2012 Summer Externs

**Extern: Dana Lemoine, ASLAP Foundation Summer Fellowship**

- Student, Ontario Veterinary College – University of Guelph, Guelph, ON, Canada.
- Projected graduation 2015
- Involved with ASLAP, Canadian Veterinary Medical Association and the Ontario Veterinary Medical Association

**Mentor: Carrie Freed, MLAS, DVM, DACLAM, Director, Rodent Clinical Medicine ULAR; Assistant Professor, Clinical Veterinary Preventive Medicine**

Dr. Freed is a clinical veterinarian for OSU facilities and as the Director of Rodent Clinical Medicine provides clinical and didactic support for the Laboratory Animal Residency Program. She is a member of ASLAP and AALAS, serves on the OSU IACUC, the Institutional Biosafety Committee, and is a Veterinarian for the BSL3.

**Research Project:** “Assessment of Alternatives to Sterile Surgeon’s Gloves for Survival Surgery in Rodents”
INTRODUCTION

What are the standards & regulations regarding survival surgery in rodents?
- The Animal Welfare Act and Animal Welfare Regulations exclude rats of the genus Rattus and mice of the genus Mus bred for research.¹
- According to the Guide, survival surgery in rodents requires aseptic technique and instruments.²

INTRODUCTION

What is “aseptic technique”?
- Reduces microbial contamination to the lowest possible practical level
- According to the Guide², this includes:
  - Preparation of the patient
  - Preparation of the surgeon, such as:
    - Decontaminated surgical attire
    - Surgical scrub
    - Sterile surgical gloves
  - Sterilization of instruments, supplies & implanted materials
  - The use of operative techniques to reduce the likelihood of infection

INTRODUCTION

The Guide² also states:

“The species of animal may influence the manner in which principles of aseptic technique are achieved... General principles of aseptic technique should be followed for all survival surgical procedures.”
Laboratory workers fail to follow the recommendation to wear sterile gloves for survival rodent surgeries. Attributed to the high cost of surgical gloves. $47/box of 50, $98/case of 500. $0.75 savings per pair.

PART 1

THE EFFECTS OF AUTOCLAVING ON EXAM GLOVE INTEGRITY

Database searches did not bring up any literature on the effects of autoclaving modern disposable exam gloves.

- 1960: Surgeon’s rubber gloves sterilized at high temperatures (115-120°C) become vulcanized and unusable.
- 1963: Steam sterilization of surgeon’s rubber gloves reduced the tensile strength of the gloves and increased breaking elongation.

- Keep in mind
  - This is before the widespread use of disposable gloves
  - Glove manufacturing and quality control criteria have changed since the 60s

ARE THERE SUITABLE ALTERNATIVES TO USING STERILE SURGICAL GLOVES FOR SURVIVAL SURGERY IN RODENTS?

There is some existing data on the integrity and barrier quality of exam and surgical gloves. Not a completely impermeable barrier. Fail at rates ranging from 1-10%. Evaluating glove integrity:

- The FDA has a standard test procedure for medical examination & surgeon’s gloves
  - May not be sufficient to detect micro-perforations
- One study used an air inflation test

BACKGROUND INFORMATION

Autoclave sterilization:

- Sterilizes contents through exposure to high-pressure saturated steam at high temperatures
- Pre-vacuum removes trapped air from the autoclave to ensure proper steam sterilization
- Sterilization relies on a combination of PRESSURE, TEMPERATURE and TIME
- Temperature tape and chemical indicator strips are used to verify that sterilization parameters were reached.
**DESIGN**

CONTROLS: Sterile latex & nitrile, Unsterilized latex & nitrile exam gloves

EXPERIMENTAL:

<table>
<thead>
<tr>
<th>Glove Type</th>
<th>Pack Type</th>
<th>Position in Pack</th>
<th>Days Post Sterilization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Latex</td>
<td>Drape</td>
<td>Top</td>
<td>0</td>
</tr>
<tr>
<td>Standard Nitrile</td>
<td>Drape + Instruments</td>
<td>Middle</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Peel pouch + Instruments</td>
<td>Bottom</td>
<td>7</td>
</tr>
</tbody>
</table>

Each pair of gloves represents 2 data points
3 reps of each glove/pack type combination → 6 data points/condition

**PACK SETUP**

- Gloves were visually inspected for defects prior to packing
  - Any found to be defective were removed from the study
- Cuffs were folded over approximately 2½”

**DRAPE:**
5 pairs of gloves wrapped in a blue surgical towel

**DRAPE + INSTRUMENTS:**
5 pairs of gloves, 1 forceps, 1 scissors, 1 needle driver and 4 4x4 gauze pieces wrapped in a blue surgical towel

**POUCH + INSTRUMENTS:**
5 pairs of gloves, 1 forceps, 1 scissors, 1 needle drive and 4 4x4 gauze pieces in a 7x12 autoclave pouch

**TESTING PROCEDURE**

1. Open pack and don one pair of gloves following sterile gloving technique
2. Visually inspect gloves for holes and tears
3. Stretch Test 1
4. Performance Test

**TESTING PROCEDURE**

- Stretch Test
  - Will the gloves withstand reasonable levels of stress placed on them?
    - Stretched each finger of the glove to a length of 6”
    - Stretched the cuff to a length of 6” on two sides
    - Visually inspected gloves for holes and tears
**Testing Procedure**

- **Performance Test**
  - Will the gloves hold up to the manipulation of surgical tools?
    - 5 simple interrupted stitches
  - Visually inspected gloves for holes and tears

- **Pressure Test**
  - If it's free of visible defects, is the glove porous or does it hold air?
    - Anesthesia machine was set up & pressure tested
    - Cuff of the glove secured around the end of the circuit
    - Filled glove with oxygen at a rate of 3 L/min until peak pressure was reached
    - Stopped oxygen flow and let glove sit 5 min

**Results**

- **Glove melting**
  - Gloves firmly stuck together/shut
  - Nitrile gloves did not melt at all
  - 22.8% of latex gloves melted (37 gloves)
    - Of these, 94.6% were from Box 2
    - 16.7% of gloves from Box 2 were wearable
    - Gloves from other boxes were "sticky" but were still easy to separate & don
  - No further testing was possible on melted gloves

- **Glove defects**
  - Holes, tears, or breaks in the glove
  - No defects found in sterile latex, unsterilized latex, and unsterilized nitrile gloves
  - Overall defect rate (# defects/glove)
    - Autoclaved Latex: 0.008
      - 1 defect found after stretch test 1
    - Autoclaved Nitrile: 0.031
      - 5 defects found in 4 gloves, all created during stretch test 2
    - Sterile nitrile: 0.125
      - 1 defect in 8 gloves tested, created during stretch test 2
RESULTS

 Pressure Test
   Peak pressures
    ○ May reflect the elasticity of the glove and/or the presence of holes

Peak Pressure

<table>
<thead>
<tr>
<th>Pressure (cmH2O)</th>
<th>sterile</th>
<th>unsterilized</th>
<th>autoclaved</th>
<th>sterile</th>
<th>unsterilized</th>
<th>autoclaved</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
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<td>20.0</td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>25.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.0</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>35.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

RESULTS

 In general, nitrile gloves reached a higher pressure and lost more pressure during the pressure test than did the latex gloves.

Further analysis...
   ANOVA will be done to look for any effects of pack type, position in pack, days post-sterilization or combinations thereof.
   Preliminary calculations suggest that there are not statistically significant differences between them.

PART 2

THE EFFECTIVENESS OF TWO DISINFECTANTS IN CREATING ASEPTIC GLOVE CONDITIONS

BACKGROUND INFORMATION

 Alcohol (70% isopropyl alcohol)
   The Guide specifically states that “alcohol is neither a sterilant nor a high-level disinfectant”
   Effective at reducing bacterial counts, but not active against bacterial spores
   Does not provide sustained anti-microbial activity
   There is a fair amount of discussion in the literature as to whether or not alcohol works “well enough” for surgery

BACKGROUND INFORMATION

 SPOR-KLENZ Ready To Use
   Manufactured by Steris Life Sciences Group
   Cold sterilant: 1.00% hydrogen peroxide with 0.08% peroxyacetic acid
    ○ This combination is a chemical sterilant suitable for use on “critical items”
   Label instructions
    ○ Sterilization: immerse for a minimum of 5½ hours
    ○ Broad-spectrum disinfection: treated surfaces must remain wet for 10 minutes
GLOVES

Glove Type  x  Handwashing  x  Disinfectant
standard latex    washed hands    70% isopropyl alcohol
standard nitrile    unwashed hands    Spor-klenz
sterile latex    washed hands    70% isopropyl alcohol
sterile nitrile

GROUPS

<table>
<thead>
<tr>
<th>Group</th>
<th>Glove Type</th>
<th>Handwashing</th>
<th>Disinfectant</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Washed Sterile Latex</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>B</td>
<td>Washed Sterile Nitrile</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>C</td>
<td>Unwashed Sterile Latex</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>D</td>
<td>Unwashed Sterile Nitrile</td>
<td>-</td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td>Washed Latex Alcohol</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Washed Latex Spor-klenz</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Washed Nitrile Alcohol</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Washed Nitrile Spor-klenz</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Unwashed Latex Alcohol</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>J</td>
<td>Unwashed Latex Spor-klenz</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>Unwashed Nitrile Alcohol</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>Unwashed Nitrile Spor-klenz</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

PROCEDURE - CONTROLS

Gloves

- Latex: Henry Schein Criterion Surgeon's Gloves
- Nitrile: Kimberly-Clark Purple Nitrile KC500 Sterile Powder-Free Exam Gloves

The “Gold Standard”

- Assume gloves are sterile after donning

1. Open gloves in hood following sterile gloving technique

2. Satisfy hand washing condition

3. Don gloves following sterile gloving technique

4. Run in place 5 minutes

5. Culture

PROCEDURE

Handwashing condition:

- Washed hands:
  - 1 minute of vigorous hand washing with CliniClean Antibacterial Hand Soap and warm water prior to donning gloves
  - Unwashed hands
  - Proceeded to donning gloves immediately

Gloves

- Latex: Henry Schein Criterion Surgeon’s Gloves
- Nitrile: Kimberly-Clark Purple Nitrile KC500 Sterile Powder-Free Exam Gloves

The “Gold Standard”

- Assume gloves are sterile after donning

1. Open gloves in hood following sterile gloving technique

2. Satisfy hand washing condition

3. Don gloves following sterile gloving technique

4. Run in place 5 minutes

5. Culture

Glove culturing procedure:

- Swabbed the palmar surface of the distal phalanges on the left hand in order from 1st to 5th

- Returned swab to broth tube

Prior to starting each trial:

- BHI broth tubes opened only in the hood
- Sterile swab was placed in each tube
- Donned PPE
**PROCEDURE - TEST GROUPS**
- High Five brand exam gloves
  - One box for each glove type/handwash combo
- Stored in microisolator mouse cages

**PROCEDURE - TEST GROUPS**
1. Open glove container inside hood
2. Satisfy hand washing condition
3. Inside hood, remove two gloves from the box touching only the cuff and don.
4. Culture 1
5. Disinfect gloves

**PROCEDURE - TEST GROUPS**
- Disinfection procedure:
  - At a distance of approximately 12”, sprayed each side of both hands 2 times with disinfectant
  - Rubbed hands together until disinfectant dried
    - 30 seconds for 70% isopropyl alcohol
    - 90 seconds for Spor-Klenz

**PROCEDURE - TEST GROUPS**
1. Open glove container inside hood
2. Satisfy hand washing condition
3. Inside hood, remove two gloves from the box touching only the cuff and don.
4. Culture 1
5. Disinfect gloves
6. Culture 2
7. Run in place 5 min.
8. Culture 3

**PROCEDURE**
- Break off end of swabs & close tubes
- Incubate tubes at 35°C for 24 hours
- Evaluate tubes for growth (cloudy/clear)

**PROCEDURE**
- A subset of the positive cultures (at least 20% from each group) underwent further testing for identification purposes
  - Plated on Sheep’s Blood Agar and incubated at 35°C for 24 hours
  - Gram staining
  - Gram negative rods: API 20 E biochemical ID strips
  - Staph spp.: Mannitol Salt Agar
RESULTS

Overall, 47.7% of standard exam gloves were contaminated after donning:
- 42% of latex, 53% of nitrile
- Contamination rates varied by box

- Latex: 10.00%
- Nitrile: 100.00%

Post-disinfection contamination rates (culture 2):
- 0.03% of gloves disinfected with Spor-klenz were contaminated
- 43.8% of gloves disinfected with alcohol were contaminated

Statistical analysis (Cochran-Mantel-Haenszel):
- No effect of glove type or hand washing
- Very significant effect of disinfectant (p<.05)

All sterile gloves were free of contamination after 5 minutes of activity.

Post-activity contamination rates of standard exam gloves vs. sterile gloves:
- Fisher’s Exact Test
- 25% of gloves disinfected with alcohol were contaminated post-activity
  - Significantly different from sterile gloves (p<.05)
- 0.03% of gloves disinfected with Spor-klenz were contaminated post-activity
  - NOT significantly different from sterile gloves

Result combinations for all 3 cultures

<table>
<thead>
<tr>
<th>Result</th>
<th>Possible Explanations</th>
<th>Overall</th>
<th>Alcohol</th>
<th>Spor-klenz</th>
</tr>
</thead>
<tbody>
<tr>
<td>- - -</td>
<td>Consistently clean</td>
<td>38.5%</td>
<td>9</td>
<td>16</td>
</tr>
<tr>
<td>* - -</td>
<td>Disinfectant effective</td>
<td>32.3%</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>* * -</td>
<td>Dessication, Slow action of disinfectant, Sampling error</td>
<td>7.7%</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>* * *</td>
<td>Sampling error</td>
<td>7.7%</td>
<td>5</td>
<td>-</td>
</tr>
<tr>
<td>- * -</td>
<td>Disinfectant ineffective</td>
<td>4.6%</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td>* - *</td>
<td>Sampling error in culture 2, Disinfection &amp; recontamination</td>
<td>3.1%</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>* - +</td>
<td>Contamination - skin, clothes, environment</td>
<td>3.1%</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>- * +</td>
<td>Sampling error in culture 1</td>
<td>3.1%</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>* + *</td>
<td></td>
<td>32</td>
<td>33</td>
<td></td>
</tr>
</tbody>
</table>
The Staphylococcus species cultured was NOT S. aureus
Spores were observed in multiple Bacillus cultures

Autoclaving Gloves
- Autoclaved exam gloves may be an acceptable alternative to sterile surgical gloves
- FDA's Acceptable Quality Level for defects is 1.5% for surgeon's gloves and 2.5% for exam gloves
- 0.8% of autoclaved latex gloves had visible defects
- 2.47% of autoclaved nitrile gloves had visible defects, but only after the 2nd stretch test
- One box of latex gloves had a high proportion that melted in the autoclave

Disinfecting Gloves
- Alcohol applied in the manner prescribed in this study does not consistently eliminate bacteria from the glove surface
- Noisy data on alcohol...
  - Bio-film in alcohol bottle?
  - Experimental error?
- Alcohol disinfection procedure may have been insufficient
- Alcohol evaporated within 30 seconds
- 0.3 mL of alcohol no more effective than washing hands with plain soap & water
CONCLUSIONS & DISCUSSION

Disinfecting Gloves
- Disinfecting standard exam gloves with Spor-Klenz may be a suitable alternative to sterile surgical gloves.
- Handwashing with antibacterial soap seems to be unimportant in determining contamination levels of the gloves.
- Provided that care is taken to minimize skin contact with the outer glove surface when donning.
- Surgical scrubbing only eliminates bacteria from hands 62% of the time.

Disinfecting Gloves
- Generally, 10^5-10^8 bacteria required to cause infection.
- Is the contamination observed in this study biologically relevant?

Bacterial species found
- Bacillus, Staph, Strep and Pasteurella species are very common.
- Stenotrophomonas maltophilia
  - Found in soil, water and contaminated medical solutions/devices.
  - Has been reported as a source of nosocomial infections.
- Chryseomonas luteola
  - Reported as the causative agent in some post-surgical infections.
- Sphingomonas paucimobilis
  - Widespread in the environment, found in hospital equipment and clinical specimens.
  - Capable of causing infections, but they are rarely serious.
- No growth - possibly anaerobic bacteria.
- Unknown relevance to post-surgical infections due to difficulty culturing.

Based on the results of this study...
- Disinfecting standard exam gloves with Spor-Klenz through the methods described in this study reliably eliminates bacteria and spores from the glove surface.
- Autoclaving standard exam gloves did not appear to significantly impact their performance.

These methods of treating standard exam gloves provide cost-effective alternatives to using sterile surgical gloves for rodent survival surgeries.

REFERENCES


THANK YOU!!!
- Dr. Freed
- Joann Petty
- Lori Mattax, Crystal Forrider, & Becky Glock
- Carrie McBride
- Dr. Bergdall, Dr. Hickman-Davis, Dr. Lewis & Dr. Coble
- ULAR
**Extern:** Michael Bradley, ASLAP Foundation Summer Fellowship

- Student, The Ohio State University, Columbus OH
- Projected graduation 2015
- Involved with ASLAP, OVMA, OSU student chapter AVMA, American Association of Bovine Practitioners, American Association of Swine Veterinarians, OSU Shelter Medicine Club, Animal Behavior Club, Food Animal Club, Zoo & Wildlife Medicine Club, Veterinary Business Management Association and Class of 2015 Student Government Parliamentarian

**Mentor:** Dondrae Coble, DVM, DACLAM, Director Experimental Surgery Core ULAR, Assistant Professor Clinical, Veterinary Preventive Medicine

Dr. Coble is a clinical veterinarian for OSU facilities and as the Director of the Experimental Surgery Core provides clinical and didactic support for the Laboratory Animal Residency Program. He is a member of AALAS, ACLAD, ASLAP, ASP, APV and serves on the AALAS Program Committee and the OSU College of Veterinary Medicine Admissions Committee and IACUC.

**Research Project:** “Monitoring the Intraoperative Temperature during Swine Surgery: An Analysis of Heating Devices”
Monitoring the Intraoperative Temperature During Swine Surgery: An Analysis of Heating Devices

Michael Bradley
ASLAP Summer Fellow
August 16th, 2012

Swine Surgical Models
- Size, physiology and anatomy are similar to man
- Common surgical research animal
  - Cardiovascular
  - Dermal
  - Transplantation
  - Renal
  - GI
- Teaching/training exercises
  - CMIS
  - Emergency Medicine
  - Anesthesia
  - Urology
  - Electrosurgery

Importance of Maintaining Intraoperative Normothermia
- Normal rectal temperatures are 101.6°-103.6°F
- Effects of hypothermia
  - Cardiovascular
  - Renal
  - CNS
  - Hepatic
  - Immune system
- Regulatory requirements and recommendations
  - AWA requires adequate veterinary care
  - The Guide states: 
    - "Maintenance of normal body temperature minimizes cardiovascular and respiratory disturbances caused by anesthesia."

Physiology of Maintaining Normothermia
- In man, normal interthreshold range is 1-2°F
- Physiologic responses occur outside of this range
  - Hyperthermia
    - Sweating
    - Vasodilation
  - Hypothermia
    - Shivering
    - Vasoconstriction
  - Metabolic heat production
    - Utilized more by species weighing less than 50kg

Anesthetic-Induced Hypothermia
- Anesthesia lowers the interthreshold range to 5-7°F
- Normal physiologic responses can still occur
- Anesthesia lowers Basal Metabolic Rate (BMR)
- Body heat production decreases
- Anesthesia decreases sympathetic tone
- Blood (ie heat) becomes preferentially redistributed to the extremities

Methods of Heat Transfer
- Radiation
  - The transfer of energy to or from a body by means of electromagnetic radiation
  - Ex: A heat lamp
- Conduction
  - The transfer of energy between objects that are in physical contact
  - Ex: A warm hand touching a cold surface

Radiation: 
Conduction: 
Heat Transmittance Means: 

Methods of Heat Transfer

- **Convection**
  - The transfer of energy between an object and its environment, due to fluid motion
  - Ex: A warm breeze

- **Evaporation**
  - Heat transfers to liquid on surface, which then vaporizes
  - Ex: Wet organs exposed in open laparotomy

Project Aims

- Evaluate intraoperative thermal loss in swine
  - Survival and non-survival surgery
  - 3 different heating devices
- Examine the cost vs. benefit of the heating devices
  - Thermal supplementation
    - $11.50 per use
    - Water Blanket
    - Bair Hugger®

Materials and Methods

- **Treatment groups**
  - Bair Hugger®
  - Circulating Water Blanket
  - Heated Surgical Table
  - No heat applied (control)
- Some pigs received warmed IV fluids
  - IV fluids kept in 120ºF warmer
  - This data was analyzed separately

<table>
<thead>
<tr>
<th></th>
<th>Survival</th>
<th>Non-Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bair Hugger®</td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td>Water Blanket</td>
<td>14</td>
<td>5</td>
</tr>
<tr>
<td>Heated Table</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Control</td>
<td>N/A</td>
<td>9</td>
</tr>
</tbody>
</table>

Heated Surgery Table

- Produced by Shor-Line
- Evenly produced heat (97ºF)
  - Conduction
  - Heating element for table costs $500-900

Circulating Water Blanket

- Produced by Gaymar Industries
- Circulates hot water (107ºF)
  - Conduction
- Effective in avoiding hypothermia in dogs and cats
  - $289 for the pump, $17 for each pad

Bair Hugger®

- Produced by Arizant Animal Health
- Blows hot air (110ºF) through holes in mat
  - Convection
- Effective in avoiding hypothermia in cats and man during surgery
  - $1150 for air blower, $12 for each mat (single use)
Materials and Methods

- Temperature Monitoring
  - Esophageal temperatures
  - Accurate measurement of core temp. in a variety of species^6,10,13
  - Retrieval does not interfere with surgical techniques
  - Temp. taken every 15 minutes

Materials and Methods

- Treatment subjects
  - Yorkshire Pigs ~100lb
  - Survival surgeries
    - Scrubbed and prepped with aseptic technique
    - Covered with drapes
    - Spent variable time in OR prep
    - 97°F cutoff for additional thermal support
  - Non-survival surgeries
    - Not covered with drapes
    - Placed on heating device upon entrance to OR
    - 95°F cutoff for additional thermal support

Results: Survival Surgery

![Graph showing rate of temperature loss per 15 min in survival surgery from start time on table.](image)

Results: Non-Survival Surgery

![Graph showing comparisons in non survival surgeries of temperature vs. time.](image)
Results: Effect of Warmed IV Fluids

Control Non-Survival vs. Heated Table Non-Survival

Temperature (F) vs. Time Increments (15 min)

Control Non-Survival
No Fluids N=4

Heated Table Non-Survival
Heated Table A
No Fluids N=4

Results: Survival vs. Non-Survival

Temperature (F) vs. Time Increments (15 min)

Control
Survival N=10
Non-Survival N=5

Bair Hugger® vs. Circulating Water Blanket
No statistical difference

Bair Hugger® vs. Heated Table
Only difference is non-survival surgeries after 150 min
Observed Survival surgeries were shorter than 150 min
Would Heated Table alone be sufficient for short survival surgeries?

Bair Hugger® vs. Control
Significantly different after 90 minutes in non-survival surgery
Is no thermal support acceptable for short surgeries?
Different shaped air mat?

Discussion

Water Blanket
Significantly different from heated table only at 180 min
No difference between control
Does have much slower rate of loss

Heated Table
No statistical difference between control
Simultaneous use with other devices?
Survival surgery data

Effect of drapes
Reduced rate of loss in survival surgeries
Could supplying drapes alone help retain heat?
Do drapes trap device-produced heat?

Cost-benefit analysis
Bair Hugger® and CWB
$11.50 Thermal supplementation cost
Bair Hugger® is more expensive
Bair Hugger® uses single use mats
Bair Hugger® cost effective?
No charge for Heated Table
No difference between table and other devices before 150 min
Charge?
**Extern:** Ashley Berardi, OSU CASS Summer Fellowship

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- Projected graduation 2014
- Involved with ASLAP, OSU student chapter AVMA, OSU Shelter Medicine Club, Veterinary Business Management Association, Student Chapter of the American Animal Hospital Association, Behavior Club- Fundraising Chair

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**Research Project:** “Assessment of Alternatives to Sterile Surgeon’s Gloves for Survival Surgery in Rodents”
Evaluation of Various Routes of Administration of Meloxicam for Postoperative Analgesia in Mice

Ashley Berardi
2012 ULAR Summer Extern

Objectives

- Our goal is to research approved analgesics for rodents and determine if we can find a better alternative to controlled drugs like buprenorphine and ulcerogenic NSAIDs.
- What makes a good analgesic?
  - Ease of use by staff
  - Provides pain relief
  - Minimal side effects
  - Cost of use

Drugs to Compare

- Opioid Analgesic
  - Buprenorphine
- Non-Steroidal Anti-Inflammatory Drugs (NSAIDs)
  - Carprofen
  - Ibuprofen
  - Flunixin
  - Meloxicam

Opioid Analgesics

- Buprenorphine
  - 1. Given IP or SQ 0.05-0.1 mg/kg
  - 2. Opioid analgesic: partial mu agonist
  - 3. Controlled substance
  - 4. Side effects: nausea = no food consumption

NSAIDs

NSAID Mechanism of Action

Photos courtesy of J. Balasubramaniam
**COX, COX, and more COX**

**COX-1**
- Constitutive = part of normal enzyme complement
- Maintains normal physiology

**COX-2**
- Inducible = released due to stimulus
- Causes inflammation

**Specifications of COX-1 and COX-2**

<table>
<thead>
<tr>
<th>NSAID</th>
<th>COX-1</th>
<th>COX-2</th>
<th>COX1:COX2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flunixin</td>
<td>0.008</td>
<td>0.01</td>
<td>0.7</td>
</tr>
<tr>
<td>Meloxicam</td>
<td>0.9</td>
<td>0.3</td>
<td>3.0</td>
</tr>
<tr>
<td>Carprofen</td>
<td>13.2</td>
<td>0.1</td>
<td>129.0</td>
</tr>
</tbody>
</table>

For this table, the author based individual COX numbers on IC50, which is the concentration that produces 50% inhibition of enzyme activity.

**Commonly Used Analgesics**

- **Ibuprofen/ Motrin**
  1. Given 30 mg/kg in water bottle (~250 mL)
  2. Non-specific COX inhibitor
  3. May be chondrotoxic with chronic use
  4. Questionable use in preg animals

- **Carprofen/ Rimadyl**
  1. Given 5-10 mg/kg SQ daily
  2. COX 1 sparing effects
  3. Commonly used in dogs
  4. Possible antineoplastic effects?

- **Flunixin Meglumine/ Banamine**
  1. Given 2.5 mg/kg SQ
  2. No selectivity for COX 1 or 2
  3. Subsequent dosing not helpful
  4. Other indications
    - Equine: foal diarrhea, colitis, post and pre race Tx
    - Canine: heat stroke, parvovirus Tx, disk problems
    - Bovine: acute respiratory dz, acute coliform mastitis
    - Porcine: piglet diarrhea, agalactia/hypogalactia

- **Meloxicam/ Metacam**
  1. Available in oral and injectable formulations
  2. Selective against COX 2
  3. Common uses: Osteoarthritis and post surgical pain
**Experimental Design and Groups**

- 4 Treatments with four mice in each group
  1. Oral Meloxicam in water bottles
  2. Subcutaneous Meloxicam
  3. Ibuprofen in water bottles
  4. Injectable Meloxicam in water bottles

Food, Water, Wheel Activity, Weights measured everyday of study

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pre-surgical meds</th>
<th>Surgery Day</th>
<th>Post-Surgical Meds</th>
<th>Hot Plate Test</th>
<th>Mice euthanized</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oral Meloxicam</td>
<td>Yes</td>
<td>Day 1</td>
<td>Yes</td>
<td>Day 4</td>
<td>No</td>
</tr>
<tr>
<td>Subcutaneous Meloxicam</td>
<td>Yes</td>
<td>Day 1</td>
<td>Yes</td>
<td>Day 5</td>
<td>No</td>
</tr>
<tr>
<td>Ibuprofen in water bottles</td>
<td>Yes</td>
<td>Day 1</td>
<td>Yes</td>
<td>Day 6</td>
<td>No</td>
</tr>
<tr>
<td>Injectable Meloxicam in water bottles</td>
<td>Yes</td>
<td>Day 1</td>
<td>Yes</td>
<td>Day 7</td>
<td>No</td>
</tr>
</tbody>
</table>

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**Cage Set Up**

- Cranial
- Caudal

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**Running Wheels**

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**Hot Plate Test**

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**Surgical Procedure**

- Laparotomies entering the abdominal cavity provided the post operative pain needed to test each analgesic.

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**Surgical Prep**

- Mice anesthetized with 1-3% Isoflurane in an induction chamber
- 3 cm square area shaved on the abdomen
- Alternating chlorhexidine scrub with 70% isopropyl alcohol
- Eye lubrication applied to prevent corneal dessication
Time to Surgerize!

- Mice are moved from prep table to a separate surgery table with a heating pad
- Deep plane of anesthesia acquired
- #15 scalpel blade to make a 1 cm incision on ventrum
- Tip of blade is used to enter abdominal cavity

Incision Closure and Recovery

- Subcutaneous tissue layer is closed with 3-0 suture using simple interrupted pattern
- Skin is apposed and closed with a single wound clip
- Mouse is moved to recovery area

Results

- What are we looking for?
  - **Weights**: drop post-op with a return to baseline
  - **Food**: less consumption post-op
  - **Water**: difficult to measure
  - **Hot Plate**: increased time spent on hot plate
  - **Wheel Activity**: drop in activity post-op

Results: Oral Meloxicam in Water

Results: SubQ Inject. Meloxicam

Results: Ibuprofen in Water
Results: Inj Melox in Water

Results: Average Wheel Activity

Post Surgery Hot Plate Test Results

Discussion

Conclusion

Money, Money, Money......MONEY!

- What is the best drug?
  - Ibuprofen
  - Oral Meloxicam
  - SubQ Meloxicam
  - Ibuprofen in Water
  - Oral Meloxicam in Water
  - Inj. Meloxicam in Water

- For next time:
  - More mice = larger n
  - More wheels ; good parameter to measure return to activity
  - Look for continuing trends ; which treatment brings animals closest to baseline day 1 post-op?

- What we can take away:
  - Current treatments used by techs (Motrin water and SubQ Meloxicam) seem to be effective
  - Looking at cost/dose, oral meloxicam in water may be a noteworthy treatment

Cost/dose calculations are based on a 30 gram mouse that consumes an average of 5 mL of water daily.
References


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