AN IMPROVED USER INTERFACE FOR A RESPIRATORY PROFILE MONITOR IMPROVES THE DETECTION OF INADEQUATE TIDAL VOLUMES

Authors: Matthias Görges, PhD[1]; Lara M. Brewer, PhD[2], Dwayne R Westenskow, PhD[2], and Joseph A Orr, PhD[2]
1) University of British Columbia, Vancouver, BC, Canada; 2) University of Utah, Salt Lake City, UT, USA

Background/Introduction: Elevated Vd/Vt, the ratio of physiologic deadspace to tidal volume, has been associated with an increase in mortality (1, 2). An increase in measured Vd/Vt, when tidal volume is fixed, is mainly caused by an increase of alveolar deadspace, as the amount of airway deadspace is relatively constant. The ARDSnet trial demonstrated that patients who were ventilated with 6mL/kg volume (Vt) and slightly higher PEEP had a 22% decrease in mortality (3). While smaller Vt with a small amount of PEEP may be lung-protective, care must be taken to ensure sufficient minute ventilation to prevent carbon dioxide (CO_2) buildup. Chosing the optimal Vt and respiratory rate pair for a given patient may be challenging if the deadspace is not considered. The purpose of this study is to evaluate if new screens, developed for a future version of a respiratory profile monitor, help facilitate this decision making process.

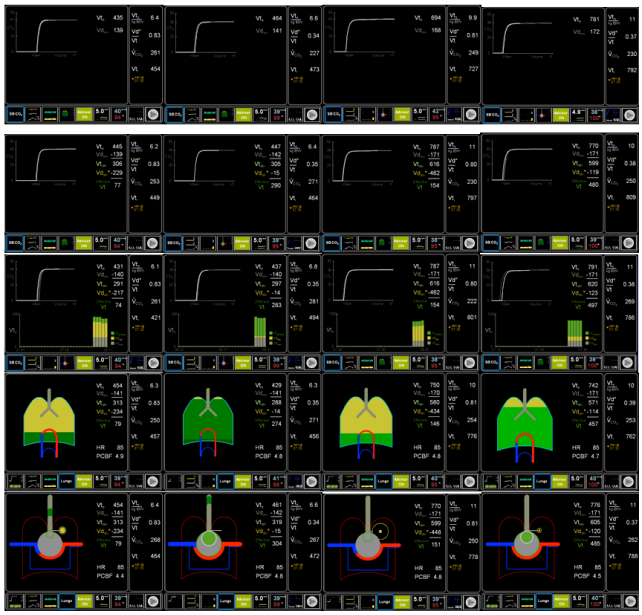

Figure 1: Graphical presentations of deadspace information. The rows, in order from top to bottom, show the following presentations: Control, Calculations, Trends, Physiologic Lung icon, and West Lung icon. The columns, in order from left to right show the four different scenarios: normal Vt_e (high Vd_{alv}), normal Vt_e (low Vd_{alv}), high Vt_e (high Vd_{alv}), and high Vt_e (normal Vd_{aw}).

Methods: An iterative redesign process, based on the NM3 respiratory profile monitor (Philips Respironics, Wallingford, CT), which uses a combination on-airway CO_2 and flow sensor to measure volumetric CO_2, was used to design new screens. Variables were grouped by task and higher-level graphical data presentations were introduced. The existing $SBCO_2$ curve (Control) was compared against all four new data presentation (see Figure 1) concepts using a repeated-measures, within-subject experimental design, with one independent variable: data presentation, and one controlled variable: scenario order. The new data presentations were evaluated in a mocked-up NM3 monitor where we replaced the display with a small touch screen and fed the control elements into a laptop. For each screen the participants were asked 3-4 situational awareness questions. The times required to answer the questions and accuracy of responses were recorded.

Results: Thirteen respiratory therapists, with a median experience of 11 years, participated in the study. The West Lung icon allowed a quicker decision compared to the Control screen as to whether the delivered tidal volume was adequate (median times 5.0 and 2.9s respectively, 95% CI for difference 0.1-2.7s). For the question of whether the alveolar dead space was normal or high, accuracy was improved for all new presentations but the Physiologic Lung (88.6%, with 93.2% for Calculations, 84.1% for Trend, and 90.9% for West Lung, compared to 65.9% for Control). Decision times for this question improved for both lung icons (median times 2.3s for the Physiologic Lung and 3.4s for the West Lung, compared to 5.5s for Control). No difference for decision speed and accuracy were found for the question of whether V/Q mismatch was of concern.

Conclusions: We expect the new screens to reduce respiratory therapists' workload and improve medical decision making, thereby potentially improving patient safety.

References: [1] Respir Care. 2004;49(9):1008-14; [2] Chest. 2007;132(3):836-42; [3] N Engl J Med. 2000;342(18):1301-8