
1. PURPOSE

This Standard Operating Procedure (SOP) describes methods for anesthetizing swine.

2. RESPONSIBILITY

Principal Investigators (PIs) and their research staff, veterinarians, veterinary care staff.

3. INTRODUCTION

- 3.1. Perform a thorough physical exam and obtain an accurate body weight.
- 3.2. Withdraw food (not water) for 12 hours (2 hours for neonates) prior to anesthesia in order to reduce the risk of aspiration of stomach contents.
- 3.3. Monitor animals closely during induction, maintenance, and recovery from general anesthesia. Monitoring must be documented.
 - 3.3.1. Never leave an anesthetized animal unattended.
 - 3.3.2. Monitor animal every 5 minutes; record the following parameters every 15 minutes:
 - 3.3.2.1. Anesthetic depth: absence of reflexes, e.g., pedal/eyelid/eyelash/palpebral, absence of movement, muscle relaxation (jaw tone).
 - 3.3.2.2. Respiratory function (ventilation): respiratory rate, oxygen saturation (SpO₂), thoracic wall or rebreathing bag movements, and auscultation. End-tidal carbon dioxide (ETCO₂) should be included where capnography equipment is available. Blood gas analysis may be indicated for critical patients or procedures.
 - 3.3.2.3. Cardiovascular function (circulation): capillary refill time (CRT), mucous membrane color, pulse quality, heart rate and rhythm, and blood pressure. Electrocardiography (ECG) should be included where equipment is available.
 - 3.3.2.4. Body temperature: rectal or esophageal temperature.
- 3.4. Apply ophthalmic ointment to prevent corneal desiccation. Reapply as needed, every 30 minutes at a minimum.
- 3.5. Keep animals warm by providing a heat source until the animal has recovered from anesthesia. Care should be taken to not overheat or burn the animals.
- 3.6. Maintain records of each anesthesia procedure and include:
 - 3.6.1. Date and time of procedure
 - 3.6.2. Principal investigator and Animal Use Protocol (AUP)
 - 3.6.3. Species and animal's identification
 - 3.6.4. Animals' weight
 - 3.6.5. Name, dose, route, and time of administration of each drug
 - 3.6.6. Description of the procedure
 - 3.6.7. Measurements of the animal's anesthetic depth and vital signs
 - 3.6.8. Time of recovery
 - 3.6.9. Name of the individual monitoring the animal and of the surgeon

4. MATERIALS

- 4.1. Material or equipment to provide or conserve body heat (e.g. warm-water circulating pad)
- 4.2. Gas anesthesia machine (calibrated within the last 12 months) with adequate gas scavenging system or filter
- 4.3. Tight-fitting mask
- 4.4. Monitoring equipment, e.g., stethoscope, thermometer, pulse oximeter, capnograph, ECG
- 4.5. Ophthalmic ointment (natural tears)
- 4.6. Intra-venous catheter
- 4.7. EMLA cream
- 4.8. Isoflurane
- 4.9. Butorphanol (10mg/mL) * Controlled drug
- 4.10. Acepromazine (10mg/mL)
- 4.11. Dexmedetomidine (0.5mg/ml)
- 4.12. Atipamazole (5mg/ml)
- 4.13. Glycopyrrolate (0.2mg/mL)
- 4.14. Ketamine (100mg/mL) *Controlled drug
- 4.15. Propofol (10mg/mL)
- 4.16. Sterile isotonic saline (0.9% saline) or Lactated Ringer's Solution (LRS)
- 4.17. Xylocaine spray
- 4.18. Sterile lubricant (e.g. water soluble jelly)
- 4.19. Endotracheal tubes, cuffed, sizes 5.0 to 9.0
- 4.20. Laryngoscope
- 4.21. Plain gauze rolls

5. PROCEDURES

5.1. Sedation:

- 5.1.1. Used for short periods of restraint for non-painful procedures (e.g. blood collection).

Drug	Dose	Route	Duration of Effect	Notes
Acepromazine	0.2mg/kg - 1.1mg/kg	IM	30 minutes	Laryngeal reflexes preserved.
Dexmedetomidine	0.2mg/kg	IM	Dose dependent	Profound drop in heart rate. Can be reversed with atipamezole by administering the same volume of Dexmedetomidine used.

5.2. Premedication/sedation:

- 5.2.1. Administer intramuscularly:
 - 5.2.1.5. Butorphanol: 0.25mg/kg
 - 5.2.1.6. Acepromazine: 0.2mg/kg
 - 5.2.1.7. Glycopyrrolate: 0.01mg/kg
 - 5.2.1.8. Ketamine: 25mg/kg

5.3. Place an intravenous catheter (e.g. auricular vein) :

- 5.3.1. To provide IV fluid therapy and venous access during surgery.

5.4. IV fluid administration:

5.4.1. Administer isotonic saline (0.9% saline) or Lactated Ringer's Solution at a rate of 2-5 mL/ kg//hour.

5.5. Induction:

5.5.1. Used to allow for endotracheal intubation:

Drug	Dose	Route	Notes
Propofol	1 to 2 mg/kg	IV, slowly	May produce apnea.
Isoflurane	3 to 5% with oxygen 0.8 to 1.5 L/min	Inhalant	Use a tight-fitting mask.

5.5.2. Apply ophthalmic ointment (natural tears) to both eyes to prevent dryness and damage to the cornea.

5.6. Intubation:

5.6.1. Placement of an endotracheal tube is recommended for delivery of isoflurane anesthesia when:

5.6.2. Profound sedation, preventing protective airway reflexes, is required. As a guide, light sedation should last under 30 minutes and is performed for less invasive procedures.

5.6.3. Surgical level anesthesia is required.

5.6.4. Head or airway cannot be accessed readily due to position, equipment, etc.

5.6.5.

5.6.6. Use cuffed endotracheal tubes as they reduce the possibility of aspiration of saliva or stomach contents.

5.6.7. Intubation:

5.6.7.1. Lubricate endotracheal tube with sterile lubricant.

5.6.7.2. With the animal in sternal, dorsal, or lateral recumbency, extend the neck and head so that they are in a straight line.

5.6.7.3. Pull the tongue forward so that the epiglottis is visible.

5.6.7.4. Use the laryngoscope to disengage the epiglottis from the soft palate, exposing the glottis and vocal chords.

5.6.7.5. Spray the larynx with 2% xylocaine to help decrease laryngospasm (spasmodic closing and opening of the glottis).

5.6.7.6. Insert the endotracheal tube (with the convex side facing upwards) gently into the proximal larynx.

5.6.7.7. Gently rotate the endotracheal tube 180° and apply gentle pressure to insert into the trachea. Confirm proper placement by checking for the animal's breath as it exits the endotracheal tube during exhalation.

5.6.7.8. Secure the endotracheal tube by tying a piece of gauze around the tube then behind the animal's head.

5.6.7.9. Inflate the cuff of the endotracheal tube.

5.6.7.10. Verify adequate ventilation of both lungs by auscultation.

5.7. Isoflurane anesthesia:

5.7.1. Induction (only if injectable anesthetics cannot be used; the animal should be premedicated to reduce stress of induction):

5.7.1.1. Use a tight-fitting mask.

5.7.1.2. Adjust the oxygen flowmeter to 0.8 to 1.5 L/min.

- 5.7.1.3. Adjust the isoflurane vaporizer to 3% to 5%.
- 5.7.2. Maintenance:
- 5.7.2.1. Use the endotracheal tube or mask connected to the anesthesia machine.
- 5.7.2.2. Adjust the flowmeter to 50ml/kg/min (recirculating system) or 100-200 ml/kg/min (for Bain system).
- 5.7.2.3. Adjust the isoflurane vaporizer to 1.5 to 2.0% (dose to effect).
- 5.7.2.4. Apply ophthalmic ointment (natural tears) to both eyes to prevent dryness and damage to the cornea.
- 5.7.2.5. When not under assisted ventilation, animal should be manually ventilated or “bagged” every 5-10 minutes to ensure proper air exchanges.
- 5.7.3. Recovery:
- 5.7.3.1. Turn off the isoflurane vaporizer but keep the animal on oxygen for 2 to 5 minutes or longer if oxygen saturation levels are low.
- 5.7.3.2. Remove the endotracheal tube as soon as the animal shows signs of impending arousal, i.e., when when the animal starts swallowing on its own and reflexes begin to return.
- 5.7.3.3. Provide supplemental heat until the animal’s temperature is consistently rising and approaching normal values.
- 5.7.3.4. Monitor the animal in his home cage until it is ambulatory to ensure it regains full consciousness.

SOP REVISION HISTORY

DATE	NEW VERSION
2016.09.21	5.1.1. Administer intramuscularly (can be mixed in the same syringe):
2016.09.21	5.6.2.3 Adjust the isoflurane vaporizer to 1.5 to 2.0% (dose to effect).
2016.09.21	5.6.3.1. Turn off the isoflurane vaporizer but keep the animal on oxygen for 2 to 5 minutes or longer if oxygen saturation levels are low .
2016.09.21	5.6.3.2 Remove the endotracheal tube as soon as the animal shows signs of impending arousal, i.e., when reflexes begin to return .
2018.12.06	5.1. Sedation: 5.1.1. Used for short periods of restraint for non-painful procedures (e.g. blood collection). Drug: Acepromazine, Dose: 0.2mg/kg to 1.1mg/kg, Route: IM, Duration of Effect: 30 minutes, Notes: Laryngeal reflexes preserved. Drug: Dexmedetomidine, Dose: 0.2mg/kg, Route: IM, Duration of Effect: Dose dependent, Notes: Profound drop in heart rate. Reversed with equal volume of Atipamezole
2018.12.06	4.8. Buprenorphine (0.3mg/mL) Butorphanol (10mg/mL) *Controlled drug 4.10. Atropine (0.5mg/mL) Glycopyrrolate (0.2mg/mL) 4.12. Tiletamine/zolazepam (Telazol) *Controlled drug 4.13. Thiopental sodium (Pentothal) powder *Controlled drug 4.15 Pentobarbital (54.7mg/ml) *Controlled drug
2018.12.06	5.2. Premedication/sedation:
2018.12.06	5.2.1.1. Buprenorphine: 0.05-0.1mg/kg Butorphanol: 0.25mg/kg
2018.12.06	5.2.1.3. Atropine: 0.05mg/kg Glycopyrrolate: 0.01mg/kg
2018.12.06	5.2.1.4. Ketamine: 10-15 25mg/kg or Telazol: 2-5 mg/kg
2018.12.06	5.5.2. Administer pentothal 10mg/kg or propofol 1-2 mg/kg intravenously.
2018.12.06	5.4.4. For non-recovery anesthesia, use pentobarbital 10-20 mg/kg intravenously.
2020.05.13	3.3 Keep animals warm by providing a heat source until the animal has recovered from anesthesia. Care should be taken to not overheat or burn the animals.
2020.05.13	5.7.1. Induction (only if injectable anesthetics cannot be used; the animal should be premedicated to reduce stress of induction): 5.7.1.1. Use a tight-fitting mask. 5.7.1.2. Adjust the oxygen flowmeter to 0.8 to 1.5 L/min. 5.7.1.3. Adjust the isoflurane vaporizer to 3% to 5%.
2020.05.13	5.7.1.4. Apply ophthalmic ointment (natural tears) to both eyes to prevent dryness and damage to the cornea. 5.7.1.5. When not under assisted ventilation, animal should be manually ventilated or “bagged” every 5-10 minutes to ensure proper air exchanges.

2020.05.13	5.7.3.3. Monitor the animal in his home cage to ensure it regains full consciousness and able to stand in a sternal position.
2023.08.14	2. RESPONSIBILITY Principal Investigators (PIs) and their research staff, veterinarians , veterinary care staff.
2023.08.14	3.1. Perform a thorough physical exam and obtain an accurate body weight.
2023.08.14	5.6.2. Use cuffed endotracheal tubes are preferred as they reduce the possibility of aspiration of saliva or stomach contents.
2023.08.14	5.6.3.2. With the animal in sternal, dorsal, or lateral recumbency, extend the neck and head so that they are in a straight line.
2023.08.14	5.7.3.2. Remove the endotracheal tube as soon as the animal shows signs of impending arousal, i.e., when the animal starts swallowing on its own and reflexes begin to return.
2023.08.14	5.7.3.3. Provide supplemental heat until the animal's temperature is consistently rising and approaching normal values.
2023.08.14	5.7.3.4. Monitor the animal in his home cage until it is ambulatory to ensure it regains full consciousness and able to stand in a sternal position.
2023.09.01	3.3. Monitor animals closely during induction, maintenance, and recovery from general anesthesia. Monitoring must be documented.
2023.09.01	3.3.2. Monitor animal every 5 minutes; record the following parameters every 15 minutes: 3.3.2.1. Anesthetic depth: absence of reflexes, e.g., pedal/eyelid/eyelash/palpebral, absence of movement, muscle relaxation (jaw tone). 3.3.2.2. Respiratory function (ventilation): respiratory rate, oxygen saturation (SpO2), thoracic wall or rebreathing bag movements, and auscultation. End-tidal carbon dioxide (ETCO2) should be included where capnography equipment is available. Blood gas analysis may be indicated for critical patients or procedures. 3.3.2.3. Cardiovascular function (circulation): capillary refill time (CRT), mucous membrane color, pulse quality, heart rate and rhythm, and blood pressure. Electrocardiography (ECG) should be included where equipment is available. 3.3.2.4. Body temperature: rectal or esophageal temperature.
2023.09.01	3.4. Apply ophthalmic ointment to prevent corneal desiccation. Reapply as needed, every 30 minutes at a minimum.
2023.09.01	3.6. Maintain records of each anesthesia procedure and include: 3.6.1. Date and time of procedure 3.6.2. Principal investigator and Animal Use Protocol (AUP) 3.6.3. Species and animal's identification 3.6.4. Animals' weight 3.6.5. Name, dose, route, and time of administration of each drug 3.6.6. Description of the procedure 3.6.7. Measurements of the animal's anesthetic depth and vital signs 3.6.8. Time of recovery 3.6.9. Name of the individual monitoring the animal and of the surgeon
2023.09.01	4.5. Monitoring equipment, e.g., stethoscope, thermometer, pulse oximeter, capnograph, ECG
2023.09.01	5.5.1. Placement of an endotracheal tube is recommended for delivery of isoflurane anesthesia when: 5.5.1.1. Profound sedation, preventing protective airway reflexes, is required. As a guide, light sedation should last under 30 minutes and is performed for less invasive procedures. 5.5.1.2. Surgical level anesthesia is required. 5.5.1.3. Head or airway cannot be accessed readily due to position, equipment, etc.
2023.09.06	5.3.2. It is recommended to apply EMLA cream and cover with plastic cling wrap (e.g. Saran® wrap) over the venipuncture site at least 15 minutes prior to placing the catheter. Observe the animal to prevent removing or swallowing of the plastic.
2023.09.06	5.4.1. Administer isotonic saline (0.9% saline) or Lactated Ringer's Solution at a rate of 10 2-5 mL/ kg//hour.