# MONITORING ANAESTHESIA

Pre, peri and post-operative monitoring is most important for the final outcome of anaesthesia and surgery. The monitoring procedures are aimed to assess the functions of cardiovascular, pulmonary and CNS and body temperature, fluid and electrolyte balances.

Intraoperative monitoring must be carefully done because during this stage the anaesthetic drug will act on various compensatory mechanisms and surgery will be having its effects on physiology and anatomy of the patient.

Preoperative assessment of the patient is done for the safe administration and maintenance of anaesthesia. It will help in tailoring an anaesthetic regimen suitable for the patient. The importance of preoperative assessment-

- To prepare the patient for safe administration of anaesthesia, and
- To assess the cardiovascular, pulmonary, hepatic, renal functions and haemato-biochemical and electrolyte balances (e.g., In diabetic patients, half of the insulin dose is administered after stabilization).

**Identification-** Identification includes the details of species, breed, sex, age and other identification marks.

**Main complaint**- The main complaint is detected to find out whether the disease condition will interfere with the normal anaesthetic practice and to tailor suitable anaesthetic regimen.

**History** of the present illness- Details of the duration of illness, clinical signs and severity of illness are collected. Previous medical history, mainly the previous illness, medication, vaccination, deworming, anaesthetics administered, poisoning, application of ecto-parasiticide etc., (e.g., thiopentone is used as induction agent in patients with the history of epilepsy, horse that suffered from myocarditis will be an anaesthetic risk patient.

**Physical and clinical examination** includes general body condition, palpation, percussion, auscultation, measurement of heart, pulse and respiratory rates, examination of lymph nodes, rectal temperature, appearance of the mucous membrane, reflex status, integument, location of the lesion and weight of the animal e.g., estimation of weight of a horse -(Heart girth cm- 63.7)/0.38 = body weight in Kg.

**Systemic examination** includes the assessment of cardiovascular, pulmonary, hepatic, renal gastrointestinal, central nervous system, endocrine and musculoskeletal functions.

**Presurgical laboratory examination-** It includes the determination of a complete blood count and total plasma protein etc. Further tests may include ECG, radiography and other special examinations.

## Indirect monitoring

Indirect monitoring of CNS function is assessed by the reflex status. The reflex status is modified by the stages of anaesthesia, drugs used and cerebral blood flow. The following reflexes are assessed:

*Pedal reflex*- This reflex is elicited by applying firm pressure on the interdigital skin in dogs and cats, squeezing the claws to gather in cattle and swains and firm pressure on the pastern on horses. Pedal relfex is abolished in stage III anaesthesia. It is reliable in barbiturate anaesthesia to assess the depth of anaesthesia, whereas with halogenated inhalants it disappears even in the light plane of anaesthesia.

*Palpebral reflex:* Tapping the skin at the medial canthus or running the finger along the eyelashes stimulates this reflex. It is abolished in the light plane of anaesthesia in dogs where as in horses, sluggish response can be noticed even at surgical plane of anaesthesia when inhalants are used. Palpebral reflex is not abolished during ketamine anaesthesia

*Corneal reflex:* This reflex is stimulated by gentle palpation of the cornea on the lateral aspect. The response is observed by the closure of eyelids. In horses, the absence of corneal reflex indicates deep plane of anaesthesia, in dogs it is not reliable and in cattle it may be abolished by repeated stimulation. Corneal reflex is not abolished during ketamine anaesthesia.
*Lacrimation:* In horses and cattle, lacrimation is reduced during deep plane of anaesthesia, leading to drying of cornea. It may result in keratitis and ulceration. Sterile mineral oil or plain eye ointment must be instilled to prevent corneal ulcer.
*Yawning:* yawning is elicited in dogs under light plane of anaesthesia when the mouth is opened.
*Swallowing reflex:* This reflex disappears at the light plane of anaesthesia with exception of young foals. This reflex is protected in ketamine anaesthesia.
*Laryngeal reflex:* This reflex is abolished in the light plane anaesthesia except with ketamine induction. In cats, local anaesthetic is sprayed on the larynx to prevent laryngeal spasm before intubation.
*Anal reflex:* This reflex is abolished in the middle of III stage of anaesthesia in dogs and cats. In horses, it is abolished soon after induction with ketamine. This reflex is elicited by sudden gentle manipulation of the anus and the response will be sphincter contraction.
*Pupillary reflex:* In general, the pupil in un-premedicated animals will dilate during early excitement phase and then constricts progressively up to surgical anaesthesia. Again, the pupil will dilate as the animal enters into the IV stage of anaesthesia (progressive medullary paralysis) followed by respiratory and cardiac arrest. Pre-anaesthetic agents alter the papillary reflex e.g., atropine induces pupillary dilatation and narcotics induce constriction in dogs.
*Position of the eyeball:* The position of eyeball depends on the species and the anaesthetic used. In small animals the eyeball rotates medially and ventrally in the early stages and then centrally placed at plane I surgical anaesthesia when inhalants like halothane or isoflurane is used. In horses under halothane anaesthesia, nystagmus is common during light plane of anaesthesia and it is centrally placed at the surgical plane of anaesthesia. In ruminants the eyeball rotates ventrally in light plane of anaesthesia, then gradually rotates dorsally and finally fix to the central position.
OTHER REFLEXES
*Muscle relaxation:* It will be modified with the use of anaesthetics and muscle relaxants. In small animals the jaw tone is used as the criteria of muscle relaxation and anaesthetic dept.
*Hearing sense:* It is the last sense to disappear during induction and the first sense to reappear during recovery.

Heart rate can be monitored by using stethoscope, electronic stethoscope, oesophageal stethoscope, electronic heart rate meters, electrocardiography and Doppler blood flow detector. Heart rates below 50 to 60 bpm in dogs and cats, 25 bpm in horses and ruminants is considered to be low heart rate. Heart rate above 250bpm in dogs, 300 bpm in cats, 75 bpm in horses and ruminants are considered as high heart rate. The alteration in heart rate must be simultaneously compared with cardiac output and blood pressure.

Bradycardia may result from excessive depth of anaesthesia, excessive vagal tone (often increased by intubation, vasovagal reflex and traction of abdominal organs), terminal hypoxia, endogenous and exogenous toxaemias, conduction disturbances in myocardium, hyperkalaemia and hypothyroidism. Treatment is discussed under "anaesthetic emergencies"

Tachycardia may arise due to light level of anaesthesia, hypovolaemia, hypoxia, hypercarbia, or hyperthyroidism. Normally, the pulse rate may either be equal or slightly deficit of heart rate because all the contraction may not produce palpable effective wave and waves may overlap. The abnormal conditions which cause deficit of pulse rates are:

- Premature contraction,

- Variable diastolic ventricular filling
- Electromechanical dissociation of heart.

Peripheral perfusion is assessed by the colour of the mucous membrane and the capillary refill time. The normal capillary refill time is less than 2 seconds. Pale mucous membrane and prolonged refill time are due to reduction in perfusion. The other methods to assess the peripheral perfusion is by the use of ultrasonic Doppler, electromagnetic flow probes, radionuclide imagery, nuclear magnetic resonance and position emission tomography. The reasons for reduced peripheral perfusion may be stress induced increase in sympathetic tone, hypovolemia, low cardiac output, fear and pain or exogenous α-receptor agonist catecholamine therapy**.**

Blood pressure is one of the important parameters to be monitored during anaesthesia because adequate blood pressure is needed to perfuse the brain and heart. A minimum 50 to 60 mm of Hg mean arterial blood pressure (MAP) is to be maintained for coronary and cerebral perfusion.

Central venous pressure (CVP) is the luminal pressure of the intra thoracic anterior vena cava or right atrium. The central venous catheters are positioned through percutaneous catheterization of jugular vein. The zero level of the manometer is maintained at the heart level. The nomal CVP is 0 to 10 cm of $H_2O$ in small animals, 10 to 15 cm of $H_2O$ in awake horses, 25 to 35 cm of $H_2O$ in anaesthetized recumbent horses and 5 to 10 cm of $H_2O$ in cattle, sheep and goats. Increase in CVP could be noticed in reduced cardiac output vasoconstriction and hypervolemia. CVP decreases during vasodilatation, hypovolemia and obstruction to venous return. Fluid therapy is indicated when increase in CVP is noticed with heart failure.

*Respiratory rate:* Carbon dioxide is the primary chemical stimulant of respiratory centers to maintain normal respiratory pattern. Hypocapnia in anaesthetized patients may result in apnoea. In anaesthetized patients each respiration must be long and large to satisfy the ventilatory requirement and oxygen demand.

Bradypnoea may result from cerebral oedema, neoplasia or haematoma, anaesthetic depression and hypoxia, and medullary dysfunction

Tachypnea may be associated with normo-ventilation or hypoventilation and may be attributed to hypercapnia, hypoxia, hypotension, hyperthermia, too light level of anaesthesia induces tachypnoea and hyperventilation, too deep anaesthesia induces tachypnea and hypoventilation, airway obstruction results in tachypnoea and hypoventilation, pneumothorax, hydrothorax, chylothorax, haemo-thorax and diaphragmatic hernia, space occupying abdominal lesions such as gastric/intestinal tympany, ascites, neoplastic mass, gravid uterus and pyometra, atelectasis and airway collapse and anesthetic drugs like ketamine, diazepam and certain narcotics. Treatment involves proper intubation, artificial ventilation once every 30 seconds in case of apnea, institution of intermittent positive pressure ventilation, etc.

The normal respiratory effort is smooth, easy, regular and comprised of thoracic and diaphragmatic movements. The abnormal ventilatory efforts are:

Exaggerated breathing effort- indicative of respiratory stimulation.
Stertorous- indicative of upper airway obstruction
Wheezing- indicative of lower airway narrowing
Crepitation- indicative of fluid bubbling sound
Intercostal retraction during inspiration- indicative of upper airway obstruction
Predominance of diaphragmatic component during inspiration-indicative of deep anaesthesia.

*The mucosae:*

Cyanosis indicates severe hypoxemia. If cyanosis is noticed during anaesthesia immediately the oxygen supply must be checked for the correct delivery. The oxygen is supplied at the rate of 10

ml/kg/min in circle system and 20 ml/kg/min in nonrebreathing system. The other reasons for cyanosis are shock, hypothermia, cardiac arrest and intrathoracic lesions. Drugs like acetaminophen induces cyanosis in cats and benzocaine induces cyanosis in dogs and cats.

*Blood gas analysis*

Arterial blood is collected in 2 ml heparinized syringe with 22 to 25 G needle and the needle is corked or the needle guard is replaced immediately and the syringe is sent for analysis using blood gas analyzer. Partial pressure of carbon dioxide is denoted as $PaCO_2$. The normal $PaCO_2$ is 35 to 45 mm Hg. $PaCO_2$ less than 35 mm Hg indicates hyperventilation, above 45 mm Hg indicates hypoventilation; above 60 mm Hg indicates severe respiratory acidosis; less than 20mm Hg indicates severe respiratory alkalosis and decreased cerebral blood flow. $PaCO_2$ level indicates the ventilatory status of the patient. This level can be used to calculate the alveolar partial pressure of oxygen ($PaO_2$) using the formula as- $PaO_2 = FiO_2 \times ( P B – P H_2O ) – PaCO_2 / R$

The normal $PaO_2$ is 90 to 100 mm Hg. $PaO_2$ less than 60 mm Hg indicates hypoxia and hypoventilation. Animals breathing enriched oxygen mixture will be having higher $PaO_2$. Pa02 indicates the oxygenating capability of the lung.

*Metabolic acidosis*

The pH will indicate the metabolic acidosis and is attributed to the lactic acidosis secondary to inadequate tissue perfusion due to vasoconstriction, hypotension, hyperthermia or infusion of acidotic fluids. Bicarbonate is administered only for the patients having bicarbonate deficit, not for all acidotic conditions.

- The amount of bicarbonate in mEq to be administered is calculated as base or bicarbonate deficit x 0.3 x body weight in kg (approximately 1 to 5 mEq/kg).
- Bicarbonate solution must be administered slowly because rapid administration may cause alkalemia, hypokalemia, decreased ionized calcium, hypotension, nausea, vomiting, collapse and even cardiac arrest.

*Temperature r*ecording is important in anaesthetized patients as it indicates the systemic function. The temperature can be recorded at deep rectum, cervical oesophagus, pharynx and under the tongue. During anaesthesia drop in temperature could be noticed due to the reduction in metabolic rate. Pre-anaesthetic agents like acepromazine deplete the catecholamine in the thermoregulatory center and render the animal to pick up the environmental temperature.

*Urine output* is an indirect assessment of visceral perfusion. Urinary catheters are placed aseptically and the urine is collected. The normal expected urine output in anaesthetized animals is 1 to 2 ml/kg/hr. If the urine output is reduced lactated Ringer's is administered at the rate of 20 to 40 ml/kg rapidly to induce diuresis. The other agents administered to induce diuresis are

- Furosemide 5 mg/kg diuresis occurs in 5 to 10 minutes
- Glucose, Mannitol (0.5 g/kg over 20 to 30 minutes) as infusion
- Dopamine 1 to 5 μg/kg/min.