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Characteristics and outcomes of patients treated with airway pressure release ventilation for acute respiratory distress syndrome: A retrospective observational study☆

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ABSTRACT

Background: The optimal mode of ventilation in acute respiratory distress syndrome (ARDS) remains uncertain. Airway pressure release ventilation (APRV) is a recognized treatment for mechanically-ventilated patients with severe hypoxaemia. However, contemporary data on its role as a rescue modality in ARDS is lacking. The goal of this study was to describe the clinical and physiological effects of APRV in patients with established ARDS.
Methods: This retrospective observational study was performed in a 23-bed adult intensive care unit in a tertiary extracorporeal membrane oxygenation (ECMO) referral centre. Patients with ARDS based on Berlin criteria were included through a prospectively-collected APRV database. Patients receiving APRV for less than six hours were excluded.
Results: Fifty patients fulfilled the eligibility criteria. Prior to APRV initiation, median Murray Lung Injury Score was 3.5 (interquartile range (IQR) 2.5–3.9) and PaO_2/FiO_2 was 99 mmHg (IQR 73–137). PaO_2/FiO_2 significantly improved within twenty-four hours post-APRV initiation (ANOVA $F(1, 27) = 24.34$, $P < .005$). Two patients (4%) required intercostal catheter insertion for barotrauma. Only one patient (2%) required ECMO after APRV initiation, despite a majority (68%) fulfilling previously established criteria for ECMO at baseline. Hospital mortality rate was 38%.
Conclusions: In patients with ARDS-related refractory hypoxaemia treated with APRV, an early and sustained improvement in oxygenation, low incidence of clinically significant barotrauma and progression to ECMO was observed. The safety and efficacy of APRV requires further consideration.

1. Background

The mortality associated with acute respiratory distress syndrome (ARDS) remains high and has changed little in the last twenty years [1]. Despite the advent of lung protective ventilatory strategies, consensus on the optimal mode of ventilation in patients with ARDS is lacking. Airway pressure release ventilation (APRV) is an established mode of ventilation based on the open-lung approach, allowing unrestricted spontaneous breathing with intermittent mandatory ventilation [2–4]. Positive pressure (P_{high}) is applied for a prolonged time (T_{high}), with a release phase (P_{low}) for a short period (T_{low}) [2,3].

Potential advantages of using APRV in ARDS include increased recruitment of lung units due to an increase in functional residual capacity, reduction in atelectrauma through decreased cyclical recruitment and derecruitment, unrestricted spontaneous breathing improving ventilation/perfusion (V/Q) matching and reduction in sedation and neuromuscular blockade requirements [2,5–10].

Compared with other conventional ventilatory modes, APRV may improve oxygenation, length of stay in the intensive care unit (ICU) and ventilator-free days [6–8,11–16]. As such, APRV may represent an alternative to extracorporeal membrane oxygenation (ECMO) [17] in patients with severe hypoxaemic respiratory failure secondary to ARDS. However, data investigating the safety and efficacy of APRV as a rescue therapy in this group is lacking [9,10].

☆ Conflicts of interest: The authors declare that there are no conflicts of interest.

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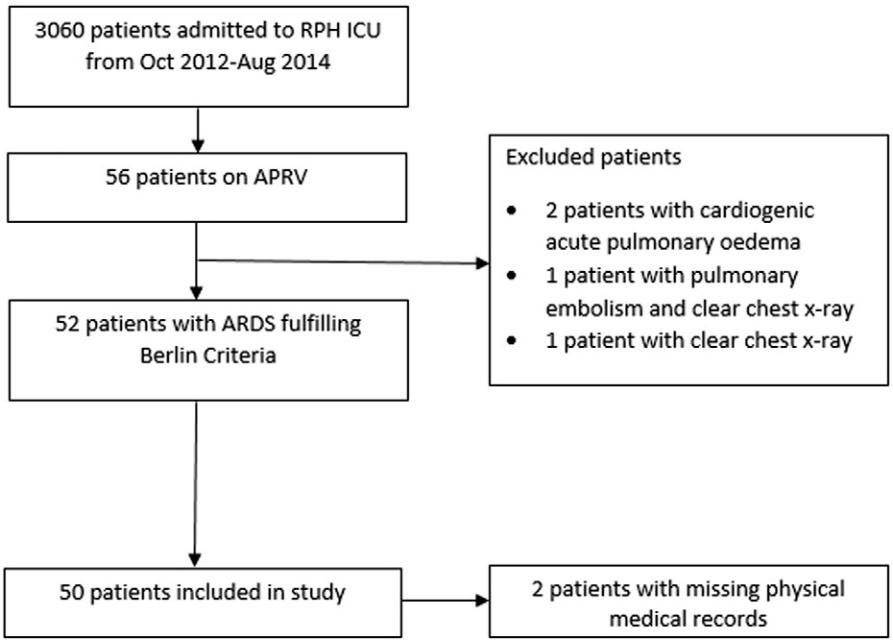

Fig. 1. Flow chart of the patients included in the study.

Therefore, the objective of this study was to describe the safety and efficacy of APRV initiation in patients with established ARDS, with the consideration of its role as a rescue therapy and alternative to ECMO.

2. Materials and methods

This retrospective observational study was performed at Royal Perth Hospital's (RPH) ICU, a 23-bed adult ECMO referral centre in Western Australia. Ethical approval and waiver of consent was obtained from the RPH Human Research Ethics Committee (approval number REG 14–103). All patients on APRV were identified prospectively and included in a database.

Patients aged 18 years and above, receiving APRV ventilation during their index admission to the ICU and diagnosed with ARDS based on Berlin criteria [18] were included. Patients receiving APRV for less than six hours, or for an indication other than ARDS were excluded. Data related to oxygenation and ventilation was not included in analysis if a patient was initiated on ECMO. Ventilator (Puritan Bennett 840) APRV parameters were initially adjusted by the attending intensive care physician, with reference to previously published guidelines [19]. Briefly, release time was adjusted to maintain a peak expiratory flow rate termination of 50–75%, the number of releases was minimized to encourage spontaneous breathing, automatic tube compensation was set at 100%.

Data for each patient was collected on a pre-specified case report form and included baseline characteristics such as age, gender, body mass index, admission time to hospital and ICU, admission source and category, acute physiology and chronic health evaluation (APACHE) II score, date and time of intubation, mode of ventilation prior to initiation of APRV and date and time of APRV initiation. Radiographic requirements for the diagnosis of ARDS were derived from the attending radiologist's final chest x-ray report. Additional Berlin criteria were derived from the participant medical notes and ICU observation charts.

Table 1
Baseline characteristics of patients. Statistics presented as median and interquartile range (IQR) unless otherwise stated.

Characteristic	*N = 50*
Age	44 (37–55)
Male sex, n (%)	29 (58)
Admission type, n (%)	Medical 36 (72) General surgical 6 (12) Trauma 5 (10) Other 3 (6)
Source of ICU admission, n (%)	17 (34) 10 (20) 4 (8) 19 (38)
Lung injury mechanism, n (%)	Pulmonary 39 (78) Extrapulmonary 11 (22)
Acute Physiology and Chronic Health Evaluation (APACHE) II score	23 (19–29)
Predicted mortality based on APACHE II score	0.39 (0.30–0.60)
Hours from intubation to APRV	2 (0–23)
ARDS severity (Berlin criteria), n (%)	Mild 12 (24) Moderate 17 (34) Severe 21 (42)
Murray Lung Injury Score	3.5 (2.5–3.9)
Mode of ventilation prior to APRV, n (%)	Direct to APRV 14 (28) SIMV VC 6 (12) Bilevel 22 (44) Pressure support 7 (14) Assist control 1 (2)
PaO_2/FiO_2 ratio prior to APRV (mmHg)	99 (73–137)
Spontaneously breathing on initiation of APRV, n (%)	29 (58)
Noradrenaline requirement on initiation of APRV (mcg/kg/min), mean (SD)	0.15 (0.28)

Table 2
Ventilatory parameters on initiation of APRV and 12 h post-APRV initiation. Statistics presented as median and interquartile range (IQR) unless otherwise stated.

Ventilatory parameter	
On initiation of APRV	*N = 50*
P_{high} (cmH_2O)	30 (26–30)
Peak airway pressure (cmH_2O)	32 (29–35)
Mean airway pressure (cmH_2O)	25 (24–26)
Set pressure (cmH_2O)	30 (26–30)
Tidal volume (ml)	500.0 (400.0–600.0)
12 h post initiation of APRV	*N = 35*
P_{high} (cmH_2O)	28 (24–30)
Peak airway pressure (cmH_2O)	32 (28–35)
Mean airway pressure (cmH_2O)	25 (24–26)
Set pressure (cmH_2O)	28 (24–30)
Tidal volume (ml)	500.0 (400.0–650.0)