

# Adaptive Support Ventilation as the Sole Mode of Ventilatory Support in Chronically Ventilated Patients

D. M. LINTON, G. RENOV, J. LAFAIR, L. VASILIEV, G. FRIEDMAN  
*Beit Hadar, Chronic Ventilatory Center, Ashdod, ISRAEL*

---

## ABSTRACT

**Objective:** To describe the outcome of patients admitted to a new private facility for chronically ventilated patients in the Ashdod area of Israel.

**Methods:** On arrival, all patients were placed on Adaptive Support Ventilation (ASV) at 90% of target minute ventilation for lean body weight, reducing progressively in weekly decrements of 10% down to 60% of target minute ventilation if adequate spontaneous ventilation was maintained by the patient.

**Results:** Almost half (12/27) of these patients admitted in the first 12 months following establishment of the facility were successfully weaned from mechanical ventilation within 2 weeks to 2 months of admission.

**Conclusions:** The cost effectiveness of this form of closed loop mechanical ventilation in achieving weaning automatically, without the need for respiratory therapists or continuous attendance by intensive care specialists to conduct weaning trials is demonstrated by these results. (**Critical Care and Resuscitation 2006; 8: 11-14**)

**Key words:** Adaptive lung ventilation, chronic respiratory failure

---

A new private facility for chronically ventilated patients in the Ashdod area of Israel was commissioned and opened with authorisation from the Department of Health in February 2004. Patients in need of chronic ventilation and rehabilitation are able to be referred to this facility by their medical aid service providers if their families reside in the vicinity of Ashdod. This referral is only approved after a minimum of three months of chronic ventilation, with attempted weaning from that ventilation in a primary referral hospital in Israel.

The facility accepts all patients referred if they are haemodynamically stable, have no uncontrolled (persistent) or antibiotic-resistant bacterial chest infection and are chronically ventilated via a tracheotomy tube.

## PATIENTS and METHODS

All patients had their tracheotomy tubes changed on admission to new, fixed-flange thermo-sensitive, inert tracheotomy tube (Portex Ultra blue line, SIMS), with high volume low pressure cuffs, of the largest diameter accommodated by their tracheas. These tracheostomy tubes were placed as part of the chronic ventilation ward protocol, to limit airway resistance and tracheal wall cuff pressure and reduce the risk of tube rotation in the trachea. On arrival all patients were placed on Adaptive Support Ventilation (ASV), applied with a Raphael (Hamilton Medical, AG) mechanical ventilator at 90 - 100% of target minute ventilation for lean body weight.<sup>1-3</sup> The target was reduced weekly in decrements of 10% down to 60% of target minute ventilation, if

adequate spontaneous ventilation was maintained by the patient at all times.<sup>2,3</sup>

Indices of total airway resistance, lung compliance and pressure support requirement were recorded automatically and monitored continuously to determine the optimal positive end expiratory pressure (PEEP) level and possible need for bronchodilator therapy in each patient. Patients with hypoxic brain injury who had increased muscle tone or reflex muscle spasms were treated with appropriate antispasmodic medication such as clonazepam and/or baclofen. Routine nursing, as usually practiced in the institution for incapacitated patients, was provided to prevent anticipated complicat-

ions such as hospital- or ventilator-associated pneumonia, catheter associated infections or pressure sores.

In the first 12 months after opening and receiving the first patient on 24.3.04, until 23.3.05, the centre accepted 27 patients who had required chronic ventilation for periods varying from 3 months to 2 years (Table 1). The patients included 18 male and 9 females (ages 22 - 96 years). Eight patients (6 males and 2 females) were in semi-coma or coma due to hypoxic brain injury after cardiac events requiring cardiopulmonary resuscitation or severe head trauma. Three male patients and two female patients had intractable congestive cardiac failure due to severe ischaemic heart

**Table 1. Data for the first 12 months for the 27 patients who required chronic mechanical ventilation**

<i>N</i>	<i>Age</i>	<i>Sex</i>	<i>Reason for chronic ventilation</i>	<i>Admitted on</i>	<i>Date of discharge or death*</i>	<i>Status at study end</i>
1	59	M	Hypoxic injury after prolonged CPR	24.03.05	Not applicable	60 % ASV ventilation
2	73	M	CVA (Pons)	30.03.04	Not applicable	Complex Nursing section
3	47	M	Severe Head Trauma	31.03.04	30.06.04	Home
4	76	M	Abd wall dehiscence/Polyneuropathy	14.04.04	4.05.04	Home
5	78	M	Severe Head Trauma	3.05.04	Not applicable	60 % ASV ventilation
6	96	M	Recurrent aspiration pneumonia/Sepsis	20.04.04	15.08.04*	Died (on ventilation)
7	71	M	Chronic CHF	11.05.04	17.05.04*	Died (in referring Hosp)
8	73	F	CVA (Pontine)	18.05.04	16.06.04*	Died 3 days post wean
9	72	M	Chronic Sepsis + Chronic renal failure	22.06.04	7.09.04*	Died (on ventilation)
10	70	M	Hypoxic injury after prolonged CPR	15.07.04	Not applicable	60% ASV ventilation
11	71	F	Bronchiectasis + Lung Fibrosis	18.07.04	1.03.05	Home on partial vent.
12	86	F	CVA + severe COPD	11.08.04	Not applicable	60 % ASV ventilation
13	69	M	Hypoxic injury after prolonged CPR	09.09.04	22.12.04	Home on partial vent.
14	76	M	Post CABG complicated by sepsis	17.12.04	7.01.05	Home
15	79	F	Chronic IHD, MI + pulmonary oedema	30.12.04	30.03.05	Home
16	78	M	CHF + COPD	12.01.05	12.02.05*	Died (in referring Hosp))
17	50	M	Aspiration Pneumonia + COP	23.01.05	7.02.05	Home
18	78	F	Recurrent Pneumonia + CRF	18.01.05	17.02.05*	Died
19	32	F	Chronic bilateral Pneumonia + COP	7.02.05	Not applicable	60 % ASV ventilation
20	74	M	Post severe Pneumonia	7.02.05	16.03.05	Home
21	60	M	Severe Head Trauma	13.02.05	10.05.05	Complex Nursing section
22	73	F	Hypoxic injury after prolonged CPR	23.02.05	3.04.05*	Died
23	73	F	Severe COPD	27.02.05	Not applicable	60 % ASV ventilation
24	83	M	CVA (Pons)	28.02.05	Not applicable	60 % ASV Ventilation
25	22	M	Tetraplegia/Chronic respiratory failure	05.03.05	20.03.05	Home
26	49	M	ALS + recurrent pneumonia	08.03.05	Not applicable	60 % ASV ventilation
27	59	F	Hypoxic injury after prolonged CPR	20.03.05	Not applicable	60 % ASV ventilation

CPR = cardiopulmonary resuscitation, CVA = cerebrovascular accident, CHF = chronic heart failure, COPD = chronic obstructive pulmonary disease, COP = chronic organising pneumonitis, CABG = coronary artery bypass grafting, IHD = ischaemic heart disease, MI = myocardial infarction, CRF = chronic renal failure, ALS = amyotrophic lateral sclerosis, ASV = Adaptive support ventilation, CPR = cardiopulmonary resuscitation

disease. Two male and two female patients (one aged 80 years) had hemiparesis and semi-coma after large cerebrovascular accidents (CVA). One male patient had longstanding cerebral palsy with tetraplegia. One male patient had terminal amyotrophic lateral sclerosis (ALS). Two female patients had chronic organising pneumonitis and pulmonary fibrosis. Two patients had persistent sepsis and chronic renal failure. One male patient had an industrial work accident and sustained severe head trauma followed by intracranial sepsis. One male patient had critical illness polyneuropathy after sepsis and dehiscence of his anterior abdominal wall. One 96 year old male (the oldest patient) had a confusional state and chronic aspiration pneumonitis after severe sepsis due to cholecystitis. One psychiatric patient with severe schizophrenia and one patient with severe Parkinson's disease had chronic aspiration pneumonia and bronchiectasis. The study analysis ended 2 months after the date of the last admission for the period under review

## RESULTS

Almost half (12/27) of the patients admitted in the first 12 months were successfully weaned completely off mechanical ventilation within 2 weeks to 2 months of admission. All the successfully-weaned patients initially had non-cuffed, fenestrated tracheostomy tubes with speech valves inserted for a few days prior to being decannulated. All patients were monitored continuously for apnoea spells or any indication of the need for increased pressure support (above the minimum of 5 cm inspired pressure support) before and after discontinuation of ASV. Blood pressure, pulse rate, temperature, pulse oximetry and capnography were measured periodically during and after mechanical ventilation was discontinued.

All patients unable to be weaned (12/27) within a two month period after the last admission remained on no more than 60 % target alveolar ventilation on the ASV mode (*viz*: partially ventilated only). Two patients who could clearly not be weaned due to poor pulmonary compliance were subsequently sent home on portable ventilators.

There were a total of 7 deaths in patients aged between 71 and 96 years old during the period under review. Two male patients (71 and 78 years old) died in their referring hospital on full ventilation after they were sent back there shortly after admission because they were not able to be stabilised. Three patients, 2 of whom had been successfully weaned, subsequently died in the institution during the period under review. One female (80 year old) after successful weaning, died a few days later after a recurrent large CVA, and one male (94 year old) died of uncontrollable sepsis and

renal failure

## DISCUSSION

Our experience shows that it is possible and desirable to use ASV as the sole method of mechanical ventilation to provide optimal, safe ventilation support with early effective automatic weaning when possible in chronically ventilated patients.<sup>1-3</sup> None of the medical or nursing staff who work regular duty shifts at this institution, had previous experience in the weaning of chronically-ventilated or difficult-to-wean patients. The weaning was effectively done automatically by the ASV mode of ventilation, with continuous monitoring of vital signs by the attendant staff. Reductions in target ventilation setting and the final decision to discontinue mechanical ventilation support were made on each occasion by one the authors of this paper. The authors made twice-weekly ward rounds to confirm compliance with ventilation protocols and monitoring of adequate ventilation support by the closed loop ASV mode of ventilation. Automatic weaning, as opposed to physician-directed or protocol-directed weaning, where an experienced physician, intensive care nurse or respiratory therapist makes the progressive changes to ventilator settings, has been found to be safe, reliable and efficient.<sup>2-6</sup>

## CONCLUSIONS

The cost effectiveness of this form of closed loop mechanical ventilation in achieving weaning automatically without the need for respiratory therapists or continuous attendance by specialist anaesthesiologists or intensive care specialists to conduct weaning trials is obvious.<sup>6,7</sup> The additional cost of flow sensors in the patient circuit which are needed to apply the ASV mode is a small price to pay for the major benefit of successful weaning of previously chronically-ventilated patients

Received: 31 July 2005

Accepted: 14 September 2005

## REFERENCES

1. Linton DM, Brunner JX, Laubscher TP. Continuous use of an adaptive lung ventilation controller in critically ill patients in a multi-disciplinary intensive care unit. *S Afr Med J* 1995;85:430-433.
2. Linton DM, Potgieter PD, Davis S, et al. Automatic weaning from mechanical ventilation using an adaptive lung ventilation controller. *Chest* 1994;106:1843-1850.
3. Linton DM. Adaptive Lung Ventilation. *Respir Care Clin N Am*. 2001;7:409-424
4. Kollef MH, Shapiro SD, Silver P, et al. A randomized, controlled trial of protocol-directed versus physician-

- directed weaning from mechanical ventilation. *Crit Care Med.* 1997;25:567-574.
5. Ely EW. The utility of weaning protocols to expedite liberation from mechanical ventilation. *Respir Care Clin N Am.* 2000;6:303-319.
  6. Gottschalk A, Hyzer MC, Geer RT. A comparison of human and machine-based predictions of successful weaning from mechanical ventilation. *Med Decis Making* 2000;20:160-169.
  7. Petter AH, Chiolero RL, Cassina T, Chassot PG, Muller XM, Revelly JP. Automatic "respirator/weaning" with adaptive support ventilation: the effect on duration of endotracheal intubation and patient management. *Anesth Analg* 2003;97:1743-1750.