VIMA
(Volatile Induction and Maintenance Anesthesia)
How and Why

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I will use Gas Man® version 3.1

Understanding Anesthesia Uptake & Distribution

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BWH Anesthesia

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Three unique uses for Sevoflurane

Almost unique
Sevoflurane Sedation
Sevoflurane for a difficult airway
Sevoflurane Vital Capacity Induction
Sevoflurane Sedation

2 L/min FGF
Sevoflurane 2%
PO Oral Ibuprofen (Advil, Motrin) $0.50
Why do VCI?

It works

No need for other drugs

IV Induction agent (Pent/Prop)

Opioid

Muscle relaxant (any NMB)

Reversal agents for NMB
No relaxants  No Propofol
No relaxants  No Propofol  No use
No relaxants  No Propofol
  No use
  No waste
Why do VIMA?

Inexpensive
Satisfying to
Patient
Anesthesiologist
Surgeon
How to do Volatile Induction
Premedication

None, typically
Anything, as required
Try talking, first
Sedation possibility

Propofol
10 mg
BWH Pharmacy makes 10 mL syringes
2 mL syringes would be better
Volatile Induction

Fast*

Volatile agent with nitrous oxide, alone
Deep breath

51 ± 4 seconds, 1 - 4 breaths
39 ± 3 seconds, if 1 breath

Sevo + Nitrous Oxide

1) Like we published
2) Later I will describe without Nitrous Oxide
3) Later I will describe a “no prime” method
2 minute Preparation

Volatile Prime for anesthesia circuit

Oxygen Prime for lungs

Mental Prime for patient
Volatile Prime Goal

Prime the circuit with
8% Sevoflurane
66 - 75% N₂O
Semi-Closed Circuit

Volatile Prime
8% Sevoflurane
1 L / min O₂
3 L / min N₂O
Prime for 2 minutes
Same time as pre-oxygenation
Volatile Prime

Required to provide sudden, large, controlled increase in inspired anesthetic concentration

Inspired Control by any means is OK

New machines and techniques may make this easier
How to do Volatile Prime
Volatile Prime

FGF = 0 - flows all off
Empty the circuit by squeezing bag
Open relief (APL, pop-off) valve partly
Attach mask
Seal mask
   Glove, stopper, cork, plug, other
One way - seal mask with glove
Another way - seal mask and circuit with tight-fitting occluder
Prime the Circuit

Set Vaporizer
Set FGF
Let Reservoir Bag fill

When Bag is full, empty it through APL
Fill Bag second time
Fill bag third time
Why three Bag fills?
Normal flow in breathing circuit

Normal use, not Circuit Prime
Flow goes forward
In the direction of the valves
Emptying and filling reservoir bag
and lungs, alternately
Normal flow in the breathing circuit - **Inspiration**

- **CO₂ Absorbant**
- Fresh
- Exhaust
- Sampled 200 mL/min
Normal flow in the breathing circuit - Expiration

- Sampled CO₂ Absorbant
- Exhaust
- Fresh
- Flow rate: 200 mL/min
Priming the Circuit

Flow goes backwards
Blocked by each valve
Filling the reservoir
Back-fill the breathing circuit (#1)

- Fresh
- CO$_2$ Absorbant
- Exhaust
- Sampled 200 mL/min
Back-fill the breathing circuit (#1)

Exhaust

Sampled
200 mL/min

Fresh

CO₂ Absorbant
Back-fill the breathing circuit (#1)

CO₂ Absorbant

Exhaust

Fresh

Sampled 200 mL/min
Empty the reservoir bag (#1)

Sampled
200 mL/min

Fresh

Exhaust

Squeeze

CO₂ Absorbant
Fill the reservoir bag again (#2)

CO₂ Absorbant

Sampled 200 mL/min

Exhaust

Fresh
Empty the reservoir bag (#2)

CO2 Absorbant

Sampled
200 mL/min

Exhaust

Fresh
Fill the reservoir bag again (#3)

Exhaust

Sampled 200 mL/min

Fresh
Close the Exhaust Valve

Sampled
200 mL/min

Exhaust

Fresh

CO2

Absorbant Sampled Exhaust

200 mL/min

Close the Exhaust Valve
Empty reservoir bag (#3) and fill the inspired limb

Squeeze

Closed Exhaust

Fresh

Sampled 200 mL/min
Empty reservoir bag (#3) and fill the inspired limb

Closed Exhaust

Squeeze

Fresh

Sampled 200 mL/min
Empty reservoir bag (#3) and fill the inspired limb.
Empty reservoir bag (#3) and fill the inspired limb

- Sampled 200 mL/min
- Fresh
- Squeeze
- Closed Exhaust
Empty reservoir bag (#3) and fill the inspired limb

- Sampled 200 mL/min
- Closed Exhaust
- Squeeze
- Fresh
Open the Exhaust - Fill the Expired Limb (#3)

Sampled
200 mL/min

Fresh

Release
Open the Exhaust - Fill the Expired Limb (#3)

200 mL/min

Sampled

Fresh

Release
Remove Glove, Apply mask to patient (#4)

- Sampler
- Exhaust
- Release
- Fresh
- Sampled
- 200 mL/min
- Patient
Circuit is ready
Circuit is ready

After third bag-fill
Here is how to test when ckt is ready
Sample from Reservoir Bag Attachment

<table>
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<th>Bag #</th>
<th>CO₂ (mHg)</th>
<th>O₂</th>
<th>N₂O</th>
<th>SEU</th>
<th>MAC</th>
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JHP Jun 12, 2000 11:23
2 minute Preparation

Volatile Prime for anesthesia circuit √

Oxygen Prime for lungs

Mental Prime for patient
While priming circuit
Preoxygenenate
Simple Circuit
Simple parts
Simple parts

- Oxygen source
- Sampling (oxygenating) Elbow
- Mask
- 15-22mm adapter
- Reservoir bag (with cut end)
Option in some countries: SiBI* Connector

Facilitates pre-oxygenation during circuit prime

*Single Breath Induction Connector
Airway Agent and CO$_2$ (most)
Exhaled and Fresh Gas mix during inhalation

Inspired = perfect mix of Fresh and Absorber gas

Sampled 200 mL/min

Exhaust

Fresh

CO₂ Absorbant
Unique CO2 Absorber Assembly
FGF enters downstream of Inspiratory valve
Inspiratory concentration has two phases
  Fresh Gas
  Absorber Gas
  These two do not mix; they arrive in sequence
Inspired peak concentration is very high
Inspired mean concentration is much lower
GE “ADU” FGF path

CO₂ Absorbant

I,E

ADU
Airway Agent and CO₂ (ADU)
Some monitors report Inspired = Peak Inspired
This is a problem if Mean and Peak differ
Mean is representative of what affects uptake
GE-Datex-Ohmeda monitors now report Mean Inspired
This makes them work with all circuits including ADU
Other brand monitors usually report Peak Inspired
These report incorrect inspired concentration
Next slide shows example
2 minute Preparation

Volatile Prime for anesthesia circuit ✓

Oxygen Prime for lungs ✓

Mental Prime for patient
Mental Prime Patient

Instruct and practice VC

VC = Vital Capacity breath

Breathe all the way out
Take a deep breath in
Hold it in
Maintain positive verbal contact
Create positive experience through words and actions
2 minute Preparation is done

- Volatile Prime for anesthesia circuit ✓
- Oxygen Prime for lungs ✓
- Mental Prime for patient ✓

Ready for Volatile Induction
VI - Volatile Induction

Say and Do
Say: “Exhale”
Do: Switch to Sevoflurane mask
Say: “Inhale and hold inspiration”
Do: Maintain positive verbal contact
Maintain high (7%) inspired sevoflurane conc.
One Breath Induction

If patient breathes out
Instruct patient to
take another deep breath and hold it
Take another deep breath and hold it
Take another deep breath and hold it
Data from BWH First Series

18 patients with perfect data for analysis

In first 20 seconds after VCI

Sevoflurane \( \%M \)  SD
Inspired = 6.2 ± 0.8
Expired  = 4.2 ± 0.8

Nitrous Oxide
Mean = 58 ± 6

Most lost lash reflex in 1 breath
Some required 2 breaths
Few required 3 breaths
J Philip current technique

Sevoflurane in Oxygen, no Nitrous Oxide
No need to pre-oxygenate
Oxygenation and Anesthetization together
Anesthetize and Oxygenate together
VCI Sevo 8% in Oxygen

Slightly slower
No Second Gas Effect
No additional effect of N2O
Always quite adequate
Impact of N2O on VCI
GE Aisys requires no circuit prime
Inspired = 8 % first big breath
Inspired = 8 % first big breath
Inspired is maintained at 8%
Graphic Trend - Agent & MAC
Volatile Induction Phase Two
Deepen Inhalation Anesthesia

Applies to all the techniques above
Volatile Induction Phase Two
Deepen Inhalation Anesthesia

After loss of consciousness in 1 min
Continue induction with 8% Sevo
Assist or control ventilation
Prepare to secure airway if desired
$O_2 + \text{Sevo}$

Secure airway
LMA OK in 2 minutes
ETT OK in 3 - 5 minutes (no relaxant)
Produce apnea before removing mask

Hyperventilate to apnea

Avoid losing anesthetic from
- lungs
- blood
- brain

Extends intubation window (2 MAC to 1 MAC) from 3.5 minutes to 12 minutes
Or, keep anesthesia light

Natural airway or

Minor airway interventions
  Oropharyngeal airway
  Nasopharyngeal airway

Deepen anesthesia before incision
Monitor

Carefully
Often
BP q 1 minute (for a while)
Always “automatic”
Induction is complete
Maintenance begins
Get Sevo level down to 1 MAC

Usually requires
High FGF
Vaporizer Off
Expired falls to < 1 MAC
Vaporizer on (3%)
FGF = 4 LPM while vaporizer is off
VM - Volatile Maintenance Anesthesia

We have always done this
Maintain desired anesthetic depth
Decrease fresh gas flows to save cost
Increase vaporizer setting
Maintain previous expired anesthetic conc.
Maintain previous anesthetic depth
Increase and decrease depth as required
React or anticipate
VM - Volatile Maintenance Anesthesia

Depth = Constant + Adjust as required

Three anesthetic conditions
  Constant
  Increase
  Decrease
VM - Volatile Maintenance Anesthesia

Depth = Constant + Adjust as required

Three anesthetic conditions

Constant

Increase Vaporizer to Max = 8%

Decrease Vaporizer off = 0%

Increase FGF if required

Readjust vaporizer to near prior setting
Up and down using Overpressure and Underpressure
For short cases, remember

Awakening begins just after induction
Don’t be afraid to turn the vaporizer off
Bring expired concentration down to 1.3 MAC
Keep expired at 0.7 MAC near the very end
Prepare for recovery - always

Recovery begins with wake up
Recovery ends with patient back to normal
Normal means normal -
Patient is satisfied
Anesthesiologist is satisfied
Surgeon is satisfied
Wake up!
Volatile Emergence

Volatile emergence is smooth

Create and maintain zero (0.0) inspired agent concentration
   Empty the Reservoir Bag, Flush O₂, High FGF

Ventilate anesthetic out of lungs
   Minute ventilation > 4 L/min
   $p_{ETCO_2}$ around 36 mmHg
Problems occur with wake up if FGF or Ventilation is low

Poor circuit wash out; FGF too low

Increase FGF

FGF is low
Problems occur with wake up if FGF or Ventilation is low.

Poor lung wash out. Ventilation is too low.
Usually, wake up is better

Low inspired
Low expired
Clinical Benefits of VIMA

No need for

IV Induction agent
Opioid
Muscle relaxant (NMB)
Reversal agents for NMB

Other drugs
Complications

Avoid Side Effects
Avoid Costs
VIMA provides

Deep anesthesia from beginning to end
No additional drugs for intubation
No additional drugs for intra-op pain
Rapid awakening and return to normal
Post-op pain requires local anesthesia infiltration anesthesia and post-op analgesic
How to avoid slow wake ups
Problems occur with wake up if FGF or Ventilation is low.

Increase FGF

Poor circuit wash out;

FGF too low
Problems occur with wake up if FGF or Ventilation is low

Poor lung wash out. Ventilation is too low
Usually, wake up is better
Usually, wake up is better

Low inspired
Low expired
With Draeger Anesthesia Machines

Empty Reservoir Bag to WAG system
Watch Inspired Agent and assure zero
Press and hold Oxygen Flush Button
   OK Manual, Assist, or Control (Draeger only)
All this Fabius or Apollo
Gas Man® shows VIMA, start to end
Superimpose

Gas Man® Graph

Agent Monitor Graph
Summary

VIMA is Volatile Induction and Maintenance Anesthesia.
VIMA is an acceptable equivalent alternative to IV plus Volatile combinations.
VIMA preparation requires 2 minutes for circuit anesthetic prime, lung oxygen prime, and brain psychological prime.
VIMA Sevoflurane induction is faster than IV Propofol (51 ± 4 sec vs. 81 ± 12 sec).
VIMA w/o N2O is almost as fast
VIMA wake up is as fast and uncomplicated as Propofol induction and VM anesthesia.
Thank you

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