Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Basics of Gaseous anesthesia

Dr. Tenzin Wangchuk

Outline

- History
- Anesthetic Machine
- Mechanism of Anesthesia
- Components of anesthetic machine and its function
- Types of breathing system
- Monitoring of anesthesia
- Anesthetic emergencies

HISTORY

- Boyle Anesthetic machine is a continuous-flow type of machine used for administration of inhalational anesthetic agents.
- It Was introduced by HENRY EDMUND GASKIN BOYLE in 1917.
- It has undergone modifications
- 1920-1926 vapourizer bottles added
- 1930 plunger device in vaporizes bottle
- 1933 dry bobbin type of flow meter instead of water sight-feed type
- 1937 rotameters replaced dry bobbin type of flow

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

BASIC FUNCTION

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

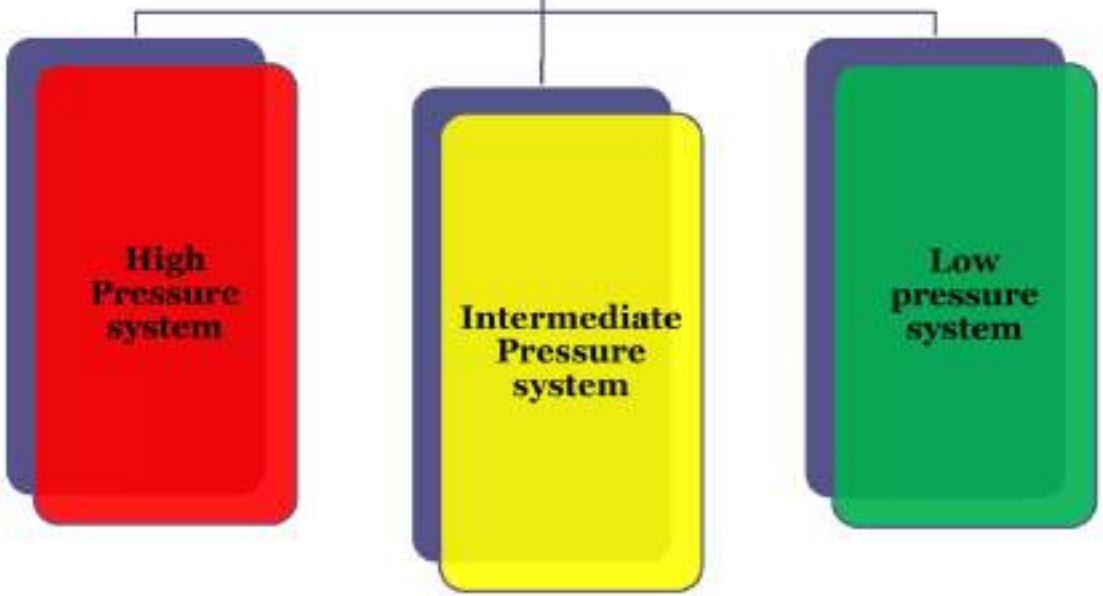
Mechanisms of Anesthesia..

1. Oxygen + anesthetic into rebreathing bag
2. Animal breathes in via rebreathing bag
3. Capillaries exchange Oxygen and anesthetic into bloodstream
4. Anesthetic reaches the brain

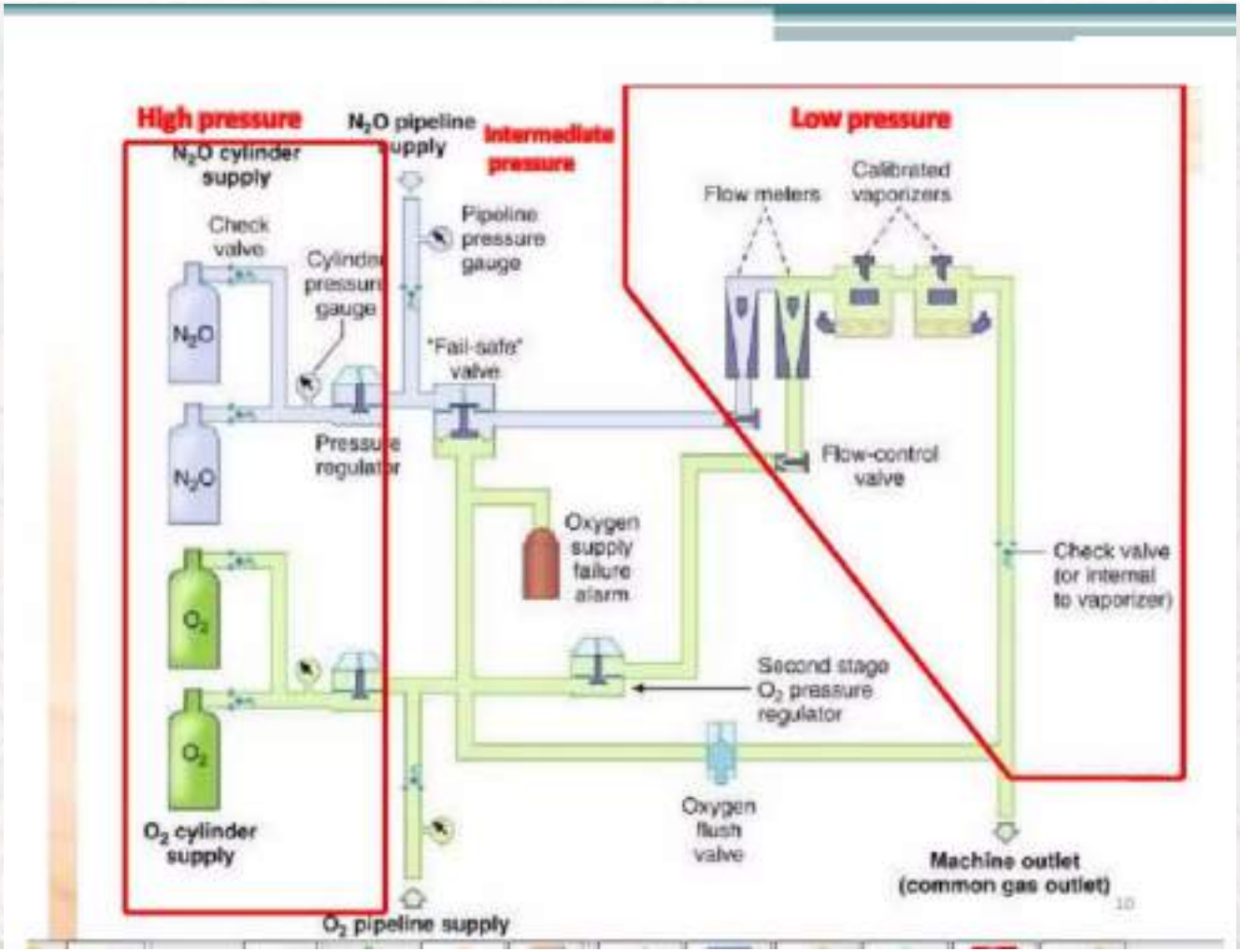
COMPONENTS OF ANESTHESIA MACHINE

- Comprises of 3 different pressure systems
- HIGH PRESSURE SYSTEM: from cylinder to pressure reducing valves.
- INTERMEDIATE PRESSURE SYSTEM: from pressure reducing valves to flow meters.
- LOW PRESSURE SYSTEM: from flow meters to the common gas outlet on machine.

Pneumatic system



Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital



Breathing system

Definition:

- **A breathing system:** is an assembly of components which connects the Pt airway to the anesthesia machine, creating an artificial atmosphere from & to the Pt breathes.

- provide the final conduit for the delivery of anesthetic gases and oxygen to the patient.

- They are designed to allow either spontaneous or intermittent positive pressure ventilation (IPPV).

COMPONENTS OF BREATHING SYSTEM

- BREATHING TUBES

- ADJUSTABLE PRESSURE LIMTING VALVE
- RESERVOIR BAG
- CONNECTORS AND ADAPTORS

Adjustible Pressure Adjustible (APL) valve

- Also called as pressure relief or pop-off valve
- Used to adjust the pressure in the breathing system.
- Left fully open: during spontaneous ventilation
- partially closed : during manual or assisted bag ventilation,;;;; allows venting of excess gas from the breathing system into the waste gas scavenging system
- In mechanical Ventilation: The APL valve is excluded from the circuit when the selector switch is changed from manual to automatic ventilation

- RESERVOIR BAG
- The reservoir bag is an important component of breathing systems
- Made of antistatic rubber or plastic. Black bags are antistatic
- Acts as a monitor of patient's ventilatory pattern
- Can be used to assit or control the ventilation.

Selection of reservior bag

- The reservoir bag should be at least 4 to 6 times the patient's tidal volume.
- Tidal volume is often quoted as 10-20 mL/kg. The middle value, 15 mL/kg, is commonly used in small animals.
- If 15 mL/kg is multiplied by 4 and 6 then 60 and 90, respectively, become constants.
- 4 x 15 = 60
- 6 x 15 = 90

Tubing

- ❖ corrugated to prevent kinking
- ❖Inspiaratory limb
- ❖Expiratory limb
- ❖Y piece
- ❖Unidirectional valves
- ❖Internal diameter 15mm and exeternal diameter of 22mm

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Vaporizer

- What is it?
- What does it do?
- Preparation: fill it

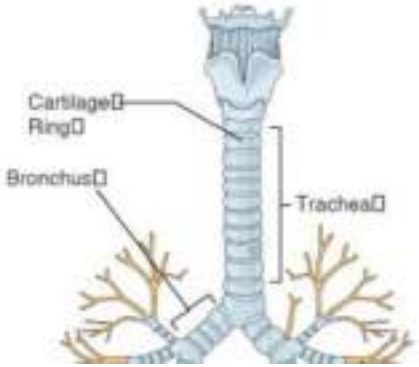
Co2 absorber

Sodasorb

- Absorbs excess Carbon Dioxide
- When granules are full, they turn blue
- Change at least once a month

Preparation:

- **Endotracheal** tube: What is it??
- What does it do??
- Check for:
  - Correct size
  - Check cuff



Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Selecting an ET Tube

LENGTH

- Extend from _____ to cranial to the _____.

- If you extend into only one bronchus:

Endotracheal tube

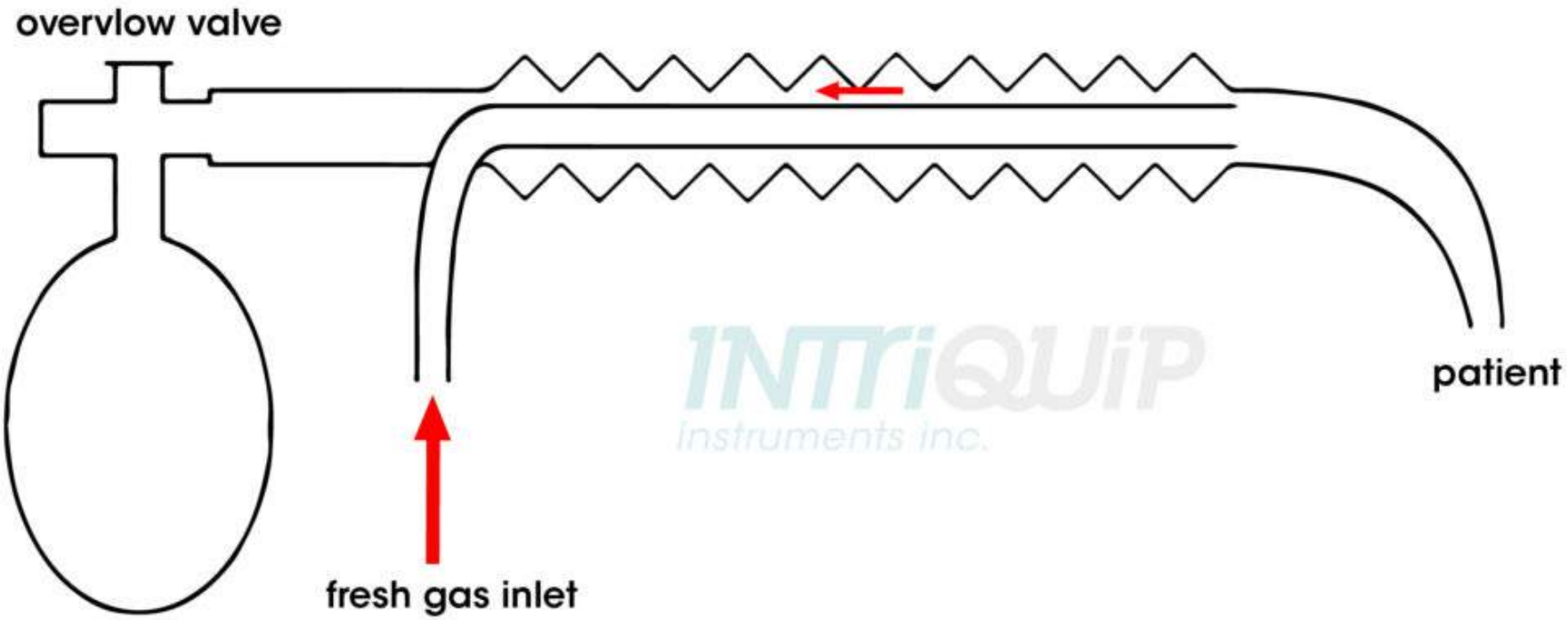
Size of endotracheal tube : internal diameter (ID)

- Male: ID 8.0 mms . Female : ID 7.5 mms
- New born - 3 months : ID 3.0 mms
- 3-9 months : ID 3.5 mms
- 9-18 months : ID 4.0 mms
- 2- 6 yrs : ID = (Age/3) + 3.5
- > 6 yrs : ID = (Age/4) + 4.5

Non-Rebreathing Circuit (NRB, BAIN)

- The non-rebreathing circuit is a physically simpler system. In this circuit, oxygen flows through a flow meter and into the vaporizer.
- At this point, gases exiting the vaporizer go directly to a hose for delivery to the patient with no inhalation flutter valve.
- Exhaled gases pass through another hose and may enter a reservoir bag, but do not enter a CO2 absorber.
- The gas is then released into a scavenger.
- Used for patients weighing less than 7kgs
- Minimum oxygen flow-rates of at less 200-300ml/kg/minute

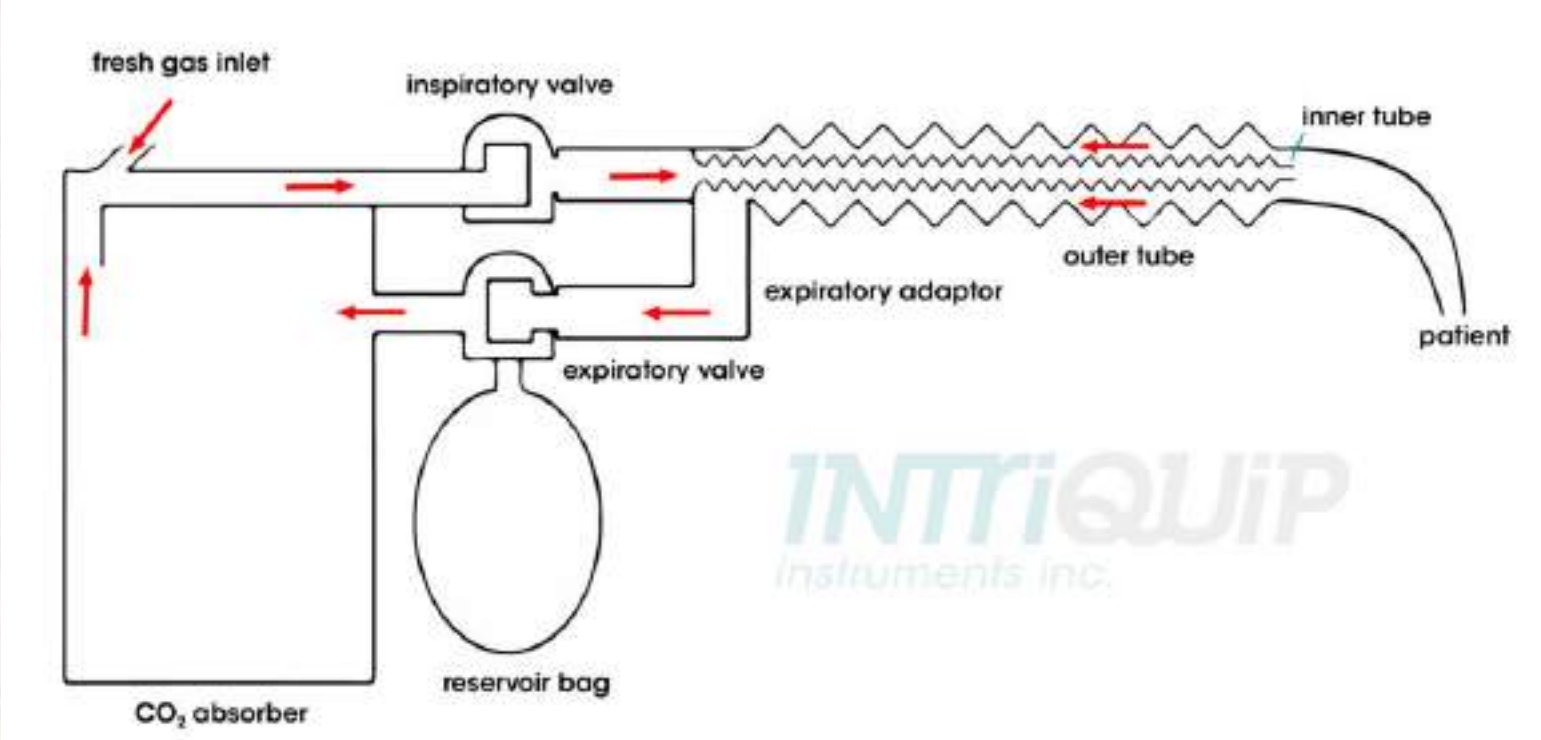
Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital



Rebreathing (Circle) Systems

- With rebreathing anesthesia the flow of gas through the machine is circular:
- reservoir bag–inhalation valve–inspiration hose–animal–expiration hose–exhalation valve–carbon dioxide canister–back to the inhalation valve.
- A rebreathing circuit is used for patients weighing over 7kgs.
- Economical: expired oxygen and anesthetic vapor are re-circulated and reused, using less oxygen and anesthetic agent compared with a non-rebreathing system.
- Humidification of inspired gas, preserving heat and moisture of the patient.
- Warmth: during the absorption of CO2 in soda lime, heat is generated. This helps to preserve further body heat.
- Flow rate is 25-50ml/kg/min.

Rebreathing (Circle) Systems



Rebreathing (Circle) Systems

- With rebreathing anesthesia the flow of gas through the machine is circular:
- reservoir bag–inhalation valve–inspiration hose–animal–expiration hose–exhalation valve–carbon dioxide canister–back to the inhalation valve.
- A rebreathing circuit is used for patients weighing over 7kgs.
- Economical: expired oxygen and anesthetic vapor are re-circulated and reused, using less oxygen and anesthetic agent compared with a non-rebreathing system.
- Humidification of inspired gas, preserving heat and moisture of the patient.
- Warmth: during the absorption of CO2 in soda lime, heat is generated. This helps to preserve further body heat.
- Flow rate is 25-50ml/kg/min.

INHALANT ANAESTHTICS

- Chemical compounds possessing general anaesthetics properties delivered by INHALATION.
- **Volatile**
  - Halothane
  - Isoflurane
  - Enflurane
  - Sevoflurane
  - Desflurane
- **Gaseous**
  - Nitrous oxide
  - Xenon

PHARMACOKINETICS

M.A.C. – (Minimum alveolar Concentration)Min. anaesthetic conc. in pulmonary alveoli at 1 atm. that produces immobility to any painful stimulus in 50% animals exposed.

MAC(small)- More potent – Less dose req.

- 1 MAC - Produces light anaesthesia
- 1.5MAC - Surgical anaesthesia
- 2MAC - Deep anaesthesia
- 0.5MAC – Animal awaken after anaesthesia.

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

AGENT	MAC	POTENCY
Methoxy-flurane	0.29%	Most potent
Halothane	0.87%	
Isoflurane	1.28%	
Enflurane	2.06%	
sevoflurane	2.4%	
desflurane	10.32%	
Nitrous oxide	200%	Least potent

Isoflurane

- Structural isomer of Enflurane
- More potent
- More volatile and less soluble in blood
- Does not react with soda lime
- It is an exceptionally stable compound
- Mild pungent , musty ,ethereal odour
- Most widely used agent.

Dose :

- Induction = 3.5-5%
- Maintenance = 1.5-2%

How often to monitor?

- *Ideally* check & record vitals every 5 minutes

5 mins

8 parameters can be monitored under GA

1. Heart rate and rhythm
2. Pulse rate
3. MM colour
4. RR, depth and character
5. CRT
6. Temperature
7. Oxygen saturation
8. Pupil size and position

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

	Dog	Cat
HR	**80**-140	**110**-140
RR	10-30	20-40
°C	38°	38°
CRT	< 2 sec	< 2 sec
SpO2	> 95%	> 95%
BP (diast)	60-100 mmHg	60-100 mmHg
BP (syst)	110-160 mmHg	110-160 mmHg

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

	VENTILATION			Pupil	Eyeball position	Eye reflexes	Lacrimation	Response to surgical stim.
	Intercostal	Diaphragm	Pattern					
Awake			Irregular panting					
Stage II			Irregular breath-holding			Palpebral		
Stage III LIGHT Plane 1			Regular					
MEDIUM Plane 2			Regular shallow					
DEEP Plane 3			Jerky			Corneal		

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Reflexes that can be monitored under GA

1. Pedal reflex
2. Jaw tone
3. Skin pricking
4. Anal pinching
5. Palpebral reflex
6. Corneal reflex
7. PLR
8. Response to visceral stimulus
9. Ear twitch
10. Cutaneous reflex
11. Reaction to painful stimulus
12. Righting reflex
13. Pharyngeal reflex
14. Laryngeal reflex

When is SpO2 too low?

SpO_2	Interpretation
95 %	Normal
92 %	**Start looking for a reason**
90 %	Hypoxaemia present **Try to improve oxygenation**
85 %	Moderate to severe hypoxaemia **Lowest acceptable 85(dogs),87(cats)**
80 %	Life-threatening hypoxaemia

Management of Anaesthetic Complications

The potential problems an animal can have with breathing under anaesthetics…

1. Prolonged Inspiration
2. Prolonged Exhalation
3. Abdominal Movement during breathing
4. The re-breathing bag is not moving
5. Hypoventilation – the patient is breathing too slow
6. Hyperventilation – the patient is breathing too fast

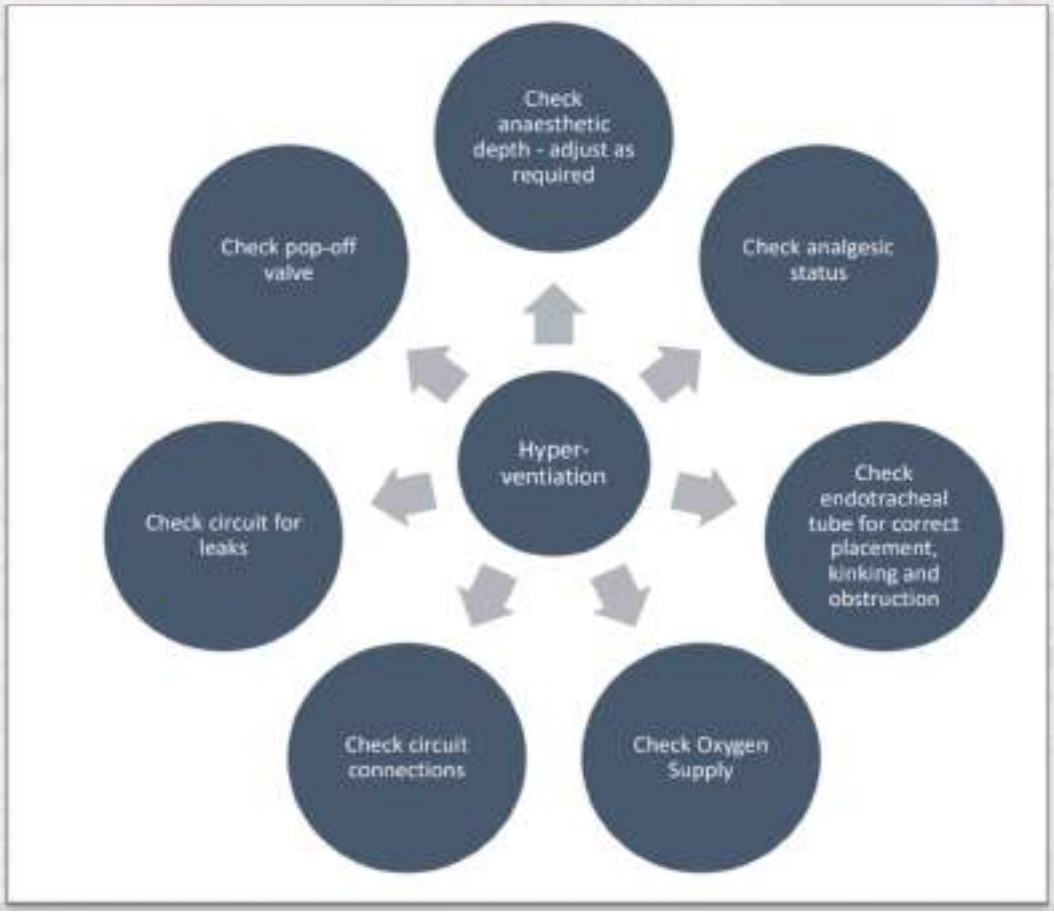
Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Management of Hypoventilation

- Assess anaesthetic depth
  - For patients who are at a deep plane of anaesthesia
    - Turn of anaesthetic vaporizer
    - Disconnect the patient from the anaesthetic circuit
    - Flush the anaesthetic circuit with oxygen to remove anaesthetic gas
    - Reconnect the patient to the anaesthetic circuit and administer 100% oxygen at appropriate flow rates, and begin positive pressure ventilation
    - Reverse any reversible anaesthetic agents
  - For patients who are at a light plane of anaesthesia, begin provision of positive pressure ventilation
- Administer intermittent positive pressure ventilation to assist patient breathing efforts
  - Administer 2 breaths with tidal volume 20-30 ml/kg initially, then begin as follows
    - 1 breath every 4-5 seconds
    - 15 ml/kg tidal volume
- **Do not allow your patient to remain apnoeic for longer than 15 seconds**

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Management of Hyperventilation

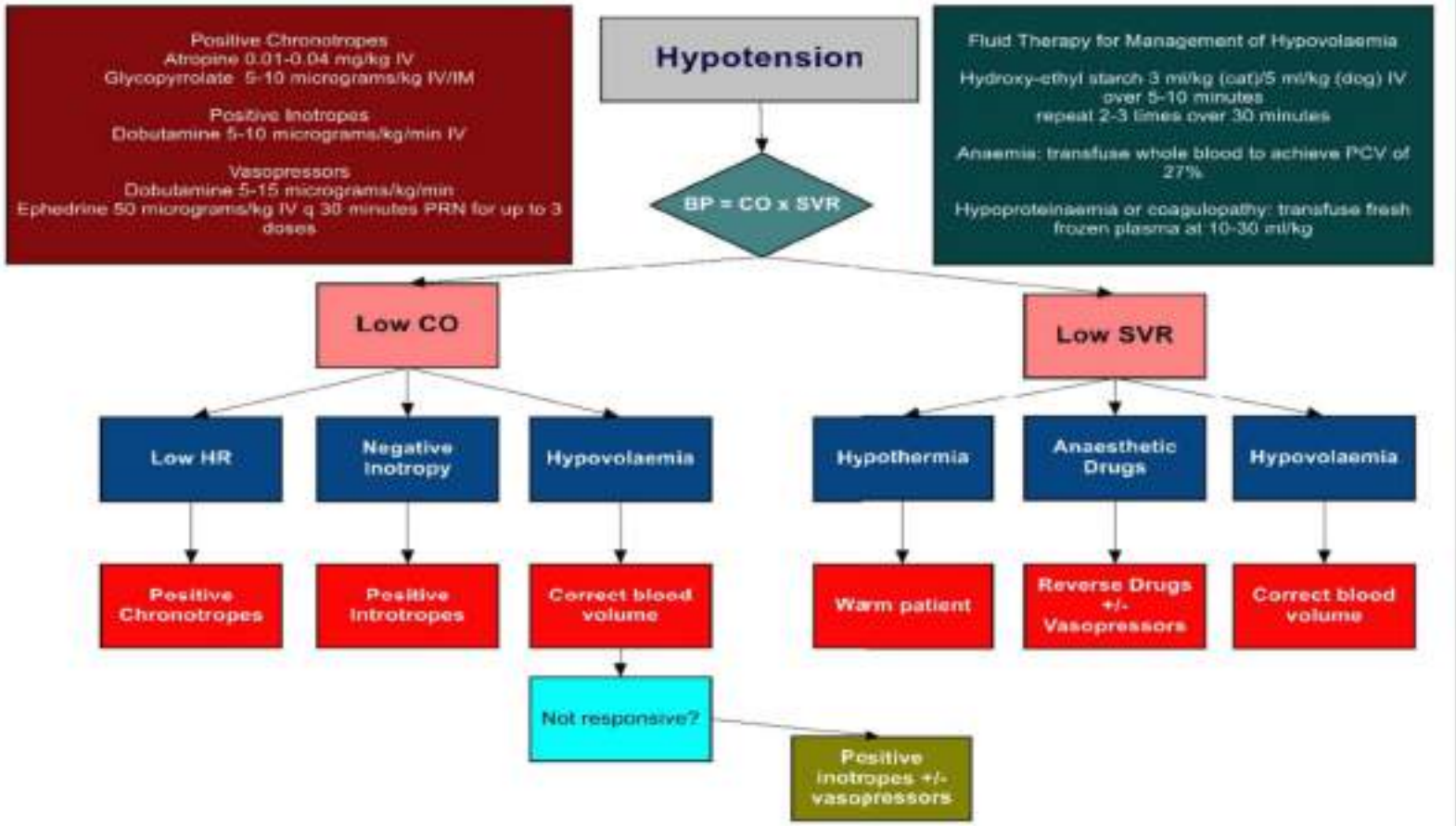


Management of Excessive Anaesthetic Depth

- Turn of anaesthetic vaporizer
- Disconnect the patient from the anaesthetic circuit
- Flush the anaesthetic circuit with oxygen to remove anaesthetic gas
- Reconnect the patient to the anaesthetic circuit and administer 100% oxygen at appropriate flow rates
- Administer intermittent positive pressure ventilation to assist patient breathing efforts
    - 1 breath every 4-5 seconds
    - 8-15 ml/kg tidal volume
- Reverse any sedative or analgesic medications
    - Opiates
        - Administer Naloxone @ 0.02-0.04 mg/kg IV and repeat every 30 minutes as required (dogs)
        - Administer Naloxone 0.05-0.1 mg/kg IV and repeat every 60 minutes as required (cats)
    - Alpha-2 agonist (Xylazine or medetomidine)
        - Administer yohimbine (for xylazine) or atipamezole (for medetomidine) as directed

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Algorithm for the Management of Hypotension in Anaesthesia



Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital

Cardiovascular effect of anesthetic drugs

Drug	*Heart Rate*	*Cardiac Contractility*	*Cardiac Output*	*Blood Vessel Tone (SVR)*	*Blood Pressure*
Anticholinergic (atropine, glycopyrrolate)	Increased	Increased	Increased	No change	No change or increased
Alpha-2 agonist drugs (medetomidine, dexmedetomidine, xylazine)	Decreased	Decreased	No change of decreased	Increased	Increased then decreased
Alfaxalone (effects dose-dependent)	No change or increased	No change or decreased	No change or decreased	No change or decreased	No change or decreased
Benzodiazepines (midazolam, diazepam)	No change	No change	No change	No change	No change
Barbiturates	Increased	Decreased	Decreased	Increased	Decreased
Ketamine	Increased	Increased	Increased	Increased or no change	Increased or no change
Opioids	Decreased	No change or mild decrease	No change or mild decrease	No change or mild decrease	No change or decreased
Phenothiazines (acepromazine)	No change of increased	No change or decreased	Increased	Decreased	Decreased
Propofol	No change or increased	Decreased	Decreased	Decreased	Decreased
Isoflurane	No change or increased	Decreased	Decreased	Decreased	Decreased

Cause of Hypothermia	Mechanism
Pre-operative Environment	• Duration of anaesthesia • Cold surgical site preparation solutions • Alcohol application to patient skin
Theatre Environment	• Operating theatre temperature • Exposure of body surface • Cold surgical irrigation fluids • Cold intravenous fluids and blood products
Anaesthesia	• Vasodilatation – redistribution of body heat from core to periphery • Inhalant anaesthetics – impair thermoregulatory vasoconstriction • Muscle relaxants – impair shivering • Intravenous agents (midazolam, sufentanyl, dexmedetomidine) lower shivering threshold • Regional analgesia – vasodilatation occurs in local anaesthetic-affected tissues
Surgical Technique	• Exposure of body tissues to sub-physiological temperatures • Duration of surgery

Adverse Effects of Hypothermia

Temperature (degrees Celsius)	Adverse Effects
32-37	Shivering (impaired in anaesthesia) Peripheral vasoconstriction (impaired in anaesthesia)
36-37	Tachycardia (dog) Bradycardia (cat)
<36	Bradycardia Prolonged clotting times Impaired platelet function
<34	ECG: Increased P-R; Wide QRS; Increased Q-T interval
<33	Arrhythmias
31-32	Depressed consciousness, lethargy and coma
<31	Shivering ceases Marked decrease in metabolism ("hibernation")
28-31	Cardiac arrhythmias (atrial fibrillation etc.)

Prevention and Management of Anaesthetic-Induced Hypothermia

1. **Pre-anaesthetic patient warming: 30 -60minutes**
2. **The anaesthetic period**

a. Airway heating and humidification: Recommended flow rate are 30ml/kg for rebreathing circuits, and 200ml/kg for non-rebreathing

b. Warming intravenous fluids: Fluids should be warmed to 37 degrees C

c. Cutaneous warming:

i. Operating room temperature: 23ºC

ii. Passive warming

iii. Active warming

3. **Post-anaesthesia warming therapy**

a. External warming device

b. Fluid warmer in conjunction with external warming devices

Royal Government of Bhutan
Department of Livestock
National Veterinary Hospital