Effect of a fluid challenge on EIT-derived expiratory lung impedance in critically ill patients

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Background

Acute circulatory failure is a life-threatening condition. Fluid loading aims to increase cardiac output and restore organ perfusion. Only 50% of patients are fluid responders, while the remainders are at risk of volume overload (peripheral and pulmonary edema).

Electrical impedance tomography (EIT) shows lung impedance as determined by small electrical currents. An increase in intrapulmonary gas volume increases impedance, while an increase in blood or fluid volume, lowers it. In healthy volunteers, saline administration led to a decrease in lung impedance.

Aim of the present study was to assess the effect of a fluid challenge on EIT-derived lung impedance in critically ill patients with acute circulatory failure.

Methods

Hemodynamic and respiratory variables, blood samples, cardiac ultrasound and EIT measurements were recorded before a 4 ml/kg fluid challenge, and repeated at the end of fluid infusion and 20 minutes after. As a surrogate for stroke volume, the stroke distance assessed by pulsed-wave Doppler examination of the left-ventricular outflow tract velocity-time integral (VTI) was measured; an increase >15% of VTI identified fluid responders. Factorial Analysis of variance for repeated measures was used to compare the values obtained during each study phase.

Results

We enrolled 13 patients (8 males, age 70±10 years, BMI 26±4 kg/m^2). The average volume of the fluid challenge was 280±90 ml. 5 patients were fluid responders (38.5%).

Systolic blood pressure significantly increased with fluid challenge (105±13 vs. 119±24 vs. 121±26 mmHg, p=0.005), as did the VTI (19.5±4.2 vs. 22.1±5.6 vs. 21.9±5.4 mm, p=0.002). End-expiratory lung impedance significantly decreased after fluid administration: 1700±814 vs. 431±436 vs. 207±202 arbitrary units, p<0.001. The decrease in lung impedance was associated with worsening oxygenation (R=0.560, p=0.047) (Figure 1).

Conclusions

Electrical impedance tomography, thanks to its high temporal resolution, could be a valuable tool to assess the effect of fluid loading on lung water.