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Randomized Controlled Trial Comparing Adaptive-support Ventilation with Pressure-regulated Volume-controlled Ventilation with Automode in Weaning Patients after Cardiac Surgery

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Background: **Adaptive-support ventilation (ASV) is a minute ventilation–controlled mode governed by a closed-loop algorithm. With ASV, tidal volume and respiratory rate are automatically adjusted to minimize work of breathing. Studies indicate that ventilation in ASV enables more rapid weaning. The authors conducted a randomized controlled trial to determine whether ventilation in ASV results in a shorter time to extubation than pressure-regulated volume-controlled ventilation with automode (PRVCa) after cardiac surgery.**

Methods: **Fifty patients were randomly assigned to ASV or PRVCa after elective coronary artery bypass grafting. Respiratory weaning progressed through three phases: phase 1 (controlled ventilation), phase 2 (assisted ventilation), and phase 3 (T-piece trial), followed by extubation. The primary outcome was duration of intubation (sum of phases 1–3). Secondary outcomes were duration of mechanical ventilation (sum of phases 1 and 2), number of arterial blood gas samples, and manual ventilator setting changes made before extubation.**

Results: **Forty-eight patients completed the study. The median duration of intubation was significantly shorter in the ASV group than in the PRVCa group (300 [205–365] *vs.* 540 [462–580] min; $P < 0.05$). This difference was due to a reduction in the duration of mechanical ventilation (165 [120–195] *vs.* 480 [360–510] min; $P < 0.05$). There were no significant differences between the ASV and PRVCa groups in the number of arterial blood gas samples taken or manual ventilator setting changes made.**

Conclusions: **ASV is associated with earlier extubation, without an increase in clinician intervention, when compared with PRVCa in patients undergoing uncomplicated cardiac surgery.**

RAPID weaning and extubation plays an important part in "fast-track" recovery after uncomplicated cardiac surgery.[1–3] Different strategies have been proposed to reduce the duration of mechanical ventilation after elective coronary artery bypass grafting, including the use of automated microprocessor modes of ventilation such as adaptive-support ventilation (ASV).[4,5] ASV is a minute ventilation–controlled mode where the optimal combination of tidal volume and respiratory rate are governed by a closed-loop algorithm based on the Otis equation.[6] The Otis equation determines the respiratory rate that is most efficient in terms of work of breathing for the clinician-set minute ventilation, based on the expiratory time constant of the respiratory system. With ASV, the ventilator delivers pressure-controlled breaths in the absence of spontaneous respiratory activity by adjusting inspiratory pressure to achieve the target tidal volume, whereas it changes to pressure support when spontaneous breathing occurs.[7,8] The ventilator delivers additional pressure-controlled breaths if the respiratory rate is below the target respiratory rate during spontaneous breathing. The goal of ASV is to maintain the patient in iso–minute ventilation and reduce the work of breathing.[9,10] Minute ventilation can be manually adjusted by changing the target minute ventilation, setting a percentage of the initial calculated target. Because adjustments to tidal volume and respiratory rate are made automatically, the need for clinician intervention may be less,[11] and weaning may therefore be faster than protocol-driven methods that require clinician input.[5]

In pressure-regulated volume-controlled and volume-support ventilation, the ventilator delivers a constant pressure during inspiration. This pressure is adjusted on a breath-by-breath basis to maintain the preset tidal volume. When automode is activated with inspiratory efforts, the ventilator switches automatically from controlled to support mode and returns to controlled mode should the patient become apneic. As the patient makes greater inspiratory effort, the inspiratory pressure is automatically reduced. Because adjustments to inspiratory pressure and mode are made automatically, the need for clinician intervention may also be less, and weaning may again be faster than protocol-driven methods that require clinician input.[12]

Therefore, in effect, both ASV and pressure-regulated volume-controlled ventilation with automode (PRVCa)

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are forms of pressure-controlled and pressure-support ventilation. However, the algorithm governing the level of pressure delivered and whether a controlled or support breath is delivered is different. Both ASV and PRVCa have been shown to be superior to simple protocol-driven weaning using synchronized intermittent mandatory ventilation (SIMV) followed by pressure-support mode[5,11,12]; however, there are no studies to determine whether ASV is superior to PRVCa. Therefore, we conducted an unblinded randomized controlled trial to determine whether ventilation in ASV mode results in a shorter time to extubation in postoperative cardiac surgical patients than with PRVCa mode.

Materials and Methods

Approval for the study was obtained from the Clinical Research Ethics Committee of The Chinese University of Hong Kong (Shatin, Hong Kong, China), and preoperative written consent was obtained from all study patients. This was an unblinded randomized controlled trial. Inclusion criteria were adult patients (> 18 yr) undergoing elective coronary artery bypass grafting. These patients were consecutively screened for eligibility. The preoperative exclusion criteria were concomitant valvular or aortic surgery, age older than 80 yr, preoperative left ventricular ejection fraction less than 30%, chronic obstructive pulmonary disease requiring bronchodilator therapy, significant hepatic disease (alanine aminotransferase or aspartate aminotransferase >150 U/l), renal failure (creatinine >200 μM), history of seizure, or stroke.

Postenrollment exclusion criteria were severe early postoperative hemorrhage (chest tube drainage > 500 ml/h), surgical complications necessitating reoperation, myocardial ischemia (ST-segment depression) lasting more than 30 min, postoperative cardiac failure necessitating high-dose inotropes or intraaortic balloon pump, refractory hypoxemia (ratio of arterial oxygen tension [Pa_{O_2}] to fraction of inspired oxygen [F_{IO_2}] < 150 mmHg), or occurrence of neurologic deficit.

All study patients were anesthetized using a standard approach: premedication with 7.5–10 mg oral midazolam; induction with 5–10 μg/kg fentanyl, 20–50 μg/kg midazolam, and 0.2 mg/kg etomidate; muscle relaxation with 1 mg/kg rocuronium; and maintenance of anesthesia with propofol (1 mg $\cdot$ kg^{-1} $\cdot$ h^{-1}) or sevoflurane (end-tidal carbon dioxide concentration kept between 0.5 and 4%). Boluses of 50–100 μg fentanyl were given for intense stimulation and on rewarming. Coronary artery bypass grafting was performed using a standard technique by a single surgical team. Cardiopulmonary bypass was used in most cases (table 1). During transfer from the operating room to the intensive care unit (ICU), all patients were sedated with a propofol infusion of 1–2 mg $\cdot$ kg^{-1} $\cdot$ h^{-1}. In the ICU, patients were given nurse-controlled analgesia using morphine boluses of 1–2 mg intravenously, repeated at 10-min intervals as required.

Table 1. Preoperative Clinical Variables

Variable	ASV, n = 23 [92]	PRVCa, n = 25 [100]
Age, yr	68 (56–70)	62 (56–67)
Sex, M/F	18/5	23/2
Height, cm	166 ± 10	164 ± 6
Weight, kg	67.7 ± 13.8	68.7 ± 11.6
Body mass index, kg/m^2	24.8 ± 3.5	25.9 ± 4.0
Preoperative left ventricular ejection fraction, %	61 ± 15	69 ± 11*
Parsonnet score	6 (3–11)	6 (3–6)
EuroSCORE	4 (0–5)	2 (0–4)*
Anesthesia duration, min	217 ± 35	230 ± 37
Surgical procedure		
CABG—on pump	18	21
CABG—off pump	5	4
CPB duration, min	77 (58–84)	72 (64–87)
Cross clamp duration, min	42 ± 8	42 ± 9
Fentanyl total dose, μg/kg	9.8 ± 2.3	9.4 ± 2.8
Midazolam total dose, mg/kg	0.11 (0.03–0.14)	0.11 (0.1–0.14)
Temperature on ICU arrival, °C	36.3 ± 0.8	36.1 ± 0.7

In brackets are the percentages of patients in each group successfully completing the study. Values are mean ± SD or median (interquartile range), except number of males and females.

* $P < 0.05$ *vs.* adaptive-support ventilation (ASV) group.

CABG = coronary artery bypass graft; CPB = cardiopulmonary bypass; EuroSCORE = European System for Cardiac Operative Risk Evaluation; ICU = intensive care unit; PRVCa = pressure-regulated volume-controlled ventilation with automode.

On arrival to the ICU, patients were randomly assigned to either the ASV group or the PRVCa group using sealed envelopes. The randomization sequence was computer generated to ensure equal numbers of patients in each group. Two different ventilators were used because no single ventilator provides both ASV and PRVCa. Patients randomly assigned to ASV were ventilated using the Galileo ventilator with software version GMP 03.43 (Hamilton Medical AG, Rhazuns, Switzerland). Patients randomly assigned to the PRVCa group were ventilated in PRVCa using the Servo^{i} ventilator (Maquet, Solna, Sweden). The ventilation protocol is given in figure 1. Respiratory weaning for all study patients consisted of three consecutive phases. Phase 1, the controlled-ventilation phase, began at the start of mechanical ventilation in the ICU and ended with the recovery of sustained assisted breaths. Phase 2, the assisted-ventilation phase, began with the recovery of sustained assisted breaths and ended when peak airway pressures less than 15 cm H_2O were achieved during assisted breaths for at least 20 min or when patients were deemed to have failed the weaning protocol (fig. 1). For phase 3, patients underwent a T-piece trial for at least 30 min. After 30 min, patients were extubated, provided they fulfilled the following extubation criteria: fully responsive, pain free, adequate cough, no significant hemorrhage (chest tube

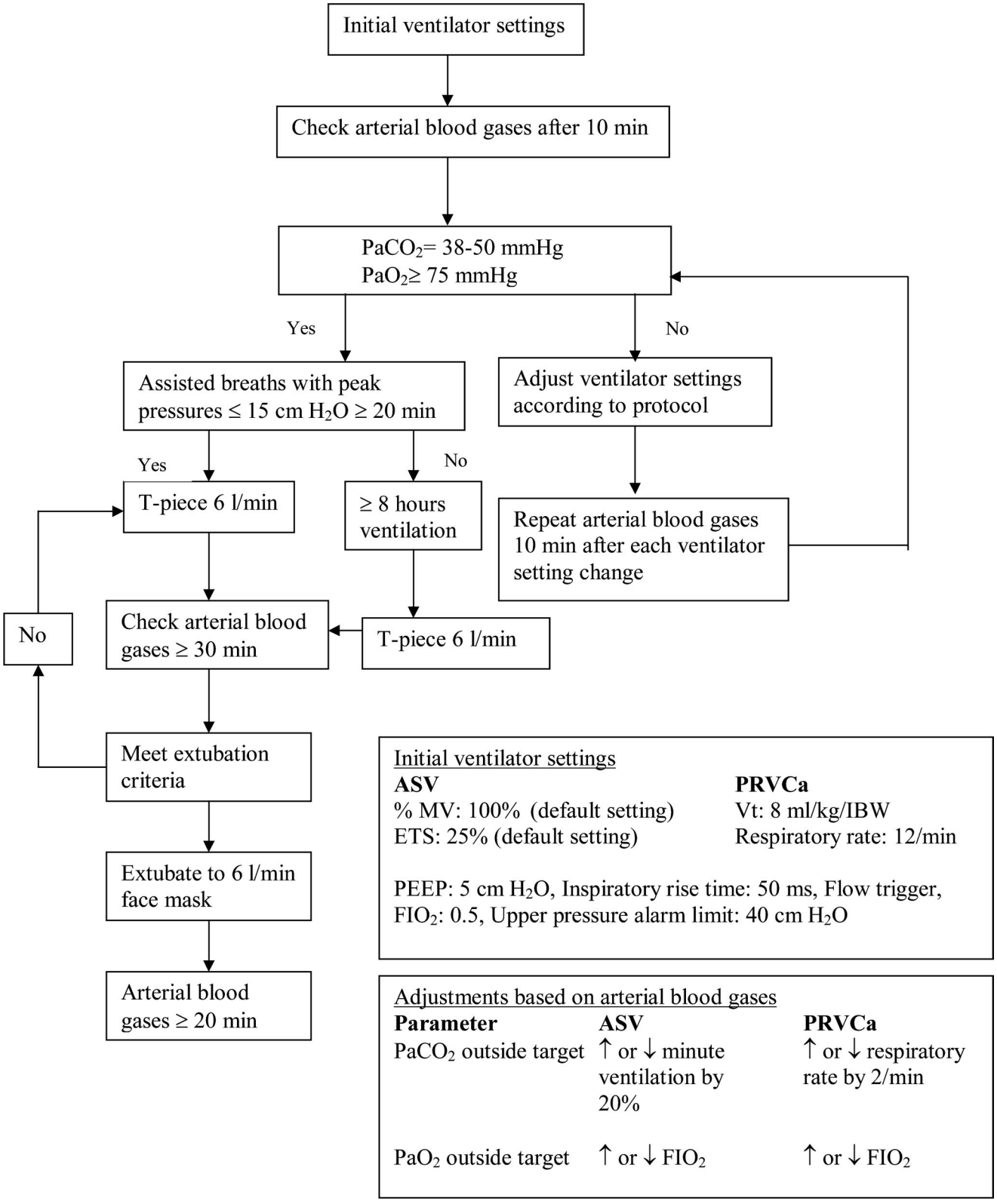

Fig. 1. Ventilation protocol for adaptive-support ventilation (ASV) and pressure-regulated volume-controlled ventilation with automode (PRVCa). ETS = expiratory trigger sensitivity; F_{IO_2} = fraction of inspired oxygen; IBW = ideal body weight; MV = minute ventilation; $Paco_2$ = arterial carbon dioxide tension; Pao_2 = arterial oxygen tension; PEEP = positive end-expiratory pressure; V_T = tidal volume.

blood loss ≤ 100 ml/h), stable cardiorespiratory parameters (absence of uncontrolled arrhythmia, mean arterial pressure ≥ 60 mmHg on dopamine < 2 $\mu g \cdot kg^{-1} \cdot min^{-1}$ and/or epinephrine < 0.1 $\mu g \cdot kg^{-1} \cdot min^{-1}$, respiratory rate ≤ 30 breaths/min), and satisfactory arterial blood gas results on a fraction of inspired oxygen concentration of

0.5 or less (pH 7.35–7.45, arterial carbon dioxide tension [$Paco_2$] ≤ 50 mmHg, Pao_2 ≥ 75 mmHg) using a blood gas analyzer (Chiron Medilab 865; Bayern, Switzerland). Patients who did not meet the protocol criteria for a T-piece trial within 8 h were considered to have failed the weaning protocol. They underwent a T-piece trial provided they had stable cardiorespiratory parameters at the discretion of the senior intensive care resident and were extubated on successful completion of the trial. Data from these patients were included in the analysis.

Other aspects of ICU management followed standard unit protocols. In brief, arterial blood pressure, central venous pressure, electrocardiography, and pulse oximetry were monitored continuously. Normal saline and gelatin-based colloid solutions were used for fluid resuscitation. Hemoglobin concentrations were maintained at 8 g/dl or greater. Dopamine or epinephrine was used to maintain mean arterial pressure at 60 mmHg or greater, and glyceryl trinitrate and sodium nitroprusside were used to treat hypertension (mean arterial pressure ≥ 100 mmHg). The bedside nurses assessed analgesic requirements and gave boluses of 1–2 mg morphine to a total of 10 mg on patient request if the patient was fully awake or if the patient was still sedated when hypertensive and restless.

Demographic data (table 1) were obtained from patients' notes and charts. Hemodynamic parameters (heart rate, mean arterial pressure), arterial blood gas results, and total morphine dose were recorded. Respiratory parameters (tidal volume, respiratory rate, minute ventilation, peak airway pressures, mean airway pressures) and total duration of mechanical ventilation (phases 1 and 2) were continuously recorded and electronically downloaded from the ventilators. Postoperative morbidity and mortality data were obtained from prospectively collected databases.

The primary outcome of this study was duration of postoperative intubation. Secondary outcomes were duration of postoperative mechanical ventilation (phases 1 and 2), duration of phases 1–3, number of patients failing to wean within 8 h, number of arterial blood gas samples, and manual ventilator setting changes before extubation.

Statistical Analysis

A prospective power calculation indicated that a sample size of 25 per group was required to achieve 80% power based on an effect size of a probability of 0.24 that an observation in the PRVCa group is less than an observation in the ASV group using the Mann–Whitney test, an α of 0.05 (two-tailed), and a 20% dropout.

Data were analyzed with SPSS 14.0 for Windows (Chicago, IL). Continuous variables were tested for normality using the Kolmogorov-Smirnov test with Lilliefors significance correction and for homogeneity of variance using the Levene test. Those variables that met both criteria are given as mean ± SD, and the others are given as median (interquartile range). The durations of intubation, mechanical ventilation, and each phase were compared using the Mann–Whitney U test and are expressed as median (interquartile range). For cardiorespiratory variables (table 2) mean values were compared by two-way analysis of variance for repeated measures to assess the effect of group and phase. No *post hoc* comparisons were made. *P* values (two-tailed) less than 0.05 were considered significant.

Results

Of the 50 patients enrolled in the study, 48 successfully completed the study and were considered in the statistical analysis (fig. 2). Two patients (ASV group) were withdrawn because of postoperative bleeding, and their data were excluded from the analysis. One patient (PRVCa group) required reintubation 30 h after extubation because of lobar collapse of the lung. Data from this patient were included in the analysis. Preoperative left ventricular ejection fraction was lower and European System for Cardiac Operative Risk Evaluation (EuroSCORE) was higher in the ASV than the PRVCa group, but otherwise the two groups did not differ in their baseline and perioperative characteristics (table 1).

Median duration of intubation was significantly shorter in the ASV group than in the PRVCa group. The observed reduction in intubation time was mainly a result of shortening of duration of mechanical ventilation (table 3).

Seventeen patients in the PRVCa group and 3 patients in the ASV group did not reach the protocol criteria for a T-piece trial within 8 h because they did not reach either the target airway pressure (1 ASV group, 14 PRVCa group) or the target pH (2 ASV group, 3 PRVCa group). All of these patients successfully underwent a T-piece trial and were extubated promptly. The data from these patients was included in the nonparametric analysis of time to extubation.

Cardiorespiratory variables in the various phases of the study are given in table 2. Total morphine dose and number of manual ventilator setting changes before extubation were similar in the two groups. Postoperative morbidity and mortality are described in table 4. No adverse events directly related to mode of ventilation were noted.

Discussion

These results demonstrate that use of ASV in patients after uncomplicated coronary artery bypass grafting is associated with more rapid weaning of mechanical ventilation and extubation compared with use of PRVCa. An observational study reporting the use of ASV in 155 patients after cardiac surgery has shown that it is safe, is easy to apply, and allowed extubation of 86% of patients

Table 2. Cardiorespiratory Variables of the Patients in the ASV Group (n = 23) [92] and PRVCa Group (n = 25) [100]

Parameter	Group	Phase 1	Phase 2	Phase 3	*P* Value
RR, breaths/min	ASV	14.7 ± 4.4	18.8 ± 5.4	19.4 ± 2.9	< 0.001*
	PRVCa	15.8 ± 2.9	15.2 ± 3.0	19.1 ± 3.9	
V_T, ml/kg	ASV	7.3 ± 1.0	7.1 ± 0.9	NA	< 0.005†
	PRVCa	8.0 ± 0.9	8.2 ± 1.5	NA	
MV, ml · kg^{-1} · min^{-1}	ASV	109 ± 39	133 ± 40	NA	< 0.001‡
	PRVCa	127 ± 29	124 ± 30	NA	
Ppeak, cm H_2O	ASV	17 ± 2	16 ± 4	NA	< 0.05*
	PRVCa	21 ± 5	19 ± 4	NA	< 0.005†
Pmean, cm H_2O	ASV	9 ± 1	8 ± 2	NA	< 0.001*
	PRVCa	10 ± 1	8 ± 1	NA	
pH	ASV	7.39 ± 0.06	7.35 ± 0.04	7.34 ± 0.04	< 0.001*
	PRVCa	7.38 ± 0.06	7.39 ± 0.06	7.35 ± 0.05	
$Paco_2$, mmHg	ASV	37 ± 6	40 ± 6	41 ± 6	< 0.05*
	PRVCa	37 ± 6	36 ± 8	39 ± 5	
Pao_2/Fio_2, mmHg	ASV	314 ± 109	369 ± 116	355 ± 79	< 0.05*
	PRVCa	339 ± 146	387 ± 84	391 ± 119	
Heart rate, beats/min	ASV	81 ± 11	82 ± 13	82 ± 12	
	PRVCa	81 ± 10	81 ± 10	83 ± 12	
MAP, mmHg	ASV	81 ± 9	79 ± 8	79 ± 7	
	PRVCa	79 ± 6	79 ± 5	79 ± 5	

In brackets are the percentages of patients in each group successfully completing the study. Values are mean ± SD. Differences between groups and phases are not significant unless otherwise stated.

* Phase comparison. † Group comparison. ‡ Interaction between phase and group.

ASV = adaptive-support ventilation; MAP = mean arterial blood pressure; MV = minute ventilation; NA = not applicable; $Paco_2$ = arterial carbon dioxide tension; Pao_2/Fio_2 = ratio of arterial oxygen tension to fraction of inspired oxygen; Pmean = mean airway pressure; Ppeak = peak airway pressure; PRVCa = pressure-regulated volume-controlled ventilation with automode; RR = respiratory rate; V_T = tidal volume.

within 6 h.[4] Findings from our study were similar. ASV was well tolerated, 74% of patients in the ASV group were extubated within 6 h, and no adverse events related to mechanical ventilation were reported.

Two recently published randomized controlled studies have compared ASV with SIMV in the time to extubation after fast-track cardiac surgery.[5,11] Sulzer *et al.* [5] showed a reduction in the duration of intubation in the ASV group, whereas Petter *et al.*[11] found no difference in duration of intubation, although ASV had the advantage of requiring fewer ventilator manipulations. However, in the study of Sulzer *et al.*,[5] the reduction in ventilation time was predominantly due to a reduction in the duration of controlled ventilation, raising the possibility that the apparent benefit of ASV may simply reflect a delay in manually switching patients in the SIMV group to pressure support. In our study, ASV was compared with PRVCa. Neither of these modes requires a manual switch to an assist mode. Furthermore, both are pressure-preset modes.

Our data and those of Sulzer *et al.*,[5] combined with the finding of Petter *et al.*[11] of fewer ventilator manipulations, suggest that ASV may be superior to both PRVCa or SIMV with pressure support for weaning patients after uncomplicated coronary artery bypass grafting in terms of reducing duration of intubation. In our study, duration of intubation was reduced by 4 h.

The optimal weaning method remains controversial, and some would question whether even more rapid extubation could be achieved by regular, repeated assessment by an experienced clinician. Although this has not been formally tested, this view is supported by our findings that all the patients who failed the weaning protocol successfully completed a T-piece trial and were rapidly extubated and the previous finding that the majority of ventilated patients do not require weaning.[13,14] The disadvantage of such an approach is that it requires an additional intervention by an experienced, trained clinician and therefore is likely to be less suitable in busy or less well-attended units.

There were significant differences between the ASV and PRVCa groups in peak airway pressures and tidal volumes in phases 1 and 2 of the study. This is likely to be due to the different algorithms used in the two modes. In ASV, the inspiratory pressure and rate are adjusted to maintain the preset minute ventilation while minimizing work of breathing, whereas in PRVCa, the inspiratory pressure is adjusted to maintain the preset tidal volume. Minute ventilation and $Paco_2$ did not differ significantly between groups, suggesting that the differences in inspiratory pressure and tidal volume were not due to intrinsic differences between the two groups of patients. The fact that use of ASV resulted in a lower tidal volume may well be the explanation of the more rapid achievement of the target pressure for initiation of a T-piece trial (phase 3) in the ASV group.

The data reveal no benefit of ASV in terms of postoperative complications, mortality, ICU duration of stay, and postoperative duration of stay. The study was not designed to examine these endpoints. Adequate investigation of low-frequency events would have required a

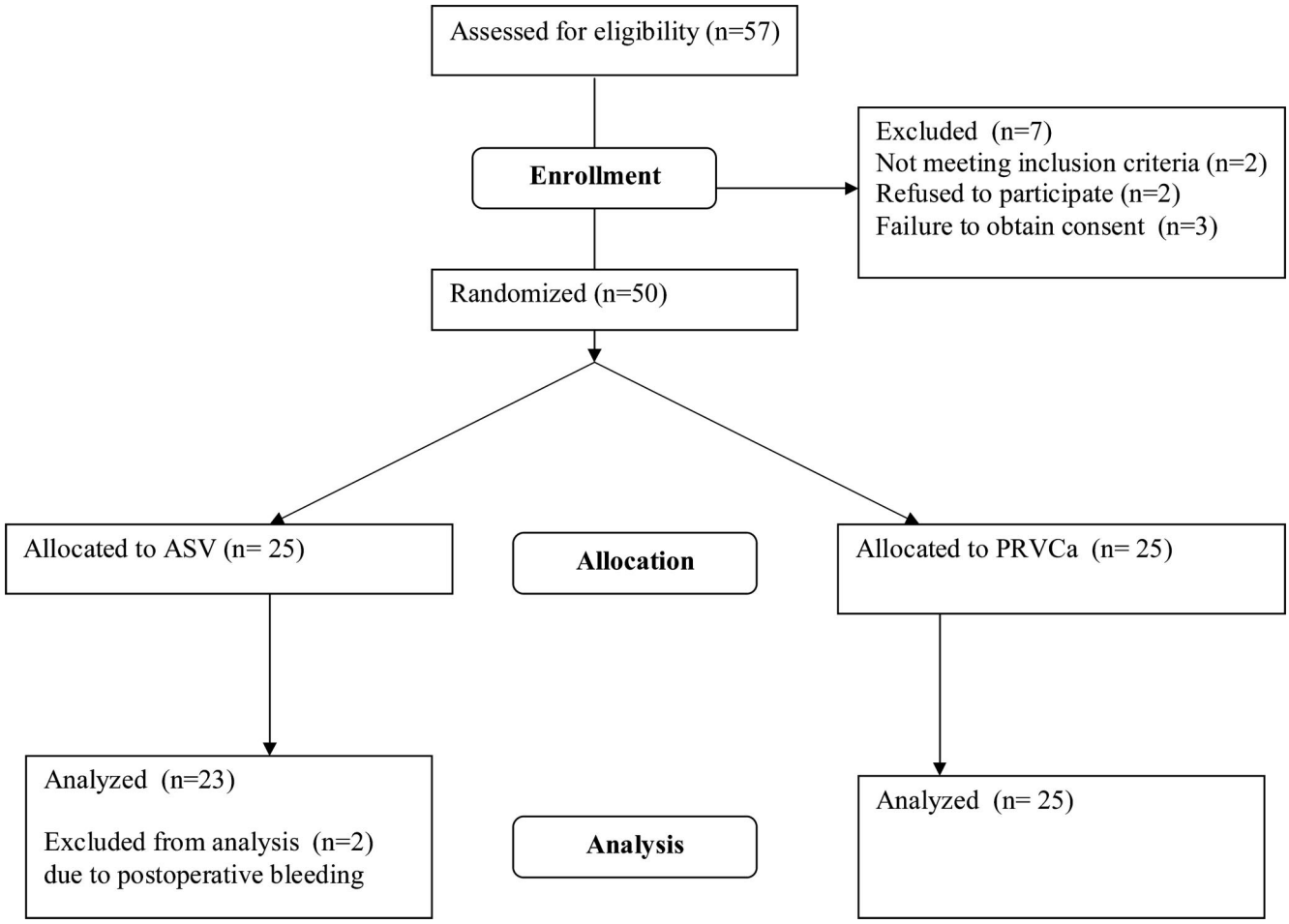

Fig. 2. Flowchart of the study. ASV = adaptive-support ventilation; PRVCa = pressure-regulated volume-controlled ventilation with automode.

much greater sample size, and in our hospital it is usual for cardiac surgical patients to remain in the ICU overnight regardless of whether they require mechanical ventilation. However, in units with a higher turnover and a greater pressure on cardiac intensive care beds, the reduction in time to extubation might result in shorter ICU stay and therefore significant cost savings.[1]

There were a number of limitations of the study. First, it was impossible to blind the two groups, as with most studies on mechanical ventilation. Second, the study was not powered to demonstrate a difference in patient morbidity or mortality. Third, it could be argued that the airway pressure criteria for initiation of a T-piece trial were excessively stringent and that use of more relaxed criteria would have resulted in earlier extubation. However, this should not have a differential effect depending on the mode of ventilation. Fourth, it is possible that the differences were due to differences in the ventilation protocols and not the modes. In particular, more rapid weaning in the PRVCa group might have been achieved had a lower target tidal volume been used. The tidal volume (8 ml/kg) was reached by clinical consensus and is broadly similar to the tidal volumes used in the comparator group of previous studies.[5,11,12] We believe, therefore, that many clinicians might choose this tidal volume although there may be argument for using low tidal volumes even in the absence of acute lung injury.[15] Equally more rapid weaning might have been achieved in the ASV group if a lower initial target minute ventilation had been set, instead of using 100% of the calculated target. Target values used in previous studies have ranged from 25% to 100%.[5,11] We used 100% because this is the most conservative value and because it is the ventilator default value. Because this was a pragmatic study, we used the ventilator default settings for inspiratory–expiratory cycling during spontaneous breathing because we believe it likely that this is the value most clinicians would use. Unfortunately, this resulted in a minor difference in the flow rate at which cycling occurred (25% of peak inspiratory flow in ASV and 30% in PRVCa). Although in theory this would have resulted in the requirement for a marginally higher pressure to achieve the target tidal volume in the PRVCa group, we believe it is unlikely that this minor difference would explain the large difference in time to extubation demonstrated in this study. Furthermore, we believe that

Table 3. Intensive Care Management of the Patients Completing the Study

Variable	ASV, n = 23 [92]	PRVCa, n = 25 [100]
Duration of mechanical ventilation, min	165 (120–195)	480 (360–510)*
Duration of intubation, min	300 (205–365)	540 (462–580)*
Duration of phase 1, min	21 (6–41)	60 (24–153)*
Duration of phase 2, min	147 (91–171)	357 (163–468)*
Duration of phase 3, min	60 (40–145)	45 (35–80)
Reintubations	0	1
Number of patients extubated after > 8 h	3	17
Number of ABGs	4.7 ± 2.4	4.9 ± 1.7
Number of manual ventilator setting changes	1.5 ± 1.3	2.2 ± 1.2
Morphine total dose, mg	4.9 ± 3	5.0 ± 2.2

In brackets are the percentages of patients in each group successfully completing the study. Values are mean ± SD or median (interquartile range).

* $P < 0.05$ *vs.* adaptive-support ventilation (ASV) group.

ABG = arterial blood gas analysis; PRVCa = pressure-regulated volume-controlled ventilation with automode.

most clinicians will use the two modes with default settings, and therefore, in these cases, the inspiratory–expiratory cycling settings can be considered an intrinsic part of the mode. Similarly, there may be subtle performance differences between the two ventilators, such that the inspiratory pressure displayed is not truly accurate. This might result in patients in one group seeming to reach the target pressure sooner. However, because ASV is only available on Hamilton ventilators and PRVCa is only available on Maquet ventilators, it is not currently possible to separate performance differences from differences in the two modes. We believe that in clinical practice, clinicians are likely to accept the pressures at face value and that therefore the differences we have demonstrated are likely to be reflected in clinical practice. Furthermore, a recent study of the performance of different ventilators concluded that, at least in pressure-support mode, the performance of ICU ventilators is relatively homogeneous.[16] Finally, it is possible that ASV did not reduce time to extubation but that PRVCa increased time to extubation. However, the previous demonstration that PRVCa results in a shorter time to extubation than SIMV suggests that this is unlikely.

Table 4. Postoperative Morbidity and Mortality

Variable	ASV, n = 23 [92]	PRVCa, n = 25 [100]
Any postoperative complications	3 (13)	3 (12)
Readmissions to intensive care	0 (0)	0 (0)
Reoperations	1 (4)	0 (0)
Arrhythmias requiring intervention	2 (9)	2 (8)
Pulmonary complications	1 (4)	1 (4)
Infective complications	0 (0)	0 (0)
Gastrointestinal complications	0 (0)	0 (0)
Postoperative strokes	1 (4)	0 (0)
New requirement for renal replacement therapy	0 (0)	0 (0)
Intensive care duration of stay, h	22 (19–23)	22 (19–23)
Postoperative duration of hospital stay, days	6 (5–6)	5 (5–7)
In-hospital deaths	0 (0)	0 (0)

In brackets are the percentages of patients in each group successfully completing the study. Results are given as number of patients (%), except for duration of stay, which is given as median (interquartile range). There were no significant differences between groups.

ASV = adaptive-support ventilation; PRVCa = pressure-regulated volume-controlled ventilation with automode.

In conclusion, the current study has shown that use of ASV is associated with earlier extubation, without an increase in clinician intervention or arterial blood gas sampling, when compared with use of PRVCa in patients after uncomplicated coronary artery bypass grafting. When combined with preexisting data, this suggests that ASV may be useful in facilitating fast-track recovery in these patients.

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