Anesthesia Machine
Intro

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Clinical Care Interactions

- Anesthetist
  - Touch
  - Observe (senses)

- Patient
  - Touch

- Work-station
  - ADS, monitors, PIMS
  - Monitoring
  - Requests
  - Care Info (lab data, image..)

- OR
- Hospital World
  - Inhalant Drugs
  - IV Drugs, Fluids
  - Other

- Observe (eyes, ears)
Anesthesia Delivery System

ADS

Anesthetist

Patient

OR

Hospital

Work-station

Inhalant Drugs
IV Drugs, Fluids
Other

Care Info
(lab data, image..)

ADS, monitors, PIMS

Clincal Care Interactions

touch

observe (senses)

monitoring

observing (eyes, ears)

touch
Workstation - Patient Interactions

Airway control
Breathing
Circulation
Drug delivery for anesthetization
Workstation - Patient Interactions

Airway control
Breathing - safe gases
Circulation
Drug delivery for anesthetization
  vapors, gases, IV
Intravenous Liquid Delivery
Monitoring
Recording
ADS - Patient Interactions

Breathing - safe gases

Drug delivery for anesthetization vapors, gases
Anesthesia Machine Evolution
1846 Morton Ether Inhaler
Inhaler had limitations
This 1850 version worked horizontal with no hands required.
Open Circuit Inhaler

Open Circuit = **Non-rebreathing**

Patient breathes in the ether vapor, breathes ether out (and it is discarded)

Breathes in new ether vapor

Breathes it out again (discarded)
Open Circuit = non-rebreathing Circuit = what you set is what you get
What you put into the circuit is what the patient gets

Give sufficient 100% oxygen flow to the reservoir bag (not to empty)
Reservoir bag gives 100% oxygen to the breathing bag

The Tidal Volume and Minute Ventilation is determined by the size and frequency of the squeeze of your hand and a perfect seal.
Manual Resuscitator

One-way valves make sure gas flows to the patient

A special valve allows exhaled gas to be removed
A bag reservoir lets you see it provides 100% oxygen to the breathing bag by never emptying and never entraining room air.
Partial Rebreathing Circuits are used in Anesthesia

Don’t throw all the exhaled gas
It contains expensive anesthetic vapors
Reuse as much as possible somehow (learn more later)
Remove (Absorb) CO₂ and Rebreathe the anesthetic

Partial rebreathing = semi-closed circuit
All ADSs use them
1890 added a Breathing Circuit
1925 Draeger

1927 Forreger added CO₂ absorption
1950 added a work surface
Then, Drawers, Temperature-compensated vaporizers, Circuit, Absorber, Common gas outlet
1990 Integrated Monitors and Data Recording
Datex-Ohmeda Central Display (CD) ADS
2000

Better ventilation for difficult patients
FGF-independent ventilation
Corrects for circuit leaks
More sensitive to water vapor
Monitors not integrated
2000
GE Aestiva
(BWH L&D and MOR HeliOx for ENT Surgery)
2000 Draeger Fabius (BWH many ORs)
2005-2010 state-of-the-art

GE Aisys MOR - many rooms

Draeger Apollo GS MOR - 6 rooms
Basics of the Anesthesia Delivery System
Anesthesia Delivery System - ADS

Anesthesia Machine
Breathing Circuit
Ventilator
Anesthesia Machine delivers gases and vapors into a breathing circuit.

Provides continuous flow of -

**Oxygen** for Life

**Air** to safely lower $F_1O_2$

**Nitrous Oxide** for partial anesthesia

**Agent vapor** for complete or partial anesthesia
(Continuous Flow) Anesthesia Machine

N₂O Air O₂

Common Outlet FGF (Fresh Gas Flow)

Vaporizer

Isoflurane Sevoflurane Desflurane

L/m  L/m  L/m  mL/m

9  9  9  900
8  8  8  600
7  7  7  400
6  6  6  300
5  5  5  200
4  4  4  100
3  3  3  50
2  2  2
1  1  1
0  0  0

mL/mL/mL/mL/mL
Flow Tubes
Oxygen and Gas Delivery

Mechanical
Physical knobs

Rotameters,
GE Aestiva, Aespire
Oxygen and Gas Delivery

**Mechanical**
- Physical knobs

**Rotameters, Digital meters**

**Draeger Fabius**

**Draeger Apollo**
Oxygen and Gas Delivery

Mechanical
Physical knobs

Rotameters, Digital meters

Draeger Fabius

Draeger Apollo
Oxygen and Gas Delivery

Electronic
Virtual knobs

Digital meters
GE Avance, Aisys

% Oxygen in FGF
NOT inspired - be careful

GE Avance, Aisys
Vaporizer Types

**Mechanical**
- Penlon Signa for isoflurane, sevoflurane
- GE Tec 3,4,5,7 for isoflurane, sevoflurane
- GE Tec 6 for desflurane (electro-mechanical)
- Draeger Vapor 19, 2000 for all agents
  - Direct-reading, temperature-compensated

**Electronic**
- GE Aladin for all agents
Anesthesia Machine
Anesthesia Machine Schematic

Stoelting & Miller Basics Anes.  

Figure 10-2. Schematic diagram of internal circuitry of an anesthesia machine.
Anesthesia Machine Schematic

Stoelting & Miller Basics Anes.  Figure 10-2. Schematic diagram of internal circuitry of an anesthesia machine.
Patient Breathing Circuit

Allows cyclic flow
To and from the patient
(AKA Breathing)
Stoelting & Miller B of A. Figure 10-8. Schematic diagram of a circle absorption anesthetic breathing system.
The Circle-Absorber System

Gas Flows

Sampled 200 mL/min

Expired

Inspired

Rebreathed

Exhaust

Fresh

CO₂ Absorbant

Sampled

Inspired

Expired

Rebreathed

Exhaust

Fresh
The Circle-Absorber System

Gas Flows

Exhaust

Expired

Rebreathed

CO₂ Absorbant

Fresh

Inspired

200 mL/min
The Circle-Absorber System

Gas Flows

Exhaust

Expired

Rebreathed

Fresh

Inspired

CO$_2$ Absorbant
The Circle-Absorber System

Gas Flows

Fresh

CO₂ Absorbant

Expired

Rebreathed

Inspired

To Patient
The Circle-Absorber System

Exhaust

Expired

CO$_2$ Absorbant

Rebreathed

Inspired

From Patient

Fresh
The Circle-Absorber System

Exhaust (APL)

Expired CO₂ Absorbant

Inspired Fresh Gas Flows

Rebreathed CO₂ Absorbant

Gas Flows
The Circle-Absorber System

Exhaust (APL)

Expired

Rebreathed Gases (O₂, N₂O, Agent)

CO₂ Absorbant

Fresh

Inspired

Gas Flows
The Circle-Absorber System

Gas Flows

Expired

Exhaust

Rebreathed Gases

No CO₂ rebreathed

Fresh

Inspired

CO₂ Absorbant

No CO₂ rebreathed
The Circle-Absorber System

Exhaust

Expired

CO$_2$ Absorbant

No Rebreathed Gases

No CO$_2$

Fresh

Inspired

Gas Flows
The Circle-Absorber System

Gas Flows

Expired

Inspired

Fresh

CO₂ Absorbant

Rebreathed Gases
No CO₂

Exhaust

Expired
Gas is sampled from circuit near patient for I/E measures

Inspired Fresh

Expired

Exhaust

Sampled 200 mL/min

CO₂ Absorbant

VE
Low FGF

More rebreathing
Inspired more dependent on Expired
Inspired less dependent on Vaporizer

View the Breathing Circuit
The Circle-Absorber System
The Anesthesia Workspace
Draeger Apollo
Workspace Setup

MRSMMAID

Machine
Room
Suction
Monitors
Airway
IV
Drugs
Workspace Setup

MRSMAID

Machine
Room
Suction
Monitors
Airway
IV
Drugs
Suction off if:
DISS hose unscrewed
Wall switch off
Hose disconnect from Canister
Canister switch off
Insert seated incorrectly
Any hole open
Flap valve closed because unit was shaken or canister is full
Flexible hose kinked
Flexible hose stepped on
Perform Machine-Assisted Tests

GE Modulus 2 Plus - none

GE Aestiva - Minor
12 Hour switch off and on
Circuit Oxygen Sensor Cal via SmartVent

GE Aisys - Major
Most circuit tests are automated
Bellows volume & pressure can feel the circuit
and make great ventilation modes

Draeger Fabius - Major
Most circuit tests are automated
Ventilator Piston can feel the circuit
and make great ventilation modes
CALIBRATE OXYGEN MONITOR

Oxygen Monitor on & sensor in air with hole plugged. Calibrate to 21%. Reconnect sensor in circuit
CHECK MACHINE FOR GAS DELIVERY

Machine On
Oxygen flows smoothly
Disconnect oxygen hose
Oxygen alarm sounds
Switch ON oxygen tank. Verify P > 1000 psi and Alarm silences.
Tank off with wrench
Turn oxygen flow up
Alarm sounds oxygen failure
Connect oxygen hose to silence alarm.
Turn up nitrous and observe alarm and/or control.
Negative Pressure Test - later
CHECK CIRCUIT FOR INTEGRITY

Attach circuit including reservoir bag
Occlude “Y” with thumb
Flush and fill bag to 30 cmH2O.
Test pressure alarms
   NAD - Continuing pressure alarm, high pressure alarm
   Ohmeda - High pressure relief
Open relief valve and verify that reservoir bag empties
Observe scavenger bag fill and empty
CHECK FUNCTION

CHECK VENTILATOR FOR FUNCTION
Ventilate reservoir bag and observe no volume loss.

CHECK SCAVENGER FOR FUNCTION
Check that reservoir bag fills and empties. Check valves not stuck.
Thank you