THE ENGSTRÖM CARESTATION CRITICAL CARE VENTILATOR

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The Engström name has a long and venerable history in both adult and pediatric critical care. My first experience with the Engström ventilator was in 1965 at the National Institutes of Health's Clinical Center. The Engström 200 and 300 ventilators were the vents of choice in our Cardiac Surgery Post-op Intensive Care Unit. Only slightly smaller than the then popular Volkswagon "bug" they were bulky, heavy and left little room to move around the bed. Frankly, they were intimidating at first sight– but unlike the VW bugs, they were the Cadillac of volume ventilators.

The new Engström Carestation is a far cry from the Engstrom 200 or 300 in terms of size, looks and versatility. It is easily movable on its cart and is very stable.The Engström Carestation (Engström) ventilator by Datex-Ohmeda, Inc. of GE Healthcare has been used extensively in Europe since mid 2004 . Only recently introduced in this country, the ventilator is not as well known in the U.S. as are the Datex-Ohmeda anesthesia machines and monitors. The company hopes their track record in the O.R. will lead the way to the I.C.U. One of the selling points for the Engström is what it offers in terms of monitoring capabilities for the price. Several features of the Engström have the potential to dramatically improve ventilator management of patients with ARDS. The measurements of functional residual capacity and dynamic alveolar pressure in ventilator patients have never been as feasible or as easy as the Engström now allows.

We were supplied with three (3) wire spiral bound, flat opening manuals. The major or main manual is the Users Reference Manual and 8.5 x 11" document consisting of 13 sections over more than 193 pages printed in a two sided configuration. There is plenty of white space in the well conceived manual for note making. The manual is easy to read, clearly written for ease of understanding and employs a multitude of tables, figures and illustrations to aid in imparting the necessary learning.

The main table of contents is eight pages long and very detailed. This leads you to the sections. Each of the thirteen sections has its own mini table of contents making finding information quick and easy. The manual has two excellent features – a glossary of abbreviations and a table of symbols and their meaning. A four page index provides and method of finding the location of needed information. Section 11 alone has 19 pages of very detailed specifications include schematic for mechanical, pneumatic and electrical systems that are clear and easy to follow.

The other two manuals are smaller, pocket sized about 5x7", and are also bound in spiral wire bindings. These manuals are printed on water "proof" paper and may be hard to read in bright environments due to glare off the pages. The first small manual deals with the Engström's "SpiroDynamics" feature. This applications manual is 17 pages long. This guide is packed with clear and meaningful illustration including graphs, drawings, tables and screenshots from a ventilator's monitor screen. The second small (22 page) manual is a application guide for use of the ventilator's FRC determining feature "FRC INview". Both of the smaller manuals are well written, clear and concise. They each contain a good amount of white space for user notes.

Functional residual capacity measurement uses a multiple-breath nitrogen washout technique that requires inspiratory and expiratory analyses of oxygen and carbon dioxide with just a 10 % change in the oxygen level. A single procedure requires two measurements of approximately 20 breaths each. FRC INview also allows a series of FRC procedures to be performed at specified intervals. FRC volumes are displayed graphically and in a table. Since a steady state is required for the FRC measurement, ten minutes may be required to complete the procedure. Therapists accustomed to a procedure that takes as long as a ventilator check may feel that stabilization takes a long time. Ten minutes can drag out but determining the FRC should be worth the wait. In addition, any change in parameters or ventilator settings will interrupt the procedure automatically. FRC measurements are ideally made before and after a lung recruitment procedure or to track changes in the patient's condition.

FRC measurements are also performed for the PEEP INview procedure. PEEP INview automatically measures FRC at incremental levels of PEEP. The clinician sets the start and stop PEEP levels along with the number of steps to be made in between. Each change in PEEP is held for five minutes to ensure stabilization. Values are plotted on a graph and displayed numerically. The Compact Airway Module is required for measuring FRC, carbon dioxide production, oxygen consumption and

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energy expenditure. Oxygen is measured with a paramagnetic sensor that never needs replacing. Lacking a mini Bunsen burner to burn hydrogen that would "consume" oxygen, I attempted to simulate oxygen consumption and carbon dioxide production by manipulating inspiratory and expiratory gas concentrations to a test lung. I was marginally successful but not enough so to produce FRC/PEEP graphs or numbers that made any sense. Therefore, I could not evaluate how easy the PEEP INview graphs are to interpret.

SpiroDynamics measures tracheal pressure via an intratracheal catheter. A tiny catheter, 2 mm in diameter, is fed down the endotracheal tube (ETT) to extend 2 cm beyond the tip of the tube. The catheter is enclosed in a sheath to a y-connection not unlike a closed suction catheter. The catheter is continuous with tubing that connects to the auxiliary pressure port. Catheter pressure eliminates the pressure from resistance of the endotracheal tube during inspiration and accurately reflects the higher alveolar pressure from the ETT during exhalation. The catheter sensor pressure is used in an algorithm to calculate a dynostatic pressure/volume curve that more accurately reflects alveolar compliance. Lower inflection point and upper deflection point are identified by the algorithm. SpiroDynamics dynostatic P/V curve in combination with FRC INview becomes Lung INview. The integration of FRC with the dynostatic curve at different levels of PEEP provides a graphic representation of recruited lung volume. Lung INview provides a better method of evaluating the effectiveness of PEEP than was previously possible.

In addition to the excellent monitoring tools just described, the Engström E has an active exhalation valve in all pressure modes and a response time of 8 ms. Standard modes include volume targeted pressure control, SIMV volume targeted pressure control and Bilevel volume targeted pressure control. Assist control function may be turned off, for example when used with high frequency jet ventilation. In volume control mode the leak compensation feature will compensate a leak of 25% or less of the tidal volume setting. Leak compensation corrects the waveforms as well as reduces the need to re-adjust alarms settings. Trigger compensation helps prevent auto-triggering. Pressure supported breaths have an adjustable flow cycle. If the inspiratory pressure equals the pressure limit during volume control, the flow decreases to lower the pressure until inspiration ends. The nebulizer by Aerogen is mesh or micropump technology and may be programmed for a specific delivery time or for the volume of medication delivered. An especially nice feature is the Snapshot. Pressing Snapshot saves the patient's values, waveforms and ventilator settings at that moment, a particularly handy feature for ventilator checks. The Spontaneous Breathing Trial function has its own alarms and can be timed. A split screen option displays the patient parameters trends during the trial on half the normal screen. And last but not least, the neonatal flow sensor at the proximal airway is the control point for triggering and for volume adjustment in the volume targeted pressure control mode. These features and the monitoring tools make the Engström Carestation ventilator worth some serious consideration.