MULTIMODAL ANALGESIA

Kelly Mayson
December 4th, 2016
BCAS/WSSA Meeting
Disclosures

- Speaker for 3M on perioperative hypothermia in 2015
Objectives

- Review the importance of multimodal analgesia
- Perioperative use of acetaminophen and NSAIDS
- Perioperative use of IV lidocaine infusions
- Perioperative use of ketamine
- Literature review and local experience
Multimodal analgesia

- Optimization of pain management is a key component to an Enhanced Recovery After Surgery Protocol.
- Defined as the administration of two or more drugs that act by different mechanisms for providing analgesia.
- Effective analgesia and minimize opioid-related side effects.
- VH definition of “adherence to multi-modal analgesia within ERAS”: minimum of two non-opioid modalities.
Adverse Effect of Under Treatment of Perioperative Pain

- Risk of thromboembolic complications
- Pulmonary complications
- Prolonged PACU, ICU, hospital stay
- Hospital re-admissions for further pain management
- Needless suffering
- Impairment of health related quality of life
- Development of chronic pain
Guidelines on Postoperative Pain

- 32 recommendations
- Only 4 supported by high quality of evidence
- Recommendation 6: “The panel recommend that clinicians offer multimodal analgesia, or the use of variety of analgesia and techniques combined with non-pharmacological interventions”
Strong Recommendations/High Quality Evidence

- **Recommendation 23:** “Clinicians consider surgical site-specific peripheral regional anesthesia techniques”

- **Recommendation 25:** “Clinicians offer neuroaxial analgesia for major thoracic and abdominal procedures, particularly in patients at risk for cardiac and/or pulmonary complications, or prolonged ileus”

- **Recommendation 15:** “Clinicians provide acetaminophen and NSAIDS as a part of multimodal analgesia for management of postoperative pain in patients without contraindications”
Acetaminophen

- Reduce opioid consumption by ~30%
- Prophylactic dose of ~1 g IV preop reduced nausea by 30% and pain if given prior to surgical incision
  - Apfel CC et al. Pain 2013;154:677-89
- Route of administration
  - Pharmacological studies show higher and earlier plasma and CSF levels with IV
  - Rectal absorption can erratic
  - Systemic review—no evidence that increased bioavailability of the IV form enhances efficacy outcomes
NSAIDS

- Strong evidence that they have benefit

- Recent meta-analysis found that administration during surgery is more effective than administration pre-emptively or after surgery

- Classical NSAIDs—are more effective in early pain after laparoscopy than COX-2 inhibitors

- A number of meta-analysis, RCT, Cohort, retrospective have not demonstrated an effect on overall mortality, CVS events*, surgical bleeding, or renal impairment in patient without kidney disease, and normal pre-op function
Nonsteroidal Anti-inflammatory Drugs and Anastomotic Dehiscence in Bowel Surgery: Systematic Review and Meta-Analysis of Randomized, Controlled Trials

Thomas P. Burton, M.B.Ch.B., Anubhav Mittal, M.B.Ch.B., Ph.D., F.R.A.C.S., Mattias Soop, M.D., Ph.D.

1 Department of Surgery, The University of Auckland, Auckland, New Zealand
2 Colorectal Surgery Unit, Department of Surgery, North Shore Hospital, Auckland, New Zealand

Dis Colon Rectum 2013:56:126

5.1% vs 2.4%

OR ratio non-selective 2.37

Postoperative Nonsteroidal Anti-inflammatory Drugs and Risk of Anastomotic Leak: Meta-analysis of Clinical and Experimental Studies

Aneel Bhangu, Prashant Singh, J. Edward F. Fitzgerald, Alistair Slessor, Paris Tekkis

OR ratio non-selective 2.37
• 13,082 patient undergoing bariatric or colorectal surgery, and 24% (3158 pts) received NSAIDS.
• Anastomotic leak was 4.8 vs 4.2%. This association was isolated to non-elective colorectal surgery, for which the leak rate was 12.3% in NSAID vs 8.3% in the non group OR 1.70
 Reviewed the two prior meta-analysis and now 12 studies.
*Smith et al concluded that there was an OR 1.46 (1.14-1.86) of anastomotic dehiscence in observational studies
*Slim—48 hours of NSAID likely safe, but should not be used if risk factors for anastomotic leaks—advanced age, malnutrition, severe co-morbidities, and or intraoperative difficulties
NSAID in Orthopedic/Spine Surgery

- Animals studies suggest a link between bone non-union but no high quality evidence in humans
- Some observational studies suggest a possible association between high dose NSAID and non-union in spinal fusion
- High quality and pediatric studies do not show an statistical difference in non-union
NSAIDs and Risk of Heart Failure

- Large retrospective study—10 year, 10 million pts, 4 European countries

- Use of NSAID in the prior 14 days was associated with a 19% risk of heart failure OR 1.19 (1.17-1.22)

- Dependent on NSAID
  - Naproxen OR 1.16 (1.07-1.27)
  - Ketorolac OR 1.83 (1.66-2.02)
  - Ibuprofen OR 1.18 (1.12-1.23)
  - Diclofenac OR 1.19 (1.15-1.24)
  - Celecoxib—OR 0.96 (0.9-1.02) no increased risk

BMJ 2016: 28: 354
~24,000 patients: 3 groups—celecoxib 100 mg BID (200 mg BID), naproxen 375 mg BID (500 mg BID), ibuprofen 600 mg TID (800 mg TID)

Risk of major adverse CVS complication: celecoxib 4.2%, naproxen 4.3%, ibuprofen 4.8%
NSAID “recommendations”

- NSAID should likely be avoided in non-elective colorectal surgery
- Avoid in patients with epidurals who are receiving VTE prophylaxis
- Risks /benefits of NSAID must be determined
  - Cardiac hx/CHF
  - Renal function
  - Surgical procedure
  - Risk of anastomotic leaks
- Need to be discussed at debriefing and if appropriate give prior to emergence
Recommendation 19: IV lidocaine

Clinicians should consider IV lidocaine in adults who undergo open and laparoscopic surgery who not have contraindications

- Weak recommendation
- Moderate quality of evidence
Systemic Lidocaine

- Anti-inflammatory analgesic
  - Inhibition of N-methyl-D-aspartate receptors and leukocyte priming
  - Stimulates the secretion of the anti-inflammatory cytokine interleukin-1 receptor antagonist

- Antihyperalgesic

- Selective depression in pain transmission in the spinal cord and reduction in tonic neural discharge of active peripheral fibers
Lidocaine infusions

Impact of Intravenous Lidocaine Infusion on Postoperative Analgesia and Recovery from Surgery
A Systematic Review of Randomized Controlled Trials
Grace C. McCarthy, Sohair A. Megalla and Ashraf S. Habib
Department of Anesthesiology, Duke University Medical Center, Durham, North Carolina, USA

Benefit in both open and MIS abdominal surgery
Decreased opioid requirements postoperatively, decreased PONV
Accelerated return of bowel function
Doses 100 mg bolus, 1.5-3 mg/kg/hr in OR +/- 1 hr in PACU
2011- meta-analysis

- 29 studies. Lidocaine reduced pain scores, opioid requirements, time to first flatus. Abdominal surgery was strongly associated with benefit.
Continuous intravenous perioperative lidocaine infusion for postoperative pain and recovery (Review)

Efficacy and safety of intravenous lidocaine for postoperative analgesia and recovery after surgery: a systematic review with trial sequential analysis†

S. Weibel¹,* J. Jokinen¹, N. L. Pace², A. Schnabel¹, M. W. Hollmann³, K. Hahnenkamp⁴, L. H. J. Eberhart⁵, D. M. Poepping⁶, A. Afshari⁷ and P. Kräcke¹
**IV Lidocaine vs placebo**

- Decreased early pain scores in MIS and open abdominal procedures
  - ≥ 2 mg/kg/hr

- VAS pain scores 4-24 hrs; lidocaine in MIS was beneficial

- Decreases ileus, time to first flatus, BM

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### Table 1. Open Abdominal Surgery

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Lidocaine</th>
<th>Placebo</th>
<th>Mean difference</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bryson 2010</td>
<td>3.9</td>
<td>4.6</td>
<td>0.7</td>
<td>0.0%</td>
</tr>
<tr>
<td>Casasuso 1985</td>
<td>1.57</td>
<td>1.7</td>
<td>0.14</td>
<td>1.0%</td>
</tr>
<tr>
<td>Grady 2012</td>
<td>4.23</td>
<td>4.9</td>
<td>0.67</td>
<td>0.0%</td>
</tr>
<tr>
<td>Herreder 2007</td>
<td>4.8</td>
<td>5.6</td>
<td>0.83</td>
<td>1.8%</td>
</tr>
<tr>
<td>Kuo 2006</td>
<td>3.3</td>
<td>4.0</td>
<td>0.68</td>
<td>0.0%</td>
</tr>
<tr>
<td>Yerdeni 2009</td>
<td>4.06</td>
<td>4.53</td>
<td>0.47</td>
<td>0.5%</td>
</tr>
<tr>
<td>Subtotal (95% Cl)</td>
<td>95</td>
<td>95</td>
<td>0.0</td>
<td>16.7%</td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2=0.00; \chi^2=0.04, df=2 (P=0.98); I^2=0.0%$

Test for overall effect: $Z=4.51 (P<0.00001)$

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### Table 2. Laparoscopic Abdominal Surgery

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Lidocaine</th>
<th>Placebo</th>
<th>Mean difference</th>
<th>IV, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kaba 2007</td>
<td>2.0</td>
<td>3.0</td>
<td>1.0</td>
<td>8.7%</td>
</tr>
<tr>
<td>Kim 2011</td>
<td>2.65</td>
<td>3.8</td>
<td>0.13</td>
<td>16.1%</td>
</tr>
<tr>
<td>Kim 2013</td>
<td>4.3</td>
<td>6.3</td>
<td>0.38</td>
<td>3.3%</td>
</tr>
<tr>
<td>Lauwrick 2006</td>
<td>3.0</td>
<td>3.0</td>
<td>0.0</td>
<td>5.2%</td>
</tr>
<tr>
<td>Saadawy 2010</td>
<td>1.8</td>
<td>4.7</td>
<td>2.9</td>
<td>7.9%</td>
</tr>
<tr>
<td>Tkuisis 2014</td>
<td>3.0</td>
<td>4.5</td>
<td>1.5</td>
<td>7.3%</td>
</tr>
<tr>
<td>Wu 2005</td>
<td>2.6</td>
<td>3.3</td>
<td>0.7</td>
<td>9.6%</td>
</tr>
<tr>
<td>Wuethrich 2012</td>
<td>2.2</td>
<td>2.4</td>
<td>0.2</td>
<td>3.8%</td>
</tr>
<tr>
<td>Yang 2014</td>
<td>3.23</td>
<td>4.06</td>
<td>0.83</td>
<td>8.9%</td>
</tr>
<tr>
<td>Subtotal (95% Cl)</td>
<td>237</td>
<td>233</td>
<td>0.0</td>
<td>62.2%</td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2=0.23; \chi^2=17.71, df=8 (P=0.00001); I^2=93%$

Test for overall effect: $Z=6.10 (P<0.00001)$

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Favors lidocaine
IV Lidocaine

- Secondary outcomes
  - Decreased PONV
  - Decrease length of stay
  - Decreased intraoperative and postoperative opioid requirements

- Only 17/45 of studies systematically looked at adverse effects, but there does not seem to increased risk

- Optimal dose and duration of infusion is still unclear
Other surgical procedures

<table>
<thead>
<tr>
<th>Study</th>
<th>Percent</th>
<th>Lower CI</th>
<th>Upper CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farag 2013</td>
<td>4.2</td>
<td>5.28</td>
<td>57</td>
</tr>
<tr>
<td>Grigoras 2012</td>
<td>1.68</td>
<td>1.9</td>
<td>17</td>
</tr>
<tr>
<td>Insler 1995</td>
<td>3.5</td>
<td>1.5</td>
<td>44</td>
</tr>
<tr>
<td>Kang 2011</td>
<td>2.7</td>
<td>1.13</td>
<td>32</td>
</tr>
<tr>
<td>McKay 2009</td>
<td>3.1</td>
<td>2.04</td>
<td>29</td>
</tr>
<tr>
<td>Omar 2013</td>
<td>3.0</td>
<td>2.22</td>
<td>24</td>
</tr>
<tr>
<td>Slovack (unpublished)</td>
<td>2.9</td>
<td>2.6</td>
<td>19</td>
</tr>
<tr>
<td>Striebel 1992</td>
<td>4.9</td>
<td>2.</td>
<td>20</td>
</tr>
<tr>
<td>Subtotal (95% CI)</td>
<td>4.9</td>
<td>2.</td>
<td>20</td>
</tr>
</tbody>
</table>

Heterogeneity: $\tau^2=0.23; \chi^2=8.46, df=5 (P=0.13); I^2=41\%$

Favors lidocaine
116 patients elective multilevel spine surgery +/- instrumentation

2 mg/kg/hr infusion starting at induction and continued until discharge from PACU, or a max 8 hr vs saline

Case duration mean 269 min

Pain scores, opioid requirements, N&V, LOS, 30 day complication, quality of life
“Complex” spine surgery post-discharge

- 30 day complication OD 0.91 (0.84-1.00) p=0.045
- Quality of life –validated Health Survey SF-12
- Lidocaine patients had higher SF-12 composite scores
- Limitation: did not assess quality of life prior to surgery

<table>
<thead>
<tr>
<th></th>
<th>Placebo</th>
<th>Lidocaine</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-12 physical 1M</td>
<td>33(27-42)</td>
<td>38(31-47)</td>
<td>0.002</td>
</tr>
<tr>
<td>SF-12 physical 3M</td>
<td>34(28-44)</td>
<td>39(31-47)</td>
<td>0.04</td>
</tr>
<tr>
<td>SF-12 mental 1M</td>
<td>54(46-59)</td>
<td>56(50-61)</td>
<td>0.74</td>
</tr>
<tr>
<td>SF-12 mental 3M</td>
<td>54(43-60)</td>
<td>58(50-61)</td>
<td>0.08</td>
</tr>
</tbody>
</table>

Anesth 2013:119: 932-40
Postoperative Use of Lidocaine

- Majority of studies ran infusions in OR or for an additional 1 hour in PACU
- Limited studies of prolonged infusions
  - Complex spine surgery—most OR ~ 4 hr, infusions for a maximum of 8 hours or until discharge from PACU (2 mg/kg/hr)
  - Grady et al. 2012—open hystectomy: \(1.2 \text{ mg/kg/hr} \times 24 \text{ hr}\)
  - Cassuto et al. 2012—2 mg/min X 24 hr
  - Horroeder 2007—2 mg/min 4 hours, stayed in PACU for additional 30 minutes
  - Kohr et al. 2007—Laparoscopy CR: \(1.33 \text{ mg/kg/hr} \times 24 \text{ hours}\)
  - Tikuisis et al. 2014—1 mg/kg/hr in PACU
  - Swenson et al. 2010—postop until 24 hours after return of bowel function (2 mg/min for pt < 70 kg, and 3 mg/min > 70 kg)
Lidocaine “protocols”

- American Society of Enhanced Recovery (ASER)
  - [www.aserhq.ors/protocols](http://www.aserhq.ors/protocols)
- University of Virginia—Intraoperative lidocaine and postoperative lidocaine until POD 2
- Beaumont Hospitals—1.5 mg/kg bolus and then 2 mg/kg/hr in OR
- John Hopkins 1.5 mg/kg bolus and infusion 1.5/kg/hr in OR
- McGill University 1.5 mg/kg bolus and 2 mg/kg/hr in OR
- Vanderbilt 1.5 bolus and 2mg/kg/hr intraop infusion. Postop 1mg/min < 70 kg, 1.5mg/min 70-100 kg, 2 mg/min for > 100 kg
IV Lidocaine vs. Thoracic Epidural

- Two studies
- 42 pts/60 pts
- Not inferior
A Clinical Comparison of Intravenous and Epidural Local Anesthetic for Major Abdominal Surgery


- Retrospective study UVa
- 216 patients (108 each arm)
- Majority (88.5%) lidocaine started in OR 2-3 mg/min
- Postop 0.5-1.0 mg/min
Patient Demographics: IV lidocaine vs Epidural

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Lidocaine Group (n = 108)</th>
<th>Epidural Group (n = 108)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y</td>
<td>57.3 (14.8)</td>
<td>58.2 (13.7)</td>
<td>0.706</td>
</tr>
<tr>
<td>Sex‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>39</td>
<td>49</td>
<td>0.439</td>
</tr>
<tr>
<td>Female</td>
<td>69</td>
<td>59</td>
<td>0.555</td>
</tr>
<tr>
<td>Body mass index, kg/m²</td>
<td>26.8 (23.1–30.7)</td>
<td>27.2 (23.0–32.0)</td>
<td>0.881</td>
</tr>
<tr>
<td>Chronic preoperative opioid use‡</td>
<td>33</td>
<td>25</td>
<td>0.432</td>
</tr>
<tr>
<td>Procedure anatomical site‡</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Bladder/prostate</td>
<td>8</td>
<td>6</td>
<td>0.808</td>
</tr>
<tr>
<td>2. Colorectal</td>
<td>19</td>
<td>42</td>
<td>0.013</td>
</tr>
<tr>
<td>3. Gastric</td>
<td>6</td>
<td>1</td>
<td>0.119</td>
</tr>
<tr>
<td>4. Gynecology</td>
<td>27</td>
<td>16</td>
<td>0.171</td>
</tr>
<tr>
<td>5. Hepatobiliary</td>
<td>11</td>
<td>3</td>
<td>0.052</td>
</tr>
<tr>
<td>6. Small bowel</td>
<td>29</td>
<td>27</td>
<td>0.929</td>
</tr>
<tr>
<td>7. Spleen/pancreas</td>
<td>6</td>
<td>5</td>
<td>1</td>
</tr>
</tbody>
</table>

*Presented as mean (SD), P value from simple t test.
†Presented as frequency, P value from χ² or Fisher exact test.
Pain Scores and Opioid consumption

Pain Scores

- Superiority region
- Non-inferiority region
- Inferiority region

Opioid consumption

- Superiority region
- Non-inferiority region
- Inferiority region

Difference in pain scores
Mean (Lidocaine) − Mean (Epidural)

Ratio of average morphine consumption
Mean (Lidocaine) / Mean (Epidural)
## Summary of Secondary Outcomes

<table>
<thead>
<tr>
<th></th>
<th>LIDOCAINE IV</th>
<th>EPIDURAL</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypotension</td>
<td>3.7% (N=4)</td>
<td>26.1% (N=25)</td>
<td>&lt; 0.0001</td>
</tr>
<tr>
<td>PONV POD 1</td>
<td>13% (N=14)</td>
<td>25.2% (N=25)</td>
<td>0.09</td>
</tr>
<tr>
<td>PONV POD 2</td>
<td>12.1% (N=12)</td>
<td>27.1% (N=28)</td>
<td>0.042</td>
</tr>
<tr>
<td>Urinary Retention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pruritus</td>
<td>2.8% (N=3)</td>
<td>27.1% (N=38)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Foley out (hrs)</td>
<td>26 (20-58)</td>
<td>50 (37-96)</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Time to first BM (hrs)</td>
<td>61 (41-85)</td>
<td>84 (53-107)</td>
<td>0.019</td>
</tr>
</tbody>
</table>
LIDOCAINE INFUSION VGH experience (N=98)

<table>
<thead>
<tr>
<th></th>
<th>LIDOCAINE INFUSION</th>
<th>NO LIDOCAINE INFUSION</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>PACU Fentanyl</td>
<td>34.2 (59.2) ug</td>
<td>81.7 (77.9) ug</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>PACU Hydromorphone</td>
<td>0.76 (1.3) mg</td>
<td>1.46 (1.3) mg</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Excessive Pain in PACU</td>
<td>4.25%</td>
<td>18.4%</td>
<td>&lt;0.05</td>
</tr>
</tbody>
</table>

Bolus of 1.5 mg/kg and run on an infusion of 1-2 mg/kg/hr in OR only.
VGH Lidocaine Experience Within an ERAS program

- Colorectal cases—consider in MIS and open cases when epidurals contraindicated
  - 53.4% of cases currently receiving a lidocaine infusion
- Conversion of MIS to open—consider postoperative infusion
- Radical Cystectomy Cases—consider in robotic cases. Open cases currently receiving epidurals or rectus sheath
- Gynecology/Oncology Cases—MIS and open. Consider postoperative infusions in complex surgery with bowel resection—intraoperative usage 20.5%
Contraindications

- Unstable coronary disease, Recent MI
- Heart failure
- 1\textsuperscript{st} and 2\textsuperscript{nd} degree heart conduction block
- Electrolyte disturbances
- Liver disease
- Seizure disorder
Compatibility

- NS
- D5W
- LR
- Plasmalyte
Monitor for Adverse Effects

- **MILD**
  - Numbness & tingling in fingers in toes, or inside mouth
  - Lightheadness, dizziness, visual disturbances, confusion
  - Metallic taste
  - Ringing in ears

- **MODERATE**
  - Nausea and vomiting
  - Decreased hearing
  - BP changes and HR
  - Confusion

- **SEVERE**
  - Loss of consciousness
  - Muscle twitching
  - Convulsions
  - Cardiac arrhythmias, cardiac arrest
If Adverse Events Occur

- Stop Infusion
- Page Perioperative Pain Service/Anesthesia
- Regional Cart with Intralipid from OR then sent to ward if necessary
Recommendation 18: Ketamine

- Clinicians consider IV ketamine as a component of multimodal analgesia in adults
- Weak recommendation
- Moderate quality evidence
Ketamine

- NMDA Receptor antagonist
- FDA approved in 1970

Figure 2
The activated primary nociceptive afferent from the periphery releases glutamate at the second order sensory neuron in the dorsal horn of the spinal cord which binds to N-methyl-d-aspartate receptors. Ketamine blocks the N-methyl-d-aspartate receptor ...
Review Article

Peri-operative ketamine for acute post-operative pain: a quantitative and qualitative systematic review (Cochrane review)

R. F. Bell¹, J. B. Dahl², R. A. Moore³ and E. Kalso⁴

2005
Peri-operative ketamine for acute post-operative pain: a

A systematic review of intravenous ketamine for postoperative analgesia

Revue méthodique de l’utilisation de la kétamine intraveineuse pour l’analgésie postopératoire

Kevin Laskowski, MD · Alena Stirling, MD · William P. McKay, MD · Hyun J. Lim, MD
Systematic Review

Pain Medicine 2015; 16: 383–403
Wiley Periodicals, Inc.

ACUTE & PERIOPERATIVE PAIN SECTION

Original Research Article
The Use of Intravenous Infusion or Single Dose of Low-Dose Ketamine for Postoperative Analgesia: A Review of the Current Literature

Jouguelet-Lacoste J, La Colla L, Schilling D, Chelly JE 2015
“Low” dose Ketamine

- < 1.2 mg/kg/hr as a continuous infusion and or < 1 mg/kg when given as a bolus

- 23/34 studies – mean reduction of opioid consumption was 40%. The degree of opioid consumption tended to be correlated with the dose of ketamine administered, however a clear dose-related effect could not be drawn

- It was not associated with serious side effects or a significant increase in the likelihood of adverse events

- No impact on sedation scores

- Long term effect on residual pain when administered as an IV infusion (intraop or intraop +24 hrs, but not as a single dose
Suggested Doses?

- 0.15 - 0.5 mg/kg bolus at induction
- 0.042 mg/kg/hr—0.6 mg/kg/hr in OR
  - Stop 45 minutes prior to emergence with laparoscopic procedures, and decrease dose by 50% with open
- Postoperatively 0.042—0.09 mg/kg/hr up to 48 hr
Mayo Clinic Recommendation

- Painful procedures
- Surgery with high risk for developing chronic postsurgical pain
- Opioid tolerant patients
- Patients with opioid-induced hyperalgesia
- Desire to minimize perioperative opioids

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Short case (<60 min)
- 0.1-0.3 mg/kg IV bolus with induction

Long case but no plan for postoperative infusion
- 0.1-0.3 mg/kg IV bolus with induction
- Repeat bolus 0.1-0.3 mg/kg every 30-60 min during operation
- Avoid dose within 30 min of emergence

Planning on postoperative infusion
- 0.1-0.3 mg/kg IV bolus with induction followed by 0.1-0.2 mg/kg/h infusion
- Infusion can be continued for 24-72 h
- After 24 h consider reducing dose to 10 mg/h or less

*IV = Intravenous*
VGH Ketamine Usage

- 0.25-0.5 mg/kg bolus
- Infusion rates 0.125-0.25 mg/kg/hr or 10 mg/hr
- Postoperative rates for opioid tolerant patients 5-15 mg/hr
- Colorectal ERAS cases
  - 20.5% of cases
- Gynecology Oncology ERAS cases
  - 37.2% of cases are receiving intraoperatively
Questions?

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