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**

Design	Randomized controlled trial ASV versus Pressure assist control ventilation
Patients	229 medical ICU patients from intubation to extubation
Objectives	Compare the MV duration, weaning duration, number of manual settings, and weaning succes rates
Main Results	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 PaCO2. 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.
Conclusion	ASV shortens total mechanical ventilation duration and the duration of weaning with fewer manual ventilator settings.

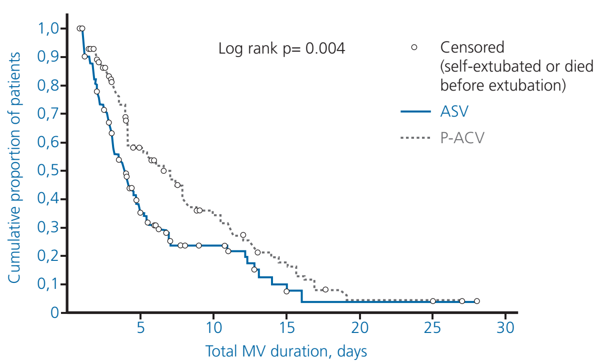

Figure 1: ASV shortens total mechanical ventilation duration compared with pressure assist/control ventilation

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**

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

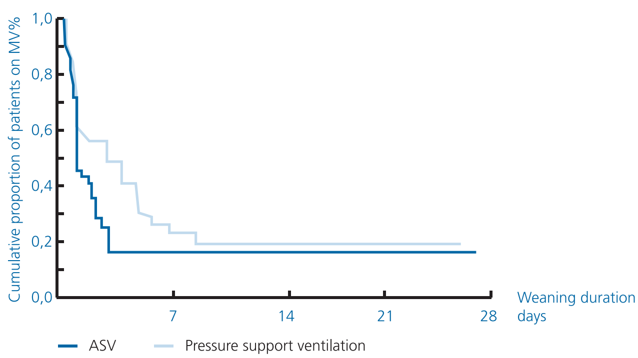

Figure 2: Patients were extubated earlier in ASV group.

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

Sulzer CF, Chioléro R, Chassot PG, Mueller XM, Revelly JP
Anesthesiology. 2001 Dec;95(6):1339-45
PMID 11748389, **http://www.ncbi.nlm.nih.gov/pubmed/11748389**

Design	Randomized controlled trial ASV versus SIMV-PS with reduction of support in 3 phases
Patients	36 patients after coronary artery bypass for fast-track cardiac surgery
Objectives	Show that a protocol of weaning based on ASV could reduce the duration of intubation
Main Results	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.
Conclusion	Weaning protocol based on ASV was feasible, accelerated tracheal extubation, and simplified ventilatory management in post-cardiac fast-track surgery.

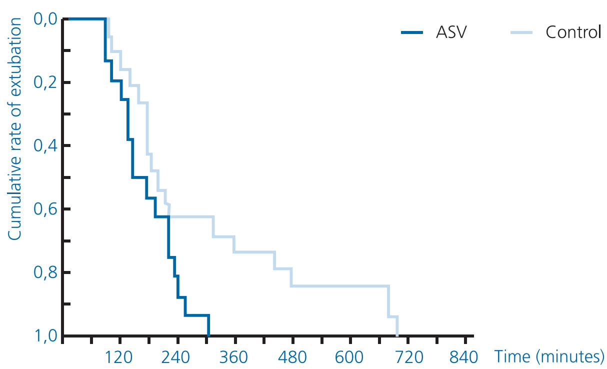

Figure 3: Patients were extubated earlier in ASV group than in control group.

Comparison of Mechanical Power During Adaptive Support Ventilation Versus Nonautomated Pressure-Controlled Ventilation–A Pilot Study

Buiteman-Kruizinga LA, Mkadmi HE, Schultz MJ, Tangkau PL, van der Heiden PLJ
Crit Care Explor. 2021 Feb 15;3(2):e0335
PMID 33604578, **http://www.ncbi.nlm.nih.gov/pubmed/33604578**

Design	Single-center, observational prospective pilot study
Patients	24 passive ICU patients
Objectives	To compare the amount of "mechanical power of ventilation" (MP) in Adaptive Support Ventilation (ASV) and nonautomated pressure-controlled ventilation (PCV)
Main Results	Compared with PCV, the median MP was lower in ASV (15.1 J/min [10.5–25.7 J/min] vs 22.9 J/min [18.7–28.8 J/min]; p = 0.04). The median tidal volume was not different (7.1 mL/kg [6.7–7.6 mL/kg] vs 7.3 mL/kg [7.0–7.7 mL/kg] PBW). The median maximum airway pressure (23 cmH2O [19–28 cmH2O] vs 28 cmH2O [25–31 cmH2O]; p = 0.012), and median respiratory rate (18 [16–22] vs 23 [20–25]; p = 0.012) were lower in ASV.
Conclusion	Compared with PCV, ASV decreased the mechanical power transferred from the ventilator to the respiratory system by lowering pressure and respiratory rate.

Randomized crossover trial to compare driving pressures in a closed-loop and a conventional mechanical ventilation mode in pediatric patients

Ceylan G, Topal S, Atakul G, Colak M, Soydan E, Sandal O, Sari F, Ağın H
Pediatr Pulmonol. 2021 Sep;56(9):3035-3043
PMID 34293255, **http://www.ncbi.nlm.nih.gov/pubmed/34293255**

Design	Randomized crossover study: 60 min in ASV 1.1 (Adaptive Support Ventilation) and 60 min in controlled mandatory ventilation with adaptive pressure ventilation (APV-CMV)
Patients	26 pediatric ICU patients with no spontaneous breathing
Objectives	To compare the respiratory system driving pressure (ΔP) in ASV 1.1 with ΔP in a physician-tailored APV-CMV mode
Main Results	Tidal volume was lower, while respiratory rate was higher in the ASV 1.1 period than in the APV-CMV period. Plateau pressure measured during occlusion maneuvers was lower in the ASV 1.1 period. ΔP was lower in ASV 1.1 compared to APV-CMV (10.4 [8.5-12.1] versus 12.4 [10.5-15.3] cmH2O; p < .001).
Conclusion	The driving pressure (ΔP) applied to the respiratory system in pediatric patients was lower using ASV 1.1 compared to APV-CMV.

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**

Design	Single-blind randomized clinical trial: ASV versus SIMV and PS
Patients	115 patients undergoing coronary artery bypass grafting; 57 in ASV group, 58 in control group
Objectives	Compare ASV to SIMV and PS in terms of atelectasis, management of ventilation, and outcome in patients undergoing cardiac surgery
Main Results	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.
Conclusion	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**

Design	Randomized controlled trial: ASV with progressive decrease in target minute ventilation or constant target minute ventilation
Patients	52 patients after elective coronary artery bypass surgery
Objectives	Compare the effectiveness of 2 different protocols for weaning
Main Results	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.
Conclusion	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**

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

Design	Randomized controlled trial, ASV versus SIMV with pressure support
Patients	20 patients after orthoptic liver transplantation fast-track surgery
Objectives	Compare the duration of intubation, the number of manual settings, high airway pressure (Paw) episodes, and blood gas analysis between the two modes
Main Results	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 vs1.5 ±1; p = .003). Peak presusre (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, PaCO2, and e PaO2 did not differ significantly between the two groups.
Conclusion	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**

Design	Randomized controlled trial ASV versus PRVC in 3 phases: controlled ventilation, assisted ventilation, T-piece trial
Patients	48 patients after coronary artery bypass, uncomplicated
Objectives	Evaluate the duration of intubation, duration of mechanical ventilation, number of arterial blood gases, and number of ventilator setting changes
Main Results	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.
Conclusion	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, Revelly JP
Anesth Analg. 2003 Dec;97(6):1743-50
PMID 14633553, **http://www.ncbi.nlm.nih.gov/pubmed/14633553**

Design	Randomized controlled trial ASV versus SIMV-PS for post-cardiac fast-track surgery. 3 phases: controlled ventilation, supported ventilation, and SBT.
Patients	34 uncomplicated cardiac surgery patients
Objectives	Evaluate the effect of ASV on ventilator management and its ability to perform respiratory weaning
Main Results	ASV required fewer ventilator setting manipulations (2.4 ±0.7 vs 4.0 ±0.8 manipulations per patient; $p < 0.05$) and endured less high-inspiratory pressure alarms (0.7 ±2.4 vs 2.9 ±3.0; $p < 0.05$) than SIMV-PS. There was no difference in duration of mechanical ventilation and ICU stay.
Conclusion	ASV resulted in an outcome similar to the control group with less manipulation: it could simplify management of post-cardiac surgery patients.
Comment	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**

Design	Pilot randomized controlled trial ASV versus VC
Patients	48 ARDS patients
Objectives	Compare the outcomes
Main Results	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. Vt was between 6 and 7 ml/kg during the first seven days.
Conclusion	ASV was usable in ARDS patients, providing the same outcomes as VC.
Comment	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.

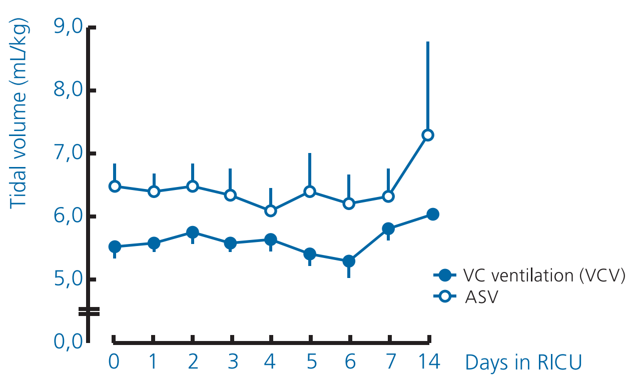

Figure 4: Tidal volume was between 6 and 7 mL/kg in ASV

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**

Design	Comparative simulation study
Patients	Lung simulator: normal lungs, ARDS, obesity, COPD, asthma
Objectives	Compare the automatic settings with survey-derived values
Main Results	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.
Conclusion	Negligible differences occurred between ventilator settings selected by ASV and the clinician in different scenarios, except in asthma.

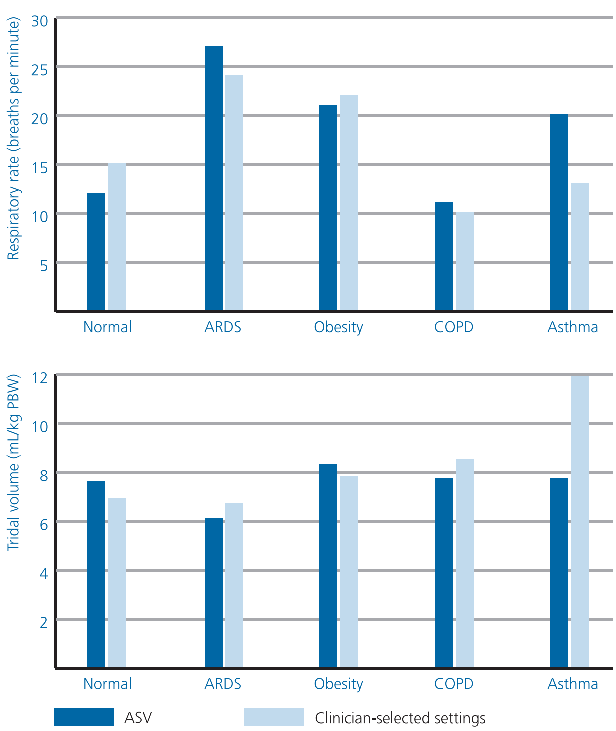

Figure 5: The only clinically relevant difference between the survey and the ASV settings was the higher Vt in status asthmaticus (but nonsignificant difference). Increasing Vt lead to decreased RR to avoid dynamic hyperinflation.

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**

Design	Before/after study 6 months before ASV implementing
Patients	70 patients before (SIMV-PS) and 79 patients ventilated with ASV, in medical ICU
Objectives	Evaluate the effect of ASV in patients recovering from acute respiratory failure
Main Results	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
Conclusion	ASV allowed early identification of extubation readiness and reduced weaning duration.

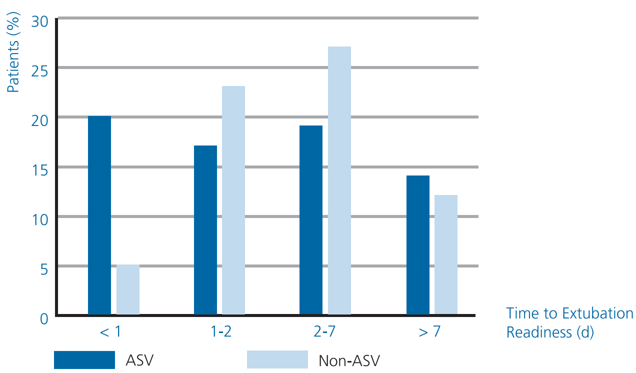

Figure 6: ASV reduced time to extubation readiness compared to conventional ventilation.

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**

Design	Prospective multicenter (6 european ICU) crossover study VC/PC switched for ASV with isoMV for 30 min, and 30 min more to achieve isoPaCO2, if necessary
Patients	88 patients in 3 groups: 22 normal lung, 36 restrictive disease, 30 obstructive disease
Objectives	Compare the short-term effects of ASV with VC or PC in passive patient
Main Results	PaCO2 was lower with ASV than controlled ventilation for the same MV. For the same PaCO2, ASV was associated with lower MV than controlled ventilation. Work of inspiration was lower during the ASV period. The combination Vt-RR varied with the group: lower Vt in patients with restrictive disease and prolonged Texp in obstructive patients
Conclusion	ASV performed more effective ventilation than conventional modes

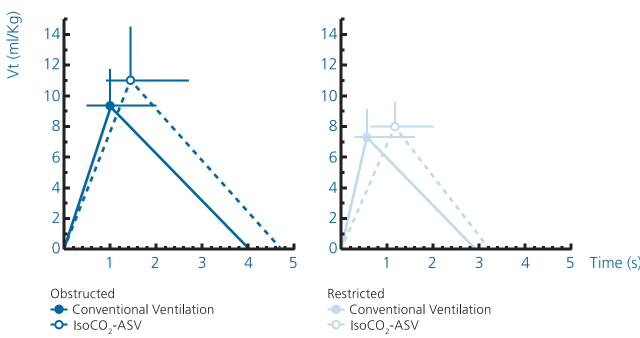

Figure 7: Ventilatory patterns were different between ASV and conventional ventilation. In obstructive patients, ASV provided more effective ventilation with higher Vt and lower RR than conventional ventilation. In restrictive patients, ASV decreased RR.

Automatic selection of breathing pattern using adaptive support ventilation

Arnal JM, Wysocki M, Nafati C, Donati S, Granier I, Corno G, Durand-Gasselin J
Intensive Care Med. 2008 Jan;34(1):75-81
PMID 17846747, **http://www.ncbi.nlm.nih.gov/pubmed/17846747**

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

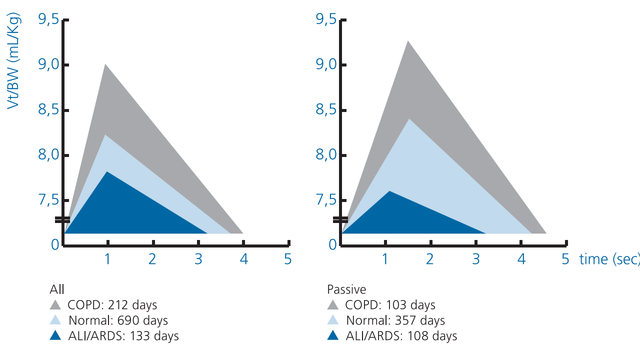

Figure 8: Vt and respiratory rate were different in all ventilation days and passive ventilation days according to lung condition.

Adaptive Support Ventilation and Lung-Protective Ventilation in ARDS

Baedorf Kassis EN, Bastos AB, Schaefer MS, Capers K, Hoenig B, Banner-Goodspeed V, Talmor D
Respir Care. 2022 Dec;67(12):1542-1550
PMID 35973716, **http://www.ncbi.nlm.nih.gov/pubmed/35973716**

Design	Crossover study with randomization to intervention comparing Adaptive Pressure Ventilation (APV) set to VT 6 ml/kg with Adaptive Support Ventilation (ASV), maintaining consistent minute ventilation with 1–2 h in each mode
Patients	17 ARDS patients
Objectives	Compare VT, driving pressure, mechanics, gas exchange, and mechanical power
Main Results	ASV mode produced marginally larger VT (6.3 [5.9–7.0] ml/kg vs 6.04 [6.0–6.1] ml/kg, $p = 0.035$). RR was lower in patients in ASV mode (25 [22–26] breaths/min vs 27 [22–30)] breaths/min, $p = 0.01$). Pplat (24.7 [22.6–27.6] cmH2O vs 25.3 [23.5–26.8] cmH2O, $p = 0.14$) and driving pressures (12.8 [9.0–15.8] cmH2O vs 11.7 [10.7–15.1] cmH2O, $p = 0.29$) were comparable between APV and ASV.
Conclusion	ASV targeted similar settings to the standard of care consistent with lung-protective ventilation strategies in ARDS patients

Comparisons of metabolic load between adaptive support ventilation and pressure support ventilation in mechanically ventilated ICU patients

Chen YH, Hsiao HF, Hsu HW, Cho HY, Huang CC.
Can Respir J. 2020 Jan 28;2020:2092879
PMID 32076468, **http://www.ncbi.nlm.nih.gov/pubmed/32076468**

Design	Prospective study: Sequential 20 min in pressure support ventilation (PSV) followed by 20 min in adaptive support ventilation (ASV)
Patients	24 ICU patients
Objectives	Compare the metabolic load between ASV and PSV
Main Results	The energy expenditure in ASV was lower than in PSV at support levels of 0 cmH2O, 8 cmH2O, and 12 cmH2O. The VO2, VCO2, and P0.1 in PSV were significantly higher than those in ASV.
Conclusion	ASV set for full support was associated with a lower metabolic load and respiratory drive than PSV

Adaptive Support Ventilation attenuates ventilator induced lung injury: human and animal study

Dai YL, Wu CP, Yang GG, Chang H, Peng CK, Huang KL
Int J Mol Sci. 2019 Nov 21;20(23):5848
PMID 31766467, **http://www.ncbi.nlm.nih.gov/pubmed/31766467**

Design	Prospective randomized trial (adaptive support ventilation (ASV) versus pressure-control ventilation (PCV)) and animal study (ASV versus volume-control ventilation (VCV))
Patients	15 ARDS patients and 18 piglets
Objectives	Evaluate whether ASV can provide a protective ventilation pattern to decrease the risk of ventilator-induced lung injury (VILI)
Main Results	In the ARDS patients, there was no difference in respiratory parameters between the groups. In the animal experiments, the ASV group had lower alveolar strain, less lung injury and greater alveolar fluid clearance compared with the VCV group.
Conclusion	ASV mode is capable of providing a ventilation pattern fitting into the lung-protective strategy and may effectively reduce the risk or severity of VILI in an animal model

Randomized Controlled Trial of Noninvasive Ventilation with Pressure Support Ventilation and Adaptive Support Ventilation in Acute Exacerbation of COPD: A Feasibility Study

Sehgal IS, Kalpakam H, Dhooria S, Aggarwal AN, Prasad KT, Agarwal R
COPD. 2019 Apr;16(2):168-173
PMID 31161812, **http://www.ncbi.nlm.nih.gov/pubmed/31161812**

Design	Randomized controlled trial Adaptive Support Ventilation (ASV) versus Pressure Support Ventilation (PSV) during Noninvasive Ventilation (NIV)
Patients	74 patients with acute exacerbation of COPD: 38 in PSV group, 36 in ASV group
Objectives	Compare the delivery of NIV with PSV and ASV in terms of NIV failure and outcomes
Main Results	The NIV failure rate was similar in the two groups (PSV vs. ASV: 34.2% vs. 22.2%, p = 0.31). There was a non-significant decrease in both the intubation rate (21.1% in PSV vs. 11.1% in ASV) and the requirement of NIV within 48 h (7.9% in PSV vs. 0% in ASV) in the ASV group. There was no difference in outcomes.
Conclusion	The application of NIV using ASV was associated with a similar success rate to PS in patients with acute exacerbation of COPD.
Comment	The inspiratory pressure was higher in the ASV group, which could explain the lower NIV failure rate.

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**

Design	Prospective crossover study, 30 minutes in ASV and 30 minutes in SIMV
Patients	60 neurosurgical ICU patients
Objectives	Compare the respiratory parameters for ventilation in ASV and in SIMV
Main Results	In ASV, peak airway pressure (17.3±4.2 cmH2O), tidal volume (6.8±1.8 ml/kg) and respiratory dead space (66.8±56.3 ml) were significantly lower than in SIMV: 21.5±5.0 cmH2O, 10.0±1.2 ml/kg, and 91.9±71.2 ml, respectively. Dynamic compliance was better in ASV (40.7±17.6 ml/cmH2O vs. 35.5±15.5 ml/cmH2O), but the difference was not statistically significant.
Conclusion	ASV provides more protective ventilation in neurosurgical ICU patients than SIMV
Comment	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**

Design	Randomized controlled trial comparing ASV with SIMV
Patients	64 patients after coronary artery bypass surgery
Objectives	Compare the effect of ASV and SIMV on the length of mechanical ventilation and hospital stay
Main Results	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.
Conclusion	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

Design	Retrospective study
Patients	1016 medical ICU patients
Objectives	Describe the clinical experience
Main Results	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.
Conclusion	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**

Design	Prospective randomized crossover study: ASV, APV, PS at baseline and with increase in dead space, in random order
Patients	14 ICU patients during assisted ventilation
Objectives	Compare ASV to APV and PS in respiratory demand increase
Main Results	Adding dead space increased MV, $PaCO_2$, work of breathing. ASV and PS ended with similar Pinsp level (12 cmH_2O) while APV Pinsp decreased (6 cmH_2O).
Conclusion	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**

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

Design	Prospective observational and simulation study, 45 min in ASV during controlled ventilation, and simulation with the same parameters and increased by 30% of MV
Patients	21 post-operative patients
Objectives	Evaluate the respiratory pattern selected by ASV in 3 lung conditions: normal lungs, restrictive diseases, and obstructive diseases
Main Results	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.
Conclusion	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**

Design	Prospective observational study ASV for post-cardiac fast-track surgery
Patients	155 uncomplicated cardiac surgery patients until recovery
Objectives	Evaluate ASV for ventilatory management during the post-operative period
Main Results	Tidal volume was 8.7 ±1.4 ml/kgPBW, plateau pressure was 20.3 ±3.9 cmH2O, 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.
Conclusion	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

Tassaux 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**

Design	Prospective, crossover interventional study, 45 min in SIMV, then 45 min in ASV, then 45 min in SIMV
Patients	10 patients intubated for respiratory failure in the early weaning period
Objectives	Describe the effects of ASV and SIMV on patient-ventilator interactions
Main Results	MV was the same in the 3 phases but Vt increased and RR decreased in ASV period. During ASV, tidal volume increased (538 ±91 vs. 671 ±100 ml, p <.05) and total respiratory rate decreased (22 ±7 vs. 17 ±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.
Conclusion	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**

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

Efficacy of adaptive ventilation support combined with lung recruitment maneuvering for ARDS

Zhang J, Yang Z, Chen K, Zhang X, Zhao T, Zhang X
Am J Transl Res. 2022 Mar 15;14(3):2109-2116
PMID 35422960, **http://www.ncbi.nlm.nih.gov/pubmed/35422960**

Design	Randomized controlled trial
Patients	100 ARDS patients: 50 patients in the control group (synchronized intermittent mandatory ventilation [SIMV]) and 50 patients in the study group (Adaptive Support Ventilation [ASV] plus lung recruitment maneuvering [LRM])
Objectives	Compare SIMV with ASV + LRM
Main Results	Mean arterial pressure, central venous pressure, heart rate, systemic vascular resistance index, pulmonary arterial pressure, and cardiac output index were not different between the two groups. Pulmonary vascular resistance index and extravascular lung water were lower in the study group than in the control group. Arterial oxygen pressure, global oxygen delivery, and oxygen uptake were higher in the study group than in the control group. Time to withdrawal, APACHE II score, and length of stay in ICU were lower in the study group than in the control group.
Conclusion	ASV + LRM improves oxygen metabolism, reduces microcirculatory resistance, and shortens ICU stay, but has no significant effect on hemodynamics

Adaptive support ventilation attenuates postpneumonectomy acute lung injury in a porcine model

Dai YL, Hsu RJ, Huang HK, Huang TW, Tsai WC, Chang H, Lan CC, Huang KL
Interact Cardiovasc Thorac Surg. 2020 Nov 1;31(5):718-726
PMID 33051664, **http://www.ncbi.nlm.nih.gov/pubmed/33051664**

Design	Animal study
Patients	15 pigs: 5 in control group, 5 in volume-control ventilation (VCV) group, 5 in adaptive support ventilation (ASV) group
Objectives	Determine whether ASV can provide protective ventilation to the remaining lung after pneumonectomy
Main Results	The ASV group had lower alveolar strain, less lung injury, and greater alveolar fluid clearance than the VCV group.
Conclusion	ASV may attenuate postpneumonectomy ventilator-induced lung injury by suppression of the inflammatory response.

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**

Design	Prospective interventional study; TMV% determined by increasing %MinVol until a mandatory breath was delivered
Patients	337 ICU patients with acute respiratory failure
Objectives	Test whether higher TMV% is associated with poorer outcomes
Main Results	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 ± 21.6%, 135 ± 53.3% and 225 ± 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.
Conclusion	High TMV% or an increase in TMV% was associated with poorer outcomes.
Comment	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, Kashefi 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**

Design	Randomized controlled trial; ASV 110% of MV and ASV 120% of MV
Patients	40 ICU patients
Objectives	Compare the differences in duration of mechanical ventilation and hemodynamic changes during recovery and length of stay
Main Results	Duration of mechanical ventilation was 12.3 ± 3.66 days in group 110% and 10.8 ± 2.07 days in group 120%. Length of stay was 16.35 ± 3.51 days in group 110% and 15.5 ± 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).
Conclusion	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**

Design	Prospective cross over study
Patients	86 patients with exacerbation of COPD under invasive ventilation
Objectives	Compare the effects on Vt-RR combination, hemodynamic variables and blood gas analysis, between ASV and SIMV
Main Results	RR, Vt and Pinsp 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. PaO2 and pH were increased during ASV period.
Conclusion	ASV delivered more physiologic ventilation improving clinical status in COPD, compared with SIMV
Comment	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**

Design	Simulation study
Patients	Lung simulator
Objectives	Compare the weaning performance of ASV, mandatory rate ventilation, and Smartcare
Main Results	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 succes with Cheynes-Stokes. Time to Pinsp stabilization was shorter for ASV (1-2 min for all situations) than for Smartcar e (8-78 min). ASV had higher rates of PS oscillations per 5 min (4-15), compared with Smart-care (0-1).
Conclusion	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**

Design	Animal study ASV versus controlled ventilation
Patients	12 anesthetized piglets for 72 h 6/group
Objectives	Compare the effects of ASV with those of controlled ventilation on diaphragmatic dysfunction
Main Results	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
Conclusion	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**

Design	Prospective interventional study in active patients, with ASV and %MV increased by 10% until mandatory breath delivered
Patients	22 ICU patients on PS
Objectives	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%
Main Results	%MV TP was 165% +/- 54% At %MV TP +20% WOB decreased At %VM - 20% WOB increased
Conclusion	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**

Design	Simulation study ASV versus VC with Vt = 6 ml/Kg predictive body weight
Patients	Lung simulator
Objectives	Compared ASV with fixed Vt of 6 ml/kgIBW in different scenarios: 60 and 80 kg, PEEP at 8, 12, and 16 cmH2O; MV 120, 150, and 200%
Main Results	In Group I = 60 kg, the number of scenarios with Pplat of 28 cmH2O 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 cmH2O or more was 10 for ASV (19%) and 21 for 6 ml/kg (39%).
Conclusion	ASV was better able to prevent VILI than fixed Vt by automatically adjusting Pinsp, sacrificing Vt.

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

Design	Prospective crossover study, VC 30 min, then ASV 30 min, then VC 30 min
Patients	13 ARDS
Objectives	Compare respiratory and hemodynamic effects between ASV and VC in ARDS patients
Main Results	During ASV period, Vt increased (373 mL vs 429 mL, p<0,05), RR (22/min vs 19/min, p<0,05) and Pinsp (32 cmH2O vs 26, p<0,05) decreased compared with VC, without change in arterial blood gases nor in hemodynamic status
Conclusion	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**

Design	Prospective interventional study during gynaecological laparoscopic surgery
Patients	22 female patients
Objectives	Test the efficacy of ASV to adapt ventilator settings during pneumoperitoneum and Trendelembourg position
Main Results	Compliance decreased and resistance increased during pneumo-trend period, MV was kept constant by an increase in Pinsp by 3.2 ±0.9 cmH2O (p < 0.01), RR by 1.3 ±0.5/min, and Tinsp/Ttot by 43%; these parameters returned toward baseline at final time. PaCO2 inscreased during the pneumoperitoneum (CO2 insufflation) and decreased at final time.
Conclusion	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**

Design	Prospective observational study %MV was reduced 10% a week, from 90% to 60%
Patients	27 patients chronically ventilated, for at least 3 months prior to admission
Objectives	Describe the outcomes
Main Results	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.
Conclusion	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**

Design	Prospective observational study ASV during pulmonary surgery
Patients	9 patients during pulmonary surgery and one-lung ventilation
Objectives	Describe the change in respiratory mechanics and the adaptation of ventilatory pattern to and from one-lung ventilation
Main Results	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 Pinsp from 18 (14-23) to 27 (19-39) cmH_2O. The controller was effective in maintaining MV.
Conclusion	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-discipinary intensive care unit

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

Design	Prospective observational study in long-term ventilated ICU patients
Patients	6 ICU patients
Objectives	Evaluate the safety of ASV from initiation to weaning
Main Results	Patients were ventilated for a mean of 51.6 h. PS was maintained at a mean level of 14.8 cmH2O. ASV selected appropriate synchronized pressure support ventilatory pattern from initiation to weaning. It allowed and encouraged spontaneous efforts.
Conclusion	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**

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

Additional files

Advanced modes of mechanical ventilation and optimal targeting schemes

van der Staay M, Chatburn RL
Intensive Care Med Exp. 2018 Aug 22;6(1):30
PMID 30136011, **http://www.ncbi.nlm.nih.gov/pubmed/30136011**

Objectives	Recent research results provide new incentives to recognize and prevent ventilator-induced lung injury (VILI) and create targeting schemes for new modes of mechanical ventilation
Conclusion	Minimization of breathing power, inspiratory power, and inspiratory pressure are the underlying goals of optimum targeting schemes used in ASV.

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
Conclusion	Explains the ASV principle and the settings.

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

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

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

Design	Meta-analysis
Patients	1143 adults ICU patients + 30 critically ill children
Objectives	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
Main Results	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
Conclusion	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, Martinón-Torres F
Indian J Crit Care Med. 2013 Jan;17(1):16-22
PMID 23833471, **http://www.ncbi.nlm.nih.gov/pubmed/23833471**

Design	Review
Conclusion	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**

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

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