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Evaluation of portable automatic resuscitators under changing impedance conditions: A lung model study.

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Background: The concern about bio-terrorism, biochemical warfare, and mass casualty situations has left many US cities wondering what would happen if multiple patients required mechanical ventilation simultaneously. Cost of reliable portable ventilators prohibits stockpiling hundreds of ventilators in every municipality. Portable and even disposable low cost automatic resuscitators (AR) have been introduced as a potential answer. We studied the performance of two of these AR in a lung model study.

Method: The Vortran VAR and Oxylator EM-100 were studied. Both devices were set according to manufacturer instructions. The VAR was operated with and without the venturi at flow rates of 20 – 40 L/min and pressure of 30 and 40 cm H₂O. The EM-100 was attached to a regulator at 50 psig and peak pressure was set at 30 and 40 cm H₂O. Both devices were connected to an Ingmar ASL 5000 test lung (Ingmar, Pittsburgh, PA). The test lung was programmed to vary compliance and resistance on a minute to minute basis to evaluate the response of each device to changing lung conditions. Volume, flow, and airway pressures were measured continuously. All tests were accomplished in triplicate. Conditions are shown below.

Condition	Compliance (ml/cm H ₂ O)	Resistance (cm H ₂ O/L/s)
1	100	5
2	50	5
3	10	20
4	100	Insp. 10 / Exp 20

Results: Both devices demonstrated significant decreases in delivered VT with a decrease in compliance. As compliance fell, both devices also demonstrated significant increases in respiratory rate. Auto-PEEP was present during all cases, with increases seen as higher airway resistances. (Auto-PEEP range of 1.2 – 4.6 cm H₂O). Airway pressures were controlled within 3 cm H₂O of set pressure and flow remained constant. Table 2 demonstrates changes in VT(L) and RR (b/min) at each of the conditions at a set peak pressure of 30 cm H₂O.

Device	Condition			
	#1	#2	#3	#4
Vortran VT (L)	1.18±0.05*	0.48±0.01	0.39±0.06	0.98±0.08
FM-100 VT (L)	1.18±0.07*	0.44±0.02	0.39±0.03	1.5±0.13

Vortran RR b/min	11±1.1*	15±2.6	32±4.1	15±1.3
EM-100 RR (b/min)	9±3.1*	12±2.7	26±4.5	6±13

All data are mean ± SD. * p<0.01 vs. other conditions. Compared using ANOVA for repeated measures.

Conclusion: Use of AR results in unpredictable changes in RR and VT as lung conditions change. This has implications for use of such devices unattended and unmonitored.