HT1AR = 5-hydroxytryptamine 1A receptors
5-HT2AR = 5-hydroxytryptamine 2A receptors
CB2R = cannabinoid CB2 receptors
CCK-8 = cholecystokinin octapeptide
COX-2 = cyclooxygenase-2
CRF = corticotrophin-releasing factor
GABA = γ-aminobutyric acid
GDNF = glial cell line–derived neurotrophic factor
GFRα-1 = GDNF family receptor α-1
IAM-1 = intracellular adhesion molecule-1
IL-6 = interleukin-6
IL-1β = interleukin-1β
NK-1 = neurokinin-1
N/OFQ = nociceptin/orphanin FQ
p38 MAPK = p38 mitogen–activated protein kinase
PGE2 = prostaglandinE2
p-GluN1 = phosphorylated GluN1
TNF-α = tumor necrosis factor-α
TRPV1 = transient receptor potential cation channel subfamily V member 1
VIP = vasoactive intestinal polypeptides

Hamza, M., & Dionne, R. A. (2009). Mechanisms of Non-Opioid Analgesics Beyond Cyclooxygenase Enzyme Inhibition. *Current Molecular Pharmacology*, *2*(1), 1–14.

Inflammation: Tumorigenesis

- **Immunoediting**: tumor cell eradication by immune system

1. **Elimination**: non-self >>> destroy
2. **Equilibrium**: tumor – antitumor balance
3. **Escape**: immune suppression >>> imbalance

Inflammation: Tumorigenesis

- Surgery Causes:
  - Tissue Damage
  - Severe Pain
  - Immunosuppression (Profound)
  - Postoperative cancer recurrence

Opioids

- Contribute to:
  - Promoting Inflammation
  - Impaired Immune Function
  - Contribute to Cancer Metastasis

Impact of perioperative pain management on cancer recurrence: an ASRA/ESRA special article

Andres Missair,[1,2] Juan Pablo Cata,[3] Gina Votta-Velis,[4] Mark Johnson,[5] Alain Borgeat,[6] Mohammed Tiouririne,[7] Vijay Gottumukkala,[3] Donal Buggy,[1] Ricardo Vallejo,[4] Esther Benedetti de Marrero,[1,2] Dan Sessler,[8] Marc A Huntoon,[10] Jose De Andres,[11] Oscar De Leon Casasola[12]

Inflammation: Tumorigenesis

- Inflammatory Mechanism causes:
  1. Nuclear transcription factor (NF-ab) release
  2. IL-6, IL-1β, TNF-α
  3. Angiogenic factors (VEGF)
  4. COX-2
  5. Src gene activation (tumor promotion)

*** May play a role in tumor progression and metastasis**

Mantovani A, Allavena P, Sica A, et al. Cancer-related inflammation. Nature 2008;454:436–44.
O'Leary DP, O'Leary E, Foley N, et al. Effects of surgery on the cancer stem cell niche. Eur J Surg Oncol 2016;42:319–25.
Piegeler T, Votta-Velis EG, Liu G, et al. Antimetastatic potential of amidelinked local anesthetics: Inhibition of lung adenocarcinoma cell migration and inflammatory src signaling independent of sodium channel blockade. Anesthesiology 2012;117:548–59.

Inflammation: Tumorigenesis

- Inflammatory Mechanism causes:
  - Pro-oncogene c (Src) gene activation:
    - Tumor promoting gene activation
    - Promotes metastasis via
      - Upregulation intracellular adhesion molecule (ICAM-1) promoting neoplastic extravasation >>> Metastasis
      - **IL-6 modulate** non-cancer stem cells to **cancer stem cells** in breast cancer contributing to metastasis

Iliopoulos D, Hirsch HA, Wang G, et al. Inducible formation of breast cancer stem cells and their dynamic equilibrium with non-stem cancer cells via il6 secretion. Proc Natl Acad Sci U S A 2011;108:1397–402.

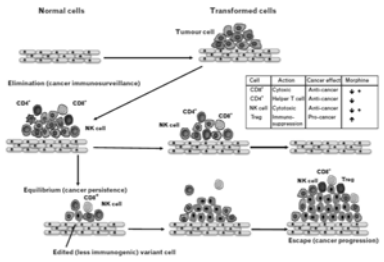
Inflammation: Tumorigenesis

- **Natural Killer (NK) Cells**
  - Tumoricidal effects on neoplastic cell prevents tumor progression
  - Prevents metastasis

Opioids Blunt NK Activity
Dose Dependent

Yokota T, Uehara K, Nomoto Y. Intrathecal morphine suppresses nk cell activity following abdominal surgery. Can J Anaesth 2000;47:303–8.

Why Avoid Opioids?



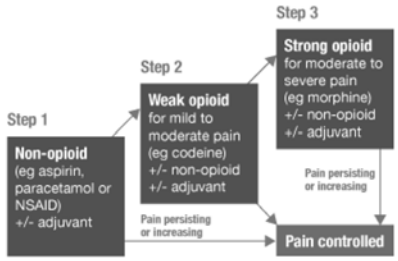
Wigmore, T., & Farquhar-Smith, P. (2016). Opioids and cancer: Friend or foe? ***Current Opinion in Supportive and Palliative Care, 10*****(2), 109-118. doi:10.1097/SPC.0000000000000208**

Role of Opioids

- Promotes:
  - Angiogenic stimulus for tumor vascularization
  - Increase in VEGF, Src Gene Activation
  - Increased NOS, NO, COX-2
  - Increased metastasis (solid tumors)
    - MOR expression in **lung cancer** contributes to metastasis
- *silencing* the expression of the **μ-opioid receptor (MOR)** in lung cancer cells **inhibits lung metastasis** by about **75%.**

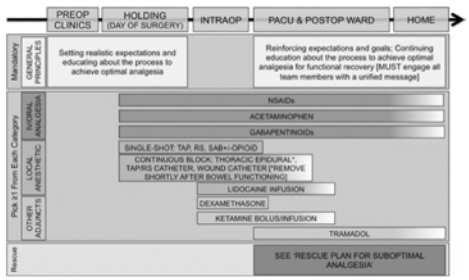
Mathew B, Lennon FE, Siegler J, et al. The novel role of the mu opioid receptor in lung cancer progression: a laboratory investigation. Anesth Analg 2011;112:558–67.

Opioid-Sparing: Framework



WHO Analgesic Ladder. Retrieved from http://www.paineurope.com/tools/who-analgesic-ladder

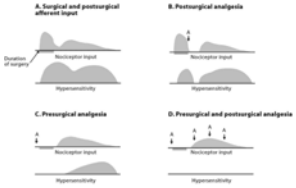
Opioid-Sparing: Innovation



Scott et al., (2017) Retrieved from: https://perioperativemedicinejournal.biomedcentral.com/articles/10.1186/s13741-017-0063-6

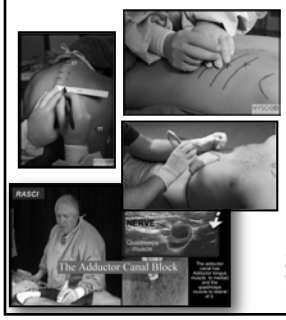
Opioid-Sparing: Theory

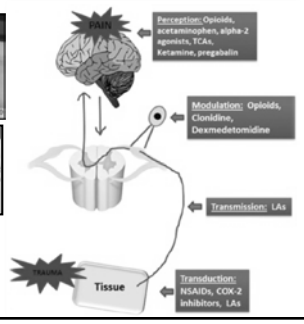
- **Regional Anesthesia**
  - Controversy M & M
- **Pre-emptive Analgesia**
  - Prevent "pain" sensitization
  - Controversy
    - Regional Anesthesia
    - Agents?
    - Research: Poor!



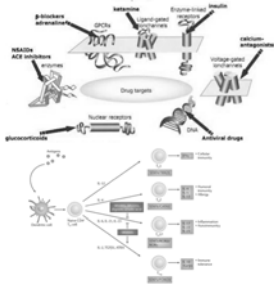
Gottschalk & Smith. (2001). New concepts in acute pain therapy: Preemptive analgesia. Am Fam Physician. 2001 May 15;63(10):1979-84.

Opioid-Sparing: Innovation





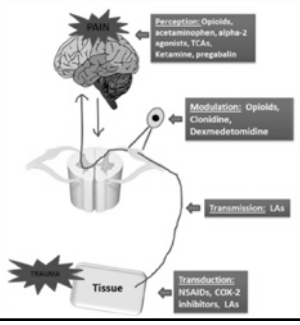
Opioid-Sparing: Theory



- **Pharmacological Agents**
  - Receptor Model Theory
    - Ionic Channels
    - Opioid/mu
    - GABA
    - NMDA
    - Adrenergic
    - Muscarinic
  - **Modulation & Feedback**
    - Agonist/Antagonists
    - Transporter Proteins
    - Synergism Theory

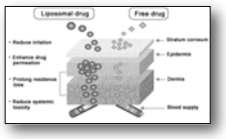
Kojetin & Burris. (2014). REV-ERB & ROR nuclear receptors as drug targets. Nature Reviews Drug Discovery 13, 197-216.

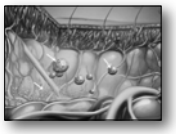
Opioid-Sparing: Innovation

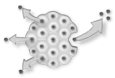


- Lidocaine
- Gabapentinoids
- NSAIDS
- COX-2 Inhibitors
- Acetaminophen
- TCAs & SSRI
- Magnesium

Liposomal Bupivacaine: Background







Medication Dosing

– Liposomal Bupivacaine 266mg/20ml (13.3mg/ml)
– Dilute: up to 280ml sterile saline (300 ml Total)
  - With Free Bupivacaine: < 50% Liposomal Dose
  - Typical total volume 40ml to 60ml

"Bupivacaine HCl may be administered immediately before EXPAREL or admixed in the same syringe, as long as the ratio of the milligram dose of free bupivacaine HCl to EXPAREL does not exceed 1:2"

Bupivacaine Comparison

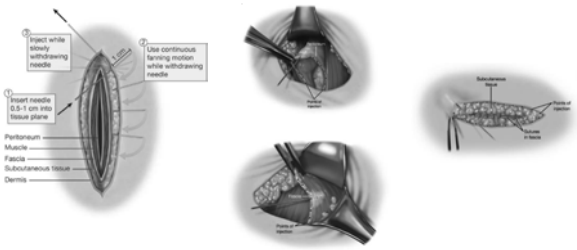
Liposomal

- Onset: 5 minutes
- Peak Onset:
  - 30-120 minutes
- Half-Life: **24-34 Hours**
- Duration:
  - 24 Hours (Local) & 96 Hours (Systemic)

Free

- Onset: 5-10 minutes
- Peak Onset:
  - 30-45 minutes
- Half-Life: **3.5 Hours**
- Duration:
  - 6-8 Hours

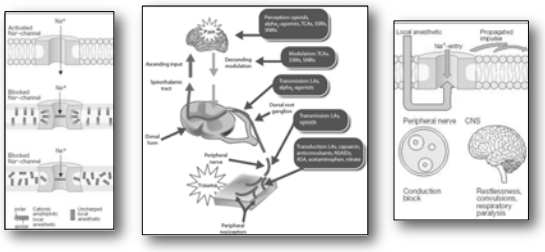
Surgical Wound Infiltration



Joshi, G. P., Janis, J. E., Haas, E. M., Rameshaw, R. J., Nihira, M. A., & Dynkin, B. J. (2016). Surgical Site Infiltration for Abdominal Surgery: A Novel Neuroanatomical-based Approach. *Plastic and Reconstructive Surgery Global Open*, *4*(12), e1181. http://doi.org/10.1097/GOX.0000000000001181

Lidocaine Infusion

Infusion: 2mg/minute



Lidocaine Infusion

Infusion: 2mg/minute

Key points

- a **potent anti-inflammatory**, anti-hyperalgesic, and **gastrointestinal pro-peristaltic** drug.
- Level 1 evidence from gastrointestinal surgery demonstrates **decreased** *pain scores*, *opioid analgesic consumption*, and side-effects.
- Useful acute pain adjunct to achieve enhanced recovery after surgery outcomes.
- Patients may show particular benefit when they have ***acute hyperalgesia,*** when opioids are not effective in treating acute pain, or both.
- lidocaine infusions may be safely continued for several days after operation.

Intravenous lidocaine for acute pain: an evidence-based clinical update

S Eipe, MBBS MD, S Gupta, MD FRCPC, J Penning, MD FRCPC

BJA Education, Volume 16, Issue 9, 1 September 2016, Pages 292–298,
https://doi.org/10.1093/bjaed/mkw008
Published: 12 April 2016

IV Lidocaine

- Rimback et al: decrease POI & Visceral Pain
- Potent Anti-Inflammatory
  - Enhanced NK Cell activity
  - Decrease IL-β_1, IL-6, IL-8, ICAM-1, Src
  - Inhibits prostanoids, thromboxane, leukotrienes, and downregulates VGSC

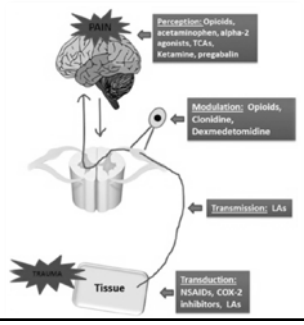
Rimback G, Cassuto J, Tollesson PO. Treatment of postoperative paralytic ileus by intravenous lidocaine infusion. Anesth Analg 1990;70:414–9.

IV Lidocaine

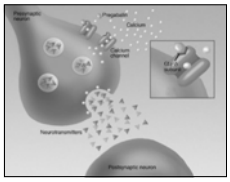
- Inhibits human adenocarcinoma cell migration & proliferation
  - Due to Src Kinase inhibition
- Increase DNA methylation
  - Causes: Tumor activity suppression
  - Decrease breast cancer cells (estrogen pos & neg)

Lirk P, Berger R, Hollmann MW, et al. Lidocaine time- and dose-dependently demethylates deoxyribonucleic acid in breast cancer cell lines in vitro. Br J Anaesth 2012;109:200–7.
Castellano S, Kuck D, Sala M, et al. Constrained analogues of procaine as novel small molecule inhibitors of DNA methyltransferase-1. J Med Chem 2008;51:2321–5.
Hollmann MW, Gross A, Jelacin N, et al. Local anesthetic effects on priming and activation of human neutrophils. Anesthesiology 2001;95:113–22

Opioid-Sparing: Innovation

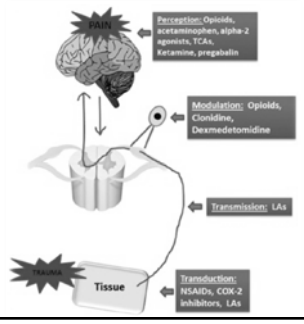


- Gabapentinoids

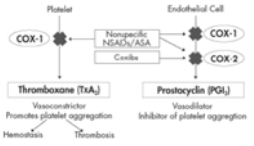


Blommel & Blommel. (2007). Pregabalin: An antiepileptic agent useful for neuropathic pain. Am J Health Syst Pharm. 64(14):1475-1482

Opioid-Sparing: Innovation



- NSAIDS
- COX-2 Inhibitors



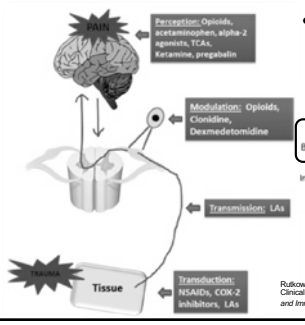
DeMaria. (2017). NSAIDs, Coxibs, and Cardio-Renal Physiology: A Mechanism-Based Evaluation: COX-2 Inhibitors and Vascular Physiology. Retrieved from www.medscape.com

NSAIDs and COX-2 Inhibitors

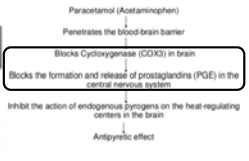
- Reduce COX-2 and prostaglandins
- Breast Cancer & Colon Cancer
  - Reduced metastatic cancer: breast surgery
    - 20% Relative/10% Absolute reduction
  - Aspirin reduced metastatic colon cancer
  - COX-2 reduction
    - Decreased lung adenocarcinoma

Muscat JE, Chen SQ, Richie JP, et al. Risk of lung carcinoma among users of nonsteroidal antiinflammatory drugs. Cancer 2003;97:1732–6.
Schreinemachers DM, Everson RB. Aspirin use and lung, colon, and breast cancer incidence in a prospective study. Epidemiology 1994;5:138–46.
Harris RE, Beebe-Donk J, Alshafie GA. Reduced risk of human lung cancer by selective cyclooxygenase 2 (cox-2) blockade: Results of a case control study. Int J Biol Sci 2007;3:328–34.

Opioid-Sparing: Innovation



- Acetaminophen



Rutkowski, K., Nasser, S. M., & Ewan, P. W. (2012). Paracetamol hypersensitivity: *Clinical features, mechanism and role of specific IgE. International Archives of Allergy and Immunology, 159*(1), 60-64. doi:10.1159/000335213

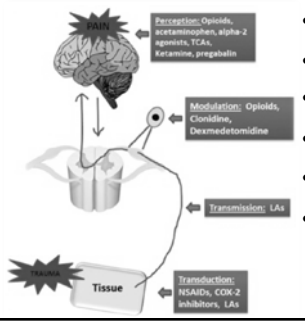
Acetanilide Derivative
(Acetaminophen)

1000mg IV Q6Hours

- Pharmacodynamic Profile
- IV is Superior: Why?
  - **IV 70% Availability**

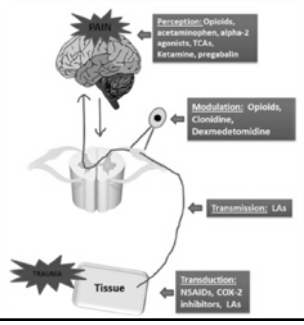
Res ipsa loquitur

Opioid-Sparing: Innovation

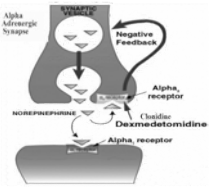


- Alpha-2 Agonists
- NMDA Antagonist
- GABA-type A
- Local Anesthetics
- Steroids
- Beta-Blockade

Opioid-Sparing: Innovation

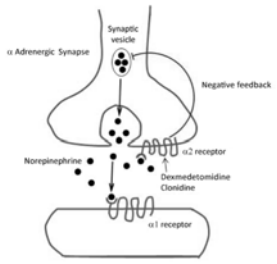


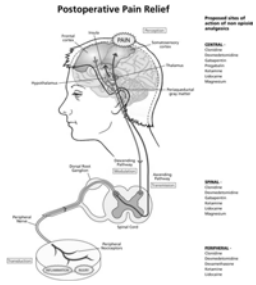
- Alpha-2 Agonists



Alpha-2 Agonist
(Clonidine, Dexmedetomidine)

(Infusion: 0.3 mcg/Kg/Hr)

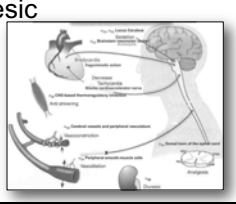




Alpha-2 Agonist
(Clonidine, Dexmedetomidine)

Infusion: 0.3 mcg/Kg/Hr

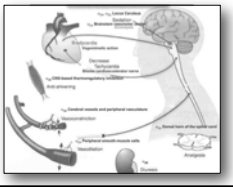
- anti-hypertensive effect
- sedative, anxiolytic, analgesic
  - **Modulation Pain Pathway**
- side effects:
  1. Bradycardia
  2. Hypotension
  3. Sedation



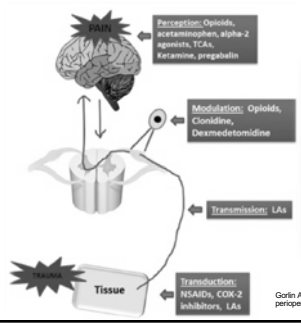
Alpha-2 Agonist
(Clonidine, Dexmedetomidine)

Infusion: 0.3 mcg/Kg/Hr

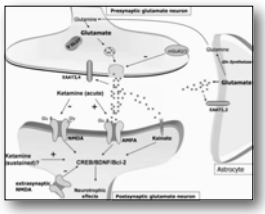
- Analgesic, sedative
  - Not studied to date for immune modulation



Opioid-Sparing: Innovation



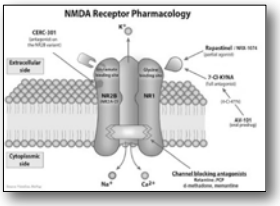
- NMDA Antagonist

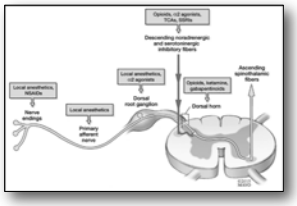


Gorlin AW, Rosenfeld DM, Ramakrishna H. Intravenous sub-anesthetic ketamine for perioperative analgesia. J Anaesthesiol Clin Pharmacol 2016;32:160-7

NMDA Receptor Antagonist
(Ketamine)

Infusion: 10 mg/Hr





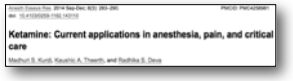
NMDA Receptor Antagonist
(Ketamine)

Infusion: 10 mg/Hr

"*survived the strong winds of time*"

Wide variety of clinical applications & newly found effects;

1.Neuroprotective
2.Anti-inflammatory
3.Anti-tumor Effects


Ketamine: Current applications in anesthesia, pain, and critical care

" usefulness of low dose ketamine regimens have helped to widen the clinical application profile of ketamine. "

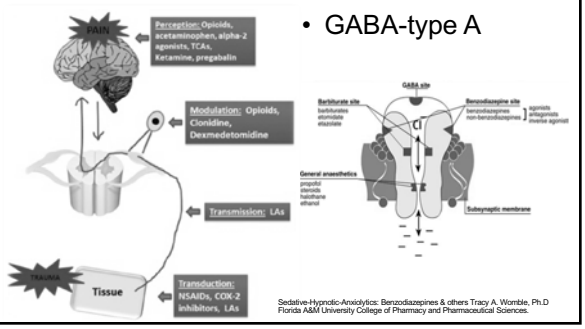
NMDA Receptor Antagonist
(Ketamine)

Infusion: 10 mg/Hr

- Activates the innate immune function
- significantly reduced lung metastasis when administered prior to surgery
- Decrease: IL-6, TNF-α
- Optimizes NK cells (benefit)
  - Doses as low as 0.15 mg/kg

DeClue AE, Cohn LA, Lechner ES, et al. Effects of subanesthetic doses of ketamine on hemodynamic and immunologic variables in dogs with experimentally induced endotoxemia. Am J Vet Res 2008;69:228–32

Opioid-Sparing: Innovation

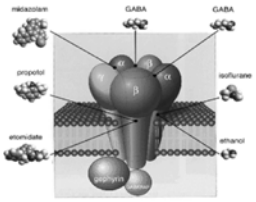


- GABA-type A

Sedative-Hypnotic-Anxiolytics: Benzodiazepines & others Tracy A. Womble, Ph.D Florida A&M University College of Pharmacy and Pharmaceutical Sciences.

Sedative Hypnotic
(Propofol)

Infusion: 25-150 mcg/Kg/minute



Traditional Methodology: Direct Cost

Drug	Cost per Unit	Units	Total Cost
Midazolam	$2.40	1	$2.40
Famotidine	$2.53	1	$2.53
Sufentanil	$8.00	3	$24.00
Propofol	$2.30	1	$2.30
Cis-Atracurium	$24.40	3	$73.20
Glycopyrrolate	$46.75	1	$46.75
Neostigmine	$52.85	1	$52.85
Desflurane	$6.99	6	$41.94
Crystalloid	$1.95	3	$5.85
Ondansetron	$0.70	2	$1.40
Bupivicaine	$36.64	1	$36.64
Hydromorphone	$8.08	1	$8.08
		Total Cost	**$297.94**

ERAS Methodology: Direct Cost
(**The Alternative**)

Drug	Cost per Unit	Units	Total Cost
Gabapentin	$12.00	1	$12.00
Celebrex	$4.15	1	$4.15
Tramadol	$7.35	1	$7.35
Acetaminophen	$35.40	3	$106.20
Alvimopan	$700.00	1	$700.00
Dexmedetomidine	$31.92	1	$31.92
Propofol	$2.30	9	$20.70
Ketamine	$21.24	1	$21.24
Lidocaine 0.4%	$2.53	1	$2.53
Albumin 5%	$83.72	3	$251.16
Glycopyrrolate	$46.75	1	$46.75
Neostigmine	$52.85	1	$52.85
Crystalloid	$1.95	1	$1.95
Ondansetron	$0.70	2	$1.40
Bupivicaine	$36.64	1	$36.64
Liposomal Bupivicaine	$285.00	1	$285.00
Hydromorphone	$8.08	1	$8.08
		Total Cost	**$1,428.30**

Variable Cost of Adverse Drugs Events (ADE)

- PONV
- Ileus
- Respiratory Depression
- Immobility/DVT
- Urinary Retention
- Mental Status Change
- Increased LOS
- 30 Day Readmission

Post-Operative Nausea & Vomiting (PONV)

Post-Operative Nausea & Vomiting (PONV)

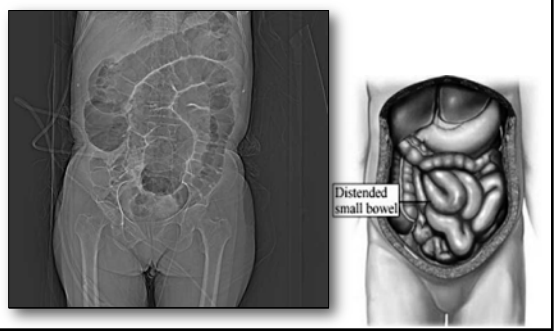
- **15%-33% occurrence** surgical outpatients
- Adjusted **incremental cost $75** (95% CI - $67-$86) per patient
  - **$87.12 per patient** today
- Average **Delayed Discharge** by 60 minutes (234 min. versus 171 min.)
- **Lasting Effects**; up to 72 hours
- **Quality of Life:** lower for PONV – **The Intangible**
  - Only 49% rate 1 for PONV versus 94% rated 1 for POD 1 to 3
    - Most Patients experiencing PONV at 72 hours

REPORTS OF ORIGINAL INVESTIGATIONS

A time-motion economic analysis of postoperative nausea and vomiting in ambulatory surgery

Ivan Parra-Sanchez, MD · Rania Abdallah, MD · Jing You, MS · Alex Z. Fu, PhD · Martin Grady, MD · Kenneth Cummings III, MD · Christian Apfel, MD · Daniel I. Sessler, MD

Post-operative Ileus (POI)



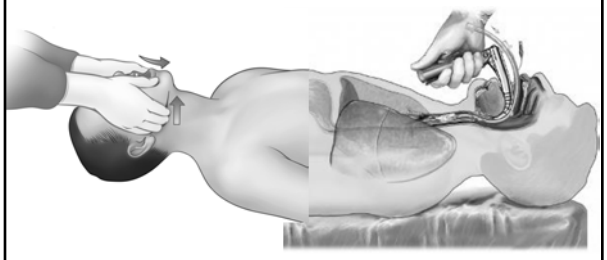
Post-Operative Ileus (POI)

- **Occurrence:** 10-40% in patients undergoing Radical Cystectomy
  - **Average Occurrence Rate**: 15.6%
  - POI Contributes to 50-70% of all complications
  - **Increases LOS:** mean of **4 days** (Range: 3-10 days)
    - **Doubles the cost** of Hospital Stay
  - **Cause:** Opioid binding to gastrointestinal mu-receptors
  - Additional **Overall Cost** due to POI**: $10,246.00 per event**

- **Prevention:** Alvimopan which binds to gastrointestinal mu-receptors
- **Direct Cost:** $700 per hospital stay
- **Results:** 50% Rate Reduction in POI to 7.8%

Alvimopan for prevention of postoperative paralytic ileus in radical cystectomy patients: a cost-effectiveness analysis

Respiratory Depression: ORAE



Respiratory Depression:

PHARMACOECONOMICS AND OUTCOMES IN PAIN AND PALLIATIVE CARE

Gary M. Ozkeda, Tong J. Gan, Bernadette H. Johnson, and Scott B. Robinson

Effect of Opioid-Related Adverse Events on Outcomes in Selected Surgical Patients

- N = **319,898**
- Incidence: **3.3%** (12.2% Overall)
- Cost: **$155.33 per patient**
- LOS: **3.3 Days**
- 30-Day Readmission: 6.4%

Post-Operative Urinary Retention (POUR)

Postoperative Urinary Retention (POUR)

- **Occurrence: 2.1%**, based on the Surgical Care Improvement Project
  - **Sample Size**: **415,409** surgical patients
  - **Study:** 43,030 developed POUR
    - POUR Contributed **9.2%** of Urinary Tract Infections
  - **Increases LOS:** mean of 1.1 days

National incidence and outcomes of postoperative urinary retention in the Surgical Care Improvement Project

Alex K. Wu, M.D.[a,*], Andrew D. Auerbach, M.D.[a], David S. Aaronson, M.D.[a,b]

[a]Department of Urology, University of California San Francisco, San Francisco, CA, USA; [b]Department of Urology, Kaiser Permanente Medical Group, Oakland, CA, USA

Variable Cost Benchmarks

Incidence: Variable Cost Per Episode

Incidence	Cost Per Episode	Probability
Respiratory Depression	$568.00	3.30%
PONV	$87.12	15.00%
Post-Operative Ileus	$10,247.00	15.60%
Urinary Retention	$1,357.00	2.00%
Mental Status Change	$2,500.00	15.00%
DVT	$4,159.00	2.20%
30-Day Readmission	**$11,200.00**	5.40%
Length of Stay	$2,064.00/Day	10.0 Days

Cost Benefit & Cost Effectiveness

A Factor of 5.6

Traditional Strategy	Incidence	Opioid-Sp
8.00%	Pruritus	**0.00%**
3.30%	Respiratory Depression	**0.00%**
15.00%	PONV	7.50%
15.60%	Post-Operative Ileus	7.80%
2.00%	Urinary Retention	**0.00%**
15.00%	Mental Status Change	3.00%
2.20%	DVT	1.00%
5.40%	30-Day Readmission	**0.00%**
10.0 Days	Length of Stay	**7.00 Days**
$1,379.38	Cost Per Episode (Probability)	$247.69

Summary

- Public Health: Opioid Pandemic
- Opioid Crisis
- Non-Opioid Framework
- Non-Opioid Premise
- Non-Opioid Theory
- Non-Opioid Techniques
- Opioid Rescue