

Inhaled anesthetic agents

Hesham M. I. El Zenati, MD

Consultant Anesthesia, ICU & Perioperative Medicine

Definitions

- **Gas**

- Any substance above its critical temperature is gas
- N_2O & Xenon are gases at room temperature

- **Vapor**

- Gaseous form of substance that is primarily liquid at room temperature (below its critical temperature)

Critical temperature

- Temperature above which substance cannot be liquefied no matter how much pr. applied

Gas	Critical Temp.
Oxygen (O ₂)	–118°C
Nitrous oxide (N ₂ O)	36.5°C
Carbon dioxide (CO ₂)	30°C

Inhaled anesthetic agents

- Volatile liquids (**Halogenated** compounds)
 - Halothane
 - Isoflurane
 - Sevoflurane
 - Desflurane
- Nitrous oxide (N_2O)
- Xenon

Vapor Pressure

- Volatile liquid in closed container → molecules escape from liquid phase to vapor phase until number of molecules in vapor phase constant
- Molecules in vapor phase bombard wall of container & create pressure known as *Saturated vapor pressure (SVP)*

Partition coefficient

- Relative solubility's of anesthetic in air, blood & tissues
- Ratio of concentrations of anesthetic gas in each of two phases at equilibrium

Physical properties

Agent	Saturated vapor pressure at 20 °C (kPa)	Boiling point at atmospheric pressure (°C)	Blood–gas coefficient	Oil–water coefficient
Halothane	32.3	50.2	2.30	220.0
Enflurane	23.3	56.5	1.91	120.0
Isoflurane	33.2	48.5	1.40	170.0
Sevoflurane	23.5	58.5	0.60	55.0
Desflurane	88.5	23.5	0.42	18.7
Nitrous oxide	5500	−88	0.47	3.0
Xenon	Above critical temperature	−108.1	0.115	20.0

Minimum alveolar concentration (MAC)

- A measure of potency
- Defined as: *the minimum alveolar concentration that prevents reaction to a standard surgical stimulus (skin incision) in 50% of subjects*

Minimum alveolar concentration (MAC)

Agent	MAC %
Halothane	0.75
Isoflurane	1.2
Sevoflurane	2
Desflurane	6
Nitrous oxide	104

Factors altering MAC

Factors increasing MAC

Infancy

Hyperthermia

Hyperthyroidism

Catecholamines and sympathomimetics

Chronic opioid use

Chronic alcohol intake

Acute amphetamine intake

Factors decreasing MAC

During the neonatal period

Increasing age

Pregnancy

Hypotension

Hypothermia

Sedatives

Acute opioid use

Acute alcohol intake

Chronic amphetamine intake

Ideal inhaled anesthetic agent

Physical

- Stable to light & heat
- Inert in contact with metal, rubber & soda lime
- Preservative-free
- Not flammable or explosive
- Pleasant odor
- Atmospherically friendly
- Cheap

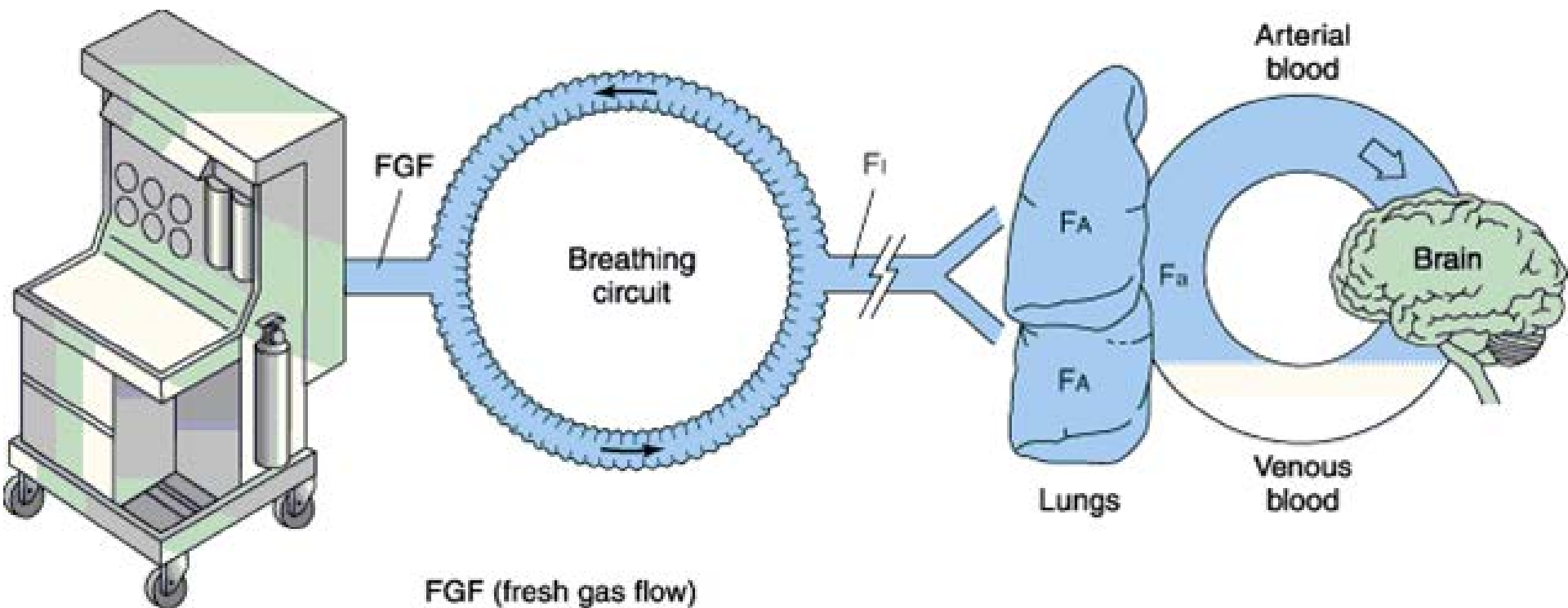
Ideal inhaled anesthetic agent

Biochemical

- High oil:gas partition coefficient; low MAC
- Low blood:gas partition coefficient
- Not metabolized
- Non-toxic
- Only affects CNS
- Not epileptogenic
- Some analgesic properties

Kinetics

- Partial pressure of inhaled anesthetic within alveoli (P_A) in equilibrium with that in arterial blood (P_a) & subsequently brain (P_B)
- (P_A) gives indirect measure of (P_B)



Anesthesia machine

FGF (fresh gas flow)

F_i (inspired gas concentration)

F_A (alveolar gas concentration)

F_a (arterial gas concentration)

Metabolism

- Hepatic cytochrome P450

Agent	Percentage metabolized	Metabolites
N ₂ O	<0.01	(N ₂)
Halothane	20	Trifluoroacetic acid, Cl ⁻ , Br ⁻
Sevoflurane	3.5	Inorganic and organic fluorides Compound A in the presence of soda lime
Isoflurane	0.2	Trifluoroacetic acid and F ⁻
Desflurane	0.02	Trifluoroacetic acid

Nitrous oxide (N₂O)

- Used alongside volatile agents
- In combination with oxygen (O₂) as entonox
- High MAC

Effects

Respiratory

- ↓TV & ↑RR

Cardiovascular

- Mild direct myocardial depressant effects
- ↑Sympathetic activity

CNS

- ↑CBF (avoided in ↑ICP)
- Analgesia & sedation

Contraindications

- N_2O cause rapid expansion of any air-filled space (pneumothorax, vascular air embolus & intestinal lumen)
- Prolonged use interferes with vitamin B12, protein & DNA synthesis

Halothane

Physical Properties

- Clear, colorless liquid
- Non-flammable
- Characteristic sweet smell

Pharmacodynamic properties

CVS

- Dose dependent ↓ Cardiac contractility, ↓ HR & ↓ SVR
- Sensitizes myocardium to circulating catecholamines & cause arrhythmias

RS

- Dose dependent ↓ TV & ↑ RR
- Bronchodilatation
- Non-irritant

Pharmacodynamic properties

CNS

- Cerebral vasodilatation, ↑ CBF & ↑ ICP

Other

- Autoimmune hepatitis
 - Metabolites bind to hepatic proteins on hepatocyte cell membrane & modifying their structure
 - Modified hepatocyte antigens elicit antibody → hepatic necrosis & failure

Isoflurane

Physical Properties

- Clear, colorless liquid
- Non-flammable
- Pungent smell

Pharmacodynamic properties

CVS

- Mild ↓ Cardiac contractility
- Dose dependent ↓ SVR & ↓ MAP
- Reflex tachycardia
- Coronary vasodilatation

Pharmacodynamic properties

RS

- Dose dependent ↓TV & ↑RR
- Bronchodilatation
- Respiratory irritant

CNS

- Low concentrations (< 1 MAC) do not increase CBF & ICP

Other

- Reduces muscle tone in pregnant uterus

Sevoflurane

Physical properties

- Clear, colorless liquid
- Not degraded by light
- Reacts with soda lime to form compound A
- Non-flammable

Pharmacodynamic properties

CVS

- Dose dependent ↓CO, ↓SVR & ↓MAP
- Does not reduce HR

RS

- Less respiratory depression than other drugs
- Bronchodilatation & non-irritant

CNS

- Has similar actions as isoflurane

Other

- ↓Muscle tone in pregnant uterus

Desflurane

Physical properties

- Clear, colorless liquid
- Non-explosive but flammable
- Requires a specialized vaporizer heats desflurane & keeps it under pressure

Pharmacodynamic properties

CVS

- Dose dependent ↓ myocardial contractility, SVR & MAP
- ↑ HR

RS

- Dose dependent ↓ TV & ↑ RR
- It is potent irritant

CNS

- < 0.8 MAC → does not cause increase intracranial pressure.

Other

- ↓ Renal blood flow

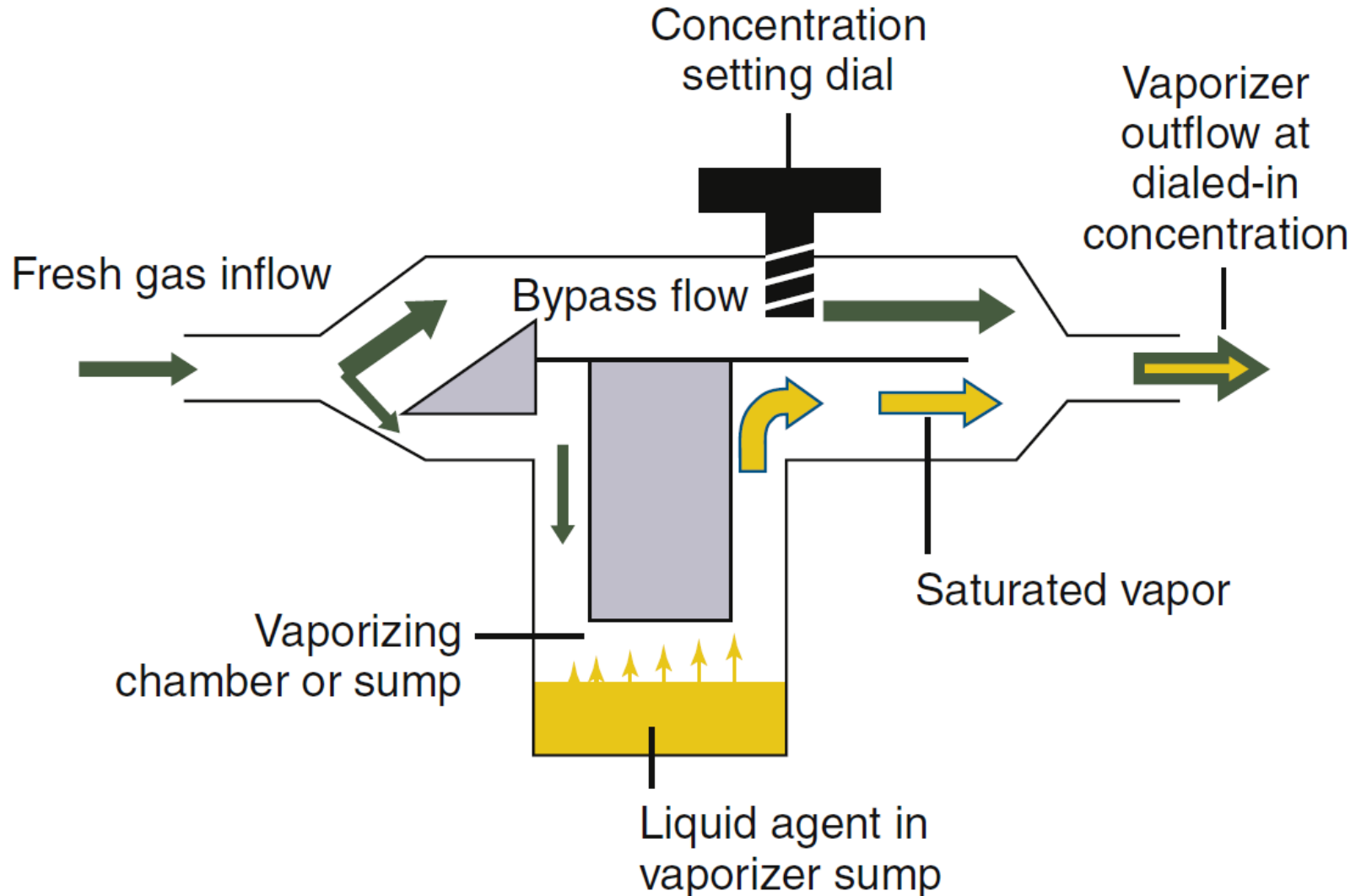
Xenon (Xe)

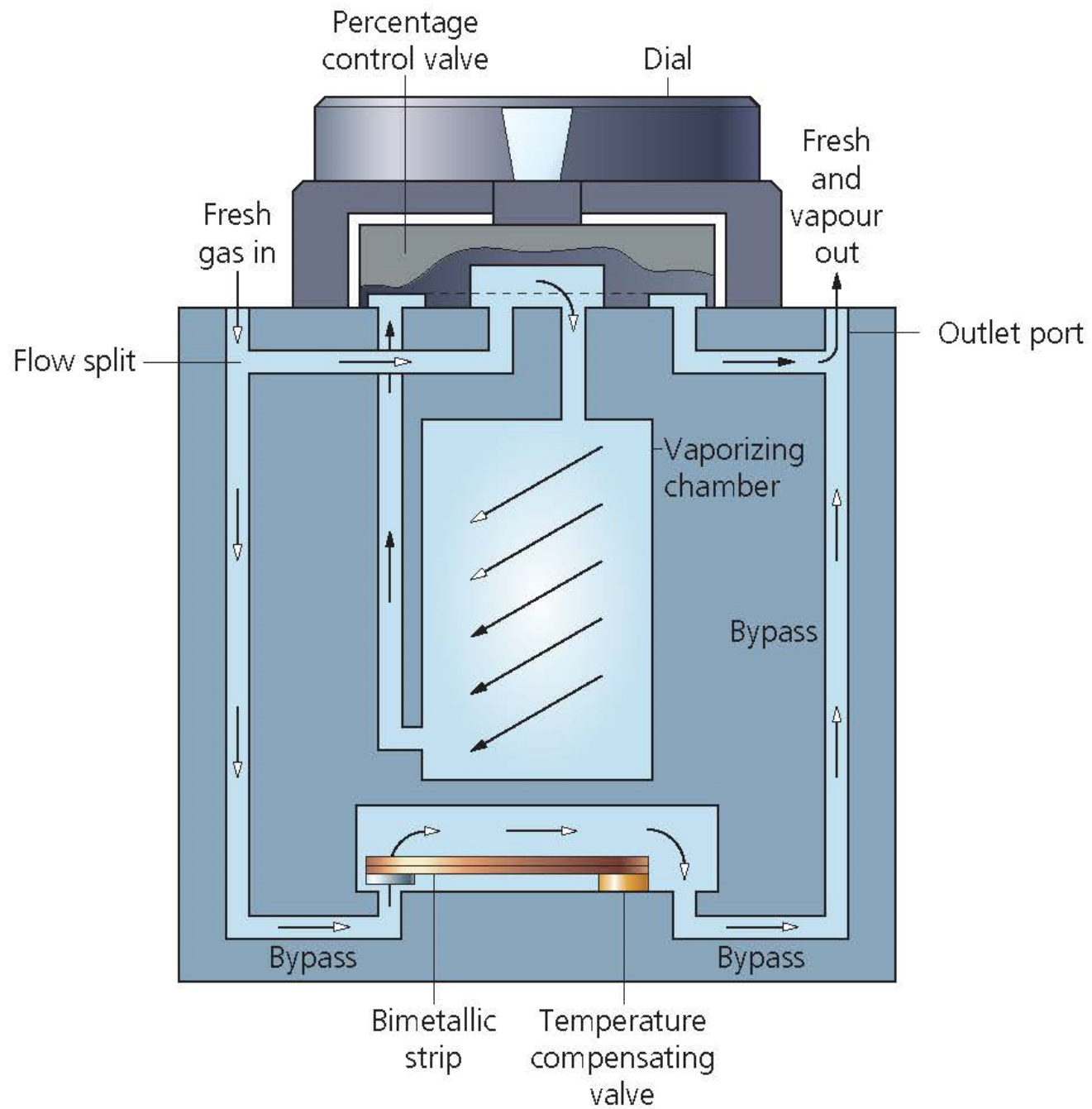
- Anesthetic agent for the future
- Very expensive
- Non-flammable & does not support combustion
- Rapid induction & emergence
- High MAC (low potency)

Pharmacodynamic properties

- CNS – anesthesia & analgesia
- CVS – Cardiostable
- RS – non-irritant, ↑TV & ↓RR

Variable bypass vaporizer









250 ml e No 4456

Sevoflurane

INHALATION ANAESTHETIC

POM

ABBOTT

FDG9632

SUPRANE
(desflurane)

liquid for inhalation

240 ml

Baxter

Batch No : 04D27A31
Use before : 01 - 2007

THANKS