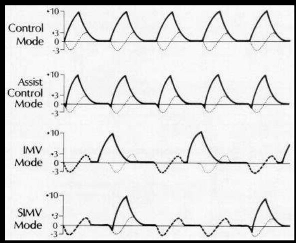
Introduction to various modes of mechanical ventilation



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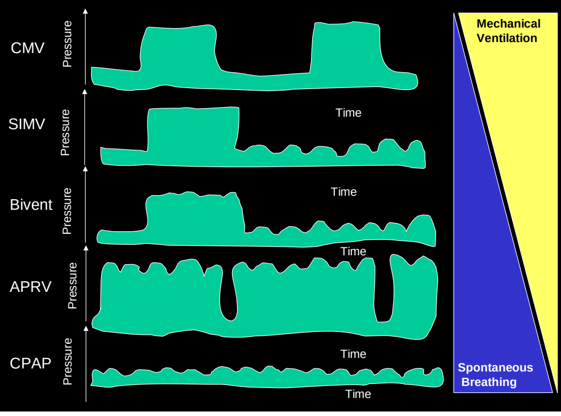
APRV Airway pressure release ventilation
ASB Assisted spontaneous breathing
ASV assisted spontaneous ventilation
ASV Adaptive support ventilation
ASV assisted spontaneous ventilation.
ATC Automatic tube compensation
Automode Automode
BIPAP Bilevel Positive Airway Pressure
CMV Continuous mandatory ventilation
CPAP Continuous positive airway pressure
CPPV Continuous positive pressure ventilation
EPAP Expiratory positive airway pressure
HFV High frequency ventilation
HFFI High frequency flow interruption
HFJV High frequency jet ventilation
HFOV High frequency oscillatory ventilation
HFPPV High frequency positive pressure ventilation
ILV Independent lung ventilation
IPAP Inspiratory positive airway pressure
IPPV Intermittent positive pressure ventilation
IRV Inversed ratio ventilation
LFPPV Low frequency positive pressure ventilation
MMV Mandatory minute volume
NAVA Neurally Adjusted Ventilatory Assist
NIF Negative inspiratory
NIV Non-invasive ventilation
PAP Positive airway pressure
PAV and PAV+ Proportional assist ventilation and proportional assist ventilation plus
PCMV (P-CMV) Pressure controlled mandatory ventilation
PCV Pressure controlled ventilation or
PC Pressure control
PEEP Positive end-expiratory pressure
PNPV Positive negative pressure ventilation
PPS Proportional pressure support
PRVC Pressure regulated volume controlled ventilation
PSV Pressure Support Ventilation or PS
(S) IMV (Synchronized) intermittent mandatory ventilation
S-CPPV Synchronized continuous positive pressure ventilation
S-IPPV Synchronized intermittent positive pressure ventilation
TNI Therapy with nasal insufflation
VCMV (V-CMV) Volume controlled mandatory ventilation
VCV Volume controlled ventilation or VCVS Volume Support

Concepts and Modes of Mechanical Ventilation



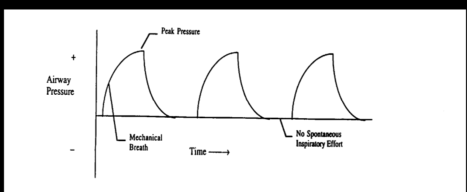
Ventilation modes

Controlled: **CMV**

Fully or partially assisted: **SIMV**
SIPPV
A/C / PTV
PSV

SIMV + PSV
SIPPV + PSV

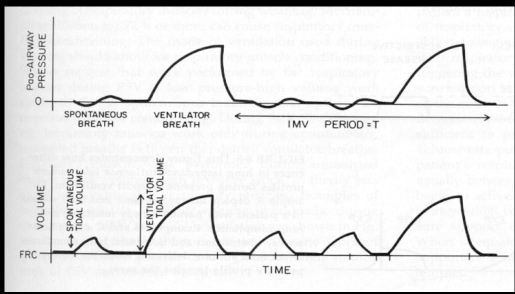
CMV



Control Modes

– every breath is fully supported by the ventilator
– in classic control modes, patients were *unable* to breathe except at the controlled set rate
– in newer control modes, machines may act in assist-control, with a minimum set rate and all triggered breaths above that rate also fully supported.

IMV



Ingento EP & Drazen J: Mechanical Ventilators, in Hall JB, Scmidt GA, & Wood LDH(eds.): *Principles of Critical Care*

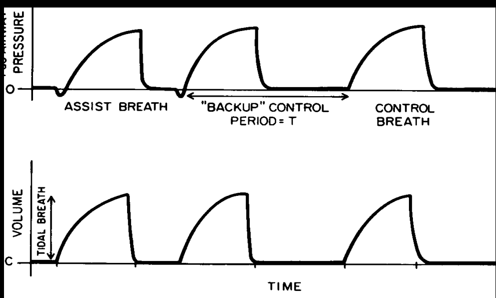
SIPPV (or PTV or A/C) and SIMV

Terminology:

Triggered ventilation can be divided into patient triggered (PTV), otherwise known as synchronous intermittent positive pressure ventilation (SIPPV) or assist control (A/C), the infant being able to trigger a positive pressure inflation with each breath,

and synchronized intermittent mandatory ventilation (SIMV), the infant being able to trigger only a pre-set number of positive pressure inflations.

Assist-control



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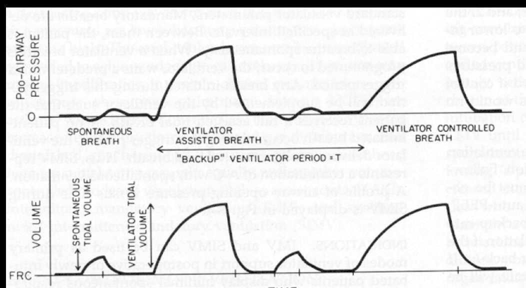
SIMV



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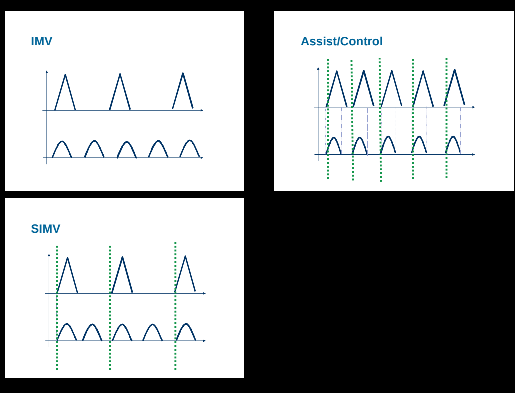
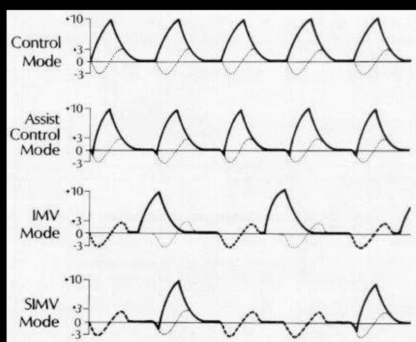
IMV, SIMV, SIPPV (or A/C or PTV), PSV





Does the mode make the difference?

SIMV versus IMV in neonatal ventilation

	BW <1000 gm		BW 1000-1499 gm		BW 1500-2000 gm		BW >2000 gm		All BW	
	IMV (n = 45)	SIMV (n = 45)	IMV (n = 44)	SIMV (n = 48)	IMV (n = 25)	SIMV (n = 27)	IMV (n = 46)	SIMV (n = 47)	IMV (n = 160)	SIMV (n = 167)
Duration of ventilation (hr)	801	596	138	136	77	102	93	72[a]	120	103
Median (95% CI)	(499-1020)	(148-973)	(101-280)	(98-344)	(43-107)	(72-107)	(72-106)	(64-77)	(101-142)	(94-118)
Sedation required: No. (%)*	15 (43)	23 (60)	26 (59)	21 (44)	16 (64)	13 (48)	35 (78)	33 (73)	92 (58)	90 (54)
Total doses first 4 days	5.6 (4.5)	6.8 (5.4)	5.9 (4.4)	3.2 (3.1)[a]	7.3 (7.5)	4.7 (3.7)	6.6 (6.1)	6.2 (6.5)	6.3 (5.5)	5.4 (5.3)
At 1 hr: FIO_2	0.48 (0.23)	0.52 (0.27)	0.61 (0.27)	0.53 (0.25)	0.59 (0.26)	0.48 (0.18)	0.70 (0.25)	0.71 (0.27)	0.60 (0.26)	0.57 (0.26)
MAP (cm H_2O)	7.4 (1.7)	7.6 (2.2)	9.1 (2.8)	8.3 (2.4)	8.8 (2.8)	7.7 (2.0)	9.2 (2.6)	8.6 (1.8)	8.6 (2.6)	8.1 (2.2)[b]
OI	6.4 (4.4)	8.3 (8.7)	10.3 (8.8)	6.8 (4.6)[b]	7.7 {7.3)	5.4 (3.3)	6.2 (5.0)	5.3 (4.3)	7.7 (6.7)	6.5 (5.8)
Paralysis: No. (%)	5 (11)	2 (4)	2 (5)	2 (4)	1 (4)	0	7 (15)	6 (13)	15 (10)	10 (6)
Air leak: No. (%)	10 (22)	7 (15)	9 (20)	10 (21)	3 (12)	1 (4)	2 (4)	0	24 (15)	18 (11)
IVH (grade III or IV): No. (%)	6 (13)	7 (16)	2 (5)	5 (10)	3 (12)	0	0	0	11 (7)	12 (7)
Death: No. (%)	7 (15)	7 (16)	2 (5)	3 (6)	1 (4)	1 (4)	0	0	10 (6)	11 (7)
Oxygen										
At 28 days: No. (%)†	32 (79)	29 (77)	22 (50)	25 (52)	7 (28)	7 (26)	0	1 (2)	59 (39)	61 (39)
At 36 wk PCA: No. (%)†	28 (72)	18 (47)[b]	14 (32)	12 (25)	6 (24)	4 (15)	NA	NA	NA	NA

Results are mean (SD) where otherwise not indicated.
CI, Confidence interval; *PCA*, postconceptional age; *NA*, not applicable.
Significant differences between IMV and SIMV within BW groups:
[a] $p = 0.02$.
[b] $p < 0.05$.
*Excludes infants who received anticonvulsant drugs for seizures.
†Percentage of survivors at time of stated analysis.

Conclusions: **We found that SIMV was at least as efficacious as conventional IMV, and may have improved certain outcomes in BW-specific groups.**

Bernstein G et al. J PEDIATR 1996;128:453-63

PTV (A/C) versus IMV

	Trigger No (%)	Conventional No (%)
Death or chronic lung disease		
Yes	219 (47.4)	220 (48.7)
No	243	232
Pneumothorax		
Yes	62 (13.4)	47 (10.3)
No	402	411
Ultrasound abnormality to nearest 6 weeks		
Yes	146 (34.5)	154 (36.5)
No	277	268
Median interquartile range of ventilation duration in survivors (days)	6, (3–15)	6, (3–15)

Baumer JH *Arch Dis Child Fetal Neonatal Ed* 2000;**82**:F5–F10

PTV with <u>inspiratory times of between 0.2 and 0.25 seconds</u>, the ventilator set to trigger at each inspiratory effort, backup rate of 35 breaths a minute.

IMV with ventilator rates set initially at between 40 and 65 breaths a minute … and <u>initial inspiratory times between 0.2 and 0.6 seconds.</u>

PTV (A/C) versus IMV

	Trigger No (%)	Conventional No (%)
Death or chronic lung disease		
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There was no observed benefit from the use of PTV, with a trend towards a higher rate of pneumothorax under 28 weeks of gestation. Although PTV has a similar outcome to IMV for treatment of RDS in infants of 28 weeks or more gestation, within 72 hours of birth, it was abandoned more often. It cannot be recommended for infants of less than 28 weeks' gestation with the ventilators used in this study.

Synchronized mechanical ventilation for respiratory support in newborn infants (Review)

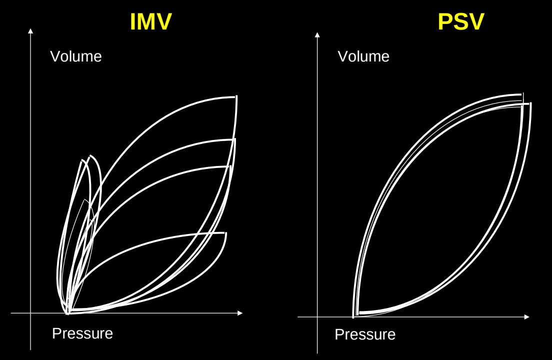
Comparison 02. PTV / SIMV vs CMV

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Death	5	1729	Relative Risk (Fixed) 95% CI	1.19 [0.95, 1.49]
02 Airleaks	6	1769	Relative Risk (Fixed) 95% CI	1.03 [0.80, 1.34]
03 Duration of ventilation (hours)	4	1402	Weighted Mean Difference (Fixed) 95% CI	-34.78 [-62.11, -7.44]
04 Extubation failure	4	1056	Relative Risk (Fixed) 95% CI	0.93 [0.68, 1.28]
05 Severe IVH	5	1729	Relative Risk (Fixed) 95% CI	1.03 [0.74, 1.43]
06 CLD (oxygen dependency at 28 days)	4	805	Relative Risk (Fixed) 95% CI	0.91 [0.75, 1.12]
07 CLD (oxygen dependent at 36 weeks PCA)	2	1310	Relative Risk (Fixed) 95% CI	0.90 [0.75, 1.08]

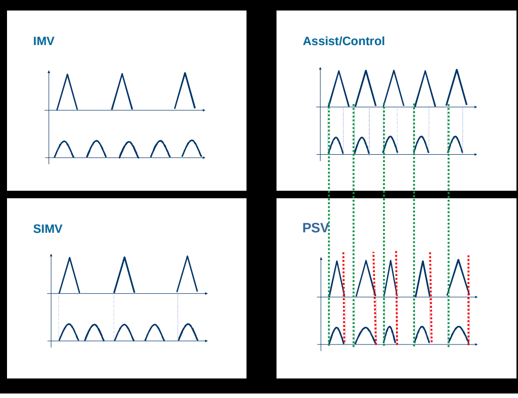
Comparison 03. PTV vs SIMV

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Duration of weaning (hours)	3	120	Weighted Mean Difference (Fixed) 95% CI	-42.38 [-94.35, 9.60]
02 Weaning failure	3	120	Relative Risk (Fixed) 95% CI	0.78 [0.31, 1.93]
03 Extubation failure	3	120	Relative Risk (Fixed) 95% CI	1.00 [0.37, 2.67]
04 Air leaks	3	120	Relative Risk (Fixed) 95% CI	0.80 [0.23, 2.83]

Greenough A et al. *Cochrane Database of Systematic Reviews* 2004, Issue 3. CD000456.



IMV, SIMV, SIPPV (or A/C or PTV), PSV

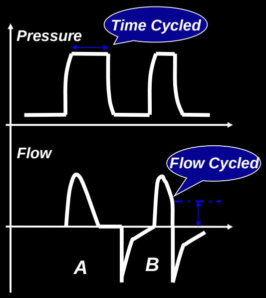


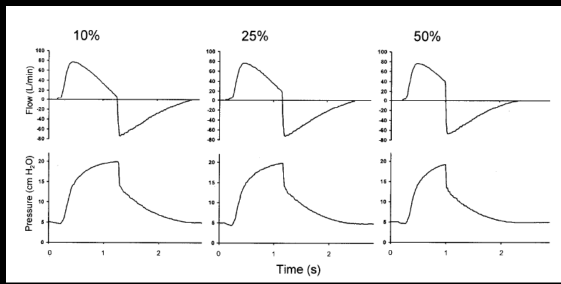
Pressure Control vs. Pressure Support

Constant insp. pressure
Decelerating, variable inspiratory flow rate

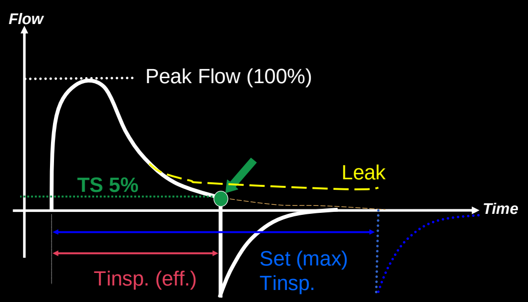
Time cycled: (A)
- Pressure Control

Flow cycled: (B)
- Pressure Support





Termination Sensitivity = Cycle-off Criteria



PSV improves respiratory function in VLBW infants when compared to SIMV

TABLE 2—Results Concerning Spontaneous Respiratory Rate (RR), Tidal Volume (V_T), Minute Volume (V_{min}), and Mean Airway Pressure (MAP) During Four Ventilation Phases[1]

	First ventilation cycle		Second ventilation cycle	
Test phase	1: SIMV (4 hr)	2: PSV (4 hr)	3: SIMV (4 hr)	4: PSV (4 hr)
RR b/min: mean (SE)	56.08 (3.87)	43.63 (3.54)	53.05 (4.23)	43.18 (3.96)
V_T ml/kg: mean (SE)	4.57 (0.30)	6.88 (0.27)	5.28 (0.24)	6.96 (0.25)
V_{min} ml/kg: mean (SE)	256.0 (23.86)	349.0 (24.44)	271.0 (21.74)	388.0 (24.81)
MAP cm H_2O: mean (SE)	7.06 (0.41)	7.73 (0.34)	7.05 (0.40)	7.56 (0.29)

[1]Results are reported as mean and SE in parentheses. A significant difference was observed by ANOVA for repeated measures (RR, $P = 0.000000$; V_T, $P = 0.000000$; V_{min}, $P = 0.000000$; MAP, $P = 0.018694$). The Newman-Keuls post hoc test showed the following differences: spontaneous respiratory rate (RR) test phase 1 vs. 2, $P = 0.000124$; test phase 3 vs. 4, $P = 0.000238$; tidal volume (V_T), test phase 1 vs. 2, $P = 0.000121$; test phase 3 vs. 4, $P = 0.000121$; test phase 1 vs. 3, $P = 0.016384$; minute volume (V_{min}), test phase 1 vs. 2, $P = 0.000124$; test phase 3 vs. 4, $P = 0.000123$; mean airway pressure (MAP) test phase 1 vs. 2, $P = 0.033747$; test phase 3 vs. 4, $P = 0.121438$.

Migliori C et al. Pediatr Pulmonol. 2003;35:364–367

SIMV versus SIMV + PSV

<u>minimal ventilator settings:</u>

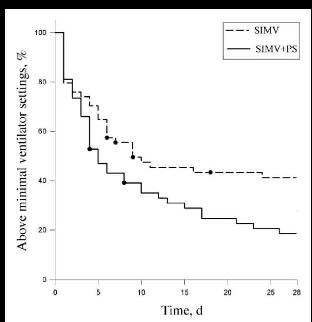
PIP 16 cm H2O

FIO2 0.30

PEEP 5 cmH2O

SIMV rate 15 breaths per minute

and remained on these settings for 48 hours



Reyes ZC et al. *Pediatrics* 2006;118;1409-1417

SIMV versus SIMV + PSV

Reyes ZC et al.
Pediatrics 2006;118;1409-1417

CONCLUSIONS. The results of this study suggest that the addition of PS as a supplement to SIMV during the first 28 days may play a role in reducing the duration of mechanical ventilation in extremely VLBW infants, and it may lead to a reduced oxygen dependency

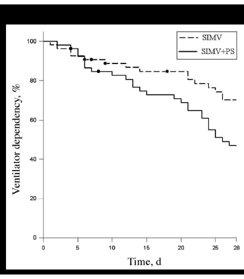


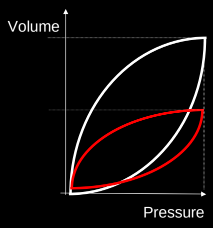
TABLE 3 Respiratory Outcomes Assessed From Birth Until Discharge or Death for All Infants and Within Birth Weight Strata

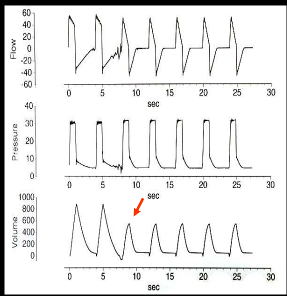
Variable	All Infants			BW 500–699 g			BW 700–1000 g		
	SIMV ($n = 54$)	SIMV+PS ($n = 53$)	P	SIMV ($n = 23$)	SIMV+PS ($n = 22$)	P	SIMV ($n = 31$)	SIMV+PS ($n = 31$)	P
Age at final extubation, d	44 (25–73)	35 (14–74)	.91[a]	58 (39–110)	68 (35–110)	.73[a]	29 (21–53)	24 (10–40)	.366[a]
Days on mechanical ventilation[b]	34 (19–59)	22 (10–52)	.18[c]	57 (34–81)	51 (25–85)	.85[c]	25 (8–47)	15 (6–23)	.118[c]
Days on supplemental oxygen[b]	72 (46–96)	49 (38–87)	.11[c]	85 (55–138)	86 (56–140)	.98[c]	58 (44–87)	41 (34–51)	.034[c]
On oxygen at 36 weeks' PMA[d]	23 (48)	16 (33)	.21[e]	12 (63)	11 (58)	1.0[e]	11 (38)	5 (17)	.142[e]

Results are expressed as median (25th to 75th percentile) or n (%).
[a] Log-rank survival analysis.
[b] On infants alive at discharge.
[c] Mann-Whitney rank-sum test.
[d] On infants alive at 36 weeks' PMA.
[e] χ^2 test.

Compliance Changes During Pressure Controlled Ventilation

Compliance ↓



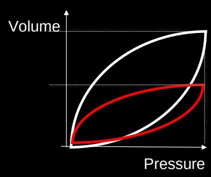


Volume Ventilation

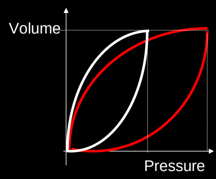
Tidal volume, is not affected by the rapidly changing pulmonary mechanics

Compliance ↓

Pressure Ventilation:
Decreased Tidal Volume



Volume Ventilation:
Increased Pressure



Combination "Dual Control" Modes

Combination or "dual control" modes combine features of pressure and volume targeting to accomplish ventilatory objectives which might remain unmet by either used independently.

Combination modes are pressure targeted

- **Partial support is generally provided by pressure support**
- **Full support is provided by Pressure Control**

Combination "Dual Control" Modes

Volume Assured Pressure Support
(Pressure Augmentation)

Volume Support
(Variable Pressure Support)

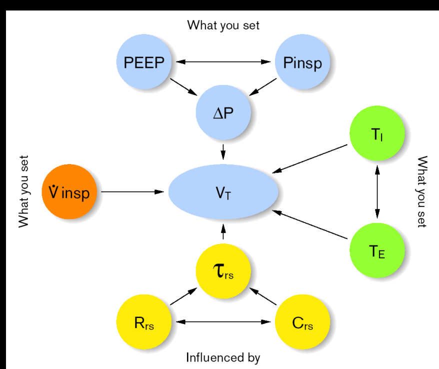
Pressure Regulated Volume Control
(Variable Pressure Control, or Autoflow)

Airway Pressure Release
(Bi-Level, Bi-PAP)

PRVC (Pressure regulated volume control)

A control mode, which delivers a set tidal volume with each breath at the lowest possible peak pressure.

Delivers the breath with a decelerating flow pattern that is thought to be less injurious to the lung…… "the guided hand".

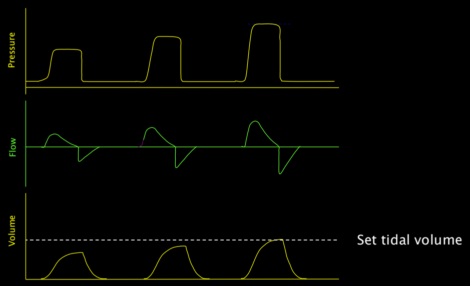


Volume Guarantee: New Approaches in Volume Controlled Ventilation for Neonates.
Ahluwalia J, Morley C, Wahle HG. Dräger Medizintechnik GmbH. ISBN 3-926762-42-X

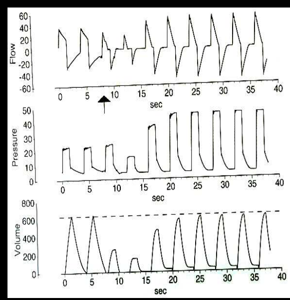
PRVC

Decelerating inspiratory flow pattern (square wave pressure build up)

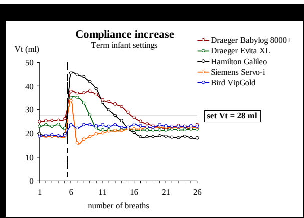
Pressure automatically adjusted according respiratory mechanics to deliver set tidal volume

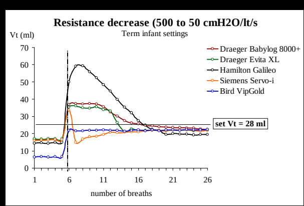


PRVC Automatically Adjusts To Compliance Changes



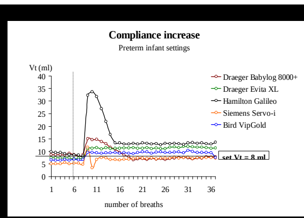
Is VTV safe?

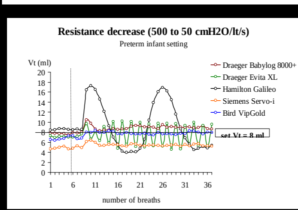




Jaecklin T et al. ICM 2007

Is VTV safe?



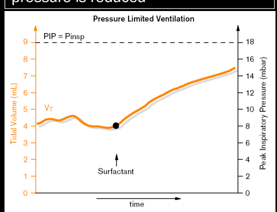


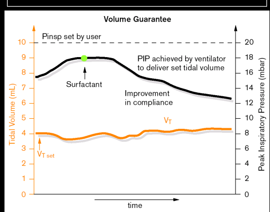
Jaecklin T et al. ICM 2007

Advantages of volume targeted ventilation

A significant increase in lung compliance, such as following exogenous surfactant administration will lead to a proportional increase in delivered VT unless the inflating pressure is reduced

As the VT increases due to improving compliance after surfactant administration, the ventilator automatically drops the PIP.





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PRCV: Advantages

Decelerating inspiratory flow pattern

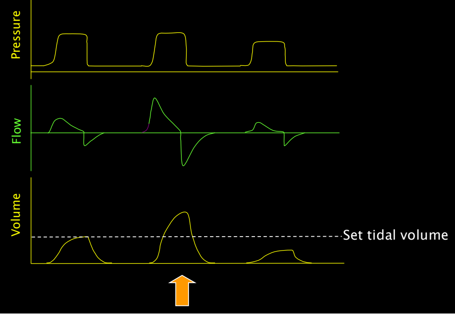
Pressure automatically adjusted for changes in compliance and resistance within a set range

- Tidal volume guaranteed
- Limits volutrauma
- Prevents hypoventilation

PRVC: Disadvantages

Pressure delivered is dependent on tidal volume achieved on last breath

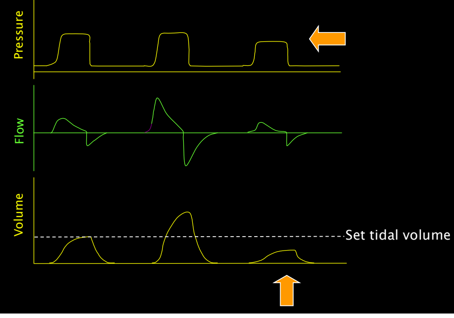
Intermittent patient effort ⇒ variable tidal volumes



PRVC: Disadvantages

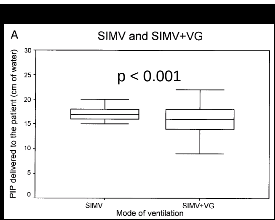
Pressure delivered is dependent on tidal volume achieved on last breath

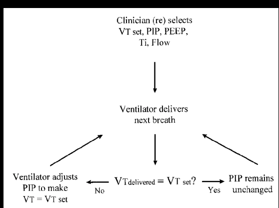
Intermittent patient effort ⇒ variable tidal volumes

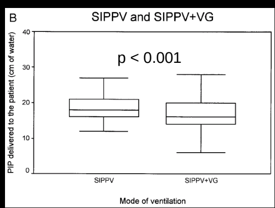


Volume Targeted Ventilation

Concept: deliver the set Vt at the lowest airway pressure possible







Cheema IU ***Pediatrics* 2001;107:1323–1328**

Volume Targeted Ventilation

	SIMV	SIMV + VG	*P* Value	SIPPV	SIPPV + VG	*P* Value
PIP, mean (standard error) cm of water	17.1 (3.4)	15.0 (7.5)	<.001	18.7 (8.3)	17.1 (9.3)	<.001
Mean airway pressure, mean (standard error) cm of water	6.9 (2.8)	6.5 (3.1)	.005	9.8 (4.6)	9.6 (4.5)	.008
Expired tidal volume, mean (standard error) mL/kg	5.0 (5.6)	4.9 (5.2)	.59	4.8 (3.4)	4.8 (3.2)	.62
Expired minute volume, mean (standard error) mL/min/kg	291 (2.1)	289 (2.1)	.89	331.6 (2.0)	334.5 (2.2)	.72
Fractional inspired oxygen, mean (standard error)	0.31 (0.3)	0.31 (0.3)	.38	40.4 (0.4)	41.0 (0.4)	.56
Transcutaneous partial pressure of carbon dioxide, mean (standard error) kPa	5.9 (2.2)	6.0 (2.2)	.47	6.4 (2.8)	6.4 (2.9)	.86
Transcutaneous partial pressure of oxygen, mean (standard error) kPa	8.6 (8.8)	8.4 (8.7)	.40	7.7 (4.4)	7.6 (4.0)	.30

Cheema IU ***Pediatrics* 2001;107:1323–1328**

	PSV + VG (n = 30)	PSV (n = 23)
Birth weight (g)	1,125 ± 370	1,197 ± 333
GA (weeks)	28.5 ± 2	29.4 ± 1.6
Antenatal steroids	26 (86%)	20 (86%)
Age at study (hours)	3 ± 2	3 ± 2

[1] P = ns. SD, standard deviation.

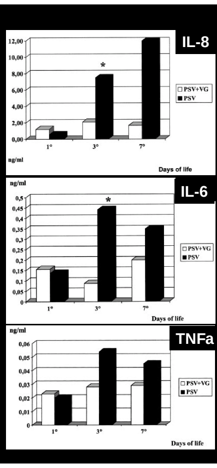
TABLE 3—Outcome[1]

	PSV + VG group (n = 30)	PSV group (n = 23)
Length of ventilation (days; mean ± standard deviation)	8.8 ± 3	12.3 ± 3
Surfactant (doses; median)	1	1
BPD (n)[2]	3 (10%)	4 (17%)
CLD (n)[3]	3 (10%)	4 (17%)
Deaths (n)	5 (16%)	6 (26%)
IVH (≥3) (n)	1 (3%)	2 (8%)
PLV (n)	1 (3%)	2 (8%)
ROP (≥2) (n)	2 (6%)	1 (4%)
PIE (n)	2 (6%)	2 (8%)
PDA closure (n)	22 (73%)	20 (86%)
PNX (n)	0 (0%)	3 (13%)

[1] ROP, retinopathy of the premature; PIE, pulmonary interstitial emphysema; PNX, pneumothorax; PDA, patency of ductus arteriosus; BPD, bronchopulmonary dysplasia. P = ns.

[2] O_2 dependency at 28 days.

[3] O_2 dependency at 36 weeks.



Lista G Pediatr Pulmonol. 2004; 37:510–514

Volume targeted ventilation: A Self Weaning Mode

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Methods:

PSV group: The weaning strategy consisted of reducing the pressure support level progressively over time, so that the work of breathing was shifted from ventilator to the patient.

PSV-VG group: Weaning was a more automatic process once appropriate levels of Vt had been established.

Similar blood gas goals (e.g., pH>7.25; pO2, 50–75 mmHg; pCO2, 40–65 mmHg) were achieved during weaning from mechanical ventilation in both groups.

Outcome VTV: Death in Hospital

Analysis 01.01. Comparison 01 Volume-targeted vs pressure limited ventilation, Outcome 01 Death in hospital

Review: Volume-targeted versus pressure-limited ventilation in the neonate
Comparison: 01 Volume-targeted vs pressure limited ventilation
Outcome: 01 Death in hospital

Study	Volume targeted n/N	Pressure limited n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Volume guarantee					
× Keszler 2004	0/9	0/9		0.0	Not estimable
Lista 2004	5/30	6/23		44.2	0.64 [0.22, 1.84]
Subtotal (95% CI)	39	32		44.2	0.64 [0.22, 1.84]
Total events: 5 (Volume targeted), 6 (Pressure limited)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.83 p=0.4					
02 Volume controlled					
Piotrowski 1997	4/27	8/30		49.3	0.56 [0.19, 1.64]
Sinha 1997	1/25	1/25		6.5	1.00 [0.07, 15.12]
Subtotal (95% CI)	52	55		55.8	0.61 [0.22, 1.65]
Total events: 5 (Volume targeted), 9 (Pressure limited)					
Test for heterogeneity chi-square=0.16 df=1 p=0.69 I² =0.0%					
Test for overall effect z=0.98 p=0.3					
Total (95% CI)	91	87		100.0	0.62 [0.30, 1.29]
Total events: 10 (Volume targeted), 15 (Pressure limited)					
Test for heterogeneity chi-square=0.16 df=2 p=0.92 I² =0.0%					
Test for overall effect z=1.28 p=0.2					

0.001 0.01 0.1 1 10 100 1000
Favours vol targeted Favours press lim

The Cochrane Library 2007, Issue 1

Outcome VTV: Duration of mechanical ventilation

Analysis 01.04. Comparison 01 Volume-targeted vs pressure limited ventilation, Outcome 04 Duration of intermittent positive pressure ventilation (days)

Review: Volume-targeted versus pressure-limited ventilation in the neonate
Comparison: 01 Volume-targeted vs pressure limited ventilation
Outcome: 04 Duration of intermittent positive pressure ventilation (days)

Study	Volume targeted N	Volume targeted Mean(SD)	Pressure limited N	Pressure limited Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weight (%)	Weighted Mean Difference (Fixed) 95% CI
01 Volume guarantee							
Lista 2004	30	8.80 (3.00)	23	12.30 (3.00)		69.0	-3.50 [-5.13, -1.87]
Subtotal (95% CI)	30		23			69.0	-3.50 [-5.13, -1.87]
Test for heterogeneity: not applicable							
Test for overall effect z=4.21 p=0.00003							
02 Volume controlled							
Sinha 1997	25	5.10 (2.72)	25	6.75 (5.58)		31.0	-1.65 [-4.08, 0.78]
Subtotal (95% CI)	25		25			31.0	-1.65 [-4.08, 0.78]
Test for heterogeneity: not applicable							
Test for overall effect z=1.33 p=0.2							
Total (95% CI)	55		48			100.0	-2.93 [-4.28, -1.57]
Test for heterogeneity chi-square= 1.53 df=1 p=0.22 I² =34.8%							
Test for overall effect z=4.24 p=0.00002							

-10.0 -5.0 0 5.0 10.0
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The Cochrane Library 2007, Issue 1

Pressure-Regulated Volume Control Ventilation vs. Synchronized Intermittent Mandatory Ventilation for Very Low-Birth-Weight Infants

Table 2. Ventilator Settings and Acute Physiological Measurements

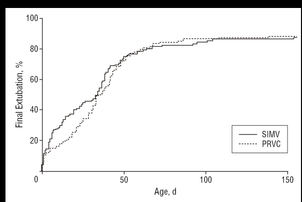
	SIMV*	PRVC*	RR (95% CI)†	MD (95% CI)†
At 6 h of age				
On assigned mode	102/108 (94)‡	102/104 (98)‡	1.04 (0.98-1.10)	NA
F_{IO_2}	0.29 (0.13)	0.31 (0.16)	NA	0.02 (−0.02 to 0.06)
Ventilator rate, breaths/min§	35 (7)	40 (10)	NA	5 (2-7)‖
Peak inspiratory pressure, cm H_2O	15.0 (2.7)	13.8 (2.8)	NA	−1.2 (−1.9 to −0.4)‖
Mean airway pressure, cm H_2O	7.1 (1.5)	7.0 (1.4)	NA	−0.2 (−0.6 to 0.2)
Tidal volume, mL/kg¶	18.4 (4.6)	16.0 (5.2)	NA	−2.4 (−3.9 to −0.8)‖
Minute ventilation, mL · /kg^{-1} · min^{-1}	638 (210)	642 (322)	NA	4 (−83 to 93)
Pa_{CO_2}, torr	38 (8)	39 (8)	NA	2 (−1 to 4)
Oxygenation index	3.0 (1.6)	3.6 (2.9)	NA	0.6 (−0.1 to 1.3)
Arterial to alveolar O_2 ratio	0.50 (0.20)	0.47 (0.21)	NA	−0.03 (−0.09 to 0.03)
At 12 h of age				
On assigned mode	101/108 (94)‡	94/103 (91)‡	0.98 (0.90-1.05)	NA
F_{IO_2}	0.30 (0.17)	0.29 (0.13)	NA	−0.01 (−0.05 to 0.03)
Ventilator rate, breaths/min§	30 (8)	40 (11)	NA	9 (7-12)‖
Peak inspiratory pressure, cm H_2O	14.0 (2.5)	12.7 (2.5)	NA	−1.4 (−2.1 to −0.6)‖
Mean airway pressure, cm H_2O	6.6 (1.4)	6.9 (1.3)	NA	0.3 (−0.1 to 0.7)
Tidal volume, mL/kg¶	17.8 (5.4)	14.1 (4.0)	NA	−3.5 (−5.0 to −2.0)‖
Minute ventilation, mL · kg^{-1} · min^{-1}	529 (204)	542 (206)	NA	14 (−54 to 81)
Pa_{O_2}, torr	64 (20)	65 (16)	NA	1 (−5 to 6)
Pa_{CO_2}, torr	38 (10)	38 (8)	NA	−1 (−3 to 2)
Oxygenation index	3.3 (2.0)	3.9 (3.9)	NA	−0.6 (−0.4 to 1.5)
Arterial to alveolar O_2 ratio	0.44 (0.19)	0.43 (0.18)	NA	−0.01 (−0.06 to 0.05)

D'Angio CT et al. Arch Pediatr Adolesc Med. 2005;159:868-875

Pressure-Regulated Volume Control Ventilation vs. Synchronized Intermittent Mandatory Ventilation for Very Low-Birth-Weight Infants

Table 3. Respiratory Outcomes

	SIMV*	PRVC*	RR (95% CI)†	MD (95% CI)†
Alive and extubated at 14 days	44/108 (41)	38/104 (37)	0.90 (0.64-1.26)	NA
Alive and extubated at 28 days	55/106 (52)	47/104 (45)	0.87 (0.66-1.15)	NA
Alive and extubated at 36 weeks' PMA	88/105 (84)	87/104 (84)	1.0 (0.89-1.12)	NA
Alive without BPD at 36 weeks' PMA	60/105 (57)	66/104 (63)	1.1 (0.89-1.38)	NA
BPD in survivors at 36 week' PMA	32/92 (35)	27/93 (29)	0.83 (0.55-1.27)	NA
Died before discharge‡	13/107 (12)	13/104 (13)	1.03 (0.50-2.11)	NA
Age at final extubation in survivors, d§	24 (0-154)‖	33 (0-138)‖	NA	9 (−2.6 to 20.6)
Final extubation by 14 days	36/108 (33)	20/104 (19)	0.58 (0.36-0.93)¶	NA



Conclusion:

In mechanically ventilated infants with birth weights of 500 to 1249 g, using PRVC ventilation from birth did not alter time to extubation.

D'Angio CT et al. Arch Pediatr Adolesc Med. 2005;159:868-875

Lung-protective ventilation strategies in neonatology: What do we know—What do we need to know?

Anton H. van Kaam, MD, PhD; Peter C. Rimensberger, MD

Crit Care Med 2007; 35:925–931

A total of 24 RCTs and 3 systematic reviews comparing various CMV modes and settings and 2 RCTs investigating permissive hypercapnia reported no differences in mortality or bronchopulmonary dysplasia.