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The Whelping Bitch and Paediatrics Mini Series

Session 2: Dystocia and Anaesthesia of the Caesarean Patient

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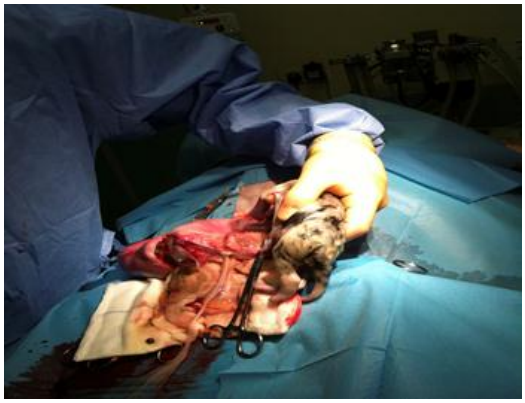

The choice of a particular anaesthetic protocol should be tailored to the specific animal, taking into account various factors (i.e., condition of the dam and fetuses, the veterinarian's experience and familiarity with various anaesthetic agents and techniques, clinic facilities, personnel available, and an emergency versus elective cesarean presentation). This article covers the perioperative and anaesthetic management of cesarean sec- tion in dogs, including preoperative assessment; specific agents used for premedication, induction, and maintenance of anaesthesia; anaesthetic monitoring; and treatment of hypotension.

Pre-Operative Assessment

Accurate assessment and stabilization of a patient is essential before administering an anaesthetic. The preoperative assessment (i.e., signalment, history, physical examination, laboratory findings) dictates which anaesthetic is most appropriate. Historical information should include the general medical history and pertinent information focused on the reproductive system. Specifically, information on the sequence of events and duration of labor should be obtained via questions including:

• When did signs of first-stage labour start?
• Have any foetal membranes or puppies been visualized at the vulva?
• Have any puppies been delivered? If so, in what condition (i.e., alive, dead, deformed)?
• What was the time interval between puppies that have been delivered?
• What is the previous pregnancy and whelping history, especially regarding dystocia and response to medical or surgical intervention?

General historical information on anaesthetic episodes, surgery, illnesses, and medications should also be obtained. Predisposing factors for dystocia (e.g., fetopelvic disproportion, pelvic fracture malunion, hypocalcemia, large litter size) should be assessed. The physical examination should be thorough and complete but performed in a timely manner as dictated by the condition of the dam. The abdomen should be palpated to assess the size and tone of the uterus in conjunction with a digital vaginal and rectal examination. Vaginoscopy may be indicated if obstructive pathology such as vaginal bands is suspected. Abdominal radiography and/or ultrasonography can be valuable in detecting fetal presence, number, size, and position. Ultrasonography is a more sensitive diagnostic tool for determining fetal viability because radiography cannot differentiate between live and freshly dead fetuses.1 Ultrasonography can be used to measure foetal movement and heart rates. Fetal heart rates of 150 to 200 bpm indicate a healthy fetus, whereas lower heart rates of 100 to 150 bpm may indicate fetal stress. Laboratory tests should be conducted as dictated by the patient's physical status. A packed cell volume as well as total protein, blood urea nitrogen (BUN), calcium, glucose, and electrolyte levels are the recommended minimum laboratory test database that should be obtained before administering anaesthesia for cesarean section.

1 Relative anemia and possibly a decreased BUN level may be caused by changes in maternal physiology that occur with pregnancy. Haematocrit values within the normal reference range may actually represent dehydration in late term pregnant dams. Calcium levels are most likely decreased in small-breed dogs, dogs with large litters, or those diagnosed with uterine inertia. Serum total calcium measurement is an insensitive indicator of calcium homeostasis, so measurement of ionized calcium is preferred. More extensive serum biochemical testing should be conducted as indicated by the clinical status of the dam. Results can help detect acid–base disturbances and direct fluid therapy choices. In an emergency, therapy may need to be initiated before test results are available.

Premedication

Premedication provides sedation and analgesia for the dam and permits a decreased dose of induction and inhalation anaesthetics required for surgery. Premedication reduces anxiety, especially if the dam has already started parturition, has had a prolonged second-stage labour, has delivered pups, or has uterine inertia. Premedication also facilitates placement of an intravenous catheter, allowing fluid therapy and drug delivery before induction of anaesthesia. Premedication can have adverse effects on foetuses because most agents can cross the placental barrier; therefore, using short-acting drugs that can be antagonized is preferred. Opioids provide sedation and analgesia to the dam with minimal cardiac depression but are associated with dose dependent respiratory depression and bradycardia in both the dam and foetuses. The respiratory depressant effect of opioids can be reversed in the dam and fetuses by administering naloxone if necessary.

Benzodiazepines produce skeletal muscle relaxation and mild sedation. They can potentiate respiratory depression associated with opioids. Dose-dependent, prolonged sedation can occur in neonates because the foetal liver does not have mature hepatic enzyme systems with which to metabolize benzodiazepines. This effect can be antagonized with the reversal agent flumazenil in neonates after delivery. Midazolam is water soluble and has a shorter duration of action than does diazepam; thus midazolam is the preferred benzodiazepine for cesarean section. Benzodiazepines can be used intravenously immediately before induction.

Phenothiazine tranquilizers can cause maternal hypotension by a1-adrenergic blockade and hence lead to foetal hypoxia. Acepromazine has a long duration of action, cannot be reversed, and requires hepatic metabolism. In neonates, acepromazine can cause respiratory depression and decreased ability to thermoregulate; therefore, this drug is not recommended for routine use in patients undergoing cesarean section. One potential indication for acepromazine use is to help facilitate handling, decrease anxiety, and decrease catecholamine release in very anxious, stressed, or aggressive dams. In this instance, acepromazine should be used at very low doses (0.01 to 0.02 mg/kg SC, IM, or IV).

a2-Agonists used in small animal anaesthesia (i.e., medetomidine) are not recommended in patients undergoing cesarean section because these drugs have been identified as risk factors for increased puppy mortality. Adverse cardiovascular effects include profound bradycardia, potentiation of arrhythmias, decreased myocardial contractility, and initial hypertension followed by hypotension.

Patients undergoing caesarean section are reported to have an increased risk of passive ("silent") gastric reflux. Increased gastric acidity and decreased lower esophageal tone secondary to increased abdominal pressure caused by the gravid uterus are factors that may increase the incidence of esophageal reflux in dogs undergoing cesarean section. Rapid intubation with a cuffed endotracheal tube and monitoring for passive gastric reflux are advised. If regurgitation or vomiting has occurred perioperatively, esophageal lavage and appropriate medical therapy for reflux esophagitis should be administered. After surgery, patients that have regurgitated should be carefully monitored for aspiration pneumonia and oesophageal stricture.

Intravenous Fluid Therapy

Intravenous fluid therapy is strongly recommended for all dogs undergoing cesarean section. Fluid therapy should begin preoperatively, and fluid deficits and electrolyte or acid–base imbalances should ideally be corrected before surgery. Fluid therapy with crystalloids helps counteract the hypotensive effects of anaesthetics and maintain cardiac output and uterine blood flow. Selection of crystalloid versus colloid fluid and the need for additives are based on clinical parameters and laboratory test results. The crystalloid of choice is lactated Ringer's solution administered at an initial rate of 5ml/kg/hr. Higher rates of administration are used if hypotension or hypovolemia are encountered. Intravenous fluids should be warmed to body temperature to minimize the chance of inducing or potentiating preexisting maternal hypothermia. Colloid solutions (e.g., blood products) remain in the vascular space longer than crystalloids and may be useful for refractory hypotension. Blood transfusion with whole blood or packed red blood cells may be required if blood loss is severe; thus, ideally, dogs should be blood-typed and fresh blood should be available if severe haemorrhage is anticipated.

Pre-oxygenation

Dogs in late pregnancy are more prone to hypoxemia because of decreased functional reserve capacity and increased metabolic rate. Maternal hypoxaemia can lead to fetal hypoxia and acidosis. Animals are most susceptible to hypoxaemia during anaesthetic induction, when transient apnea frequently occurs because of an anaesthetic induction agent. It is strongly recommended to pre-oxygenate the dam with 100% oxygen by face mask for 3-5 minutes (4 to 6 L/min) before and during induction of general anaesthesia until an

endotracheal tube is placed. Premedication decreases the potential stress of face-mask oxygenation.

Regional and Local Anaesthetic Techniques

Epidural anaesthesia can be used as the sole anaesthetic method to successfully perform cesarean section in dogs. The technique of epidural injection has been well described. Epidurally administered lidocaine provides good regional anaesthesia and abdominal muscle relaxation. Hypotension caused by sympathetic blockade with resulting vasodilation is one of the main complications of epidural anaesthesia. Therefore, blood pressure monitoring is important when epidural anaesthesia is used. Hypotension associated with epidural anaesthesia should be treated with intravenous fluid boluses but may be refractory and require treatment with pressors. Preemptive fluid loading is recommended to minimize this potential complication. With epidural anaesthesia, the dam is not endotracheally intubated; thus supplemental oxygen can be administered only by face mask or nasal insufflation, and regurgitated material is more likely to be aspirated. The disadvantages of epidural anaesthesia include the frequent need for sedation and a lack of airway protection.

General Anaesthesia Techniques

Induction

A short time between induction and delivery of neonates is desirable, but a very short time has not been shown to have a beneficial effect on puppy survival. If the abdomen has been clipped in the preparation area, induction can be done in the operating room. This decreases the time from induction to delivery and prevents the need for patient repositioning and transportation after induction. The aim of using any induction agent is to provide rapid transfer to unconsciousness and allow endotracheal intubation for airway protection and ventilatory support with high inspired oxygen concentrations. Inhalation induction can be achieved via a mask or chamber. Using nitrous oxide and inhalation agents with a lower solubility (e.g., sevoflurane, isoflurane) makes induction more rapid. Inhalation induction of anaesthesia is more rapid in pregnant animals because of decreased functional reserve capacity and increased minute volume, permitting rapid equilibration between inspired and alveolar anaesthetic concentrations. Disadvantages of inhalation induction are stress and hypoxemia in the dam, leading to catecholamine release, maternal hypoxia, and fetal hypoxia and acidosis. Inhalation induction takes longer than injectable induction, and the risk of regurgitation and aspiration is higher because the airway is unprotected. Because of these concerns, we recommend using an injectable induction technique over inhalation induction for patients undergoing cesarean section. Induction with rapidly acting injectables facilitates endotracheal intubation, which protects the airway and allows assisted ventilation.

Propofol is a rapid, ultra–short-acting non-barbiturate injectable induction agent. The reported induction dose for propofol is 6 to 8 mg/kg IV in dogs that have not been premedicated; premedication may reduce this induction dose by 25% to 70% (i.e., 2 to 5 mg/kg IV). Propofol is metabolized in the liver and readily crosses the placenta, reaching the fetal circulation. Propofol can cause hypotension as a result of arteriolar vasodilation; because this is more severe in dogs that have preexisting hypovolemia, an intravenous fluid bolus (i.e., 5 to 10 ml/kg) should be administered to the dam before induction. Hypotension caused by propofol does not result in a baroreceptor-mediated heart rate increase, so bradycardia may occur and should be treated with anticholinergic administration.Because transient dose- and rate-dependent apnoea and respiratory depression are common with propofol use, assisted ventilation in the immediate induction period may be required. Large, rapid boluses are associated with more severe respiratory depression. Propofol does not provide analgesia, so additional means of analgesia, such as opioid premedication, should be provided. Propofol can be used as a sole maintenance agent via either constant-rate infusion (CRI) or repeat boluses. Unlike thiopental, repeated boluses of propofol do not have a cumulative effect on the dam but may be associated with more severe neonatal respiratory depression. Because of the pharmacokinetic properties of propofol, it is considered the induction agent of choice for cesarean section anaesthesia by many anaesthesiologists. Ketamine (4 to 6 mg/kg IV) combined with diazepam (0.2 to 0.4 mg/kg IV) or midazolam (0.1 to 0.3 mg/kg IV) can be used in critically ill dams. Ketamine causes less cardiovascular depression in dams than does propofol or thiopental but may have significant depressant effects in neonates. The use of ketamine is associated with a decreased likelihood of all pups breathing spontaneously at birth and greater neonatal depression compared with the use of other induction agents.

Maintaining Anaesthesia

Using inhalation anaesthesia with a cuffed endotracheal tube allows delivery of higher concentrations of inspired oxygen and controlled or assisted ventilation, if required. All inhalation anaesthetics cross the placenta because of their lipid solubility and low molecular weight. Volatile inhalation agents cause potent cardiovascular and respiratory depression. The delivery of inhalation anaesthetics should be titrated to effect and the delivered concentration kept as low as possible to avoid anaesthetic overdose and minimize neonatal respiratory depression. Neonates rapidly eliminate inhalation anaesthetics once spontaneous respiration commences. The MAC of inhalation anaesthetics in humans and animals is decreased during pregnancy by 28% to 40% for isoflurane. If mechanical or assisted ventilation is used during anaaesthesia, care must be taken to avoid maternal hyperventilation, which can lead to severe maternal hypocapnia (partial pressure of carbon dioxide <32 mm Hg) and an associated decrease in uterine and umbilical blood flow and increased maternal oxygen affinity for haemoglobin. These conditions lead to decreased oxygen delivery to fetuses and fetal hypoxemia. If the dam is breathing spontaneously and

not being mechanically ventilated during anaesthesia, intermittent “sigh” breaths are recommended to help maintain good maternal ventilation by preventing pulmonary atelectasis. Isoflurane and sevoflurane can be used as maintenance inhalation anaesthetics. Isoflurane use is associated with increased neonatal survival compared with halothane. Sevoflurane has not been specifically evaluated in veterinary cesarean section anaesthesia but have cardiopulmonary depressant effects similar to those of isoflurane. Nitrous oxide should not be used for cesarean section or should be used only to expedite inhalant induction and terminated once the dam has been intubated. Nitrous oxide decreases the maternal inspired oxygen concentration and can cause diffusion hypoxia in neonates. Because no anaesthetic protocol is suitable for every cesarean section, protocols should be tailored to each patient. Protocols that include propofol and isoflurane are recommended, and those using xylazine, ketamine, or methoxyflurane should be avoided.

Anaesthetic Monitoring

Accurate, continuous monitoring of cardiovascular and ventilation parameters, temperature, and depth of anaethesia is important for anaesthetic episodes, especially during cesarean section.

Cardiovascular Monitoring

Heart rate can be measured by pulse detection, oesophageal stethoscope, electrocardiography, or pulse oximeter. Arterial pulse, which reflects the difference between systolic and diastolic pressures, can be directly palpated at the lingual, digital, or pedal arteries. However, the pulse quality and magnitude are not reliable indicators of cardiac output, blood pressure, or tissue perfusion. An oesophageal stethoscope provides a simple, inexpensive means of monitoring heart sounds but cannot be relied on to give adequate warning of circulatory insufficiency. Electrocardiography indicates the electrical activity of the heart and records a heart rate but does not supply information about cardiac contractility or blood pressure. Because electrocardiography can give erroneous results during interference, it should not be relied on as the sole means of monitoring heart function. Most pulse oximeters indicate a pulse rate and measure oxygen saturation (SpO2). Many injectable and inhalation anaesthetics cause decreased cardiac output, systemic vascular resistance, or both, resulting in hypotension and potentially poor tissue perfusion. Blood pressure can be measured by direct or indirect techniques. Direct blood pressure monitoring using an arterial catheter and aneroid manometer or strain gauge transducer is the gold standard and provides the most accurate information on blood pressure status, giving systolic, diastolic, and mean blood pressure readings. It provides continuous information and accurate readings in hypo-, normo-, and hypertensive states. Arterial catheter placement also allows serial arterial blood sampling for blood gas analysis—the gold standard for assessing ventilation.

Placing an arterial catheter can be technically demanding and time-consuming and can delay delivery of puppies; therefore, invasive blood pressure monitoring is not routinely recommended for cesarean section. Noninvasive blood pressure monitoring using a Doppler flow detector and sphygmomanometer is an easy, inexpensive method, providing an acceptable estimate of the systolic arterial pressure in dogs. No information about diastolic or mean blood pressures can be gained with the Doppler method. The noninvasive oscillometric technique provides an automatic readout of systolic, mean, and diastolic blood pressures as well as pulse rate. There is a good correlation between osillometric and direct arterial pressure measurements in hypo-, normo-, and hypertensive states unless vasoconstriction or bradycardia is present. The main disadvantages of the noninvasive osillometric technique are that it is more expensive than the Doppler method and readings may be unreliable in very small animals. Hypotension is a common complication in anaesthetized patients, resulting from the cardiac depressant effects of anaesthetics, particularly inhalation agents. Hypotension can be significant during cesarean section because haemorrhage and increased intra-abdominal pressure decrease cardiac return. Hypotension that requires treatment during anaesthesia is defined as mean arterial pressure below 60 mm Hg and/or systolic arterial pressure below 80 mm Hg. Initial treatment involves decreasing the depth of anaesthesia and administering a crystalloid fluid bolus (5 to 10 mg/kg IV). If crystalloid therapy is ineffective, synthetic colloids can be given as a 5 ml/kg IV bolus rather than repeated crystalloid boluses, which risk haemodilution and pulmonary overload. Opioids produce fewer cardiovascular-depressant effects than do inhalation anaesthetics and can be administered via intravenous bolus (e.g., fentanyl at 2 µg/kg) or CRI (e.g., 5 to 20 µg/kg/hr) to decrease the concentration of inhalation anaesthetics administered, possibly resulting in improved blood pressure and tissue perfusion.40 If bradycardia is present, anticholinergics (i.e., atropine, glycopyrrolate) can be given to increase the heart rate and improve cardiac output. If these measures do not improve blood pressure, inotropes are indicated to improve cardiac contractility, cardiac output, and blood pressure.

Respiratory Monitoring

Arterial blood gas analysis is the gold standard for assessing ventilation, arterial oxygenation, and acid–base status. The technique for arterial sampling and interpretation is well described. Capnography can be used to assess ventilation by measuring the end-tidal carbon dioxide concentration, which approximates the alveolar carbon dioxide concentration, which should in turn approximate the partial pressure of arterial carbon dioxide (PaCO2). The value displayed on the capnograph can be interpreted as the lowest value for PaCO2, but true values of PaCO2 may be higher than the displayed values. Capnography is best used as a trend analysis tool and does not replace arterial blood gas analysis as the best method of assessing adequacy of ventilation. Pulse oximetry provides a simple non-invasive means of monitoring arterial oxyhaemoglobin saturation (SpO2) of the dam during anaesthesia.

It also provides information on the pulse (heart) rate. The relationship between SpO2 and arterial blood gas measurements of PaO2 is not linear. Most animals remain sufficiently oxygenated as long as SpO2 is 90% or greater, corresponding to a PaO2 of greater than 60 mm Hg. SpO2 measurements are best used as a real-time trend indicator of arterial oxyhaemoglobin saturation during surgery but do not replace arterial blood gas analysis as the gold standard of assessing arterial oxygenation. A haematocrit of greater than 15% is required for accurate pulse oximeter readings in dogs. Respiration can be monitored by direct observation of thoracic wall movement and subjective assessment of breathing bag excursions. Electronic respiratory monitors can also be used as additional aids but do not replace the need for direct monitoring of respiration and do not provide information about the effectiveness of ventilation.

Temperature Monitoring

Maternal hypothermia can be significant with cesarean section. Core body temperature should be monitored with an esophageal or rectal probe. Methods of supporting body temperature include heated operating tables, warmed intravenous and abdominal lavage fluids, radiant heat lamps, and circulating warm-air blankets.

Summary

Understanding the changes in maternal and fetal physiology that occur during pregnancy and the pharmacokinetics and pharmacodynamics of anaesthetics is necessary to formulate an effective and safe anaesthetic plan for pregnant dogs. No single anaesthetic protocol is suitable for every cesarean section. All patients undergoing cesarean section should be administered intravenous fluids. Pre-oxygenation of the dam for 3-5 minutes before and during induction until endotracheal intubation is strongly recommended to decrease the risk of hypoxemia. Premedications that can be specifically antagonized (e.g., opioids, benzodiazepines) are preferred so that depressant effects in neonates can be reversed. Anaesthetic protocols that include propofol and isoflurane are associated with decreased maternal mortality and increased neonatal survival and vigor. Selection of appropriate anaesthetics and good perioperative management minimize the risks to the dam and puppies, help decrease maternal and neonatal mortality, and increase neonatal vigor.

Dystocia

Dystocia is the abnormally slow or difficult delivery of the fetus. The word derives from the Greek dystokia: *dys* - badly and *tokus* - childbirth. Says it all, really. Although the majority of dogs and cats will deliver normally, dystocia is seen regularly (estimates between 15-20%), with certain dog breeds over-represented - brachycephalics, and also some giant breeds.

Dystocia is not as common in cats, has been reported to be about 6% - and again over-represented in pure and exotic breeds.

The causes of dystocia have been divided into maternal and fetal. **Maternal** causes include primary uterine inertia, small pelvic canal, and less commonly, uterine torsion, and vaginal septum or stricture. **Fetal** causes of dystocia are either fetal oversize (singleton, anasarca or other anomaly), or fetal malposition. Secondary uterine inertia is not a cause of dystocia, but is myometrial fatigue resulting from obstruction due to one of the causes listed above. **Primary uterine inertia** can be **complete** or **partial**, and is the commonest cause of dystocia. With complete primary uterine inertia, no puppies or kittens are delivered. In partial primary uterine inertia, part of the litter is delivered, but then the uterus fatigues before parturition is complete. The reasons for primary uterine inertia are thought to be:
- Very large or very small litter size leading to inadequate uterine stimulation;

- Systemic disorders

- Low plasma oxytocin

- Low prostaglandin/high progesterone levels.

It can be challenging to recognize complete primary inertia. There are often no signs at all, or there can be a lack of Stage 1 transitioning to Stage 2. Certainly, a prolonged known gestational periods, failure to deliver 36 hours after rectal temperature drop or signs of toxaemia, can indicated complete primary inertia. Signs of partial primary inertial are prolonged (> 4 hours) interval between pups, and no significant abdominal straining.

Diagnostics

A well lubricated digital vaginal exam and also rectal examination can determine if there is a fetus in the birth canal, and the state of the vagina (with respect to tone, and contractions). Sometimes malposition can be detected. The two most valuable diagnostic tools, however, that aid decision-making are **radiography** and **ultrasonography**. Lateral and ventro-dorsal abdominal views will allow us to determine the number of fetuses and their position. Breech is considered normal in dogs and cats, but if the fetus is transversely presented, or breech with hips flexed or the neck is flexed, then the malposition can cause fetopelvic disproportion. Very large fetuses (e.g., singletons) and anasarcas can also be determined. Gas in the fetal sacs and fetus indicates fetal death and is evident as early as 6 hours following demise. Fetuses that have been dead for several days will show skeletal collapse. Ultrasound is not as accurate for determining the number of fetuses, but provides an excellent indication of fetal viability. Normal fetal heart rates in a conscious dam are around 220 bpm, and fetal limb movement is evident. The fetus is considered to be in distress if the fetal heart rate drops to less than 190 bpm in the conscious dam. Severe fetal distress (150-160) is an indication for

immediate C-section

Treatment of dystocia

Once dystocia is recognized, it should be treated as soon as possible. At our institution, **immediate C-section** is indicated if:

- there is obstruction to the birth canal, or
- there is unresolvable fetal malposition, or
- there is meconium staining in the vagina, or
- there is bloody or other abnormal vaginal discharge before the first pup, or
- the fetal heart rate is between 150 and 170, or
- the fetal heart rate is between 170 and 190, **AND** there is no movement, or
- it has been 4 hours since the last pup, or
- there has been more than 30 minutes of active abdominal straining, or
- the bitch has signs of systemic disease.

If, on the basis of your diagnostics, there is no obstruction to the birth canal, there is no foetal malposition or fetal monster, and fetal heart rates are normal or if they are Between 170 and 190 but they are moving, and it has been less than 4 hours since the last pup delivered, then medical management can be considered. Medical management typically consists of fluids and electrolyte correction (animals are rarely hypoglycaemic or hypocalcemic), and oxcytocin 0.2 U/5kg IM or SQ. If a fetus is delivered, oxytocin can be repeated every 30-40 minutes. Most dogs, however, will go to caesarian…

Caesarean

The word caesarian derives from the Latin root *caedere* or *caesus.,* to incise or cut. The following describes a team approach developed over many colony and client C-sections where delivery of a healthy pup and saving the dam were critical. The key to success with C-sections is in the **team**. Everything associated with prioritizing both fetuses and mother - anesthesia induction and maintenance, clipping and preparing for surgery, the surgical technique and neonatal resuscitation - all happen in very close concert. It is understood that not all facilities have a plethora of people to help at all times, so extra and willing folk (e.g., the owners, receptionist, kennel maid, delivery man) may have to be recruited. The time to removal of first fetus (often the most compromised) is critical.

10 step protocol for emergency delivery by caesarian:

1. Assemble team

Round up folk and designate a resuscitation team leader. The anesthetist, surgeon (and assistant if possible) must never forget that time is crucial. Experienced anesthesia support greatly facilitates this mission.

2. Teams split

Anesthesia team: stays with animal and starts preparing animal (see Step 3.) **Resuscitation team**: gets equipment together – see below under Neonatal Resuscitation

3. Preoxygenate, clip and prep

Many laboring bitches can be clipped and even have an initial prep while conscious and receiving oxygen. Take care to avoid clipper rash and nipple damage – there is no need to clip too wide. As soon as the bitch is catheterized, clipped and vacuumed, she can be taken into the OR for induction.

4. Move to OR, induce, and line block

We use IV propofol induction followed by endotracheal intubation with administration of oxygen only. A generous line block with lidocaine is infused into both deep and superficial layers. The bitch is maintained on IV Propofol only with no (or minimal) isoflurane until fetuses are removed. Dorsal recumbency is fine, supine hypotension is not an issue in cats and dogs. Animal receives the final prep following line block.

5. Drape and incise

The surgeon needs to work quietly and surely, in unhurried movements, but not pausing – always be thinking of the next step in the procedure. It is probably slightly easier if surgeon stands on right side of dog. Towels are quartered around the midline, covering the nipples, and secured with towel clamps. The towel clamps should **not** penetrate through the skin. Barrier and fenestrated drapes follow. Incise firmly from 2-3 cm cranial to umbilicus to pubis (but drape up to xiphoid). Clamp any significant bleeders with hemostats but no other hemostasis – no electrocautery yet, no ligatures. Careful nick in linea right in the middle of the incision length, then fingers protecting uterus and lifting linea, cut with Mayo scissors, up and down. The linea is usually quite wide and obvious in these girls.

6. Deliver the first pup

Gently bring body of uterus up, be careful of your fingertips on the broad ligament, as the uterine and ovarian vessels are ginormous. If there are only a few pups, you can also exteriorize both uterine horns. Pack off with a couple of laparotomy sponges on either side of the uterus. Transverse or longitudinal incision in body, with #15 blade, extend with

Metzenbaums. Open sacs by lifting up with Debakey forceps and cutting with blade or scissors – pup will present immediately. Hold up with head down, two hemostats on umbilicus, leaving at least 2-3 cm of cord with pup. Cut between clamps and hand off onto sterile, warmed towel.

7. Deliver the rest

Immediately upon delivery of the first pup, the assistant should start applying gentle yet persistent traction on the placenta, while the surgeon starts to milk the next fetus down from the opposite horn. The placenta will slowly start to separate – if torn off too quickly, bleeding will ensue and some placenta may be retained. Each pup is delivered in a similar manner to the first, with the placenta being brought out immediately afterwards, alternating from one horn to the other. After one or two pups are delivered, the uterine horns are usually easily exteriorized. If there is no neonatal movement or if there are signs of meconium staining, these should be reported as the pup is handed off. The presence of a clearly dead fetus indicates culture and sensitivity.

As soon as the pups are delivered, inhalation anesthesia can be started (sometimes a little is needed before this), and the urgency (of the surgical team) is lessened.

8. Reconcile placentae, flush and suction

Reconcile the number of placentae with the number of pups. Check that you have all fetuses extracted, and there is not a small, mummified fetus high in one horn. No more than a quick flush and suction of the uterine horns is typically needed. By this time, you should notice some involution of the uterus beginning to occur.

9. Close uterus

The uterus can be closed in a snug, single layer, simple continuous suture pattern, using a 3-0 monofilament absorbable suture. The muscular organ starts to contract and longitudinal ridges appear in the body and horns. This will attenuate hemorrhage from the placentation sites, so it is important to note that it occurs. If the uterus remains flaccid, oxytocin should be administered.

10. Close

Following uterine closure, the abdomen can be lavaged and suctioned, using a new suction tip. A routine three-layer closure is performed, using an intradermal suture pattern in the skin. Finally, the abdominal skin is rinsed thoroughly with warm saline to rinse off any residual scrub or solution from the surgical prep.