Participants in the Pig Animal Use Training Session, in writing or in speech, or by demonstration will be able to:

1. Demonstrate proper techniques for handling and restraint of pigs for routine procedures, i.e., physical examination, administration of medicine, and venipuncture.

2. Observe pigs for normal and abnormal physical and behavioral changes, (i.e., charging, diarrhea, lameness, etc.) and report such findings to the appropriate veterinary medical personnel.

3. Demonstrate the site and techniques for administration of medication by the following routes:
   a. subcutaneous
   b. intramuscular
   c. intravenous
   d. oral

4. Obtain blood samples from pigs and describe the advantages and disadvantages of different routes.

5. Discuss the appropriate methods of sedation and anesthesia (including agent, route, and monitoring).

6. Discuss indications and methods of providing analgesia.

7. Discuss appropriate methods of euthanasia.

8. Discuss appropriate location and techniques for survival surgery in pigs.
INTRODUCTORY DATA

1. Swine in Biomedical Research

Cardiovascular System
- Electrical transmission and conduction
- Myocardial infarcts
- Patent ductus arteriosus
- Hypertrophic and congestive cardiomyopathies
- Cardiovascular surgery (transplantation, prosthetics)

Gastrointestinal System
- Esophageal and gastric ulcers
- Nutritional and metabolic studies
- Atherosclerosis (spontaneous and induced)
- GI surgery

Skin
- Familial melanomas in Sinclair miniature swine
- Transdermal drug delivery systems
- Surgical models: Wound healing
  - Skin flaps
  - Grafts

Dental

2. Classification

Order: Artiodactyla
Family: Suidae
Genus: Sus

Common farm pig breeds: Miniature pig breeds:

- Berkshire Poland China Yucatan
- Chester White Spotted Poland China Hanford
- Duroc Landrace Hormel
- Hampshire Tamworth Gottingen
- Hereford Yorkshire
- Pietrain Sinclair

3. Husbandry

A. Housing:

Pigs may be housed in stalls or in dog runs on solid floors bedded with shavings or on open flooring.
Lighting: 12 hours on and 12 hours off. (Pigs up to 30 days of age should have 24 hour lighting to encourage round the clock feeding.)

Temperature recommendations vary with age, breed, and weight:

Neonates: 32 - 35°C (Thus, neonates should be housed with heat lamps or mats.)

Weanlings: 25 - 27°C

Hanford minipigs: 17 - 20°C

Yucatan minipigs and micropigs: 20 - 25°C

With younger pigs, it is especially important to remember that the ideal temperature must be at the level of the pig.

B. Feed and Water

Ad libitum water should be given by automatic watering device or water pan.

Diet recommendations at the University of Washington:

Nursing piglets and weanlings up to 4 weeks of age: "Litter milk" supplement ad libitum.

Weanlings 4 – 8 weeks: "Starter Diet"

70 - 125 lbs. (>8 weeks): "Grower Diet"

Adult pigs and those >125 lbs.: "Maintenance Diet"

Adult minipigs: "Minipig Chow"

Many commercial diets contain antibiotics.

4. Malignant Hyperthermia

Porcine Stress Syndrome

Genetic predisposition in Landrace, Pietrain, and Poland China breeds.

- Syndrome characterized by rapid increased rectal temperature (42 - 45°C), muscle rigidity, tachycardia, and metabolic acidosis.

- Precipitated by halothane, succinylcholine, curare, gallamine.
5. **Selective Normative Data**

A. **Mini/Micro Pigs**

1. **Temperature:**
   - Rectal temperature: 39.0°C (+/- 0.2)*
   - Skin temperature: 33.6°C (+/- 0.3)*
   * Room temperature at pig level: 20.6°C (+/- 0.76)

2. **Oxygen Consumption:** 6.22 ml/kg/min.

3. **Heat Production:** 1.01 Kcal/min.

4. **Respiration Rate:** 30 breaths/min.

5. **Pulse:** 100 – 150 beats/min.
   
   **Sites:**
   - Sublingual artery *(ventral surface of the tongue)*
   - Medial saphenous artery *(medial aspect of the distal femur/proximal tibia)*
   - Brachial artery *(medial aspect of the humeroradial joint)*

6. **Blood Pressure:** 130 – 60/105 – 115 mmHg (10-25kg)
   
   **Site:** Tail; good correlation to the venous pressure

7. **Litter size:** 5-6

B. **Farm Pigs**

1. **Rectal Temperature:**
   - Piglets (farm) 39.0 - 40.5°C
   - Adult (farm) 38.5 - 40.0°C

2. **Heart Rate** 60 - 80 beats/min.

3. **Respiratory Rate** 8 - 18 breaths/min.

4. **Sexual Maturity** 7 - 9 months

5. **Estrus Cycle Frequency** 18 - 24 days

6. **Duration of Estrus** 2 – 3 days

7. **Gestation Period** 115 days

8. **Litter Size** 9-10

9. **Weaning Age** 6-8 weeks (with prestarter ration and warmth)
NORMAL VALUES

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBC (x 1,000,000/cubic mm)</td>
<td>7.62</td>
<td>+/- 0.69</td>
</tr>
<tr>
<td>Hgb (g/dl)</td>
<td>13.00</td>
<td>+/- 1.40</td>
</tr>
<tr>
<td>Hct. (ml%)</td>
<td>42.70</td>
<td>+/- 5.90</td>
</tr>
<tr>
<td>Sed. rate (mm/hr)</td>
<td>4.90</td>
<td>+/- 0.60</td>
</tr>
<tr>
<td>Platelets (x 1,000 cubic mm)</td>
<td>306.00</td>
<td>+/- 77.00</td>
</tr>
<tr>
<td>WBC (x 1,000 cubic mm)</td>
<td>16.40</td>
<td>+/- 1.80</td>
</tr>
<tr>
<td>Neutrophils (%)</td>
<td>30.00</td>
<td>+/- 9.00</td>
</tr>
<tr>
<td>Eosinophils (%)</td>
<td>4.20</td>
<td>+/- 1.00</td>
</tr>
<tr>
<td>Basophils (%)</td>
<td>1.10</td>
<td>+/- 0.90</td>
</tr>
<tr>
<td>Lymphocytes (%)</td>
<td>61.60</td>
<td>+/- 11.20</td>
</tr>
<tr>
<td>Monocytes (%)</td>
<td>3.50</td>
<td>+/- 1.60</td>
</tr>
</tbody>
</table>

WEIGHT

Weight (Kg): Varies widely with breed, gender, diet, and feed consumption

<table>
<thead>
<tr>
<th>Age</th>
<th>Domestic Pig</th>
<th>Minipig</th>
<th>Micropig (CRL)</th>
</tr>
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<tbody>
<tr>
<td>Newborn</td>
<td>0.9 - 1.4</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>3 Months</td>
<td>20 - 40</td>
<td>10 - 12</td>
<td>7 – 9</td>
</tr>
<tr>
<td>5 Months</td>
<td>100</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>8 Months</td>
<td>250 – 410</td>
<td>70 – 75</td>
<td>19</td>
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## BIOCHEMICAL PARAMETERS

<table>
<thead>
<tr>
<th>Parameter</th>
<th>MALE</th>
<th>FEMALE</th>
</tr>
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<tbody>
<tr>
<td>Bilirubin (mg/dl)</td>
<td>0.20</td>
<td>0.15</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>154.00</td>
<td>151.00</td>
</tr>
<tr>
<td>Creatinine (mg/dl)</td>
<td>1.85</td>
<td>1.70</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>85.00</td>
<td>90.00</td>
</tr>
<tr>
<td>Urea nitrogen (mg/dl)</td>
<td>16.00</td>
<td>14.50</td>
</tr>
<tr>
<td>Uric acid (mg/dl)</td>
<td>1.22</td>
<td>1.15</td>
</tr>
<tr>
<td>Sodium (mEq/l)</td>
<td>142.00</td>
<td>149.00</td>
</tr>
<tr>
<td>Potassium (mEq/l)</td>
<td>5.60</td>
<td>6.20</td>
</tr>
<tr>
<td>Chloride (mEq/l)</td>
<td>100.00</td>
<td>105.00</td>
</tr>
<tr>
<td>Biocarbonate (mEq/l)</td>
<td>30.60</td>
<td>29.80</td>
</tr>
<tr>
<td>Phosphorus (mg/dl)</td>
<td>7.50</td>
<td>8.40</td>
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<tr>
<td>Calcium (mg/dl)</td>
<td>9.65</td>
<td>11.10</td>
</tr>
<tr>
<td>Magnesium (mg/dl)</td>
<td>1.60</td>
<td>2.80</td>
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<tr>
<td>Total Protein (g/dl)</td>
<td>4.9 – 7.0</td>
<td></td>
</tr>
<tr>
<td>Albumen (g/dl)</td>
<td>2.8 – 5.0</td>
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</tr>
<tr>
<td>SGOT (IU/I)</td>
<td>10.0 – 3.7</td>
<td></td>
</tr>
<tr>
<td>SGPT (IU/I)</td>
<td>15.0 – 36.0</td>
<td></td>
</tr>
<tr>
<td>Alk phos (IU/I)</td>
<td>75.0 – 225.0</td>
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</tr>
<tr>
<td>CPK (IU/I)</td>
<td>3.0 – 650.0</td>
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</tr>
<tr>
<td>LDH (IU/I)</td>
<td>262.0 – 412.0</td>
<td></td>
</tr>
<tr>
<td>Triglycerides (mg/dl)</td>
<td>56.0 – 103.0</td>
<td></td>
</tr>
</tbody>
</table>
LABORATORY OUTLINE

1. Physical Examination:
   A. Always observe respiratory rate, anal discharge, lameness, etc. prior to attempting to catch the animal.
   B. Measurable parameters – Food and water intake, weight, temperature, blood counts, etc.

2. Handling and Restraint:
   Always handle pigs firmly, but gently. Be prepared for vocalization.
   A. Manual Restraint:  Leg lift (dangerous in larger pigs)
                     Mouth snare
                     V-trough
                     Sling
                     Squeeze board or panel (preferred method in many situations)

1. Slinging Procedure:
   Place sling at entrance of room or pen in which pig is held, and move pig into the sling by hand or with panel. Unnecessary roughness should be avoided, as most pigs will accept sling restraint if the procedure is done quickly and without trouble. Slinging should be done firmly, gently, and as quickly as possible once animal is approached for restraint.

   **One-person technique** – Fasten wire panel to front of the sling prior to moving pig into sling. Move pig into sling and crank up quickly. Remove side panels and maneuver legs into appropriate leg holes and tie legs. Do not tie tight unless pig is struggling.

   **Two-person technique** – Leave front of sling open and place second person in front. When pig enters sling, have that person put hands on pig's head or ears to stabilize and keep animal still. Crank up as quickly as possible, and proceed as described above.

   Most pigs do not struggle in the sling. Restraining ropes attached to the legs should be adequately tied to prevent escape, but not excessively tight. Permanent damage to the soundness of the animals result from prolonged over-restraint by ropes tied too tight for an extended period of time. Ropes should be ¼" nylon, 6 feet in length. Place soft bandage padding around ropes for long procedures.
3. **Methods of Identification:**

   Ear tag, ear notch, tattoo

4. **Drug Administration Techniques and Blood Sampling:**

   A. **Subcutaneous** - neck, flank
   B. **Intramuscular** - neck, back of rear leg (pigs in general resist injections in the neck less than in the leg)
   C. **Intravascular** - marginal ear vein:
      1. Venipuncture for infusion or withdrawal of small quantities of blood.
         a. Select butterfly infusion set with a ¾” needle, 19-21 gauge and a 12” tubing.
         b. Prep ear with 70% alcohol using care to protect the animal's eyes from excess run-off or splashing of alcohol.
         c. Occlude vein with finger pressure on the proximal end of ear and insert needle, bevel up.
      2. Catheterization of Ear Veins – see appendix A
         a. Select catheter. 22 gauge intracatheters can be secured more easily than butterflies.
         b. Prep ear with alcohol and "raise up" selected vein.
         c. Insert needles and pass catheter through needle at least 6.0” into vein.

jugular (+/- cutdown: jugular cutdowns can be difficult in pigs)

cephalic and saphenous veins on young animals

cranial vena cava: see diagram p.14

Scrub neck area to be used for venipuncture with surgical soap or dilute Betadyne. Select appropriate needle for pig:

<table>
<thead>
<tr>
<th>Pig Size</th>
<th>Needle Size</th>
</tr>
</thead>
</table>
Samples should be drawn from the pre-cava via a stick just lateral to the breastbone. Variation approach (for pigs with excessively fat necks) should be toward the pig's right side. In swine the phrenic nerve lies in the left neck area, and trauma to that nerve can cause respiratory paralysis.

Following withdrawal of the needle, hard pressure should be briefly applied to the area from which the sample was taken. Observe for bleeding, and continue pressure until it has ceased. Use extra caution with very young pigs, as they tend to bleed more profusely than more mature animals.

5. Anesthesia and Sedation

IT IS CRITICAL TO DISCUSS CHOICES OF ANESTHETICS AND SPECIFIC MONITORING METHODS WITH VETERINARY MEDICAL/TECHNICAL STAFF BEFORE ANESTHETIZING ANIMALS; THIS IS A COMPLEX TOPIC DESERVING OF FAR MORE DETAIL AND TIME THAN ALLOWED IN A SESSION LIKE TODAY'S.

A. Anesthesia

For <10 kg pigs: Atrophine (0.5 mg/kg) 15 minutes before Ketamine (20 – 35 mg/kg) and Rompun (2 –5 mg/kg) IM Acepromazine (1.1 mg/kg), Ketamine (22 mg/kg) and Atropine (0.5 mg/kg) IM followed with 2.5% Thiamylal IV if necessary to intubate.

Inhalation anesthetics: Isoflurane has become a favorite at UW.

See Appendix – Anesthetics for additional anesthetic protocols.

B. Endotracheal Intubation

Premedicate with Acepromazine (1.1 mg/kg), Ketamine (22.0 mg/kg), Atropine (0.5 mg/kg) IM. See anesthesia section and appendix for additional combinations.

Place animal in dorsal recumbency for intubation with head and neck fully extended. The larynx should be sprayed with a topical anesthetic while being visualized with a laryngoscope. This is done to avoid
laryngospasms. Cetacain spray is commonly used. The presence of the laryngeal diverticulum may necessitate rotating during insertion.

C. Pulse Monitoring Sites

Brachial Artery – medial aspect of humeroradial joint
Saphenous Artery* - medial aspect of distal femur  *FAVORITE
Sublingual artery – ventral surface of tongue
Auricular – ear

D. Monitoring Depth of Anesthesia

Dependent upon anesthetic agents used.

Absence of leg reflex: in response to pinch to the coronary band of the hoof – indicative of depth of anesthesia
Laxity of jaw
Heart rate and blood pressure

6. Analgesia:

Buprenorphine 0.005 – 0.01 mg/kg IM q 12 hr

7. Euthanasia:

Anesthetic overdose:
Administration and routes of other agents described in other sources

Pentobarbital – 90 mg/kg IV

Other methods – Please see the Report of the AVMA Panel on Euthanasia
Procedure for Catheterization of Anterior Vena Cava in the Sling

Preparation:

Prepare the neck area the same as for venipuncture.

- For non-obese pigs under 100 lbs., a 16 gauge thin wall, 2.0" needle is best. For heavier or obese pigs, longer needles, as needed should be used, but do not increase the gauge. For minimal trauma to the animal in case of sudden movement, plus to minimize chance of hitting an artery, use shortest needle possible.

- With known bleeders (animals with poor clotting ability), or pigs with questionable precava location, locate vessel with a 20 gauge needle prior to entry with catheterization needle.

- If a pig is particularly sensitive to the needle, prep area with Lidocaine or other local anesthesia prior to catheterization.

- For young animals weighing less than 50 lbs., utilize an 18 gauge 1.5" needle and catheter set. Methodology for cannulation should be applied as described above.

- Prepare flushing syringe and saline, withdrawal syringe, sampling syringes and catheter prior to catheterization and mark each.

1. Flushing saline: To flush catheter during catheterization and later during experiment, use 10,000 units Heparin/250 cc saline solution. Designate one syringe for flushing.

2. Withdrawal syringe: Used to withdraw solution and blood prior to each sample.

3. Sampling syringes: Should be labeled and set up ahead according to protocol requirements. Monovettes available from Sarstedt are recommended, especially when manpower is limited. They serve as both syringe and centrifuge tube and can be obtained pretreated with various types of anticoagulants if desired.

4. Catheter: Should be cut into 33 –36" length and marked approximately 8" from end with permanent marker. Fill with germicide or
alcohol solution and place in the solution at least 10 – 15 minutes prior to use. Insert stub-end 18 gauge needle into end and connect the flush syringe.

- Clean hands. The person catheterizing should keep both hands clean prior to inserting the catheter. Hang a clean towel on the sling for easy access during the procedure.

**Catheterization of the Pre-Cava**

Puncture vein and insert catheter through needle until mark is just outside needle hub. Check for patency by withdrawing flush syringe. If blood flow is good, pull needle out and remove from catheter. Attach catheter to skin with a small butterfly (made from adhesive) and one or two sutures with a cutting suture needle.

Flush catheter thoroughly with flush solution and proceed with experiment.
SELECTED REFERENCES

13. Swindle, MM: Basic Surgical Exercises Using Swine, CT: Greenwood Press, 1983. (Address: 88 Post Road West, P.O. Box 5007, Westport, CT 06881)

SELECTED REFERENCES

General Characteristics and Miscellaneous

Laboratory Methodology
University of Washington
Department of Comparative Medicine


Cardiovascular


Diabetes

Gastrointestinal Function and Nutrition

Atherosclerosis and Related Research