

# Adaptive Support Ventilation (ASV)

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# A randomized controlled trial comparing the ventilation duration between Adaptive Support Ventilation and Pressure Assist/Control Ventilation in medical patients in the ICU

Kirakli C, Naz I, Ediboglu O, Tatar D, Budak A, Tellioglu E

Chest. 2015 Mar 5. [Epub ahead of print]

PMID 25742308, <http://www.ncbi.nlm.nih.gov/pubmed/25742308>

<b>Design</b>	Randomized controlled trial ASV versus Pressure assist control ventilation
<b>Patients</b>	229 medical ICU patients from intubation to extubation
<b>Objectives</b>	Compare the MV duration, weaning duration, number of manual settings, and weaning success rates
<b>Main Results</b>	Total mechanical ventilation duration was significantly shorter in the ASV group, mean 5d [2-6 d] vs 4d [3-9] days). Mechanical ventilation duration until weaning and weaning duration were significantly shorter in the ASV group, mean (84 [43-94] hrs vs. 126 [61-165] hrs; 2 [2-2] hrs vs. 44 [2-80] hrs, respectively). ASV required fewer manual settings to reach the desired pH and PaCO <sub>2</sub> . The number of patients successfully extubated on the first attempt was significantly higher in the ASV group. Weaning success and mortality at day 28 were comparable between the two groups.
<b>Conclusion</b>	ASV shortens total mechanical ventilation duration and the duration of weaning with fewer manual ventilator settings.

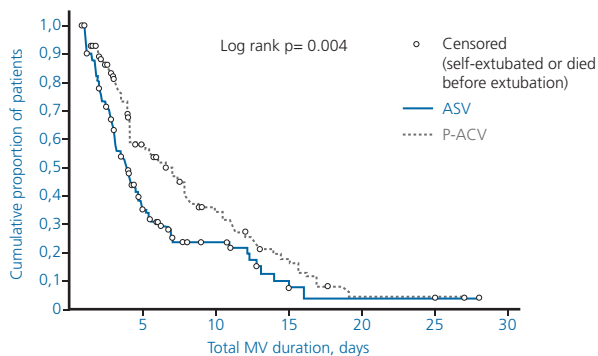


Figure 1: ASV shortens total mechanical ventilation duration compared with pressure assist/control ventilation

# Adaptive support ventilation for faster weaning in COPD: a randomised controlled trial

Kirakli C, Ozdemir I, Ucar ZZ, Cimen P, Kepil S, Ozkan SA

Eur Respir J. 2011 Oct;38(4):774-80

PMID 21406514, <http://www.ncbi.nlm.nih.gov/pubmed/21406514>

<b>Design</b>	Randomized controlled trial ASV versus PS
<b>Patients</b>	97 COPD patients
<b>Objectives</b>	Compare weaning duration
<b>Main Results</b>	ASV shortened weaning times compared to PS (24 h vs 72 h, $p=0.041$ ) with similar success rate (35/49 for ASV and 33/48 for PS)
<b>Conclusion</b>	ASV was more efficient than PS in COPD patient's weaning.

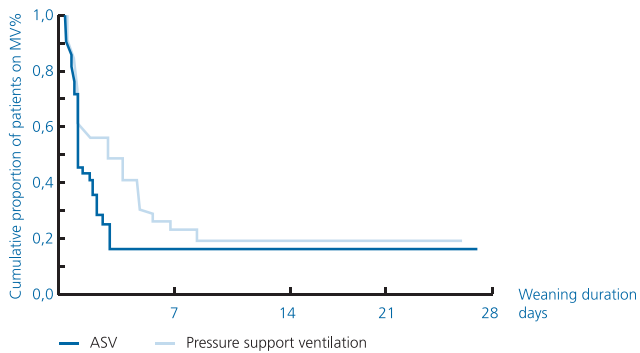


Figure 2: Patients were extubated earlier in ASV group.

# Adaptive support ventilation for fast tracheal extubation after cardiac surgery: a randomized controlled study

Sulzer CF, Chioléro R, Chassot PG, Mueller XM, Revely JP

Anesthesiology. 2001 Dec;95(6):1339-45

PMID 11748389, <http://www.ncbi.nlm.nih.gov/pubmed/11748389>

<b>Design</b>	Randomized controlled trial ASV versus SIMV-PS with reduction of support in 3 phases
<b>Patients</b>	36 patients after coronary artery bypass for fast-track cardiac surgery
<b>Objectives</b>	Show that a protocol of weaning based on ASV could reduce the duration of intubation
<b>Main Results</b>	Duration of intubation was shorter in the ASV group (3.2 [2.5-4.6] vs. 4.1 [3.1-8.6] h; $p < 0.02$ ). Fewer arterial blood gases in ASV group. More fast-track succes in ASV group.
<b>Conclusion</b>	Weaning protocol based on ASV was feasible, accelerated tracheal extubation, and simplified ventilatory management in post-cardiac fast-track surgery.

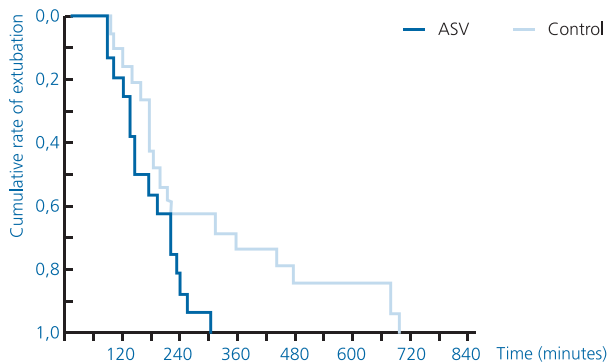


Figure 3: Patients were extubated earlier in ASV group than in control group.

## Adaptive Support Ventilation reduces the incidence of atelectasis in patients undergoing coronary artery bypass grafting: A randomized clinical trial

Moradian ST, Saeid Y, Ebadi A, Hemmat A, Ghiasi MS

Anesth Pain Med. 2017 Apr 22;7(3):e44619

PMID 28856111, <http://www.ncbi.nlm.nih.gov/pubmed/28856111>

<b>Design</b>	Single-blind randomized clinical trial: ASV versus SIMV and PS
<b>Patients</b>	115 patients undergoing coronary artery bypass grafting; 57 in ASV group, 58 in control group
<b>Objectives</b>	Compare ASV to SIMV and PS in terms of atelectasis, management of ventilation, and outcome in patients undergoing cardiac surgery
<b>Main Results</b>	The incidence of atelectasis (33% vs 65%), the number of manual changes to ventilator settings (6±2 vs. 8±2), the number of alarms (10±3 vs. 15±5), and the length of hospital stay (6±1.45 vs. 6.69±2.04 days) were lower in the intervention group than in the control group.
<b>Conclusion</b>	ASV reduced the incidence of atelectasis in patients undergoing coronary artery bypass grafting and improved the process of weaning.

## A randomized controlled trial of 2 protocols for weaning cardiac surgical patients receiving adaptive support ventilation

Tam MK, Wong WT, Gomersall CD, Tian Q, Ng SK, Leung CC, Underwood MJ

J Crit Care. 2016 Jun;33:163-8

PMID 27006266, <http://www.ncbi.nlm.nih.gov/pubmed/27006266>

<b>Design</b>	Randomized controlled trial: ASV with progressive decrease in target minute ventilation or constant target minute ventilation
<b>Patients</b>	52 patients after elective coronary artery bypass surgery
<b>Objectives</b>	Compare the effectiveness of 2 different protocols for weaning
<b>Main Results</b>	The duration of mechanical ventilation (145 vs. 309 minutes; p = 0.001) and intubation (225 vs. 423 minutes; p = .005) was shorter in the decremental target minute ventilation group compared with the constant target minute ventilation group. There was no difference in terms of adverse effects or mortality between the groups.
<b>Conclusion</b>	A progressive decrease in target minute ventilation after cardiac surgery resulted in a shorter duration of ventilation and intubation.

## A randomized controlled trial of adaptive support ventilation mode to wean patients after fast-track cardiac valvular surgery

Zhu F, Gomersall CD, Ng SK, Underwood MJ, Lee A

Anesthesiology. 2015 Apr;122(4):832-40

PMID 25569810, <http://www.ncbi.nlm.nih.gov/pubmed/25569810>

<b>Design</b>	Randomized controlled trial, ASV versus physician-directed weaning
<b>Patients</b>	68 patient after fast-track cardiac valvular surgery
<b>Objectives</b>	Compare the duration of mechanical ventilation
<b>Main Results</b>	Duration of ventilation was shorter in the ASV group 3.4 [2.3 to 4.9] hrs than in the control group 5.7 [3.6 to 8.2] hrs (P = 0.013). ASV was associated with fewer manual ventilator changes and alarms, and lower airway pressure.
<b>Conclusion</b>	ASV reduces duration of mechanical ventilation after fast-track cardiac valvular surgery and reduces the number of manual ventilator changes and alarms.

## Adaptive Support Ventilation versus Synchronized Intermittent Mandatory Ventilation with Pressure Support in weaning patients after orthotopic liver transplantation

Celli P, Privato E, Ianni S, Babetto C, D'Arena C, Guglielmo N, Maldarelli F, Paglialunga G, Rossi M, Berloco PB, Ruberto F, Pugliese F

Transplant Proc. 2014 Aug 20 [Epub ahead of print]

PMID 25150607, <http://www.ncbi.nlm.nih.gov/pubmed/25150607>

<b>Design</b>	Randomized controlled trial, ASV versus SIMV with pressure support
<b>Patients</b>	20 patients after orthotopic liver transplantation fast-track surgery
<b>Objectives</b>	Compare the duration of intubation, the number of manual settings, high airway pressure (Paw) episodes, and blood gas analysis between the two modes
<b>Main Results</b>	The length of intubation was shorter in the ASV group than in the SIMV group (153 ±22 vs 90 ±13 minutes, p = 0.05). Settings modifications were more frequent in the SIMV group vs the ASV group (6 ±2 vs 1.5 ±1; p = .003). Peak pressure (Ppeak) was higher in passive patients in the SIMV group. High Paw alarms were more frequent in the SIMV group in passive patients. The values of pH, PaCO <sub>2</sub> , and e PaO <sub>2</sub> did not differ significantly between the two groups.
<b>Conclusion</b>	ASV is superior in terms of weaning times, and it simplifies respiratory management



## Randomized controlled trial comparing adaptive-support ventilation with pressure-regulated volume-controlled ventilation with automode in weaning patients after cardiac surgery

Gruber PC, Gomersall CD, Leung P, Joynt GM, Ng SK, Ho KM, Underwood MJ

Anesthesiology. 2008 Jul;109(1):81-7

PMID 18580176, <http://www.ncbi.nlm.nih.gov/pubmed/18580176>

<b>Design</b>	Randomized controlled trial ASV versus PRVC in 3 phases: controlled ventilation, assisted ventilation, T-piece trial
<b>Patients</b>	48 patients after coronary artery bypass, uncomplicated
<b>Objectives</b>	Evaluate the duration of intubation, duration of mechanical ventilation, number of arterial blood gases, and number of ventilator setting changes
<b>Main Results</b>	The duration of intubation and of mechanical ventilation was shorter in the ASV group than in the PRVC group (300 [205-365] vs. 540 [462-580] min; $p < 0.05$ ; 165 [120-195] vs. 480 [360-510] min; $p < 0.05$ , respectively). There was no difference in the number of arterial blood gases and setting changes.
<b>Conclusion</b>	ASV allowed earlier extubation than PRVC in post-cardiac surgery without increasing the number of clinician interventions.

## Automatic "respirator/weaning" with adaptive support ventilation: the effect on duration of endotracheal intubation and patient management

Petter AH, Chioléro RL, Cassina T, Chassot PG, Müller XM, Revely JP

Anesth Analg. 2003 Dec;97(6):1743-50

PMID 14633553, <http://www.ncbi.nlm.nih.gov/pubmed/14633553>

<b>Design</b>	Randomized controlled trial ASV versus SIMV-PS for post-cardiac fast-track surgery. 3 phases: controlled ventilation, supported ventilation, and SBT.
<b>Patients</b>	34 uncomplicated cardiac surgery patients
<b>Objectives</b>	Evaluate the effect of ASV on ventilator management and its ability to perform respiratory weaning
<b>Main Results</b>	ASV required fewer ventilator setting manipulations ( $2.4 \pm 0.7$ vs $4.0 \pm 0.8$ manipulations per patient; $p < 0.05$ ) and endured less high-inspiratory pressure alarms ( $0.7 \pm 2.4$ vs $2.9 \pm 3.0$ ; $p < 0.05$ ) than SIMV-PS. There was no difference in duration of mechanical ventilation and ICU stay.
<b>Conclusion</b>	ASV resulted in an outcome similar to the control group with less manipulation: it could simplify management of post-cardiac surgery patients.
<b>Comment</b>	Minute volume settings was left at 100% in the study. A further reduction may have transitioned patients to spontaneous breathing faster.

# Adaptive support ventilation for complete ventilatory support in ARDS: a pilot randomized controlled trial

Agarwal R, Srinivasan A, Aggarwal AN, Gupta D

Respirology. 2013 Oct;18(7):1108-1

PMID 23711230, <http://www.ncbi.nlm.nih.gov/pubmed/23711230>

<b>Design</b>	Pilot randomized controlled trial ASV versus VC
<b>Patients</b>	48 ARDS patients
<b>Objectives</b>	Compare the outcomes
<b>Main Results</b>	Duration of mechanical ventilation (6 d for VC vs 5 d for ASV, $p=0.51$ ), ICU (9 d for VC vs 8 d for ASV, $p=0.9$ ), and hospital stay (11 d for VC vs 11 d for ASV, $p=0.97$ ), sedation doses, ease of use, and number of arterial blood gases were similar in the two groups. $V_t$ was between 6 and 7 ml/kg during the first seven days.
<b>Conclusion</b>	ASV was usable in ARDS patients, providing the same outcomes as VC.
<b>Comment</b>	The sample size of this study could not show reduction of duration of mechanical ventilation (for comparison = 861 patients were necessary in ARDSnet trial) but there was a nonsignificant reduction of duration of mechanical ventilation and ICU stay in the ASV group.

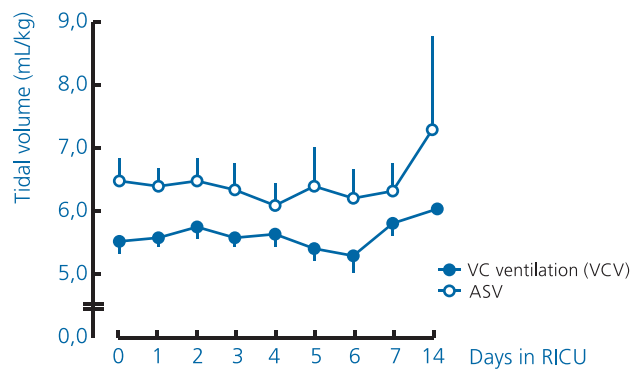


Figure 4: Tidal volume was between 6 and 7 mL/kg in ASV

# Human versus Computer Controlled Selection of Ventilator Settings: An Evaluation of Adaptive Support Ventilation and Mid-Frequency Ventilation

Mireles-Cabodevila E, Diaz-Guzman E, Arroliga AC, Chatburn RL

Crit Care Res Pract. 2012 Sep;2012:204314

PMID 23119152, <http://www.ncbi.nlm.nih.gov/pubmed/23119152>

<b>Design</b>	Comparative simulation study
<b>Patients</b>	Lung simulator: normal lungs, ARDS, obesity, COPD, asthma
<b>Objectives</b>	Compare the automatic settings with survey-derived values
<b>Main Results</b>	Difference between Vt in ASV and clinician selected for normal lungs, ARDS, obesity, COPD were negligible (-0.9 ml to 0.7 ml). For asthma, Vt selected by ASV was greater than that selected by clinician by 3,9 mL.
<b>Conclusion</b>	Negligible differences occurred between ventilator settings selected by ASV and the clinician in different scenarios, except in asthma.

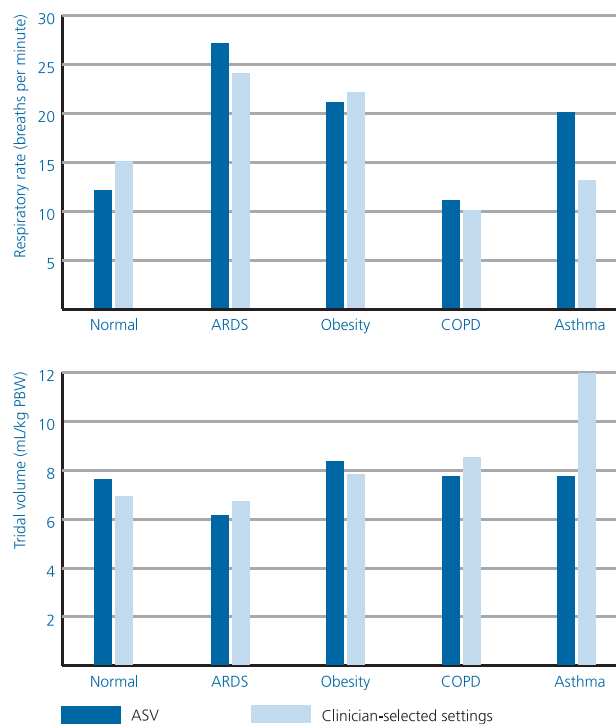


Figure 5: The only clinically relevant difference between the survey and the ASV settings was the higher Vt in status asthmaticus (but nonsignificant difference). Increasing Vt lead to decreased RR to avoid dynamic hyperinflation.

# Effects of implementing adaptive support ventilation in a medical intensive care unit

Chen CW, Wu CP, Dai YL, Perng WC, Chian CF, Su WL, Huang YC

Respir Care. 2011 Jul;56(7):976-83

PMID 21352661, <http://www.ncbi.nlm.nih.gov/pubmed/21352661>

<b>Design</b>	Before/after study 6 months before ASV implementing
<b>Patients</b>	70 patients before (SIMV-PS) and 79 patients ventilated with ASV, in medical ICU
<b>Objectives</b>	Evaluate the effect of ASV in patients recovering from acute respiratory failure
<b>Main Results</b>	In the ASV group, 20% of the patients achieved extubation readiness within 1 day, compared to 4% in the non-ASV group. Patients in the ASV group were more likely to be free from mechanical ventilation at 3 weeks. Time-to-extubation readiness was 2 days shorter in the ASV group
<b>Conclusion</b>	ASV allowed early identification of extubation readiness and reduced weaning duration.

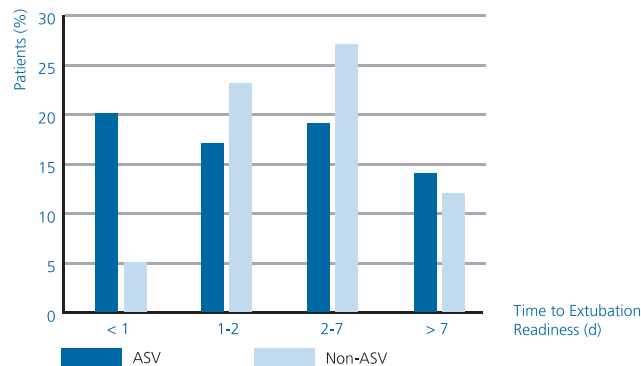


Figure 6: ASV reduced time to extubation readiness compared to conventional ventilation.

# Adaptive support ventilation versus conventional ventilation for total ventilatory support in acute respiratory failure

Iotti GA, Polito A, Belliato M, Pasero D, Beduneau G, Wysocki M, Brunner JX, Braschi A, Brochard L, Mancebo J, Ranieri VM, Richard JC, Slutsky AS

Intensive Care Med. 2010 Aug;36(8):1371-9

PMID 20502870, <http://www.ncbi.nlm.nih.gov/pubmed/20502870>

<b>Design</b>	Prospective multicenter (6 European ICU) crossover study VC/PC switched for ASV with isoMV for 30 min, and 30 min more to achieve isoPaCO <sub>2</sub> , if necessary
<b>Patients</b>	88 patients in 3 groups: 22 normal lung, 36 restrictive disease, 30 obstructive disease
<b>Objectives</b>	Compare the short-term effects of ASV with VC or PC in passive patient
<b>Main Results</b>	PaCO <sub>2</sub> was lower with ASV than controlled ventilation for the same MV. For the same PaCO <sub>2</sub> , ASV was associated with lower MV than controlled ventilation. Work of inspiration was lower during the ASV period. The combination V <sub>t</sub> -RR varied with the group: lower V <sub>t</sub> in patients with restrictive disease and prolonged T <sub>exp</sub> in obstructive patients
<b>Conclusion</b>	ASV performed more effective ventilation than conventional modes

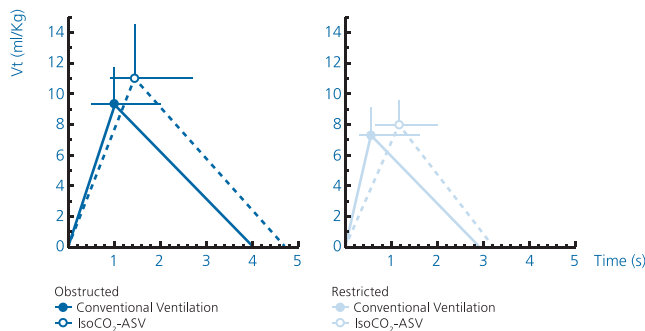


Figure 7: Ventilatory patterns were different between ASV and conventional ventilation. In obstructive patients, ASV provided more effective ventilation with higher V<sub>t</sub> and lower RR than conventional ventilation. In restrictive patients, ASV decreased RR.

## Automatic selection of breathing pattern using adaptive support ventilation

Arnal JM, Wysocki M, Nafati C, Donati S, Granier I, Corno G, Durand-Gasselín J

Intensive Care Med. 2008 Jan;34(1):75-81

PMID 17846747, <http://www.ncbi.nlm.nih.gov/pubmed/17846747>

<b>Design</b>	Prospective observational cohort study
<b>Patients</b>	243 ICU patients
<b>Objectives</b>	Compare settings automatically determined by ASV in 5 lung conditions: normal lungs, ARDS, COPD, chest wall stiffness, acute respiratory failure.
<b>Main Results</b>	On passive ventilation days, Vt-RR were different according to lung condition. On passive normal ventilation days, Vt was lower (8,3 ml/kgPBW) than in passive COPD days (9,3 ml/kgPBW) and higher than in passive ALI/ARDS days (7,6ml/kgPBW, $p < 0,05$ ). On passive normal ventilation day, RR (14/min) was lower than in passive ALI/ARDS days (18/min).
<b>Conclusion</b>	On passive ventilation days, ASV selected different Vt-RR combinations based on respiratory mechanics

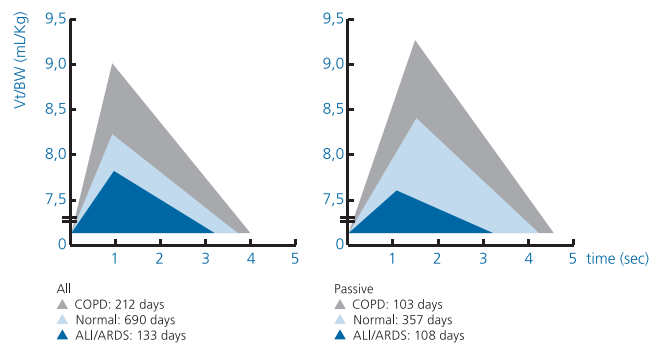


Figure 8: Vt and respiratory rate were different in all ventilation days and passive ventilation days according to lung condition.

## Comparing the effect of adaptive support ventilation (ASV) and synchronized intermittent mandatory ventilation (SIMV) on respiratory parameters in neurosurgical ICU patients

Ghodrati M, Pournajafian A, Khatibi A, Niakan M, Hemadi MH, Zamani MM

Anesth Pain Med. 2016 Oct 2;6(6):e40368

PMID 28975076, <http://www.ncbi.nlm.nih.gov/pubmed/28975076>

<b>Design</b>	Prospective crossover study, 30 minutes in ASV and 30 minutes in SIMV
<b>Patients</b>	60 neurosurgical ICU patients
<b>Objectives</b>	Compare the respiratory parameters for ventilation in ASV and in SIMV
<b>Main Results</b>	In ASV, peak airway pressure ( $17.3 \pm 4.2$ cmH <sub>2</sub> O), tidal volume ( $6.8 \pm 1.8$ ml/kg) and respiratory dead space ( $66.8 \pm 56.3$ ml) were significantly lower than in SIMV: $21.5 \pm 5.0$ cmH <sub>2</sub> O, $10.0 \pm 1.2$ ml/kg, and $91.9 \pm 71.2$ ml, respectively. Dynamic compliance was better in ASV ( $40.7 \pm 17.6$ ml/cmH <sub>2</sub> O vs. $35.5 \pm 15.5$ ml/cmH <sub>2</sub> O), but the difference was not statistically significant.
<b>Conclusion</b>	ASV provides more protective ventilation in neurosurgical ICU patients than SIMV
<b>Comment</b>	Low impact factor journal, short period of observation (30 min in each mode)

## Comparing the effects of adaptive support ventilation and synchronized intermittent mandatory ventilation on intubation duration and hospital stay after coronary artery bypass graft surgery

Yazdannik A, Zarei H, Massoumi G

Iran J Nurs Midwifery Res. 2016 Mar-Apr;21(2):207-12.

PMID 27095997, <http://www.ncbi.nlm.nih.gov/pubmed/27095997>

<b>Design</b>	Randomized controlled trial comparing ASV with SIMV
<b>Patients</b>	64 patients after coronary artery bypass surgery
<b>Objectives</b>	Compare the effect of ASV and SIMV on the length of mechanical ventilation and hospital stay
<b>Main Results</b>	The mean duration of intubation was significantly lower in the ASV group than in the SIMV group (4.83 h vs. 6.71 h, $p < 0.001$ ). The length of the hospital stay in the ASV and the SIMV groups was 140.6 h and 145.1 h ( $p = 0.006$ ), respectively.
<b>Conclusion</b>	According to the results of this study, using ASV after a coronary artery bypass graft led to a decrease in the intubation duration and hospital stay when compared with SIMV.



## Intelligent ventilation in the intensive care unit

Sviri S, Bayya A, Levin P, Khalaila R, Stav I, Linton D  
Sou Af J Crit Care. 2012 Aug;28(1): 6-12

<b>Design</b>	Retrospective study
<b>Patients</b>	1016 medical ICU patients
<b>Objectives</b>	Describe the clinical experience
<b>Main Results</b>	Duration of ventilation = 6 d. Weaning succes rate = 81%. 84% of patients ventilated with ASV mode. 96% able to wean solely using ASV mode. Less than 1% of all patient ventilated with ASV developed pneumothorax.
<b>Conclusion</b>	ASV was a safe and feasible mode of ventilation for complicated medical ICU patients.

## Adaptive support and pressure support ventilation behavior in response to increased ventilatory demand

Jaber S, Sebbane M, Verzilli D, Matecki S, Wysocki M, Eledjam JJ, Brochard L  
Anesthesiology. 2009 Mar;110(3):620-7  
PMID 19225395, <http://www.ncbi.nlm.nih.gov/pubmed/19225395>

<b>Design</b>	Prospective randomized crossover study: ASV, APV, PS at baseline and with increase in dead space, in random order
<b>Patients</b>	14 ICU patients during assisted ventilation
<b>Objectives</b>	Compare ASV to APV and PS in respiratory demand increase
<b>Main Results</b>	Adding dead space increased MV, PaCO <sub>2</sub> , work of breathing. ASV and PS ended with similar P <sub>insp</sub> level (12 cmH <sub>2</sub> O) while APV P <sub>insp</sub> decreased (6 cmH <sub>2</sub> O).
<b>Conclusion</b>	Following an increase in respiratory demand, ASV maintained the same level of pressure support; while adaptive pressure control modes such as APV, PRVC, and Autoflow, may reduce pressure support.

## Determinants of tidal volumes with adaptive support ventilation: a multicentre observational study

Dongelmans DA, Veelo DP, Bindels A, Binnekade JM, Koppenol K, Koopmans M, Korevaar JC, Kuiper MA, Schultz MJ

Anesth Analg. 2008 Sep;107(3):932-7

PMID 18713908, <http://www.ncbi.nlm.nih.gov/pubmed/18713908>

<b>Design</b>	Prospective multicenter (3 Dutch ICU) observational comparative study in postcardiothoracic surgery
<b>Patients</b>	346 patients: 262 in ASV and 84 in PC-PS
<b>Objectives</b>	Determine Vt and factors that influence Vt
<b>Main Results</b>	In ASV, Vt was dependent on only two parameters: the RR and the correctness of set body weight
<b>Conclusion</b>	RR was automatically selected so the only clinically important factor was the correctness of set body weight.

## Evaluation of adaptive support ventilation in paralysed patients and in lung model

Belliato M, Palo A, Pasero D, Iotti GA, Mojoli F, Braschi A

Int J Artif Organs. 2004 Aug;27(8):709-16

PMID 15478542, <http://www.ncbi.nlm.nih.gov/pubmed/15478542>

<b>Design</b>	Prospective observational and simulation study, 45 min in ASV during controlled ventilation, and simulation with the same parameters and increased by 30% of MV
<b>Patients</b>	21 post-operative patients
<b>Objectives</b>	Evaluate the respiratory pattern selected by ASV in 3 lung conditions: normal lungs, restrictive diseases, and obstructive diseases
<b>Main Results</b>	ASV selected higher Vt and lower RR in obstructive patients than in normal lung or restrictive patients. In simulation, patterns were the same. In the hyperventilation test, ASV chose a balanced increase in both Vt and RR.
<b>Conclusion</b>	ASV selected different parameters according to lung condition, and respiratory mechanics. In case of increase of target MV (hyperventilation), Vt and RR were increased.

## Clinical experience with adaptive support ventilation for fast-track cardiac surgery

Cassina T, Chioléro R, Mauri R, Revelly JP

J Cardiothorac Vasc Anesth. 2003 Oct;17(5):571-5

PMID 14579209, <http://www.ncbi.nlm.nih.gov/pubmed/14579209>

<b>Design</b>	Prospective observational study ASV for post-cardiac fast-track surgery
<b>Patients</b>	155 uncomplicated cardiac surgery patients until recovery
<b>Objectives</b>	Evaluate ASV for ventilatory management during the post-operative period
<b>Main Results</b>	Tidal volume was $8.7 \pm 1.4$ ml/kgPBW, plateau pressure was $20.3 \pm 3.9$ cmH <sub>2</sub> O, and arterial blood gas measurements were satisfactory. 86% were extubated within 6 h. No reintubation for respiratory failure. Considered easy to use by nurses and clinicians.
<b>Conclusion</b>	ASV was safe, feasible, and easy to apply, and allowed rapid extubation in post-cardiac surgery

## Patient-ventilator interactions during partial ventilatory support: a preliminary study comparing the effects of adaptive support ventilation with synchronized intermittent mandatory ventilation plus inspiratory pressure support

Tassaou D, Dalmas E, Gratadour P, Jolliet P

Crit Care Med. 2002 Apr;30(4):801-7

PMID 11940749, <http://www.ncbi.nlm.nih.gov/pubmed/11940749>

<b>Design</b>	Prospective, crossover interventional study, 45 min in SIMV, then 45 min in ASV, then 45 min in SIMV
<b>Patients</b>	10 patients intubated for respiratory failure in the early weaning period
<b>Objectives</b>	Describe the effects of ASV and SIMV on patient-ventilator interactions
<b>Main Results</b>	MV was the same in the 3 phases but V <sub>t</sub> increased and RR decreased in ASV period. During ASV, tidal volume increased ( $538 \pm 91$ vs. $671 \pm 100$ ml, $p < .05$ ) and total respiratory rate decreased ( $22 \pm 7$ vs. $17 \pm 3$ breaths/min, $p < .05$ ) vs. SIMV-PS. P 0.1 and sternocleidomastoid activity decreased in ASV period. Arterial blood gases and hemodynamic status remained stable.
<b>Conclusion</b>	ASV decreased inspiratory load and improved quality of patient-ventilator interaction.

## Automatic weaning from mechanical ventilation using an adaptive lung ventilation controller

Linton DM, Potgieter PD, Davis S, Fourie AT, Brunner JX, Laubscher TP

Chest. 1994 Dec;106(6):1843-50

PMID 7988211, <http://www.ncbi.nlm.nih.gov/pubmed/7988211>

<b>Design</b>	Prospective open study using ASV during weaning
<b>Patients</b>	27 long-term ventilated ICU patients fulfilling weaning criteria
<b>Objectives</b>	Evaluate ASV in weaning of mechanical ventilation in 3 groups: normal lungs, parenchymal lung disease, and COPD
<b>Main Results</b>	ASV compared to SIMV reduced PS and mandatory rate in patients ready to be extubated. When the PS level was maintained, patients failed weaning.
<b>Conclusion</b>	ASV was useful for indicating weaning readiness, sooner than PS.

## Correlation between transition percentage of minute volume (TMV%) and outcome of patients with acute respiratory failure

Peng CK, Wu SF, Yang SH, Hsieh CF, Huang CC, Huang YC, Wu CP

J Crit Care. 2017 Jun;39:178-181

PMID 28278435, <http://www.ncbi.nlm.nih.gov/pubmed/28278435>

<b>Design</b>	Prospective interventional study; TMV% determined by increasing %MinVol until a mandatory breath was delivered
<b>Patients</b>	337 ICU patients with acute respiratory failure
<b>Objectives</b>	Test whether higher TMV% is associated with poorer outcomes
<b>Main Results</b>	The TMV% measured on the first day of mechanical ventilation in patients who were weaned off the ventilator on the first day (n = 75), who were still on the ventilator on the second day (n = 249) and who died (n = 13) in the first 24 h was $106 \pm 21.6\%$ , $135 \pm 53.3\%$ and $225 \pm 47.5\%$ (p = 0.001), respectively. In patients whose TMV% increased between day 1 and day 2, the adjusted Odd Ratio for mortality was 7.0 (95%CI=2.7-18.3, p<0.001) compared to patients whose TMV% decreased.
<b>Conclusion</b>	High TMV% or an increase in TMV% was associated with poorer outcomes.
<b>Comment</b>	The most severe patients needed a higher level of support and had poorer outcomes, this is due to the disease

## The comparison effects of two methods of (Adaptive Support Ventilation Minute Ventilation: 110% and Adaptive Support Ventilation Minute Ventilation: 120%) on mechanical ventilation and hemodynamic changes and length of being in recovery in intensive care units

Kiaei BA, Kashеfi P, Hashemi ST, Moradi D, Mobasheri A

Adv Biomed Res. 2017 May 2;6:52

PMID 28553625, <http://www.ncbi.nlm.nih.gov/pubmed/28553625>

<b>Design</b>	Randomized controlled trial; ASV 110% of MV and ASV 120% of MV
<b>Patients</b>	40 ICU patients
<b>Objectives</b>	Compare the differences in duration of mechanical ventilation and hemodynamic changes during recovery and length of stay
<b>Main Results</b>	Duration of mechanical ventilation was $12.3 \pm 3.66$ days in group 110% and $10.8 \pm 2.07$ days in group 120%. Length of stay was $16.35 \pm 3.51$ days in group 110% and $15.5 \pm 2.62$ days in group 120%. These differences were not statistically significant. The heart rate in the ASV MV 120% group was decreased compared to the ASV MV 110% ( $P = 0.017$ ).
<b>Conclusion</b>	ASV MV 120% may decrease the duration of mechanical ventilation and length of stay.

## Effects of adaptive support ventilation and synchronized intermittent mandatory ventilation on peripheral circulation and blood gas markers of COPD patients with respiratory failure

Han L, Wang Y, Gan Y, Xu L

Cell Biochem Biophys. 2014 Apr;70(1):481-4

PMID 24748176, <http://www.ncbi.nlm.nih.gov/pubmed/24748176>

<b>Design</b>	Prospective cross over study
<b>Patients</b>	86 patients with exacerbation of COPD under invasive ventilation
<b>Objectives</b>	Compare the effects on Vt-RR combination, hemodynamic variables and blood gas analysis, between ASV and SIMV
<b>Main Results</b>	RR, Vt and P <sub>insp</sub> were decreased during the ASV period compared to SIMV period. Heart rate, systolic and diastolic blood pressure, central venous pressure were decreased during the ASV period. PaO <sub>2</sub> and pH were increased during ASV period.
<b>Conclusion</b>	ASV delivered more physiologic ventilation improving clinical status in COPD, compared with SIMV
<b>Comment</b>	Data at inclusion are not provided. The period of ventilation were not randomized and SIMV period was always the first one.

## Comparison of 3 modes of automated weaning from mechanical ventilation: a bench study

Morato JB, Sakuma MT, Ferreira JC, Caruso P

J Crit Care. 2012 Dec;27(6):741

PMID 22459160, <http://www.ncbi.nlm.nih.gov/pubmed/22459160>

<b>Design</b>	Simulation study
<b>Patients</b>	Lung simulator
<b>Objectives</b>	Compare the weaning performance of ASV, mandatory rate ventilation, and Smartcare
<b>Main Results</b>	ASV correctly recognized weaning success, weaning failure, weaning success with anxiety, weaning success with irregular breathing, and weaning failure with ineffective effort. The 3 modes incorrectly recognized weaning success with Cheynes-Stokes. Time to PEEP stabilization was shorter for ASV (1-2 min for all situations) than for Smartcare (8-78 min). ASV had higher rates of PS oscillations per 5 min (4-15), compared with Smartcare (0-1).
<b>Conclusion</b>	ASV recognized weaning success or failure, except with Cheynes-Stokes, with quick PS stabilization and a high rate of oscillations

## Adaptive support ventilation prevents ventilator-induced diaphragmatic dysfunction in piglet: an in vivo and in vitro study

Jung B, Constantin JM, Rossel N, Le Goff C, Sebbane M, Coisel Y, Chanques G, Futier E, Hugon G, Capdevila X, Petrof B, Matecki S, Jaber S

Anesthesiology. 2010 Jun;112(6):1435-43

PMID 20460996, <http://www.ncbi.nlm.nih.gov/pubmed/20460996>

<b>Design</b>	Animal study ASV versus controlled ventilation
<b>Patients</b>	12 anesthetized piglets for 72 h 6/group
<b>Objectives</b>	Compare the effects of ASV with those of controlled ventilation on diaphragmatic dysfunction
<b>Main Results</b>	Controlled ventilation decreased transdiaphragmatic pressure, ASV didn't decrease this pressure. Controlled ventilation was associated with atrophy of the diaphragm, atrophy was not detected in ASV group
<b>Conclusion</b>	ASV maintained diaphragmatic contractile activity, which protects against ventilator-induced diaphragmatic dysfunction

## Correlation between the %MinVol setting and work of breathing during adaptive support ventilation in patients with respiratory failure

Wu CP, Lin HI, Perng WC, Yang SH, Chen CW, Huang YC, Huang KL  
Respir Care. 2010 Mar;55(3):334-41

PMID 20196884, <http://www.ncbi.nlm.nih.gov/pubmed/20196884>

<b>Design</b>	Prospective interventional study in active patients, with ASV and %MV increased by 10% until mandatory breath delivered
<b>Patients</b>	22 ICU patients on PS
<b>Objectives</b>	Determine the ASV target point TP (delivery of mandatory breath) and measure the work of breathing WOB at %MV TP, %MV TP + 20%, %MV TP - 20%
<b>Main Results</b>	%MV TP was 165% +/- 54% At %MV TP +20% WOB decreased At %VM - 20% WOB increased
<b>Conclusion</b>	In active patients, increasing %MV decreased WOB.

## Adaptive support ventilation: an appropriate mechanical ventilation strategy for acute respiratory distress syndrome?

Sulemanji D, Marchese A, Garbarini P, Wysocki M, Kacmarek RM  
Anesthesiology. 2009 Oct;111(4):863-70

PMID 19741490, <http://www.ncbi.nlm.nih.gov/pubmed/19741490>

<b>Design</b>	Simulation study ASV versus VC with $V_t = 6$ ml/Kg predictive body weight
<b>Patients</b>	Lung simulator
<b>Objectives</b>	Compared ASV with fixed $V_t$ of 6 ml/kgBW in different scenarios: 60 and 80 kg, PEEP at 8, 12, and 16 cmH <sub>2</sub> O; MV 120, 150, and 200%
<b>Main Results</b>	In Group I = 60 kg, the number of scenarios with Pplat of 28 cmH <sub>2</sub> O or more was 14 for ASV (26%) and 19 for 6 ml/kg (35%). In group II=80 kg, the number of scenarios PP of 28 cmH <sub>2</sub> O or more was 10 for ASV (19%) and 21 for 6 ml/kg (39%).
<b>Conclusion</b>	ASV was better able to prevent VILI than fixed $V_t$ by automatically adjusting P <sub>insp</sub> , sacrificing $V_t$ .



## A comparison of adaptive Support Ventilation (ASV) and Conventional Volume-Controlled Ventilation on Respiratory Mechanics in Acute Lung Injury/ARDS

Choi I, Choi J, Hong S, Lim C, Koh Y  
Kor J crit Care Med. 2009 Aug; 24(2): 59-63

<b>Design</b>	Prospective crossover study, VC 30 min, then ASV 30 min, then VC 30 min
<b>Patients</b>	13 ARDS
<b>Objectives</b>	Compare respiratory and hemodynamic effects between ASV and VC in ARDS patients
<b>Main Results</b>	During ASV period, Vt increased (373 mL vs 429 mL, $p < 0,05$ ), RR (22/min vs 19/min, $p < 0,05$ ) and P <sub>insp</sub> (32 cmH <sub>2</sub> O vs 26, $p < 0,05$ ) decreased compared with VC, without change in arterial blood gases nor in hemodynamic status
<b>Conclusion</b>	ASV was usable in ARDS patients, decreased pressure, and maintained arterial blood gases.

## Adaptive support ventilation for gynaecological laparoscopic surgery in Trendelenburg position: bringing ICU modes of mechanical ventilation to the operating room

Lloréns J, Ballester M, Tusman G, Blasco L, García-Fernández J, Jover JL, Belda FJ  
Eur J Anaesthesiol. 2009 Feb;26(2):135-9  
PMID 19142087, <http://www.ncbi.nlm.nih.gov/pubmed/19142087>

<b>Design</b>	Prospective interventional study during gynaecological laparoscopic surgery
<b>Patients</b>	22 female patients
<b>Objectives</b>	Test the efficacy of ASV to adapt ventilator settings during pneumoperitoneum and Trendelenburg position
<b>Main Results</b>	Compliance decreased and resistance increased during pneumo-trend period, MV was kept constant by an increase in P <sub>insp</sub> by $3.2 \pm 0.9$ cmH <sub>2</sub> O ( $p < 0.01$ ), RR by $1.3 \pm 0.5$ /min, and T <sub>insp</sub> /T <sub>tot</sub> by 43%; these parameters returned toward baseline at final time. PaCO <sub>2</sub> increased during the pneumoperitoneum (CO <sub>2</sub> insufflation) and decreased at final time.
<b>Conclusion</b>	ASV adapted ventilator settings to the changes in the respiratory mechanics, keeping MV constant and provided adequate gas exchanges.

## Adaptive Support Ventilation as the sole mode of ventilatory support in chronically ventilated patients

Linton DM, Renov G, Lafair J, Vasiliev L, Friedman G

Crit Care Resusc. 2006 Mar;8(1):11-4

PMID 16536713, <http://www.ncbi.nlm.nih.gov/pubmed/16536713>

<b>Design</b>	Prospective observational study %MV was reduced 10% a week, from 90% to 60%
<b>Patients</b>	27 patients chronically ventilated, for at least 3 months prior to admission
<b>Objectives</b>	Describe the outcomes
<b>Main Results</b>	12 patients were weaned within 2 weeks and 2 months. 9 remained in 60% VM. 2 were partially ventilated at home. 4 patients died on ventilation.
<b>Conclusion</b>	ASV was safe in achieving weaning automatically

## Adaptive lung ventilation (ALV) during anesthesia for pulmonary surgery: automatic response to transitions to and from one-lung ventilation

Weiler N, Eberle B, Heinrichs W

J Clin Monit Comput. 1998 May;14(4):245-52

PMID 9754613, <http://www.ncbi.nlm.nih.gov/pubmed/9754613>

<b>Design</b>	Prospective observational study ASV during pulmonary surgery
<b>Patients</b>	9 patients during pulmonary surgery and one-lung ventilation
<b>Objectives</b>	Describe the change in respiratory mechanics and the adaptation of ventilatory pattern to and from one-lung ventilation
<b>Main Results</b>	Institution of one-lung ventilation was followed by a reproducible response of the ASV. The sudden changes in respiratory mechanics (resistance increased, compliance decreased but RC was stable) caused a transient reduction in Vt by 42 (8-59)%, with RR unaffected. In order to re-establish the preset MV, the controller increased P <sub>insp</sub> from 18 (14-23) to 27 (19-39) cmH <sub>2</sub> O. The controller was effective in maintaining MV.
<b>Conclusion</b>	The ASV controller successfully managed the transition to and from one-lung ventilation.

## Continuous use of an adaptive lung ventilation controller in critically ill patients in a multi-disciplinary intensive care unit

Linton D, Brunner J, Laubscher T  
Sou Af Med J. 1995 May;85(5): 432-5

<b>Design</b>	Prospective observational study in long-term ventilated ICU patients
<b>Patients</b>	6 ICU patients
<b>Objectives</b>	Evaluate the safety of ASV from initiation to weaning
<b>Main Results</b>	Patients were ventilated for a mean of 51.6 h. PS was maintained at a mean level of 14.8 cmH <sub>2</sub> O. ASV selected appropriate synchronized pressure support ventilatory pattern from initiation to weaning. It allowed and encouraged spontaneous efforts.
<b>Conclusion</b>	ASV provided clinically acceptable, safe, and effective ventilation during the entire mechanical ventilation period.

## Automatic selection of tidal volume, respiratory frequency and minute ventilation in intubated ICU patients as start up procedure for closed-loop controlled ventilation

Laubscher TP, Frutiger A, Fanconi S, Jutzi H, Brunner JX  
Int J Clin Monit Comput. 1994 Feb;11(1):19-30  
PMID 8195655, <http://www.ncbi.nlm.nih.gov/pubmed/8195655>

<b>Design</b>	Multicenter prospective open study Connection for 1 min for test-breaths
<b>Patients</b>	25 adult ICU patients + 17 critically ill children
<b>Objectives</b>	Test a computerized method for selecting V <sub>t</sub> , RR, and MV as startup procedure for closed-loop controlled mechanical ventilation
<b>Main Results</b>	The computerized parameters calculated with test breaths didn't differ from the conventional parameters at the initiation of mechanical ventilation
<b>Conclusion</b>	Automatic selection of ventilation parameters started mechanical ventilation with the same parameters as manual settings .

# Additional files

## Adaptive support ventilation

Campbell RS, Branson RD, Johannigman JA  
Respir Care Clin N Am. 2001 Sep;7(3):425-40  
PMID 11517032, <http://www.ncbi.nlm.nih.gov/pubmed/11517032>

**Design** Original article

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**Conclusion** Explains the ASV principle and the settings.

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## The work of breathing

Otis AB  
Physiol Rev. 1954 Jul;34(3):449-58  
PMID 13185751, <http://www.ncbi.nlm.nih.gov/pubmed/13185751>

**Design** Physiological study

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**Conclusion** Supports the ASV principle of selecting a Vt-RR combination according to the least work of breathing principle.

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## Automated versus non-automated weaning for reducing the duration of mechanical ventilation for critically ill adults and children

Rose L, Schultz MJ, Cardwell CR, Jouvett P, McAuley DF, Blackwood B  
Cochrane Database Syst Rev. 2013 Jun 6;6:CD009235  
PMID 23740737, <http://www.ncbi.nlm.nih.gov/pubmed/23740737>

<b>Design</b>	Meta-analysis
<b>Patients</b>	1143 adults ICU patients + 30 critically ill children
<b>Objectives</b>	Compare the duration of weaning from mechanical ventilation, duration of ventilation, ICU and hospital length of stay, mortality, and adverse events between automated closed-loop systems versus nonautomated strategies
<b>Main Results</b>	Closed-loop systems reduced weaning duration in mixed or medical ICU populations, duration of ventilation, and ICU length of stay. There was no difference in mortality rates or hospital stay
<b>Conclusion</b>	Automated closed-loop systems, such as ASV, reduce duration of weaning, ventilation, and ICU stay.

## Adaptive support ventilation: State of the art review

Fernández J, Miguelena D, Mulett H, Godoy J, Martínón-Torres F  
Indian J Crit Care Med. 2013 Jan;17(1):16-22  
PMID 23833471, <http://www.ncbi.nlm.nih.gov/pubmed/23833471>

<b>Design</b>	Review
<b>Conclusion</b>	Discusses ASV, appropriate ventilator settings, advantages, particular effects on oxygenation and ventilation, and monitoring .

## Closed loop mechanical ventilation

Wysocki M, Jouvet P, Jaber S

J Clin Monit Comput. 2014 Feb;28(1):49-56

PMID 23564277, <http://www.ncbi.nlm.nih.gov/pubmed/23564277>

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<b>Design</b>	Review
<b>Conclusion</b>	Provides overview of technical and engineering considerations regarding closed-loop controlled ventilation.

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Hamilton Medical AG

Via Crusch 8, 7402 Bonaduz, Switzerland

 +41 58 610 10 20

[info@hamilton-medical.com](mailto:info@hamilton-medical.com)

[www.hamilton-medical.com](http://www.hamilton-medical.com)