Accuracy and precision of end-expiratory lung-volume measurements by automated nitrogen washout/washin technique in patients with acute respiratory distress syndrome

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Introduction End-expiratory lung volume (EELV) is decreased in acute respiratory distress syndrome (ARDS), and bedside EELV measurement may help to set positive end-expiratory pressure (PEEP). Nitrogen washout/washin for EELV measurement is available at the bedside, but assessments of accuracy and precision in real-life conditions are scant. Our purpose was to (a) assess EELV measurement precision in ARDS patients at two PEEP levels (three pairs of measurements), and (b) compare the changes (Δ) induced by PEEP for total EELV with the PEEP-induced changes in lung volume above functional residual capacity measured with passive spirometry (ΔPEEP-volume). The minimal predicted increase in lung volume was calculated from compliance at low PEEP and ΔPEEP to ensure the validity of lung-volume changes.

Methods Thirty-four patients with ARDS were prospectively included in five university-hospital intensive care units. ΔEELV and ΔPEEP volumes were compared between 6 and 15 cm H2O of PEEP. Results After exclusion of three patients, variability of the nitrogen technique was less than 4%, and the largest difference between measurements was 81 ± 64 ml. ΔEELV and ΔPEEP-volume were only weakly correlated (r² = 0.47; 95% confidence interval limits, -414 to 608 ml). In four patients with the highest PEEP (≥ 16 cm H2O), ΔEELV was lower than the minimal predicted increase in lung volume, suggesting flawed measurements, possibly due to leaks. Excluding those from the analysis markedly strengthened the correlation between ΔEELV and ΔPEEP volume (r² = 0.80). Conclusions In most patients, the EELV technique has good reproducibility and accuracy, even at high PEEP. At high pressures, its accuracy may be limited in case of leaks. The minimal predicted increase in lung volume may help to check for accuracy.