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TITLE: IN VITRO AND IN VIVO EVALUATION OF A NON INVASIVE RESPIRATORY MONITOR.

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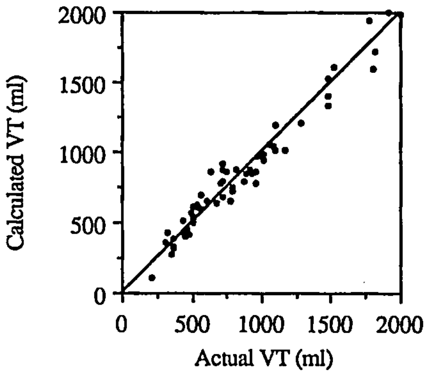
Respiratory volume monitoring usually requires the use of cumbersome devices. We have evaluated a small, light-weight (250 g) device (Breath Monitor, Voltek Enterprise, Willowdale, Ontario, Canada), designed as a non-invasive respiratory rate monitor, for the estimation of breathing rate. The device consists of a pressure transducer detecting the temperature-related changes in a thin-walled, 2x10 mm, silastic cylindrical probe. The probe is connected to the unit through a small-bore plastic tube and positioned near patient's nostril in midstream of airflow, thus exposed to inspired (cold) and expired (warm) gases. A raw and a processed analog signal are available as outputs. In order to test the feasibility and accuracy of actual VT prediction, the device was tested both in vivo and in vitro, recording breath-by-breath actual VT and analog outputs on a polygraph.

In vitro, a Harvard ventilator was used as a lung model, with expired gas warmed by a heated humidifier and inspired gas being room air. The probe was positioned at the inlet/outlet of the breathing circuit. Expired gas temperature (T), inspiratory time (Ti) and VT were changed in steps and compared to analog outputs. A derived value, *DA*, was determined as the breath-by-breath area between the raw signal tracing and a superimposed-baseline representing zero flow. Factorial analysis of variance showed a significant correlation between *DA* and either VT, Ti or T ($p<0.0001$) in a sample of 140 points. An **in vivo** evaluation was performed on two informed volunteers, who breathed at different VT and rates through the nose in an air-tight mask with the probe properly positioned at the nostril. The mask was connected to a Fleish pneumotachograph to measure actual VT. Factorial analysis of variance with actual VT as the dependent variable and *DA* and Ti as independent variables was performed (gas temperature was considered to be constant). In both subjects, *DA* significantly correlated to VT ($p<0.0001$). For each subject, model coefficients were used to calculate derived VT based upon both *DA* and Ti. Calculated VT vs. actual VT are displayed below ($r^2 = 0.96$, $N = 60$).



In summary, the Breath Monitor allows a quantitative estimate of VT when combined with an algorithm correcting each breath for inspiratory time and for gas temperature. This may be useful in a variety of clinical or experimental situations.

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TITLE: INTRALUMINAL GAUGE PRESSURE OF TRACHEAL TUBES AND RISK OF FIRE FROM CO_2 LASERS--CLINICAL MODEL

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To judge whether intraluminal gauge pressure (IGP) might influence the risk of tracheal tube fire during laser operations on the airway, a clinically relevant model was devised and tested.

PVC tracheal tubes of 6.5-mm inner diameter were attached, on one end, to a standard semi-closed anesthesia breathing circuit and, on the other end, to a test lung (resistance, 2 cm H_2O; compliance, 100 ml/cm H_2O). For ventilation, tidal volume (V_T) was set at 550 ml, rate at 10 breaths/min, and the inspiratory-to-expiratory ratio (I:E) at 1:2. Inspiratory gases of helium, 0.6, and oxygen, 0.4 were provided at a 5-L fresh gas flow rate. Carbon dioxide, 0.4, was infused into the test lung. Gas flow and airway pressure were measured and recorded on a multichannel recorder. Fractional concentration of inspired oxygen (F_IO_2) was monitored continuously with a polarographic analyzer. A carbon dioxide laser beam (10 W, 0.8-mm D) was directed at the tracheal tube at a 90 degree angle until a fire occurred or 60 s passed. Exposure of tubes to the laser beam was started at the beginnings of inspiration and expiration and at the end of expiration, with positive end-expiratory pressure (PEEP) (2.5 cm H_2O) and without PEEP for up to 60 s each, 10 tubes being tested under each condition (60 trials total). PEEP was applied with a spring/resistance device.

The incidence of fire was no different whether laser contact began at the start or end of inspiration or at the end of expiration. No matter when the laser was started, all fires occurred with no PEEP during the last 2 s of end-expiration, when airway pressure was lowest during the respiratory cycle (table). No fires occurred with 2.5 cm H_2O PEEP applied to the system.

Tracheal tube fires are most likely to occur when airway pressure is low. PEEP added to the respiratory circuit may decrease the risk of airway fire when a flammable tube is used for airway operations with the carbon dioxide laser.

Table. Incidence of Fires Caused by a Carbon Dioxide Laser in Polyvinylchloride Tracheal Tubes with Helium and Different Levels of Positive End-Expiratory Pressure (PEEP)

Initiation of Laser Exposure	Number of Fires at Different Levels of PEEP*	
	0 cm H_2O	2.5 cm H_2O
Start of inspiration	6†	0
End of inspiration	5†	0
End of expiration	5†	0

*Ten possible, ie, 10 tests were conducted at each condition. †All fires began during end-expiration regardless of when laser exposure began.