

Sedation and Anesthesia in the Pig

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When general anesthesia or heavy sedation are planned, pigs should be fasted for 12-24 hours and water should be withheld for few hours before the procedure. Piglets should be fasted for 2-4 hours.

Pigs are difficult to restraint due to their demeanor and the shape for their body. Different techniques used to restraint pigs include:

- Snout snares
- Sling (used in research setting)
- The use of 1 or 2 boards to confine the pig
- The use of a bucket over the head and push the back end of the pig against a corner

When working with pigs, try to be quick and minimize the restraint to decrease stress.

Physical exam might be limited due to their demeanor and often they will need to be sedated to collect blood. Drugs can be injected IM in the neck, in the epaxial or in the gluteal muscle. Avoid these 2 last locations if the pig is meant for human consumption. When injecting drugs IM, use a luer lock syringe and a long needle (1.5-2 inch or longer in larger pigs). Use a bigger syringe that you think you might need (i.e. use a 6 ml syringe for 3 ml volume), this way the injection will be easier and faster.

IV access can be obtained by placing a catheter in the auricular vein in most pigs. In pot-bellied pigs this site might be very challenging. Alternative locations are the cephalic and saphenous vein.

- Drugs that can be used in pigs for sedation include:

- Tranquilizers – acepromazine, azaperone. They provide sedation, however they do not provide analgesia, they are non-reversible and they have a long duration of action. They can cause hypotension.
- Benzodiazepines – diazepam, midazolam. They provide muscle relaxation but not analgesia. They can be reversed (with flumazenil), however they are not good sedative in pigs if used on their own.
- Alpha-2 agonists – xylazine. Good sedation and analgesia, but inconsistent response if used on its own. Pigs are more resistant to the effect of xylazine compared to other species and higher doses should be used to achieve adequate sedation.
- Opioids – butorphanol, buprenorphine, hydromorphone. They provide analgesia, but they may cause dysphoria or aggression if given to healthy non-painful pigs without any sedation.
- Dissociatives – ketamine, tiletamine. High therapeutic index and good restraint/anesthesia. They cause discomfort upon injection and they do not provide muscle relaxation.

Examples of protocols for sedation and anesthesia

- Example 1

- Xylazine 2 mg/kg IM
- Midazolam 0.2 mg/kg IM
- Ketamine 2-5 mg/kg IM

The drugs should be mixed together in one syringe to allow for a single IM injection. If mild/moderate sedation is required, ketamine can be used at 2-3 mg/kg. If general anesthesia (i.e. using an inhalant agent) is planned, use ketamine at 5 mg/kg. If this is not enough to allow for endotracheal intubation, an IV catheter can be placed and more ketamine or propofol can be used until the animal reaches an adequate plane of anesthesia that allows for intubation. Alternatively, an inhalant anesthetic can be delivered via facemask until intubation is possible. In pigs weighing more than 150 kg, these doses can be reduced by 15-20%.

An opioid, such as hydromorphone (0.05-0.1 mg/kg) or buprenorphine (0.02 mg/kg) can be added if more analgesia is required.

If the procedure is not painful (i.e. of hoof and tusk trimming), xylazine can be reversed with tolazoline and midazolam can be reversed with flumazenil.

- Example 2

- Telazol, which is tiletamine + zolazepam (1 vial = 500 mg) + xylazine (5 ml of 100 mg/ml = 500 mg) -> TX. Use 1 vial of Telazol (powder) and dilute it by using 5 ml of 100 mg/ml xylazine.

Give 1 ml/100 lb (2.2 mg/kg of telazol and 2.2 mg/kg of xylazine) IM for up to 300 lb of body weight. If the pig weighs more than 300 lb, give 0.5 ml/100 lb for every extra 100 lb (over the first 300 lb). For example, if the pig weighs 400 lb pig, give a total of 3.5 ml of TX. An opioid can be added if more analgesia is required. Xylazine and zolazepam (contained in the Telazol) can be reversed with tolazoline and flumazenil, respectively. This drug combination is associated with a longer recovery than the protocol described in example 1.

Orotracheal intubation can be challenging in pigs, due to their long snout, narrow dental arcades, small tracheal diameter, laryngeal diverticulum, and long soft palate. Laryngeal spasm can also occur during intubation.

- Equipment needed for orotracheal intubation:

- Laryngoscope (use a long blade for larger pigs)
- Lidocaine (in a syringe with long cannula to desensitize the arytenoids)
- Stylet (longer than the endotracheal tube, useful in larger pigs)
- Several sizes of endotracheal tubes
- Gauze strips (to hold mouth open)
- Lube
- Cuff syringe

After induction, keep the animal in sternal recumbency. Use the stylet for larger pigs. When the endotracheal tube tip is between the arytenoid cartilages, rotate the tube 180 degrees while gently pushing it into the trachea. If using a stylet, make sure the tip exits the endotracheal tube at the patient end. Place the stylet tip between the arytenoids and while holding still the stylet from the other end (distal to the patient, where the endotracheal tube connects to the Y piece of the anesthesia machine), insert the endotracheal tube using the same technique described above.

The pharyngeal recess (or pharyngeal diverticulum) is located immediately dorsal to the esophagus. If the endotracheal tube is placed in the diverticulum, it will not advance. If this happens, start over and point the endotracheal tube (or stylet) more ventrally.

Monitoring pigs under general anesthesia is similar to other species:

- Mucous membranes and CRT
- Pulses and heart rate - 60 to 90 bpm (depends on the size)
- Respiratory rate - 15 to 40 bpm
- Eye reflexes - eye position is variable, loss of corneal reflex with a dilated pupil is indicative of excess anesthetic depth
- ECG
- Blood pressure – the cuff can be placed on the front or on the back leg. An arterial catheter can be placed in the auricular, medial saphenous or femoral artery for invasive blood pressure monitoring
- Temperature - it may increase if the animal becomes stressed before the procedure.

Malignant hyperthermia is an acute and potentially fatal syndrome reported in pigs. It is an autosomal recessive disorder due to the mutation of the ryanodine receptor 1 gene, which controls Ca^{++} efflux from sarcoplasmic reticulum. Myocytes of animals affected by the mutation are unable to control this efflux.

The symptoms can present very quickly, and include:

- Increase in body temperature
- Tachypnea
- Muscle rigidity
- Vasodilation
- Hypercarbia
- Metabolic acidosis
- Death

This syndrome can be triggered by:

- Volatile inhalants (especially halothane)
- Succinylcholine
- Excitement, stress, and rough handling
- Exercise
- High ambient temperature.

Treat immediately if malignant hyperthermia is suspected. Treatment includes:

- Immediate removal of offending agent
- Ventilation with 100% oxygen (do not use the anesthesia machine as traces of inhalant can be present)
- Cooling
- Supportive therapy for acidosis and shock
- Dantrolene IV

Breeds that can carry the mutation includes: Piétrain, Landrace, Large White, Hampshire, and Poland China.

During recovery, leave the endotracheal tube in place until the pig can chew and swallow. Do not feed or give water to the pig until he can walk. Do not put a recovering pig with other subjects, as they may attack and injure the recovering pig.