PREPARING FOR MASS CASUALTIES AND MECHANICAL VENTILATION ALTERNATIVES

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BACKGROUND

The March 1995 Tokyo, Japan incident sounded a wake-up call to health care workers. The intentional release in the subway system, of a chemical neurotoxin Sarin, resulted in 11 deaths and five thousand casualties exhibiting a variety of toxic symptoms requiring medical evaluation. This number rapidly overwhelmed the health care system.[1]

The National Capital Region of Ottawa (Canada) has been fortunate to not have any more serious incident than the very rare use of tear gas. However, with the embassies of many nations located here it is believed that it is only a matter of time before an incident occurs. It had long been recognized that it was not a matter of "if" but "when" a terrorist initiated mass casualty incident would happen. Recognizing this potential scenario for the National Capital Region, the Ottawa Hospital embarked on a series of planning and preparation exercises.

As the Senior Respiratory Therapist representative (responsible for the Emergency/trauma rooms and in-patient wards) on the Chemical, Biological, Radiation, Nuclear Committee, it became rapidly apparent, through discussion, that there was a serious discrepancy between the number of ventilators that would be required and the actual ventilator resources that would be available. Although the Ottawa Hospital is a large tertiary care hospital with 3 sites (1300 beds), with 140 ventilators available on each campus, these numbers would be woefully inadequate in the context of a mass casualty incident. An additional complicating factor was that, on average, 60% of the ventilators are in use with the remaining 40% either in for maintenance or in readiness for the next patients.

In any mass casualty incident (accidental, industrial or terrorism), the finite limit of ventilators determines the number of patients that can be managed. This limit was determined to be both unacceptable and avoidable. The Respiratory Therapy department wanted to prevent compromised patient care and was cognizant of the two major factors facing the health care institution – that of limited health care dollars/funding and the potential number of patients that would present in a mass casualty incident. So, the department undertook a study to determine the most cost effective way of providing basic mechanical ventilation to a large number of patients.

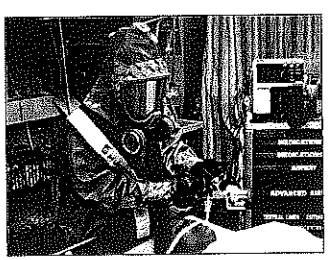
It was determined that a pneumatic automatic resuscitator would offer the best clinical options as to location (not all triage sites would have A/C power), portability, relative ease of use and must be cost effective.

METHODS

SETTINGS: (for all units tested)
TIDAL VOLUME OF 800 mls or 25 cm H2O, Rate of 12 bpm, FiO1 100%
Gas source 50 PSI oxygen

Using a 50 psig oxygen source with the gas flow unrestricted at the source. The devices were connected to:

HME equipped with a flex tube that connected to a 15/22 mm adapter. This in turn was connected to:



CHARACTERISTICS REQUIRED IN A MASS CASUALTY VENTILATOR/RESUSCITATOR

Characteristics	Ambumatic[2]	Genisis II[3]	Vortan Automatic Resuscitator[4]
Patient Type	Pediatric (>3 yrs) and adult	Pediatric (>3 years) and adult	Pediatric (>3 years) and adult
Power source	pneumatic	pneumatic	pneumatic
Portability	<1.5 lb.	<2 lb.	<1 lb.
Pressure cycled	yes	no	yes
volume cycled	yes	yes	no
Rates	12 or 20	8 –12	0 – >40
Antisuffocation valve	yes	yes	yes
pressure relief	yes	yes	yes
pressure monitoring	yes (optional)	no	yes (optional)
Alarms	audible blowoff	audible blowoff	audible blowoff
FiO2 control	60 or 100%	100%	50 or 100%
PEEP	intrinsic	intrinsic	intrinsic
single/multiple use	multiple pts	multiple pts	single
cost CDN(0.62 US$)	> $500	< $400	< $45
replacement parts required and CT scan/ MRI compatibility	yes (valves, etc) Not certified for CT Scan or MRI use	no Not certified for CT Scan or MRI use	no Certified for CT Scan or MRI use

CLINICAL SIMULATIONS – RESPONSE BY ALL UNITS TESTED

"Normal" Patient	PIP 25 cm H2O or Tidal Vol. 800 mls	Rate 12 BPM	INSP. Time
INCREASED COMPLIANCE	INCREASED DELIVERED VOLUME	DECREASED	INCREASED
DECREASED COMPLIANCE	DECREASED DELIVERED VOLUME	INCREASED	DECREASED
INCREASED RESISTANCE	MARKED DECREASE IN DELIVERED VOLUME	MARKED INCREASE	MARKED DECREASE
AIR LEAK (EX. PNEUMOTHORAX, HEMLICH VALVE, CHEST TUBES)	MARKED INCREASE IN VOLUME DELIVERED	MARKED DECREASE	MARKED INCREASE

AGENTS

AGENT:	NERVE (Sarin, Soman, Tabun, Thickened Soman, V-Agent)	LUNG DAMAGING (Phosgene Diphosgene, Chlorine, Chloropicri N, Amonnia)	BLISTERING (Sulfur Mustard, Nitrogen Mustard, Lewisite, Phosgene Oxime)	RIOT CONTROL (Tear Gas, Mace, Dibenzoxa Pine, Pepper Spray)	TRAUMA (Nonleathal Bullets, Bullets, Gas Projectile, Fragmentary Projectiles)
Excessive Mucous/Inter Pulmonary Fluid	Yes	Yes	Yes	Yes	Yes
Increased Resistance	Yes	Yes	Yes	Yes	No
Decreased Compliance	Yes	Yes	Yes	Yes	Yes
Air Leaks	No	Yes	No	No	Yes

1. (INCREASED RESISTANCE) #8.5 ET Tube connected to a wye connector equipped with two #3.0 endotracheal tubes which were placed inside of a 1 liter test lung
2. (DECREASED COMPLIANCE) #8.5 ET Tube connected to a test lung suspended in a sealed chamber which was pressurized to 20 cm H2O
3. (INCREASED COMPLIANCE) #8.5 ET tube connected to test lungs that had been (pre stretched) inflated to 4 liters for 4 days prior to use
4. (AIR LEAK) #8.5 ET tube hooked to a wye connector which in turn is attached to #2.5 ET tube open to atmosphere on one side and to a 1 liter test lung on the other.

The tests were repeated 5 times and the results averaged.

CONCLUSION

Although all three units performed as advertised, each had individual characteristics that would have to be evaluated by the potential user as suitable for their own clinical applications.

The Vortan Respir Tech Pro offered the capabilities of managing the largest number of patients at the most financially responsible costs. In addition, the unit had the advantage of ease of use. The other very important variable was that the equipment offered a simple solution to the handling of contaminated units from a biological or terrorism incident, as it was disposable.

The cost of the other units prohibited one time use and would result, therefore, in a lengthy and expensive decontamination process which might also pose a hazard to hospital staff charged with decontaminating the units.

To date, we have had no actual "hands on" experience with mass casualties but have had 2 live patient exercises.

The Author

Dave Swift, RRT, RRCP, graduated in 1983 from Algonquin College as a Respiratory Therapist. Since 1984 has been a Staff Therapist at The Ottawa Hospital – Civic Campus. For the last 11 years has been the Senior Therapist and Clinical Instructor responsible for Emergency/Trauma rooms, Neonatal special care unit and resc. rooms and all in-patient wards at The Ottawa Hospital – Civic Campus. (1053 Carling Avenue, Ottawa, Ontario, Canada, K1Y 4E9).

References

1 Brackett, D.W.; Holy Terror, Armageddon in Tokyo, New York: Weatherhill, Inc. 1996
2 Ambumatic, Manufacturer: Ambu Inc. Linthicum, MD, USA
3 Genisis II, Manufacturer: O2 Systems Inc., Mississauga, Ontario, Canada
4 VAR (Resp. Tech Pro), Manufacturer: Vortan Medical Technology, Sacramento, California, USA
5 PFAFF., B.L.; Emergency Department Management of Nerve Agent Exposure; Int. J. Trauma Nursing; 4(3); 71-8; 1998 Jul-Sep