Title: **The Current Status of the Automatic Lung Parameter Estimator**

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**Introduction:** Patients with pulmonary gas exchange abnormalities are at risk of developing hypoxaemia and hypercapnia. The underlying cause of the impaired gas exchange is due to mismatch between ventilation and perfusion of the lungs, ranging from V/Q equals zero i.e. pulmonary shunt, to infinitely high V/Q i.e. alveolar dead space.

In 2002 a system was described for measuring pulmonary gas exchange properties. The system known as the Automatic Lung Parameter Estimator (ALPE) [1] is illustrated in Figure 1i, and consisted of a ventilator (A), a gas analyser with pulse oximeter (B), and a computer displaying the captured and recorded data (C). ALPE is used to conduct a 10-15 minutes procedure where the fraction of inspired oxygen ($FiO_2$) is varied in four to six steps, such that the peripheral oxygen saturation ($SpO_2$) is in the range 88-100%. ALPE fits these data to a mathematical model to obtain parameters describing pulmonary shunt and V/Q mismatch.

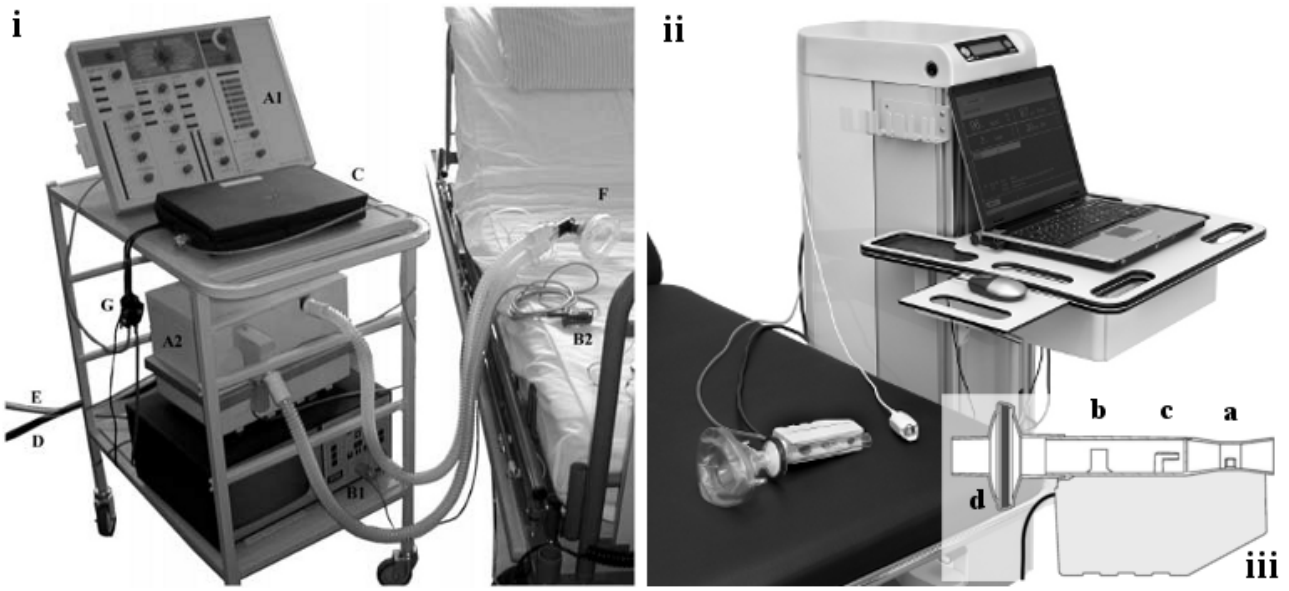


Figure 1: Part **i** of the figure (from [1] with permission) shows the 2002 experimental version of ALPE. A ventilator (A1&A2), a gas analyser with oximeter (B1&B2), and a computer (C) collecting the data are seen. Also the gas-inlet (D&E) and the face mask (F) are shown. In part **ii** of the figure the commercial available ALPE essential is seen, consisting of the main unit including gas tanks and a respiration unit. Part **iii** shows a schematic drawing of the respiration unit where flow (a) and oxygen fraction (b) is measured by mainstream sensors and proper mixing of oxygen and nitrogen is ensured by injection occurring against the stream and being distributed via a lattice (c). The disposable tube also has an antibacterial and humidity filter (d).

**Methods:** Clinical evaluation of ALPE has lead to an improved understanding of the systems limitations, the major being that ALPE includes a mechanical ventilator. Potential existed for simpler, cheaper technology for performing ALPE in patients not undergoing mechanical ventilation. This abstract describes these limitations and addresses the development of a commercial version of ALPE.

**Results:** The use of ALPE has lead to development of dedicated versions for mechanically and spontaneously breathing patients respectively. The research version for mechanically ventilated patients remains in a form similar to that of the 2002 version, having been updated for recent communication protocols and the latest readily available hardware. For spontaneously breathing patients a commercially available version of ALPE [2] has been developed (Figure 1 ii&iii). Gas delivery and measurements are integrated into a single respiratory unit (Figure 1iii). The patient breathes freely through the unit which is open to atmospheric air, introducing minimal resistance. Flow and oxygen fractions are measured via sensors integrated into the respiratory unit (a and b in Figure 1iii) with sensors protected by an antibacterial and humidity filter (d in Figure 1iii). A small amount of either oxygen or nitrogen is injected into the inspiratory stream (c in Figure 1iii). This mixing achieves inspired oxygen fractions ranging from 15% to 40%. The oxygen saturation of blood is measured with an integrated pulse oximeter.

**Discussion:** The commercially developed version of ALPE ensures a fast and precise description of pulmonary gas exchange in spontaneous breathing patients without the need for a mechanical ventilator or other additional equipment.

**References:**

[1] Rees SE, Kjaergaard S, Thorgaard P, Malczynski J, Toft E, Andreassen S. The automatic lung parameter estimator (ALPE) system: non-invasive estimation of pulmonary gas exchange parameters in 10-15 minutes. J.Clin.Monit.Comput. 2002 Jan;17(1):43-52.

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