

## Technical Bulletin

### Perioperative Care of Swine

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Swine are widely used in protocols that involve anesthesia and invasive surgical procedures. In order to ensure proper recovery of animals, preoperative, intraoperative and postoperative techniques specific to the species need to be considered.

This manuscript makes recommendations on the monitoring and care of swine during the perioperative period. Detailed descriptions of surgical and technical procedures are available.<sup>1</sup> This manuscript makes recommendations for using swine in survival surgical procedures.

#### Preoperative Care

Animals should be procured from a source which provides health monitoring in order for the veterinary staff to determine whether the animals are suitable for survival surgical procedures. Generally, animals should be stabilized in the facility for 5-7 days after shipping to recover from shipping stress. Animals should receive a physical examination shortly after arrival and receive treatment for any preexisting condition if indicated. Screening blood samples for abnormalities and fecal samples for parasites may be necessary depending upon the herd of origin and requirements of the research protocol. Animals from herds with reliable health status information and a program of vaccination and parasite treatment probably will not require this type of testing at the receiving facility. Miniature pigs should be selected for long-term projects (>3-6 weeks) because of the rapid growth of farm breeds. Consultation with the veterinary staff in advance of the shipment will enable researchers to make these determinations.<sup>1-3</sup>

Pigs should be preanesthetized in the pen or an animal prep room, taking care to maintain their body temperature (Figure 1). Animal prep rooms should be separate from the sterile operating room and the surgeon prep room and should provide for administration and monitoring of anesthetics, analgesics and emergency drugs. During the preparation procedure, animals should have IV access for administration of fluids and pharmaceuticals, in addition to monitoring of vital signs and rectal temperature. Endotracheal



Figure 1. Preanesthetized pig ready for transport to the prep room

intubation should be performed on all anesthetized animals. The surgical site should be shaved and pre-scrubbed at this time. Use of a table with a grate over a drain is recommended for preoperative preparation because they allow generalized bathing of the animals. EKG leads and blood pressure cuffs can be attached during this procedure (Figure 2). Anesthetic protocol selection and the techniques of endotracheal intubation are described in *Anesthesia and Analgesia in Swine* on this website ([www.sinclairresearch.com](http://www.sinclairresearch.com)) and more in depth in other references.<sup>1,4</sup>

#### Intraoperative Care

The final sterile preparation of the surgical site should be performed on the operating table. No consensus exists on the type of surgical scrub that is best; consequently, any standard surgical preparation solution may be utilized. In our laboratories we use three betadine scrubs. Following that procedure and the area is rinsed with alcohol. The skin is then dried with sterile gauze sponges and an iodine impregnated sticky plastic drape is applied directly to the surgical site. The animal is then draped completely with sterile drapes (Figure 3).

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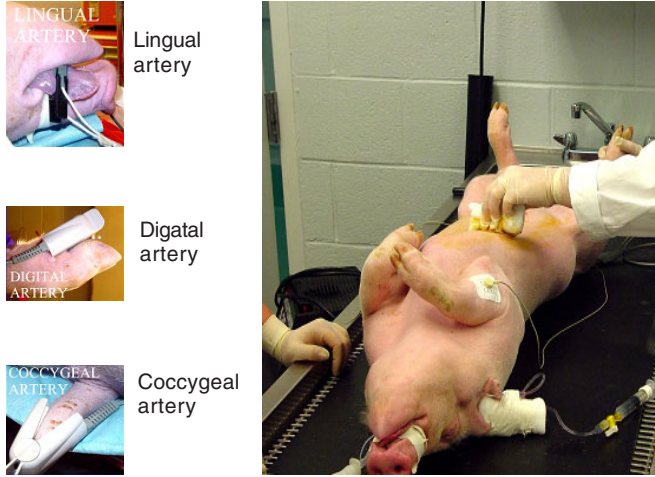


Figure 2. Anesthetized pig on prep table being prescrubbed for surgery (right) and placement of oximetry sensors

Antibiotics are not a substitute for meticulous aseptic technique. If preemptive antibiotics are indicated for a particular surgery because of a high probability of wound contamination, such as existing infection or entry of a contaminated body area, then the antibiotic should be administered prior to making the skin incision.

Standard methods of intraoperative monitoring and care apply to swine. Swine are very prone to hypothermia because they are relatively hairless and use of circulating hot water blankets and draping of the whole animal should maintain normothermia. Intravenous fluids for maintenance of homeostasis are administered at a rate of 10-15 ml/kg/hour. All of them should have EKG monitoring. In addition, pulse oximetry, capnography and non-invasive blood pressure monitors are also useful for major procedures (Figures 2,3).

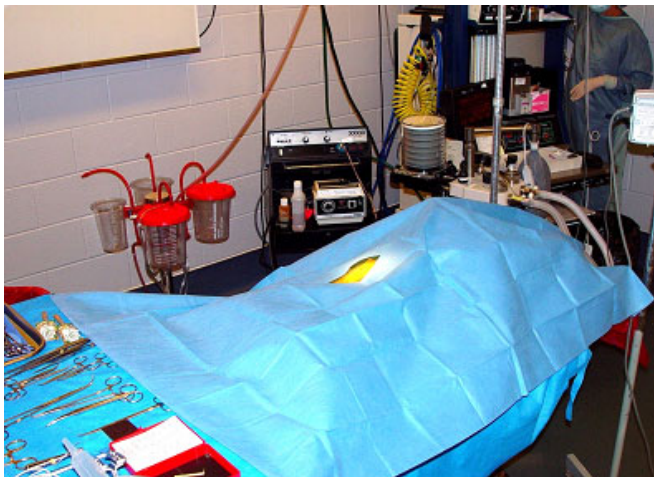


Figure 3. Aseptically draped pig ready for surgery

Intraoperative records not only provide useful physiologic information, but are also required by regulatory agencies to assure that animals are properly anesthetized and monitored. For survival procedures notation of monitoring should be performed every 10-15 minutes. Parameters to be recorded on the anesthesia sheet may include heart rate, blood pressure, blood gas values, rectal or esophageal temperature, and absence of muscle reflexes in addition to the anesthetic levels. The intraoperative monitoring sheet should also include a surgical note describing the procedure, medications administered, any complications that occur and times of these and other major events.

Preemptive analgesia is recommended and should be given before the surgical incision is made. Parenteral analgesics can either be administered in the operating room or during the induction procedures performed in the animal prep room. For some procedures it may be advisable to administer epidural analgesics, infiltrate the incision with a local anesthetic and/or perform a dorsal nerve root block. Procedures, equipment and supplies for responding to intraoperative emergencies should be available. This would include a defibrillator and a kit containing pharmaceutical agents to counteract anoxia, acidosis or alkalosis, blood pressure abnormalities and cardiac arrhythmias (Table 1).

### Surgical Technique Considerations

Proper surgical technique is important as an adjunct method of alleviating animal pain and distress. If the surgeon meticulously follows the principles of asepsis, hemostasis, minimizing tissue trauma, closure of dead space, careful approximation of the wound, avoiding tension on the incision and minimizing foreign material such as sutures, then the postoperative period will be less painful and stressful for the animal. Experience with swine has also led to species-specific considerations. Silk and surgical gut sutures are inflammatory in swine and should be avoided, in favor of the use of newer synthetic materials. Silk also has a wick-like action and can induce foreign organic material, such as bacteria, into the incision. Use of staples for skin closure also can produce problems with wound healing in swine. In this species, staples can be caught on cage surfaces while the pigs follow their normal behavior of rubbing against the cage. Staples can also collect material such as organic debris, hair or feces close to the wound. In our experience closure of the skin with a subcuticular suture pattern using a synthetic absorbable

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material provides the most satisfactory wound closure. In all cases, the surgeon should be trained and experienced in proper surgical technique.

### Postoperative Care

During recovery from anesthesia continuous monitoring with documentation of the animal's vital signs should be performed. In the immediate postoperative period the goals are to facilitate smooth recovery from anesthesia and to maintain homeostasis. When the pig has been extubated and recovers a standing reflex, the monitoring may become less intense. Depending upon the surgical procedure, the same parameters that were monitored during surgery should be monitored during the acute phase of the recovery. As a minimum, the heart rate and respiratory rate need to be observed. If preemptive analgesics were not administered, then postoperative analgesics should be administered before the animal completely recovers from anesthesia.

The environment for recovery from anesthesia for swine should preclude injury and hypothermia. Pigs can be recovered in pens or cages lined with soft pads to preclude injury. Body temperature can be maintained by keeping the room warm (>24°C/75°F), use of circulating hot water blankets, heat lamps and/or drapes to cover the animals (Figure 4).

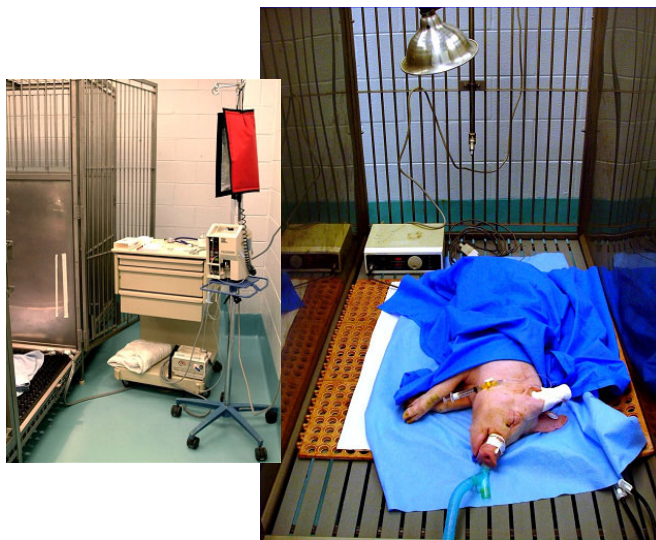


Figure 4. Postoperative recovery pen & equipment

When the animal is able to maintain itself, the postoperative monitoring can be less intense and the pig can be returned to its normal housing. Swine with surgical incisions should not be housed with other animals because of their tendency to cannibalize

wounds. Animals should be checked at least daily until their incisions heal, usually within 7-10 days.

Observations for appearance of the incision, behavioral characteristics, eating, drinking, urination, defecation, temperature, pulse and respiration should be noted during this period. We also assess postoperative pain by palpation of the wound and observation of the animal's reaction using a four-point scale. A score of 1 would indicate no reaction and a score of 4 would indicate a severe painful response to palpation. Oral and injectable analgesics are only given when indicated by clinical assessment during this period.

Some animals require much longer postoperative observation. This would include animals which have had disease states, such as heart failure, induced. It may also apply to animals with certain types of biomaterial implants, transplantation procedures or other highly invasive or debilitating procedures. For these types of protocols, professional judgment concerning what parameters need to be monitored and the frequency and depth of monitoring is required. The veterinary staff should be consulted concerning postoperative care for these procedures.

### Summary

These recommendations are based upon decades of experience managing swine for survival surgical procedures. Many of the techniques described and data supporting these recommendations have been published and are summarized in a textbook.<sup>1,4</sup> It is possible to perform many major surgical procedures in this species with minimal pain and distress to the animals, provided the species-specific considerations are addressed.

### REFERENCES

1. Swindle MM: *Swine in the Laboratory: Surgery, Anesthesia, Imaging and Experimental Techniques, 2<sup>nd</sup> Ed.*, Boca Raton, FL: CRC Press.
2. Swindle MM, Laber K, Smith AC, Goodrich JA, Bingel SA: Biology and medicine of swine, in Reuter JD, Suckow MA (eds), *Laboratory Animal Medicine and Management*, Ithaca, NY: International Veterinary Information Service, <http://www.ivis.org/library.asp>, 2003.
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4. Smith AC, Ehler W, Swindle MM: Anesthesia and analgesia in swine, in *Anesthesia and Analgesia in Laboratory Animals*, NY: Academic Press, pp 313-366, 1997.

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**Table 1. Cardiopulmonary Emergency Drugs**

AGENT	DOSAGE	INDICATION
Aminophylline	5.0 mg/kg iv	Produce bronchodilation
Amiodarone	10.0-12.0 mg/kg followed by 0.05-5 mg/kg/hr iv	Antiarrhythmic
Atropine	0.02 – 0.05 mg/kg iv	Counteract bradycardia, heart block
Bicarbonate Na	1.0 mEq/kg bolus followed by 0.5-1.0 mEq/kg/hr	Counteract acidosis
Bretylium	3.0-5.0 mg/kg iv	Antiarrhythmic
Calcium chloride	5.0-7.0 mg/kg slow iv infusion	Increase contractility
Digoxin	0.01-0.04 mg/kg iv	Counteract supraventricular arrhythmias, decrease conduction, increase contractility
Dopamine	2.0-20.0 ug/kg/min iv	Counteract hypotension, cardiogenic shock
Dobutamine	2.5-10.0 ug/kg/min iv	Counteract hypotension, cardiogenic shock
Epinephrine	0.5-2.0 ml of 1:10,000 solution iv or ic (30 ug/kg)	Counteract asystole, decreased contractility
Isoproterenol	0.01 ug/kg/min iv	Induce bronchodilation, Counteract AV block, sinus bradycardia
Lidocaine	2.0-4.0 mg/kg bolus followed by 50 ug/kg/min iv	Antiarrhythmic, antiectopic
Nitroprusside Na	0.5-0.8 ug/kg/min iv	Reduce hypertension
Neosynepherine	0.5-1.0 mg/kg iv	Increase blood pressure by vasoconstriction
Propranolol	0.04-0.06 mg/kg iv	Counteract tachycardia