Field anaesthesia of the African elephant *(Loxodonta africana)*

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Introduction

Immobilisation and anaesthesia may be required for various reasons, such as the capture, transport and clinical examination of captive animals, e.g. at a zoological park, or for minor surgical procedures. General anaesthesia is required for wound treatment, i.e trunk lacerations and dental surgery, or population control, i.e. laparoscopic vasectomy.

Free-ranging animals should be localised first, either by helicopter or vehicle. Electronic tracking may assist in this regard. Ground support includes mechanical equipment, such as hydrolic lifts and anaesthetic and surgical teams.

Elephants are large animals, with an adult body weight of between 3 000 and 5 000 kg. This has significant physiological implications when they are anaesthetised. Appropriate padding is required to prevent complications such as myositis and neuropraxia during recumbency. Mechanical equipment is needed to move animals. A hot environment is common in the elephant habitat. They flap their ears for temperature regulation as the medial ear surface is highly vascular to expose blood vessels to airflow. During anaesthesia, the ears are sprayed with water to cool them down.

Recumbency results in hypoventilation associated with hypercapnoea (partial pressure of carbon dioxide ($PaCO_2$) [50-70 mmHg] and hypoxaemia (PaO_2 40-60 mmHg). Lateral recumbency is mandatory and may be fatal in sternal recumbency. Elephants are mainly nasal (trunk) breathers (70%). Therefore, there is a risk of respiratory obstruction when the trunk becomes kinked during recumbency.

Anatomical adaptations in elephants include the diaphragm that is set at a 45-degree angle from the first ribs caudodorsally to the last ribs to minimise compression of the lungs by the intestines in the standing animal. The lung lobes are interconnected with loose pleural space connective tissue (PSCT). The parietal and visceral pleurae are thickened. There is no anatomical pleural space, but the PSCT acts as a functional pleural space, and pneumothorax is associated with lung collapse. Contrary to previous beliefs, PSCT minimally influences lung movement within thoracic cavity. Snorkelling behaviour suggests that the blood vessels and terminal airways are able to resist external pressures >150 mmHg owing to thickened pleurae.

Challenges with tracheal intubation include a long distance from the mouth to the larynx in adults, and a limited intermandibular space for manual palpation during intubation. The epiglottis and vocal cords are soft and fleshy, and difficult to distinguish from the pharyngeal mucous membrane. Intubation is performed by blind internal pharyngeal palpation to identify the larynx. A stomach tube is placed in the larynx. The tracheal tube is then railroaded over the stomach tube into the trachea. The large trachea requires a tracheal tube of 35-45 mm in diameter and 180 cm in length.

Etorphine is administered by continuous rate infusion for the maintenance of anaesthesia. Where facilities are available, isoflurane may also be administered with a circle rebreathing circuit. Positive pressure ventilation is preferred using a customised mechanical ventilator. Venturi jet ventilation is utilised for field use. Tidal volume is regulated by observing the onset of chest expansion.

Equipment used to immobolise captive animals includes a pole syringe or CO_2-powered pistol. A CO_2-powered rifle is employed for free-ranging elephants. The drug used for immobilisation is etorphine, an opioid that is 10 000 times more potent than morphine. Azaperone is co-administered to moderate high blood pressure (mean arterial pressure of +140-180 mmHg) associated with etorphine. After intramuscular administration, onset is within five minutes, and recumbency within 10-15 minutes.

To monitor anaesthetic depth, ocular signs, such as the palpebral reflex, nictitating membrane relaxation and spontaneous movement of the ears and trunk, are observed. The respiratory system is monitored by observing tidal volume and ventilation rate. Other equipment includes a capnometer and pulse oximeter. Arterial blood gas analysis is also carried out. Heart rate, pulse volume and blood pressure (invasive and non-invasive) are used for the cardiovascular system. Body temperature monitoring is mandatory in hot environments as elephants become hyperthermic in a very short period, especially after a period of excessive walking in the induction period.

Body position monitoring is also mandatory to prevent injuries during recumbency.

Etorphine is reversed with diprenorphine, a mixed agonist antagonist, for recovery from anaesthesia. The animal should be ambulatory in 5-10 minutes.

In conclusion, elephant anaesthesia poses unique challenges because of their large size creating unique anatomical and physiological changes which need to be taken into consideration to ensure safe immobilisation and anaesthetic practices.