Comment on Borges et al. “Regional lung perfusion estimated by electrical impedance tomography in a piglet model of lung collapse”

Niels Christian Hellige,1 Günter Hahn,2 and Gerhard Hellige2
1Hannover Medical School, Institute for Diagnostic and Interventional Radiology, Hannover, Germany; and 2University Hospital Goettingen, Centre of Anaesthesiology, Intensive and Critical Care Medicine, Goettingen, Germany

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TO THE EDITOR: The paper by Borges et al. (1) presents an excellent experimental study comparing two approaches for the evaluation of regional pulmonary perfusion by electrical impedance tomography (EIT) with single photon emission computerized tomography (SPECT) as well established reference method.

The negative results on the pulsatility approach confirm the skepticism addressed by recently published papers (3, 5, 6), which point out that there are many sources of error in evaluating cardiac-related impedance changes as blood flow-related signals. On the other hand, the data obtained by impedance indicator dilution are in good agreement with the perfusion distributions acquired by SPECT.

However, related to the evaluation of the indicator dilution curves as well as to the application of 20% sodium chloride solution (NaCl) the following comments are indispensable.

1) Evaluation of indicator dilution curves. The passage of the indicator bolus is recorded as a decrease of impedance because NaCl increases the ion content and hereby raises conductivity of the blood. The authors describe in section Concept of Estimating Regional Lung Perfusion by EIT that for evaluation they are “inverting these curves (multiplying by −1)” (1). To demonstrate the “negative perturbation caused by the hypertonic bolus” in Fig. 1, noninverted dilution curves and corresponding fitted gamma functions are presented.

This procedure is questionable because there is no linear correlation between indicator concentration time course and resistivity changes. Increasing sodium chloride concentration causes fairly proportional increase of conductivity that, however, is inverse to resistivity change (conductivity = 1/ resistivity). This matters that evaluation of the dilution curves recorded by EIT as impedance changes implies underestimation that increases with rising indicator concentration changes. The authors should discuss this issue in relation to the presented evaluation procedure and the resulting data.

2) Use of a 20% sodium chloride solution as indicator. The authors refer the use of hypertonic indicator solution to the 1992 publication of Brown et al. (2), who, however, applied an isotonic 0.9% NaCl solution. About 10 years later the usage of a 5.8% solution in animals was published (4). The actually utilized 20% solution is extremely hypertonic exhibiting an osmolality of ~7,000 mosM and a sodium concentration of ~3,500 meq/l compared with ~300 mosM respectively 140 meq/l in normal blood.

The hyperosmolality will cause major water shift and changes of resistance in pulmonary circulation. The appearance of the high sodium bolus in the coronary circulation after lung passage might be dangerous in patients in view of cardiac contractility and electrophysiology. Ionic x-ray contrast media such as diatrizoates with osmolarity of 2,100 mosM and sodium content of 157 meq/l today in most countries are out of use for angiography because of marked side effects.

Borges et al. conclude that they “describe a novel method based on EIT for estimating regional lung perfusion at the bedside.” This statement suggests a direct transferability of the method in clinical use. The safety of the used NaCl solution on patients should be critically reconsidered.

DISCLOSURES
No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS
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REFERENCES

Address for reprint requests and other correspondence: G. Hellige, Univ. Hospital Goettingen, Centre of Anaesthesiology, Intensive and Critical Care Medicine, Robert-Koch-Strasse 40, 37075 Goettingen, Germany (e-mail: ghellig@gwdg.de).