Breathing Circuits

Product training
Agenda

- Introduction to Breathing Circuits
- Anaesthesia Circuits
- Intensive Care Circuits
- Accessories
Introduction
What is a breathing circuit?

In general, a breathing circuit is a system of tubes and accessories connecting the patient to an Anaesthesia equipment or to an Intensive Care ventilator.

Elements
- Tubes
- Water traps
- Y-piece
- Breathing Bags
- Valves
Anaesthesia Circuits

Clinical practice
The process of Anaesthesia

Anesthesia: the process by which a patient is rendered able to undergo surgery

Goals:

- Anaesthesia: lack of awareness of surrounding events
- Akinesia: keeping the patient still to allow surgery to take place
- Muscle relaxation: to enable access through muscles to bones and body cavities
- Autonomic control: to prevent dangerous surges in hemodynamics
Anaesthesia and its stages

Premedication

- conducted in the surgical ward or preoperative holding area
- Aim is to have patient arrive in the operating room in a calm, relaxed frame of mind while causing minimal interference with breathing and cardiovascular status
- Administered orally or intravenously
Anaesthesia and its stages

Induction

- From awake to anesthetized patient
- Administered intravenously or by slow inhalation of anaesthetic vapours or combination of both
- Combined with narcotic analgesia
- Natural breathing or endotracheal intubation
- ET tube needed if muscle relaxant is administered
Anaesthesia and its stages

Maintenance

- Keep patient anesthetized with a maintenance agent
- Delivery of anesthetic gases into the patient’s lungs
- Inhaled as the patient breathes himself or delivered under pressure by each mechanical breath of a ventilator
- Level of anesthesia altered to give the minimum amount necessary to ensure adequate anesthetic depth
Anaesthesia and its stages

I’m awake again!

- Anaesthetic vapors decreased or switched off
- Muscle relaxation is reversed
- Long-acting narcotic analgesic to keep patient comfortable in the recovery room
- Patient is restored to breathing by himself
- Removal of the endotracheal tube only performed when the patient has regained sufficient control of airway reflexes
What is an anaesthetic circuit?

- Assembly of components to connect the patient’s airway to the anaesthetic machine
What does it need to do?

- Deliver the gases from the machine to the alveoli in the same concentration as set and in the shortest possible time
- Effectively eliminate CO2
- Minimal dead space and low flow resistance
- Economy of fresh gas
- Adequate humidification of inspired gas
- Light weight, compact and sturdy
- Efficiency during spontaneous as well as controlled ventilation
- Efficient removal of waste exhaled gases
## Several Classifications

<table>
<thead>
<tr>
<th>Open</th>
<th>no rebreathing</th>
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</thead>
<tbody>
<tr>
<td>Semiclosed</td>
<td>partial rebreathing</td>
</tr>
<tr>
<td>Closed</td>
<td>total rebreathing</td>
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- **MacMohan, 1951**

- **Mapleson, 1954**
  Semi-Closed Systems
  The arrow indicates the fresh gas flow entry
Mapleson systems

- Elimination of CO2 with these systems depends on FGF
- Mapleson systems functioning can change depending on parameters change, such as: FGF, dead space etc.

- FGF is crucial for breathing system working. If there is no FGF patient will not be ventilated. If FGF is too low, majority of systems doesn’t effectively remove CO2. If FGF is too high, anesthetic gases are being lost.

Setting appropriate FGF is the key here.
Magill/Mapleson A Breathing System

Mechanism of action of the Magill Breathing System during spontaneous ventilation

FGF = fresh gas flow
Lack Breathing System

a) Coaxial Lack Breathing System

b) Parallel Lack Breathing System
Mapleson B and C

- Fresh gas entry near the patient to optimise FGF and reduce rebreathing during controlled ventilation
- FGF and exhaled gases are mixed: not very efficient neither during spontaneous or controlled ventilation

- Also known as MBU or bagging system
- Used also in ICU and Emergency
Mapleson D, E, F Breathing System

- Reservoir is in the limb which carries expired gas from the patient and vents it to the atmosphere through the expiratory valve/port.
- This to reduce FGF requirements
- Work efficiently for controlled ventilation if FG entry and expiratory valve are separated by a volume equivalent to at least one tidal volume of the patient
- Not economical during spontaneous breathing.
Mapleson D during spontaneous breathing

Diagram:

- (a) Diagram showing the configuration of Mapleson D during spontaneous breathing.
- (b) Another view of the setup, highlighting the FGF (Fresh Gas Flow).
- (c) Illustration of the expired gas flow indication.
- (d) Additional perspective on the breathing circuit, emphasizing the path of expiratory gases.
Bain Breathing System

- Coaxial version of the Mapleson D
- Fresh gas flows along the inner tube and the exhaled gases flow along the outer tube
- Not efficient for spontaneous ventilation
- Fresh gas flow rate required is 150-200 ml/kg/min
- Efficient during controlled ventilation
- Fresh gas flow rate required is 70-100 ml/kg/min
Circle Breathing Systems (semi-closed and closed system)

- Soda lime canister with two unidirectional valves attached to inspiratory and expiratory tubings
- APL valve and reservoir bag are connected to the canister
- Soda lime consists of 94% calcium hydroxide, 5% sodium hydroxide and a small amount of potassium hydroxide
- Soda lime absorbs the exhaled carbon dioxide and produces water and heat
- Very efficient breathing system using low fresh gas flow and reducing pollution
- A high initial flow is required
Circle Breathing Systems
Anaesthesia Circuits

DAR range
DAR: a very comprehensive range

• Standard configurations for:
  1. Anaesthesia
  2. Intensive Care
  3. Neonatology
  4. Home Care

• Custom made” program: special breathing systems can be designed according to customer’s needs
Which material?

1. Smoothbore PVC - single use
2. Extendible Corrugated PP (Darmonia) - single use
3. Polyethylene - single use
4. Smoothbore Hytrel – autoclavable (up to 20 times, temp. 121 – 123°C)
Advantages of Smoothbore PVC

- Internally Smooth
- Clear
- Very resistant
- Low Compliance
- Flex connector 10, 15, 22 mm
- Single Use
- Custom made option
Polypropylene (Darmonia)

- Space saver
- Extendible
- Lightweight
- Low cost
- Disposable
- 22 mm only (adult)
## Material and size

<table>
<thead>
<tr>
<th></th>
<th>22 mm Adult</th>
<th>15 mm Paediatric</th>
<th>10 mm Neonatal</th>
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<tbody>
<tr>
<td>PVC</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>PVC Heated Wire</td>
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<td>x</td>
<td>x</td>
</tr>
<tr>
<td>PE</td>
<td></td>
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<tr>
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<tr>
<td>Hytrel</td>
<td>x</td>
<td>x</td>
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Questions to ask to offer the right circuits in anaesthesia

1. Type of patient being treated (adult, pediatric, neonates) – this will determine the diameter and material we can offer
2. Type of anaesthesia: closed or semiclosed;– this will determine if they need a mapleson system or a standard y-piece; closed with low flow: this might often require water traps
3. Preferred material: help by describing features
4. Diameter inspiratory/expiratory connector on ventilator: usually 22M for adult ventilators
5. Length of tube for connection between y-piece and ventilator
6. Length of extra limb with breathing bag (if needed)
7. Size of bag (1/2 l, 1 l, 2 l, 3 l): 2 l usually for adult patients
8. Accessories: elbow with CO2 port, filters, pressure line
Basic Y-piece circuit

- Available in all materials
- Extendible in 22 mm only
- Various lengths available
- Can be supplied with temp and pressure ports on the Y piece (usually for ICU)
- Can be supplied with water trap (ICU)
- Can be supplied with heated wire limb for use with hot water bath humidifiers (ICU)
- Suitable for use with closed systems
Triplex: 3-lines-in-1

- The inspiratory limb is inserted in the external expiratory limb
- An additional line for capnography to be connected directly to the instrument
- The circuit is built using three different materials:
  - PVC for the inner line
  - PE for the outer line
  - PP for the extendible limbs
Why Triplex

- Light, flexible and less bulky than conventional circuits
- Fresh gases are heated and maintain their humidity without using additional devices
- Just one tube in the area of patient’s head
- No need to change the circuit for patient transportation
- DUO (no capnoline) for ICU also with FHME
- 130, 200, 260 cm
Anaesthesia circuit with machine side filters
Anaesthesia circuit with patient side filters
Intensive Care Circuits
Questions to ask to offer the right circuits in ICU

1. Type of patient being treated (adult, pediatric, neonates) – this will determine the diameter and material we can offer
2. Type of humidification: active or passive: this will determine if they need a standard y-piece or a heated/water trap circuit
3. Preferred material: help by describing features
Circuit for active humidification
Circuit for active humidification

Check for the following parameters!

1. Diameter inspiratory connector on ventilator
   - female or male (usually 22M for adult ventilators)
2. Length of tube for connection between ventilator and humidifier
3. Diameter inlet connector on humidifier (usually 22M or 15F)
4. Diameter outlet connector on humidifier (usually 22M)
5. Length of inspiratory limb between humidifier and water trap
Circuit for active humidification

Check for the following parameters!

6. Length of inspiratory limb between water trap and “Y”-piece
7. Type of “Y”-piece (available with pressure & temperature ports at different I.D.)
8. Length of expiratory limb between “Y”-piece and water trap
9. Length of expiratory limb between water trap and ventilator
10. Diameter expiratory connector on ventilator
    -female or male (usually 22M for adult ventilators)
DAR embedded heated wire circuits

The DAR smooth bore circuits with heated wire built in outer tube spiral

- Target: ICU’s (Neonatal)
- Unique product
- Compatible with all active humidifiers such as Kendall, F&P, Hudson, DAR
DAR embedded heated wire circuits

- **Product Positioning**
  - The unique embedded heated wire circuit to ensure maximum safety for patients and staff
  - Can be customised for specific needs

- **Objectives**
  - Penetrate ICU’s breathing systems market where Filter/HME’s are not used (esp. Neonatal)
  - Obtain premium price
  - Increase customer loyalty by offering the most complete range of circuits
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- Can be supplied with water trap (ICU)
- Can be supplied with heated wire limb for use with hot water bath humidifiers (ICU)
- Suitable for use with closed systems
ICU circuit without patient side filter

always water bath humidifier

and

inspiratory and expiratory water traps/heated tubing
ICU circuit with patient side filter

- no water bath humidifier
- breathing system without water traps!