Early Recognition of Pneumothorax in Neonatal Respiratory Distress Syndrome with Electrical Impedance Tomography

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A female infant, born at 34 weeks of gestation, was admitted to the neonatal ICU owing to respiratory distress syndrome. Continuous positive airway pressure was started for respiratory support. She was included in an observational electrical impedance tomography (EIT) study (ClinicalTrials.gov, Identifier: NCT02962505) at 18 hours of age. A Swisstom BB^2 EIT monitor with a LuMon belt (size: 23.5 cm) was used to collect EIT data. Clinicians were blinded for EIT during recording.

The patient's condition deteriorated after 7 hours of follow-up and the clinician ordered a chest X-ray, in which a left-sided pneumothorax was confirmed at 17:11 (Figure 1). From 14:10 onward, retrospective EIT analysis identified a progressive pattern of EIT parameters that indicated a potential pneumothorax by *1*) increased end-expiratory lung impedance and *2*) decreased tidal EIT signal variation, both at the affected side, resulting from regionally increased air content and reduced ventilation, as well as by *3*) decreased end-expiratory lung impedance at the contralateral side, possibly due to a mediastinal shift and compression of the lung. All effects were augmented by a body position change to the contralateral side at 15:45. Similar patterns of EIT findings indicating pneumothorax have previously been observed in both animal studies and an adult patient (1–4). However, chest X-ray is still the gold standard to confirm the diagnosis in clinical practice.

Early recognition of a pneumothorax complicating respiratory distress syndrome may prevent it from becoming life threatening. In our case, the described EIT changes occurred almost 3 hours before the corresponding clinical diagnosis was made. ■

Author disclosures are available with the text of this article at www.atsjournals.org.

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Supported by the European Union's Horizon 2020 Research and Innovation Programme (Continuous Regional Analysis Device for Neonate Lung [CRADL] project) under grant agreement No. 668259.

This article has an online supplement, which is accessible from this issue's table of contents at www.atsjournals.org.

Am J Respir Crit Care Med Vol 200, Iss 8, pp 1060–1061, Oct 15, 2019

Originally Published in Press as DOI: 10.1164/rccm.201810-1999IM on May 15, 2019
Internet address: www.atsjournals.org

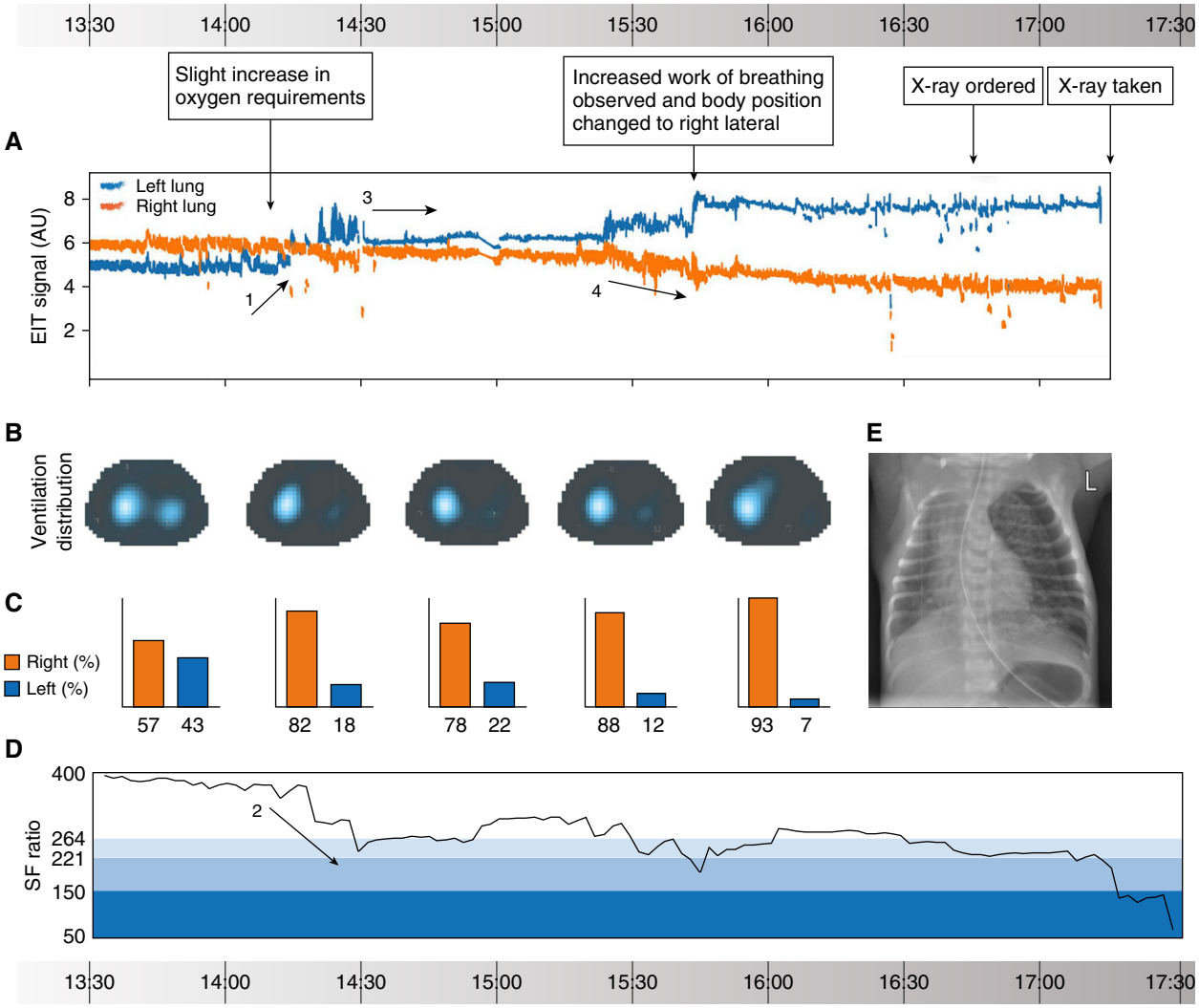

Figure 1. Four-hour examination of a preterm neonate with neonatal respiratory distress syndrome (RDS), with continuous electrical impedance tomography (EIT) monitoring at 48 scans/s during routine intensive care. (*A–C*) EIT findings are presented in terms of continuous EIT signal waveforms in the left and right sides of the thorax (*A*), functional EIT tidal images (*B*), and percentages of ventilation on the right and left sides (*C*) at selected time points. (*D*) The SF (peripheral saturation of oxygen and F_{IO_2}) ratio indicating deterioration in oxygenation is provided as a curve over time. The EIT waveforms show a sudden increase in impedance on the left side (blue line, black arrow 1) consistent with an increased content of high-impedance air in the left hemithorax at the time the pneumothorax potentially developed. Simultaneously, a slight deterioration in oxygenation was observed but was clinically interpreted as a mild worsening of RDS (black arrow 2). This was followed by a reduced amplitude of tidal impedance variation in the same blue waveform (black arrow 3) resulting from decreased regional ventilation and a prolonged fall in electrical impedance in the orange right-side waveform (black arrow 4), possibly caused by a mediastinal shift. Tidal EIT images and the percentages of ventilation show a relatively symmetric distribution with ventilation present in both lung regions before the pneumothorax, followed by a dramatic loss in ventilation in the left lung region after the pneumothorax. (*E*) A chest X-ray confirmed the presence of a pneumothorax. General clinical observations and time points of diagnostic events are given at the top of the figure. More detailed information can be found in Video E1. The Berlin definition of acute RDS was used to define the stages of impaired oxygenation (5). Mild to severe deterioration in oxygenation is illustrated by shading from light to dark blue, respectively. The SF ratio was mapped using Khemani and colleagues' equation (6). AU = arbitrary units.