Monitoring Ventilation and Perfusion in the liquid-ventilated lung
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Abstract: Total liquid ventilation (TLV) of the lungs provides lung lavage and gentle ventilation. EIT could provide real-time monitoring and allow precise control of TLV parameters. We report a preliminary EIT study in lambs of ventilation and perfusion during TLV perflubron filling. Results suggest more homogeneous ventilation with TLV and rapid blood flow redistribution to limits ventilation-perfusion anomalies.

1 Introduction
Total liquid ventilation (TLV) uses liquid perflubron instead of air for gas exchange. Since perflubron is dense ($\rho \approx 2$) it helps keep open dependent lung regions which would otherwise be collapsed (atelectatic) in pathologic conditions such as ARDS (adults) or hyaline membrane disease (neonates)[3]. Transition from air to liquid ventilation has many potential pitfalls. As Ventilated lung regions change from non-dependent to dependent, there is a risk of acute lung distention from the combined presence of air and liquid and blood redistribution to the ventilated area must occur.

We are motivated by the vision that EIT-based monitoring can identify and help avoid risks in the use of TLV. Our objective is to study the distribution of the volumes of air, perflubron and blood perfusion within the lungs using EIT. Our previous report studied EIT measurements of air and liquid volumes in one animal during the induction phase[1].

2 Methods and Results
Eight lambs (aged $2.4 \pm 0.4$ days, $3.2 \pm 0.8$ kg) were anesthetized and ventilated in a supine position using pressure controlled gaseous ventilation. Sixteen EIT electrodes were attached around the thorax and data acquired at 4.7 frames/s using the Sigmatome II EIT device. TLV was introduced using the Inolivent liquid ventilator prototype[2]. Perfusion was measured by a venous injection of a bolus of 7.9% saline solution during an apnea (Fig. 1).

Results were analysed to study the rate at which tidal ventilation and perfusion redistribute after the instillation of TLV. Representative Ventilation (gas and TLV) and perfusion images from one lamb are shown in Fig. 2. Waveforms of global and vertical slices of ventilation are shown, along with images of tidal ventilation (V) and perfusion (P).

3 Discussion
The distribution of ventilation/perfusion may be seen from these images by comparing images $V_0/P_0$ (gaseous ventilation), $V_1/P_1$ and $V_3/P_3$ (for liquid ventilation). Ventilation/perfusion matching is good and happens immediately after filling. However, the risk of overdistention was confirmed by this data and a slower filling protocol is now being used to avoid this problem.

References