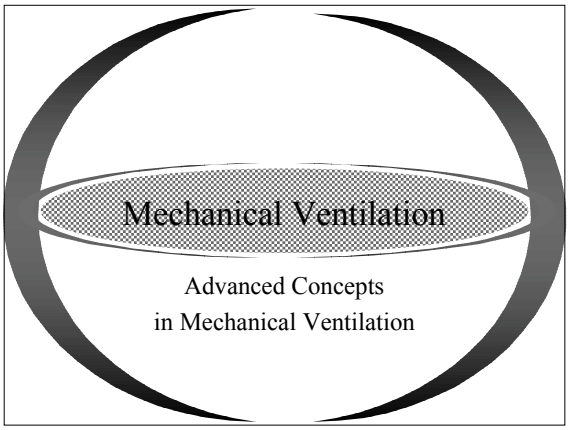

Flow-Triggering

- Trigger = the variable that causes the vent to begin the inspiratory phase
- Common triggers
  - 1-
  - 2-
  - 3-
- Effort required to trigger =

2

Flow-Triggering

Goal -

Minimal effort required by the patient to trigger inspiration, i.e. make the vent as sensitive to patient effort as possible

⇓

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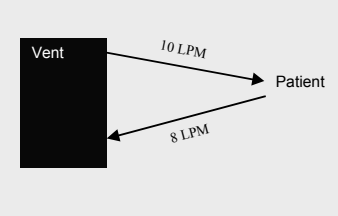
Flow-Triggering

- Flow-triggering is available on the Bennett 7200, Hamilton Galileo, Servo 300, Drager, Bear Cub, etc.

4

How Does It Work?



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Ventilator Differences

Bennett 7200

Base Flow: variable 0 - 20 lpm
Flow Sensitivity: variable 1 - 1/2 base flow

6

Ventilator Differences

Servo 300

Base Flow: preset

Flow Sensitivity:	adult	2 lpm
	pedi	1 lpm
	neo	.5 lpm

7

Effects of Flow-Triggering

patient insp effort → fresh gas *immediately* available to patient → ↓ delay time between insp effort & supply of gas

⇓

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Modes - Pressure

- Began with IPPB treatment
- Fell out of use for CMV
- Returned with new technology
- PCV, PSV, PRVC, PCIRV

9

Modes - Pressure

- Remember - volume ventilation:
  - operator sets volume
  - vol delivered until preset vol or time
  - press generated prop. to C_L, R_{AW}
- When set V, F → sets T_I → press varies
- When set V, T_I → sets F

10

Modes - Pressure

Important to remember!

If patient flow demand > set flow
⇓
"flow starvation"
⇓
↑ WOB

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Modes - Pressure

Pressure ventilation
↓
operator sets pressure
↓
volume varies with C_L, R_{AW}

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Modes - Pressure

If patient "fights" vent, splints pain, C_L ↓ and/or R_{AW} ↑

⇓

13

Modes - Pressure

- Time or flow-cycled
- Pressure-limited
- Set press reached quickly & maintained t/o inspiratory time
- Vent delivers whatever flow is necessary to maintain press & meet patient demand

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Modes - Pressure

The most significant difference between volume & pressure-based ventilation is how the flow is delivered!

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PCV vs. PSV

	PCV	*PSV*
Cycled	T	F
Limited	P	P
PEEP	yes	yes
Set Rate	yes (AC)	no

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PCV vs. PSV

	PCV	*PSV*
Set Rate	yes PCV (C) PCV (AC) SIMV (PC) SIMV (PC)+PS PCIRV	no Patient has control over RR, T_I, flow, V_T V_T depends on ΔP, pt. effort, C_L, R_{AW}

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Clinical Advantages of PCV

- Little published on optimal flow pattern
- Evidence suggests decelerating flow pattern:
  - improves gas distribution in lungs allowing ventilation with same V_T but lower PIP
  - increases patient comfort when flow responsive to demand

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① PV Reduces V/Q Mismatch

- Difficult to ventilate if C_L, R_{AW} differ from one lung region to another
- Some areas over-ventilated, some under-ventilated
- Airways with ↑ R_{AW} take longer to receive V_T

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① PV Reduces V/Q Mismatch

With PV, gas flow is high early in insp → flow reaches small airways early → allows more time for gas to be distributed according to regional C_L & R_{AW}

↓

as press gradient ↓ → flow slows → laminar flow when gas enters small airways

↓

better gas distribution (↓ V/Q mismatch)

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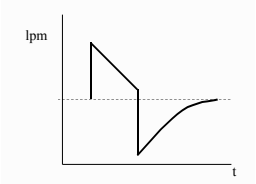
② PV Optimizes T_I

- By observing flow pattern, T_I can be optimized



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③ PV Matches Flow with Patient Demand

With volume ventilation, sometimes difficult to match vent flow to patient demand → patient/vent asynchrony

⇓

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③ PV Matches Flow with Patient Demand

- Use of PS helps only on spontaneous breaths
- Increasing flow rate > demand causes turbulent flow → PIP ↑, hit press limit, risk of barotrauma

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③ PV Matches Flow with Patient Demand

Use of pressure ventilation with decelerating flows matches flow rate to patient demand

⇓

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Remember!

- *PCV* - V_T delivered varies with:
  - C_L
  - R_{AW}
  - Set pressure
  - T_I
  - PEEP level

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Remember!

- *PSV* - V_T delivered varies with:
  - C_L
  - R_{AW}
  - Set pressure
  - Patient effort

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Primary Indication for PV

- *ARDS* in patients that volume ventilation with PEEP does not seem to be working:
  - F_IO_2 1.0
  - PIP $\geq$ 50 cmH_2O
  - PEEP $\geq$ 15 cmH_2O
  - RR $\geq$ 16/min
  - decreasing PaO_2 and C_L

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Initial Settings

- *PIP* 1/2 - 3/4 previous PIP
- *I:E* - 1:1 to 1:2

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PCIRV

- Primary use - ARDS where C_L ↓↓
- Lungs empty very quickly so can use short T_E
- Patients sedated and paralyzed
- 2:1, 3:1, 4:1, etc.

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PCIRV

- *Results* -
  - oxygenation improves
  - gas exchange improves
  - PIP decreases (↓ risk of barotrauma & CV side-effects)
  - decreases need for PEEP
  - MAP increases
  - can cause auto-PEEP

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Monitoring PCIRV

V_T	SpO_2	CVP
RR	ABG	PAP
V_E	HR	PCWP
PIP	UO	PVR
MAP	BP	$P_{ET}CO_2$
C_L	QT	$P_{(a-ET)}CO_2$
waveforms	PEEP	auto-PEEP

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PRVC/APV

- Pressure Regulated Volume Control/Adaptive Pressure Ventilation
- PC with control over volume
- Assist-control
- Available on Servo 300 (PRVC)/Hamilton Galileo (APV)

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PRVC/APV

- Set RR, T_I, target V_T
- Breath give at minimal pressure
- Exhaled V_T compared to target V_T
- Pressure automatically adjusted to achieve target V_T (breath to breath)
- Set Pressure Limit high enough

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PRVC/APV

Advantage -
Guarantee of V_T with the least amount of pressure to deliver that volume

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VS

- Volume Support (Servo 300)
- Automatic Pressure Support
- Works like PRVC/APV
- Spontaneous breathing mode (no rate set)
- Set target V_T, Pressure Limit

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VS

- *Advantage* - automatic weaning
  - as patient assumes more of the work of breathing → reduce target volume to 5-7 ml/kg
  - apnea - vent switches to PRVC
  - when no apnea, spont V_T 5-7 ml/kg, PS ≤ 8 cmH_2O → extubate

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Modes - Review

Mode	*Trigger*	*Cycled*	*PEEP*	*Limited*
AC	T, Pt	V, T	yes	F
PC	T, Pt	T	yes	P
SIMV (v)	T, Pt	V, T	yes	F
SIMV (p)	T, Pt	T	yes	P
PRVC/APV	T, Pt	T	yes	P
PS	Pt	F	yes	P
CPAP	Pt	Pt	yes	P

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AutoPEEP

- Intrinsic PEEP
- Unintended PEEP
- Inadvertent PEEP
  - Occult PEEP

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AutoPEEP

- PEEP that develops when a new breath is delivered before expiration has ended
- Air-trapping, breath-stacking
- *Cause* = expiratory time is too short

⇓

WHY?

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AutoPEEP

- Why is T_E too short?
  - COPD
  - V_E > 10 lpm
  - small ETT
  - C_L ↑
  - RR ↑
  - insp flow rate slow
  - large V_T

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Complications of AutoPEEP

1. *Increased WOB due to air-trapping*
   (impairs respiratory muscle function)

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Complications of AutoPEEP

2. *Decreased venous return*
   ↓
3. *Barotrauma*

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Complications of AutoPEEP

- Auto-PEEP can artificially look like LVF:
- But if give positive inotropic agents, diuretics → condition will get worse

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Detecting Auto-PEEP

- Auto-PEEP can't be seen on pressure manometer
- If monitoring digital V_{TE} - transient reduction in volume, then lung volume stabilizes

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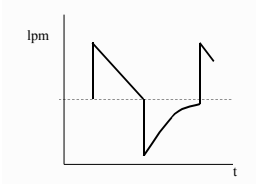
Detecting AutoPEEP

- Best way =

Graphic Wave Forms



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Other - AutoPEEP

- Patient may not be able to trigger vent (neg. pressure trigger)
  - must 1st pull off autoPEEP, the pull sensitivity → Pt/Vent asynchrony, ↑ WOB
- C_S calculation must include autoPEEP

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Decrease AutoPEEP Effects

- Increase T_E
  - ↑ flows → ↓ T_I
  - ↓ V_T
  - ↓ RR

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Decrease AutoPEEP Effects

- Decrease R_{AW}
  - secretion removal
  - bronchodilators
  - ↑ ETT size

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Decrease AutoPEEP Effects

- Permissive hypercapnia
- Add PEEP (85% of autoPEEP)

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Benefits of AutoPEEP

- AutoPEEP can improve oxygenation when using PCIRV

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