Selecting and Connecting Breathing Systems

Disclaimer

A series of booklets has been developed by the Clinical Skills Lab team (staff, recent graduates and students) from the School of Veterinary Sciences, University of Bristol, UK.
Please note:

- Each booklet illustrates one way to perform a skill and it is acknowledged that there are often other approaches. Before using the booklets students should check with their university or college whether the approach illustrated is acceptable in their context or whether an alternative method should be used.
- The booklets are made available in good faith and may be subject to changes.
- In using these booklets you must adopt safe working procedures and take your own risk assessments, checked by your university, college etc. The University of Bristol will not be liable for any loss or damage resulting from failure to adhere to such practices.

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Year Group: BVSc3 +

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Equipment list:
Selecting and Connecting Breathing Systems

Equipment for this station:

- Pen
- Paper
- Calculator
- T-piece (in CSL a strip of white tape is around this system)
- Bain (in CSL a strip of orange tape is around this system)
- Lack (in CSL a strip of brown tape is around this system)
- Magill (in CSL a strip of black tape is around this system)
- Circle (in CSL a strip of green tape is around this system)
- Anaesthetic machine
- Endotracheal (ET) tube

Considerations for this station:

- Do not use the anaesthetic machine without supervision from a member of staff
- Towards the end of this booklet there is:
  - Information about factors that need to be considered when selecting breathing systems and the rationale
  - Scenarios to practise : to decide what is the most appropriate breathing system to select, the reasons for the choice and calculate the fresh gas flow rate in each case

Anyone working in the Clinical Skills Lab must read the 'CSL_I01 Induction' and agree to abide by the 'CSL_I00 House Rules' & 'CSL_I02 Lab Area Rules'

Please inform a member of staff if equipment is damaged or about to run out.

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Clinical Skills:

Selecting and Connecting Breathing Systems

Connect the breathing system to the common gas outlet on the anaesthetic machine.
There are labelled diagrams of commonly used breathing systems on the next two pages. The breathing systems in the demonstration boxes have been colour coded with a ring of tape to help with identification.

Connect the scavenging system to the breathing system (at the arrow).

Connect the breathing system to the patient, via an endotracheal (ET) tube (in the photo there is a capnography connector between the breathing system and the ET tube).

Check that the valve on the breathing system is open - as above.

INCORRECT: Valve is closed.

Follow instructions in 'CSL_A04 Checking a Breathing System' for guidance on how to check a breathing system.

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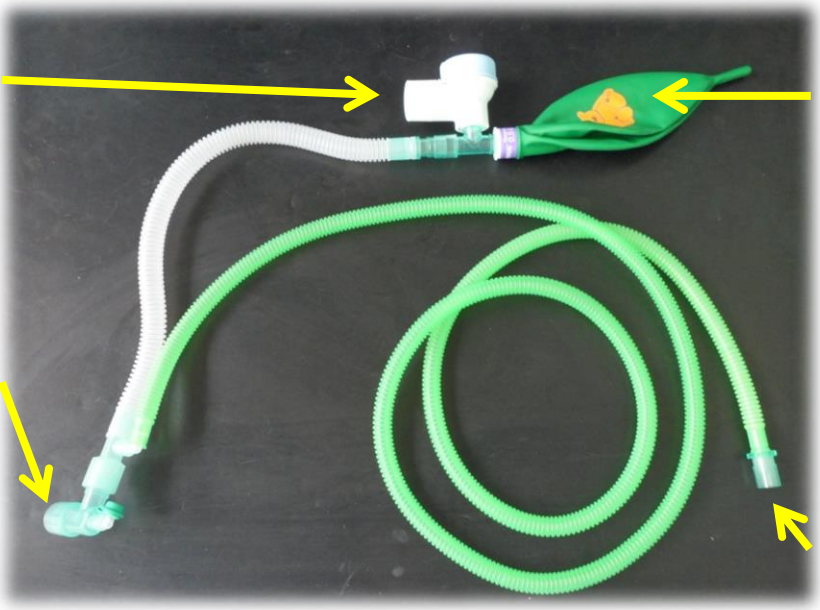
Breathing Systems

Selecting and Connecting Breathing Systems

T-piece (labelled with white tape)



Connect to scavenging

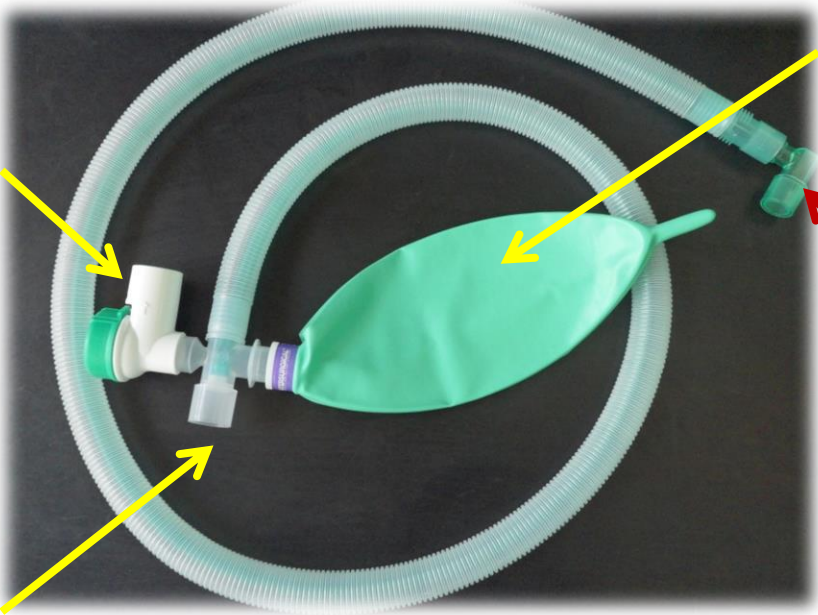
Bag on waste gas (expiratory) limb

Connect to ET tube

N.B. The system also has a capnography connector

Connect to gas flow (to common gas outlet)

Bain (labelled with orange tape)



Bag on waste gas (expiratory) limb

Connect to scavenging

Connect to ET tube

N.B. The system also has a capnography connector

Connect to gas flow (to common gas outlet)

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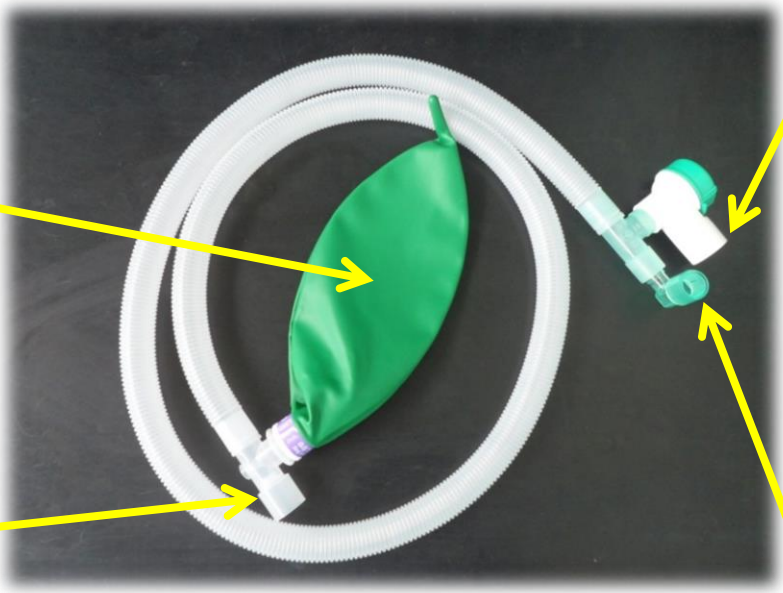
Breathing Systems

Selecting and Connecting Breathing Systems

Magill (labelled with black tape)



Bag on fresh gas flow (inspiratory) limb

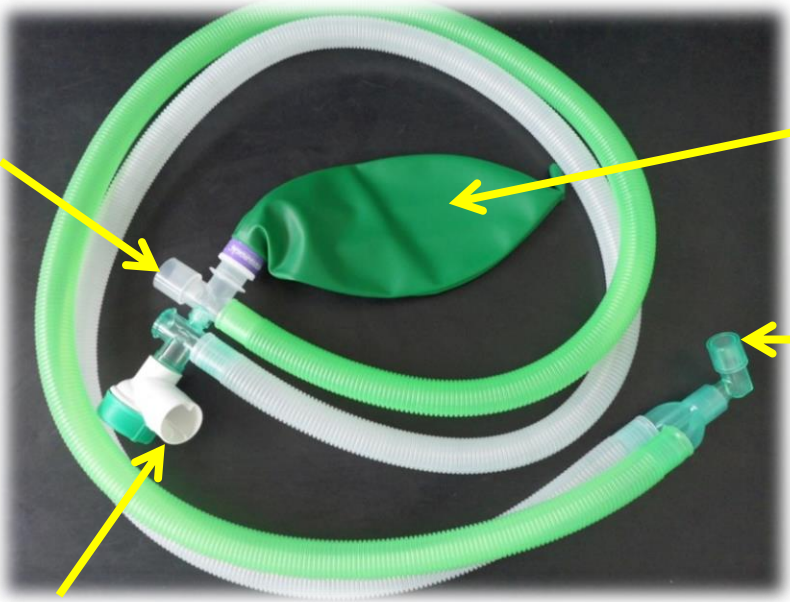
Connect to gas flow (to common gas outlet)

Connect to scavenging

Connect to ET tube

N.B. The system also has a capnography connector

Parallel Lack (labelled with brown tape)



Connect to gas flow (to common gas outlet)

Bag on fresh gas flow (inspiratory) limb

Connect to ET tube

N.B. The system also has a capnography connector

Connect to scavenging

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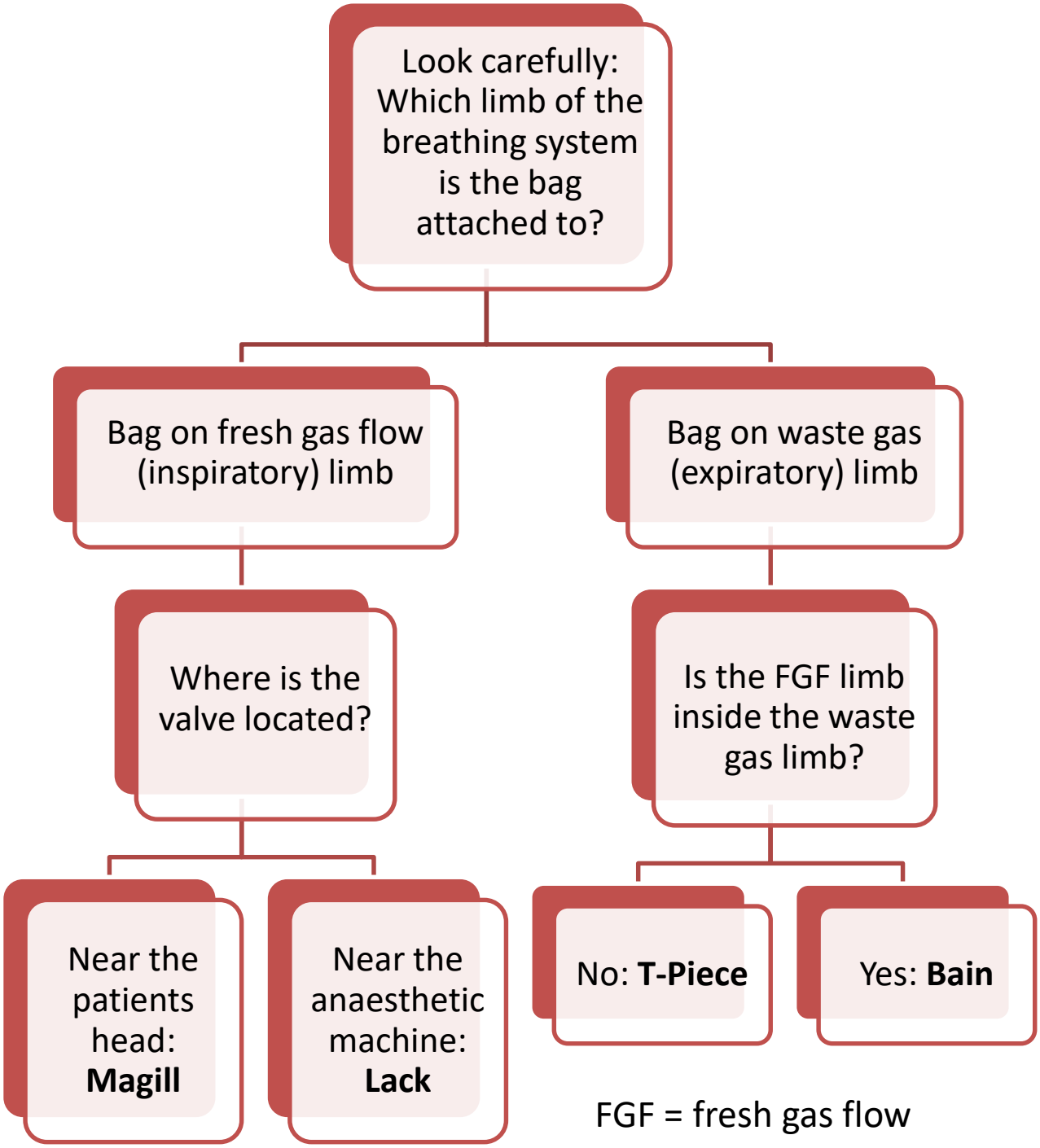
Breathing Systems

Selecting and Connecting Breathing Systems

Identifying a **non-rebreathing** breathing system:



FGF = fresh gas flow

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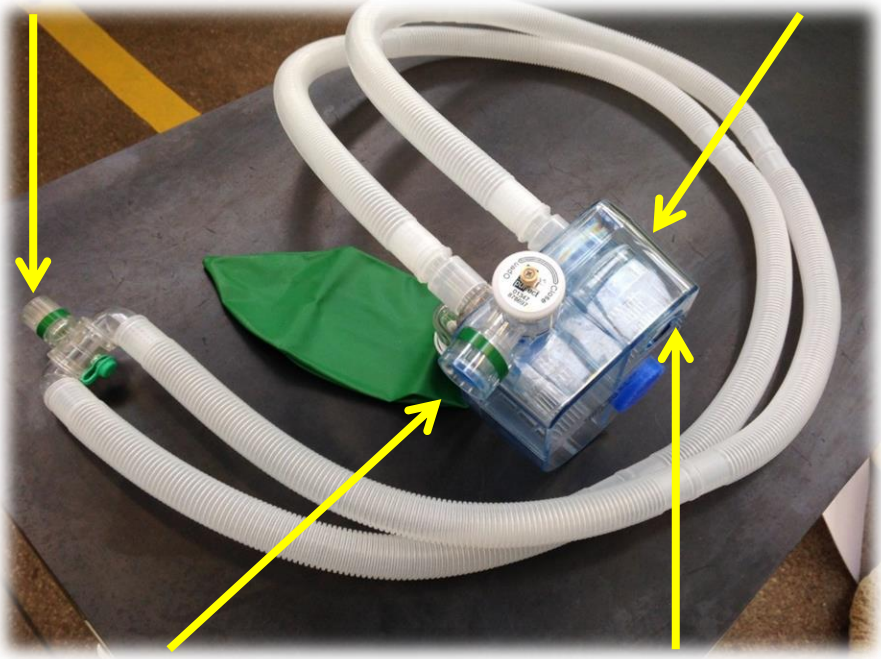
Breathing Systems

Selecting and Connecting Breathing Systems

Circle (labelled with green tape)

Connect to ET tube

Soda lime canister (as the circle is a **rebreathing** system)



Connect to scavenging

Connect to gas flow (to common gas outlet)

N.B. A soda lime canister must be used in conjunction with the circle system to absorb the CO_2 exhaled by the patient.

Over time the soda lime becomes saturated and must be replaced. This is done through a hole which is usually plugged but can be opened to allow access to the soda lime canister.

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Resetting the station:

Selecting and Connecting Breathing Systems

1. Disconnect breathing system from the anaesthetic machine, endotracheal (ET) tube and scavenging system.
2. Turn off the anaesthetic machine and scavenging if it has been in use (turned on).
3. Put all breathing systems back in the box.

Station ready for the next person:

Please inform a member of staff if equipment is damaged or about to run out.

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I wish I'd known:

Selecting and Connecting Breathing Systems

- During an anaesthetic, ensure the breathing system doesn't become kinked – this will obstruct gas flow to the patient.
- During an anaesthetic, ensure the breathing system doesn't get twisted – this could twist the endotracheal tube which can damage the patient's trachea.
- There are mini versions of some of the breathing systems so the weight ranges are for guidance only.
- There is a coaxial versions of the Lack and therefore being able to identify whether the bag is positioned on the inspiratory or expiratory limb is important.

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Further Information

Selecting and Connecting Breathing Systems

Choosing a Breathing System

There are a number of factors that influence the choice of anaesthetic breathing systems e.g.

- Size of the animal
- Economy: How much fresh gas flow will be required?
- Is IPPV (intermittent positive pressure ventilation) required?

When selecting a breathing system, a decision will need to be made between a rebreathing and a non–rebreathing system

Rebreathing system: Expired CO_2 is removed by soda lime and the remaining gases (0_2 and anaesthetic agent) are mixed with fresh gas from the anaesthetic machine which the patient inspires.

Non-rebreathing system: Expired gases are removed from the breathing system by the fresh gas flow from the anaesthetic machine.

See next page for a summary of the advantages and disadvantages of rebreathing and non-rebreathing systems.

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Further Information

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Choosing a Breathing System

This table summarises the advantages and disadvantages of rebreathing and non-rebreathing systems:

	Rebreathing system	Non-rebreathing system
Example/s	Circle	T-Piece, Bain, Lack, Magill
Advantages	• Economical • Reduced atmospheric pollution. • Conservation of heat and moisture.	• Percentage of inspired inhalant anaesthetic agent is the same as the vaporiser setting. • Low resistance.
Disadvantages	• Percentage of inspired inhalant anaesthetic agent often differs from the vaporiser setting and changes in percentage can be slow. • Higher resistance than non-rebreathing system	• Less economical • More atmospheric pollution. • Loss of heat and moisture.

This table summarises the key information about patient size and IPPV requirement to be considered when choosing a breathing system:

Breathing system	Size of animal*	Suitable for IPPV
Non-rebreathing Systems		
T-piece	<10kg	Yes
Bain	>8 to <15-20kg	Yes
Lack	>10 to <25-30kg	No
Magill	>5kg	No
Rebreathing systems		
Circle	>10kg	Yes

*Approx. guidelines as some systems have miniature versions

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Further Information

Selecting and Connecting Breathing Systems

Calculating Fresh Gas Flow (FGF) Rates

After a breathing system has been selected, decide what fresh gas flow (FGF) rate is required for that patient on that breathing system. The FGF is calculated differently for rebreathing and non-rebreathing systems.

Non-Rebreathing Systems:

FGF (ml/kg/min) = minute volume x circuit factor

There are **two methods** for calculating minute volume:

1. Calculate it using this equation: Minute volume (mls/minute) = tidal volume* x respiratory rate.
2. Use this approximation: Minute volume = 200mls/kg/min. Therefore minute volume (mls/min) = 200mls x the animals bodyweight in kg

*Remember that tidal volume is approx. 10-15mls/kg so multiply the animal's body weight in kg by 10-15 to determine the tidal volume.

The circuit factor is different for each circuit:

Breathing system	Circuit factor
T-piece	2-3
Bain	2-3
Lack	0.8-1
Magill	1

Rebreathing Systems:

- Higher FGF rate of ~2-3L/min used initially for denitrogenation and to increase the concentration of inhalant in the system
- After this the minimum FGF rate is equal to the animals metabolic oxygen demand of 10mls/kg/minute **BUT, in practice** the circuit is run with the valve open to allow excess gas to escape and the flow rate is set to *exceed* the metabolic oxygen demand. Generally a setting of 1L/min is used for small animals up to 100kg.

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Further Information

Selecting and Connecting Breathing Systems

Examples

Non-Rebreathing system

Calculate the FGF required for a 12kg dog on a Lack

N.B. using method 2 on the previous page

FGF (ml/kg/min) = minute volume x circuit factor

FGF (ml/kg/min) = (200 x 12) x 1

FGF = 2400mls/min

Then divide by 1000 to convert millilitres to litres (the flow meter on the anaesthetic machine is in litres)

FGF = 2.4L/min

Rebreathing System

Calculate the FGF for a 30kg Labrador on a circle

The animals metabolic oxygen requirement is 10mls/kg/min, so 10 x 30 = 300mls/minute.

However, to be safe the FGF is set to exceed this. The FGF typically used in a circle would be:

FGF 3L/min initially then turn down to 1L/minute.

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Scenarios

Selecting and Connecting Breathing Systems

Select the most appropriate breathing system for the following scenarios and list the reasons for your choice. There may be more than one correct answer. Also work out the fresh gas flow (FGF).

1. A 9 month old female cat has been brought to the surgery to be neutered. She weighs 3.2kg. What breathing system(s) would be the most appropriate for this case?

2. A 55kg Newfoundland has a dental booked at the practice. What breathing system(s) would be most appropriate for this case?

3. You are on clinical rotations and a 15kg Springer Spaniel is set to have a thoracotomy. What breathing system(s) would be most appropriate for this case?

4. A 9.2kg Whippet is coming in for a digit amputation. What breathing system(s) would be the most appropriate for this case?

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Answers

Selecting and Connecting Breathing Systems

1. A 9 month old female cat has been brought to the surgery to be neutered. She weighs 3.2kg. What breathing system(s) would be the most appropriate for this case?

T Piece

- Low resistance as is small patient.
- FGF = minute volume x 2 to 3

  minute volume = 200mL/kg/min

  = 200 x 3.2

  = 640mL/min
- FGF = 640 x 2 to 3 = **1.28 to 1.92L/min**

Mini-Lack

- FGF = 1 x minute volume

  = **640mL/min**
- N.B. 640mL may be difficult to set on the flowmeter so set the FGF to **1L/min**

2. A 55kg Newfoundland has a dental booked at the practice. What breathing system(s) would be the most appropriate for this case?

Circle

- Rebreathing system, allows lower fresh gas flow so is more economical
- Metabolic O_2 consumption estimate = 10mL/kg/min
- Metabolic O_2 demand = 10 x 55kg = **550mL/min**
- A minimum FGF to **1L/min** is usually used for a circle in practice

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Answers

Selecting and Connecting Breathing Systems

3. You are on clinical rotations and a 15kg Springer Spaniel is set to have a thoracotomy. What breathing system(s) would be the most appropriate for this case?

   – Will need IPPV as thorax will be open

   Bain

   – Can use for patients 10-20kg.
   – Minute volume = 200mL/kg/min
   = 200 x 15
   = 3L/min
   – FGF = minute volume x 2 to 3
   = 3L x 2 to 3
   = **6 to 9L/min**

   Circle

   – Rebreathing system, allows lower fresh gas flow so is more economical
   – Metabolic O_2 demand estimate = 10mL/kg/min
   – Metabolic O_2 demand = 10 x 15kg = **150mL/min**
   – N.B. Usually a circle FGF is set to a minimum of **1L/min**

4. A 9.2kg Whippet is coming in for a digit amputation. What breathing system(s) would be the most appropriate for this case?

   – Bain, Circle, Lack or Magill
   – Whippets tend to have a large lung capacity in comparison to body weight and so would be able to cope with resistance of a breathing system when other dogs of the same weight might not.