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Anaesthesia in Dogs and Cats: Essential Monitoring for Safer Surgery

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Anaesthesia is an integral component of small animal surgical practice, facilitating surgical interventions while maintaining unconsciousness, analgesia and physiological stability. Despite advances in anaesthetic drugs and equipment, anaesthesia-related complications remain a concern in dogs and cats, particularly when physiological disturbances are not recognized promptly. Systematic monitoring of cardiovascular function, ventilation, oxygenation, body temperature and anaesthetic depth is therefore essential throughout the peri-anaesthetic period. Modern monitoring techniques, including electrocardiography, pulse oximetry, capnography and blood pressure measurement, provide complementary information regarding patient status. However, reliable anaesthetic management requires integration of these measurements with clinical examination and an individualized anaesthetic plan. This article reviews the principles of anaesthetic monitoring in dogs and cats, the clinical significance of essential physiological parameters, common anaesthetic complications, recovery assessment and practical strategies for improving patient safety.

Introduction

General anaesthesia is routinely employed in small animal veterinary practice for orthopaedic procedures, soft tissue surgery, ovariohysterectomy, castration, dental interventions and diagnostic procedures. It facilitates appropriate surgical conditions by producing unconsciousness, immobility and, when combined with appropriate analgesic techniques, adequate control of pain. However, anaesthetic drugs can alter cardiovascular function, respiratory mechanics, thermoregulation and neurological activity. Anaesthetic complications may develop because of drug-induced physiological depression, pre-existing disease, haemorrhage, airway obstruction, equipment malfunction or inappropriate anaesthetic depth. The risk is influenced by the patient's health status, age, breed, body condition, procedure duration and the quality of perioperative care. The American College of Veterinary Anesthesia and Analgesia (ACVAA) published updated small animal anaesthesia and sedation monitoring guidelines in 2025, addressing circulation, oxygenation, ventilation, body temperature, neuromuscular blockade and anaesthetic depth. These recommendations emphasize a systematic approach to monitoring rather than reliance on individual parameters. Anaesthetic safety should be considered a continuum extending from pre-anaesthetic assessment through induction, maintenance and recovery. Continuous observation, appropriate monitoring equipment, trained personnel and timely clinical intervention are essential components of this process.

Pre-Anaesthetic Evaluation and Risk Assessment

Pre-anaesthetic evaluation provides the foundation for individualized anaesthetic management. The purpose is to identify conditions that may increase anaesthetic risk and to determine whether stabilization or additional diagnostic investigation is required.

Clinical assessment: A detailed history and physical examination should include previous anaesthetic reactions, current medications, concurrent diseases, nutritional status and the nature of the planned procedure. Cardiovascular and respiratory examinations are particularly important. Assessment should include heart rate and rhythm, pulse quality, mucous membrane colour, capillary refill time, respiratory pattern, hydration status and body temperature. Particular attention is warranted in geriatric patients, paediatric animals, brachycephalic breeds and animals with cardiac, respiratory, renal or hepatic disease.

Laboratory and diagnostic investigations: Depending on the patient's clinical condition, investigations may include complete blood count, serum biochemical analysis, blood glucose, electrolyte measurements, urinalysis, electrocardiography or echocardiography. These tests help identify abnormalities such as anaemia, electrolyte disturbances, renal dysfunction and metabolic disease that may influence drug selection and perioperative management. Diagnostic testing should be individualized rather than applied indiscriminately to every patient.

Preparation before induction: The anaesthetic machine, oxygen supply, breathing circuit, endotracheal tubes, suction equipment and emergency supplies should be checked before induction. Appropriate intravenous access, fluid therapy planning and preparation of monitoring devices improve readiness for unexpected complications.

Essential Parameters for Anaesthetic Monitoring

1. Cardiovascular Monitoring

Cardiovascular monitoring evaluates the effectiveness of circulation and helps identify haemodynamic disturbances during anaesthesia.

Heart rate and cardiac rhythm: Heart rate should be assessed by auscultation or pulse palpation and, when available, electrocardiography (ECG). Bradycardia and tachycardia may occur because of anaesthetic drugs, autonomic responses, hypovolaemia, hypothermia, pain or underlying cardiac disease. ECG identifies electrical activity and helps detect arrhythmias. However, it does not directly measure cardiac output or confirm adequate tissue perfusion. ECG findings must therefore be interpreted alongside pulse quality, blood pressure and other clinical parameters.

Blood pressure: Anaesthesia-related vasodilation and reduced cardiac output may cause hypotension. Blood pressure can be assessed non-invasively using oscillometric or Doppler techniques, while invasive arterial monitoring may be indicated in selected critically ill or haemodynamically unstable patients. Commonly used warning thresholds include a mean arterial pressure below approximately 60–70 mmHg or systolic arterial pressure below approximately 80–90 mmHg. These values are clinical alerts rather than universal treatment targets. Their significance depends on the patient, measurement method, duration of hypotension and evidence of impaired perfusion. When hypotension is detected, the clinician should evaluate anaesthetic depth, heart rate, circulating volume, haemorrhage and cardiovascular function before deciding on an appropriate intervention.

2. Respiratory Monitoring and Ventilation

Respiratory depression is an important potential effect of general anaesthesia. Reduced respiratory drive, airway obstruction and impaired pulmonary ventilation may result in carbon dioxide retention and, in severe cases, inadequate oxygenation. Respiratory rate, chest excursions, breathing pattern, airway patency and movement of the breathing system should be observed throughout anaesthesia. However, respiratory rate alone is insufficient to establish whether ventilation is adequate.

Capnography is a valuable monitoring technique that measures end-tidal carbon dioxide ($ETCO_2$) and displays changes in carbon dioxide concentration over time. It can help identify apnoea, hypoventilation, airway disconnection and sudden changes in pulmonary perfusion.

In anaesthetized dogs and cats receiving appropriate ventilation, $ETCO_2$ is commonly maintained around 35–45 mmHg, although interpretation should account for arterial-to-end-tidal differences, the underlying disease and the clinical situation.

A progressive increase in $ETCO_2$ may indicate inadequate alveolar ventilation. A sudden disappearance of the capnogram requires immediate assessment for apnoea, disconnection,

obstruction or a substantial reduction in pulmonary blood flow. Capnography should be interpreted together with respiratory observation, oxygenation and cardiovascular monitoring.

3. Oxygenation and Pulse Oximetry

Oxygenation is essential for maintaining cellular metabolism and organ function. Pulse oximetry provides a non-invasive estimate of arterial haemoglobin oxygen saturation (SpO_2). A healthy patient receiving supplemental oxygen during anaesthesia will generally have an SpO_2 reading in the high 90s when the signal is reliable. A persistent reading below 95% warrants prompt assessment, while a value approaching or falling below 90% represents a more serious warning of inadequate oxygenation. These thresholds must be interpreted in relation to the patient's condition, oxygen delivery and the reliability of the signal. Movement, poor peripheral perfusion, hypothermia, probe displacement and other artefacts can produce inaccurate readings. Therefore, an unexpected value should prompt assessment of the patient, probe position and oxygen delivery system. Pulse oximetry and capnography provide different information: pulse oximetry assesses oxygen saturation, whereas capnography provides information about ventilation and exhaled carbon dioxide. Neither replaces the other.

4. Body Temperature Monitoring

Hypothermia is a frequent complication of general anaesthesia in dogs and cats. Anaesthetic drugs impair thermoregulation, while vasodilation, reduced metabolic heat production, exposure of body surfaces and contact with cool operating tables contribute to heat loss. Small patients, kittens, puppies and debilitated animals are particularly vulnerable. Hypothermia can delay drug metabolism and recovery, alter cardiovascular function and interfere with normal physiological processes. Body temperature should be measured before, during and after anaesthesia using an appropriate thermometer or temperature probe. Preventive measures include maintaining a suitable environmental temperature, minimizing unnecessary exposure, using appropriate active warming equipment and monitoring the patient to prevent both hypothermia and thermal injury. Temperature management should continue into recovery until the patient is adequately rewarmed and stable.

5. Monitoring Anaesthetic Depth

Anaesthetic depth refers to the degree of central nervous system depression produced by anaesthetic agents. The objective is to maintain an appropriate plane of anaesthesia without unnecessary drug administration or inadequate conditions for the procedure. Clinical assessment may include jaw tone, eye position, palpebral reflexes, purposeful movement and changes in physiological parameters. These findings should be interpreted in relation to the drugs administered and the stage of anaesthesia. No single reflex reliably determines anaesthetic depth in every patient. For example, opioids and other drugs can alter physiological responses, while neuromuscular blocking agents eliminate movement without producing unconsciousness or analgesia. Where inhalant anaesthesia is used, inspired and expired anaesthetic agent concentrations can provide additional information. Advanced brain-activity-based monitoring may be useful in selected circumstances, but it does not replace clinical observation and physiological monitoring.

Species-Specific Considerations in Dogs and Cats

Although dogs and cats share many anaesthetic monitoring principles, differences in anatomy, physiology and disease presentation require individualized management. Cats are particularly susceptible to hypothermia because of their small body size and high surface-area-to-body-mass ratio. Their airway anatomy and limited tolerance of some respiratory complications also make careful airway management important. Brachycephalic dogs may have increased upper airway resistance and a greater risk of airway obstruction during induction and recovery. Airway patency, appropriate intubation and close observation during extubation are therefore especially important. Paediatric, geriatric, obese and systemically ill animals may have different physiological reserves and drug responses. Anaesthetic plans should consequently be tailored to the individual patient rather than based solely on species or body weight.

Common Anaesthetic Complications and Their Recognition

Hypotension

Hypotension may result from vasodilation, reduced myocardial performance, hypovolaemia, haemorrhage or excessive anaesthetic depth. Assessment should include verification of the reading, review of anaesthetic delivery and evaluation of heart rate, pulse quality and perfusion. Management depends on the underlying cause and may involve adjustment of anaesthetic administration, appropriate fluid therapy or cardiovascular support under veterinary supervision.

Hypoventilation and Apnoea

Reduced ventilation may lead to hypercapnia and respiratory acidosis. Capnography, respiratory observation and assessment of airway patency assist in early recognition. The response should focus on identifying the cause, ensuring airway patency and providing appropriate ventilatory support when indicated.

Hypoxaemia

Hypoxaemia may develop because of airway obstruction, inadequate oxygen supply, ventilation–perfusion abnormalities or other pulmonary complications. Assessment includes checking the airway, oxygen source, breathing circuit, pulse oximeter signal and respiratory function. Persistent or severe abnormalities require immediate intervention.

Cardiac Arrhythmias

Arrhythmias may occur in association with anaesthetic drugs, electrolyte abnormalities, hypoxia, acid–base disturbances or underlying cardiac disease. ECG helps characterize the rhythm, but clinical significance must be assessed alongside blood pressure and evidence of perfusion. Treatment should be directed at the underlying cause and the severity of the disturbance.

Hypothermia and Delayed Recovery

Hypothermia may contribute to delayed recovery, altered drug metabolism and cardiovascular instability. Persistent unconsciousness or an unexpectedly prolonged recovery should not automatically be attributed to anaesthetic drugs alone. Temperature, ventilation, oxygenation, circulation, drug effects and possible metabolic abnormalities should be reassessed.

Quick Reference: Essential Anaesthetic Monitoring Checklist

Parameter	Monitoring method	Clinical significance
Heart rate and rhythm	Auscultation, pulse palpation, ECG	Detects bradycardia, tachycardia and arrhythmias
Blood pressure	Doppler, oscillometric or invasive measurement	Identifies hypotension and hypertension
Oxygenation	Pulse oximetry	Estimates arterial haemoglobin oxygen saturation
Ventilation	Respiratory observation and capnography	Detects respiratory depression and changes in $ETCO_2$
Body temperature	Thermometer or temperature probe	Identifies hypothermia or excessive warming
Anaesthetic depth	Clinical assessment and available agent monitoring	Helps avoid excessive or inadequate anaesthesia
Recovery status	Airway, respiration, circulation, temperature and consciousness	Supports timely recognition of post-anaesthetic complications

The frequency and intensity of monitoring should reflect the patient's risk, the procedure and the available resources. Continuous monitoring is preferred for essential physiological parameters during general anaesthesia, with observations recorded at regular intervals and whenever clinically important changes occur.

Monitoring During Recovery

The recovery period remains a vulnerable phase because respiratory obstruction, hypoventilation, hypothermia and cardiovascular disturbances can persist after anaesthetic administration has stopped. Monitoring should continue until the patient has regained adequate spontaneous ventilation, airway-protective reflexes, stable circulation, appropriate body temperature and sufficient consciousness for safe recovery. Particular attention should be given to brachycephalic animals, patients with respiratory disease, prolonged procedures and animals receiving drugs that may produce residual sedation. Pain assessment is also essential. Appropriate analgesia improves patient comfort and helps distinguish pain-related agitation from other causes of abnormal behaviour during recovery. Extubation should be based on the patient's clinical status and ability to protect the airway. Patients with persistent instability or respiratory compromise require continued monitoring and supportive care.

Role of Monitoring Personnel and Standardized Protocols

Monitoring equipment is most effective when operated by trained personnel who can recognize abnormal trends and respond appropriately. A designated individual should be responsible for observing the patient, documenting vital parameters and communicating significant changes to the surgical team. Monitoring should not be treated as a secondary task during surgery. Standardized checklists, equipment checks, written anaesthetic records and clear recovery protocols help reduce avoidable errors. These measures also support communication between the anaesthetic, surgical and recovery teams.

Emerging Developments in Veterinary Anaesthesia

Recent developments include improved capnography, advanced haemodynamic assessment, electronic anaesthetic records and selected neuromuscular or brain-activity monitoring technologies. These tools can provide additional information in appropriate clinical settings.
However, technology cannot independently guarantee anaesthetic safety. Equipment limitations, artefacts and incorrect interpretation may lead to inappropriate decisions. The choice of monitoring techniques should be based on clinical requirements, patient risk, available resources and personnel expertise.

Conclusion

Anaesthetic monitoring is a fundamental component of safe surgical practice in dogs and cats. Systematic evaluation of cardiovascular function, ventilation, oxygenation, temperature and anaesthetic depth enables early recognition of physiological disturbances and supports timely clinical intervention. No single monitoring device provides a complete assessment of the anaesthetized patient. Combining objective measurements with direct observation, individualized anaesthetic planning and continuous recovery care provides a more reliable approach to patient safety. Ultimately, safer anaesthesia depends on the integration of appropriate drugs, trained personnel, functioning equipment, accurate interpretation and vigilant monitoring throughout the peri-anaesthetic period.