A new era in transport ventilation

The HAMILTON-T1 on Rega's Bombardier – Challenger 604 fleet

Transport of the critical ill patient: A challenge for mechanical ventilation

The transport of patients requiring mechanical ventilation bears considerable risk. A change of equipment as well as any change in the patient's position can affect the patient's condition. During the transport hypoxemia may occur as a consequence of the inability to reproduce bed-side ventilator settings adequately. Elevated FiO2 concentration may potentially mask a deterioration in lung function and can contribute to absorption atelectases. Hyperventilation is a common complication associated to the poor control of minute ventilation by most of the portable ventilators. Hyperventilation increases intrathoracic pressure, produces air trapping, reduces cardiac output, shifts the oxyhemoglobin dissociation curve to the left hindering oxygen unloading, and causes cerebral and myocardial vasoconstriction. These combined effects may affect patient outcome adversely. [1]

The development of dedicated transport ventilators started at the beginning of last century independent from the ICU ventilators. The transport devices needed to be rugged, lightweight, reliable and operate from battery power or from the pressure of the oxygen. A basic transport ventilator supplies mechanical ventilation at a specified rate and pressure and offers minimal monitoring and alarm capabilities.. Newer devices are more sophisticated and allow for synchronization and (limited) FiO2 therapy.

When Swiss Air-Ambulance REGA was looking to replace the transport ventilators in their jets, their request was to get a ventilator capable of continuing the care provided bed-side during air-transport. Evaluation of the transport ventilators currently available on the market did not meet their requirements. REGA required advanced ventilation technology in a stable transport platform. They found their ventilator solution through a new approach: Equipping their Ambulance jets with the HAMILTON-T1.
The HAMILTON-T1 was developed by HAMILTON MEDICAL, a SWISS company that specializes in designing, manufacturing and marketing critical care ventilators. With the HAMILTON-T1, a new approach has been used to design a ventilator: Instead of taking a transport ventilator and adding ICU features, Hamilton Medical designed a fully equipped ICU ventilator and made it shock-resistant, water-protected and light-weight. In the final phase of the development, a close partnership between REGA and HAMILTON MEDICAL allowed our ventilation specialists to tailor the HAMILTON-T1 exactly to the needs of mechanical ventilation in the air.

Fig.1: HAMILTON MEDICAL designed a fully equipped ICU ventilator and made it shock resistant, water-protected and light-weight (Photograph: HAMILTON MEDICAL)

The HAMILTON-T1:

A full featured ICU ventilator goes transport

The HAMILTON-T1 is equipped with a powerful integrated turbine delivering up to 210 l/min flow and thus guaranteeing high performance, including during non-invasive ventilation. IntelliTrig automatically adjusts inspiratory and expiratory flow trigger for a perfect synchronization between the patient and the ventilator. Besides advanced ventilation features like a FiO2 setting between 21% and 100%, biphasic modes DuoPAP and APRV, trends and loops, the HAMILTON-T1 includes the Dynamic Lung visualizing the patient's lung conditions and Adaptive Support Ventilation (ASV). ASV relies on closed-loop regulation of settings in response to changes in respiratory

mechanics and spontaneous breathing. Once a target minute volume is entered by the clinician using a percent Minute Volume setting, ASV automatically determines a target tidal volume (VT) and respiratory rate combination based on the minimum work of breathing principle.

The advantages of ASV have been shown in various studies. During transport, where conditions are even more difficult, this ventilation mode helps the medical team to optimally ventilate the patient with less user interactions and fewer alarms. The team can focus on what is important.

Case report:
Transfer of a 9-year old boy with open chest from Düsseldorf to Berlin

The first mission with the HAMILTON-T1 was flown in October, 2011 from Düsseldorf to Berlin. The patient, waiting for his transport in Düsseldorf, was a 9 year old boy with a history of cardiac arrest of unclear origin and therefore often needing to be resuscitated. He developed an acute respiratory infection and as a result a cardiac insufficiency, which was to be treated by the implantation of a ventricular-assist device; a procedure which had to be performed in Berlin.

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At the takeover in Düsseldorf, the Rega team was confronted with the boy having an open chest and being connected to an extracorporeal membran-oxygenation device (ECMO). Ventilation on a conventional ICU ventilator had been demanding. The patient was disconnected and reconnected to the HAMILTON-T1. The height of the patient was entered as basic setting and the mode ASV selected. Within a minute, the patient was showing normal ventilation parameters for the circumstances. During the entire flight, the HAMILTON-T1 adapted perfectly to the various changes in environmental and patient conditions and maintained a stable respiratory performance. Throughout the transfer with ongoing ECMO treatment, the Rega team could take care of the patient without the need to constantly check and adjust the ventilator settings. Upon arrival Berlin, the patient was disconnected from the HAMILTON-T1 and reconnected to a conventional ICU ventilator.

Another demanding transport was completed successfully and the Rega team headed back to their base in Zürich, not only satisfied and impressed by their new device, but confident in their new approach to transport ventilation with the HAMILTON-T1.

[1] Martin J. Tobin:
"Principles and Practice of Mechanical Ventilation" p. 611ff, McGraw Hill, 2006

Fig.2: Upon arrival, the patient was disconnected from the HAMILTON-T1 and reconnected to a conventional ICU ventilator (Photograph: Rega)

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