HIGHLIGHTED TOPIC | Imaging Lung Physiology

Seeing may be believing

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As visual creatures, we have evolved a sophisticated capacity to respond immediately and appropriately when confronted with an image. That immediate pattern recognition is essential for everyday function and also plays an important role in clinical practice with pattern recognition of radiologic lung images. However, respiratory system images acquired in pursuit of physiological questions do not ordinarily provide that immediate recognition, but rather require a challenging series of decisions about findings to include and findings to exclude in pursuit of the question to be addressed. Those analytic approaches based on respiratory system images, however, have ushered in a new era of lung physiology, enabling us to move forward from the simple “balloons on sticks” concepts of lung function that were derived from over a century’s worth of various exhaled breath measurements made at the mouth.

Hardly 5 years have passed since the Journal of Applied Physiology ran a Highlighted Topic on imaging (1), so why another so soon? Put simply, we believe that techniques in development now have the potential to provide new information about integrated lung function taking place at that intermediate level of scale between whole lung measurements and lung microscopy.

In this Highlighted Topic “Imaging Lung Physiology,” we solicited six concise reviews covering different aspects of lung physiology. For each solicited review we brought together at least two authors, one who might primarily be identified as a physiologist and the other an imager. This somewhat coerced collaboration likely posed a challenge to our selected authors, but our intent was to identify the physiological questions that could be informed by the imaging techniques available. Each article focuses not on one imaging modality, but rather on a respiratory system element of interest for physiologists, with the intent to highlight the most appropriate techniques. We hope this choice of focus will serve our readers by providing them with an overview of state of the art techniques.

We begin the series with a physiological wish list: What do we want to measure? In that overview, Tom Robertson and Rick Buxton (6) have laid out a series of questions that they believe imaging (in the broadest sense) could be called on to answer. We started this way because the questions we ask are too often directed by the techniques we have mastered. The intent with this contribution is to encourage broader thinking and to invite the reader to imagine what could be determined in physiological terms if only we could “see” what was going on. Undoubtedly there will be topics not covered in their review, and indeed it is our hope that it will evoke reader responses along the line of “Hey, you didn’t mention . . .” and stimulate them to consider how imaging techniques, both new and old, can be brought to bear on their area of physiological interest.

The other five reviews that comprise the invited section of the Highlighted Topic each focus on a specific area of lung physiology, the first three being: ventilation [Brett Simon, Grace Parraga, and colleagues (7)], perfusion [Sue Hopkins, Hans-Ulrich Kauczor, and colleagues (2)], and regional PO₂ and gas exchange [Johan Petersson and Robb Glenny (5)]. Clearly these are inextricably entwined consequences of physiological questions and the consequence is a (deliberate) degree of overlap, which serves to broaden the perspective from that of one pair of authors to that of a group. Even if your particular focus is only one of these topics, we encourage you to read all three of these brief reviews. Taken together we believe their sum is greater than the individual contributions. Imaging the airways themselves in disease is the topic of a fourth review [Peter Pare, Harvey Coxson, and colleagues (4)]. As the lung transitions from a healthy state to one in which disease overwhelms the underlying physiology, the airways provide an obvious target to imaging. The final review addresses lung growth and mechanical strain [Connie Hsia and Merryn Tawhai (3)] and includes both imaging itself and image-based physiological models. The power of this combination relates to the in silico experiments that can be performed with anatomically appropriate models of physiology. Some of the factors discussed in this series currently lie beyond existing imaging capabilities. If that does not change then the sophisticated modeling discussed in this review may provide the only means of accessing this information. So even if it is not strictly imaging, it provides an important means by which to visualize the physiology of the lung.

The other important component of the Highlighted Topic is our call for papers containing original lung imaging research, for which we received a considerable number of submissions. Those that appear in this and subsequent issues successfully navigated the same stringent peer review process applicable to all submissions to the Journal of Applied Physiology. They represent the state of the art in imaging lung physiology.

For those of us with errant typing skills, there are often recurrent typographic mistakes. One of us (GKP), habitually types “imagining” in place of “imaging,” but perhaps that mistake is appropriate in this case. It is our hope that this Highlighted Topic “Imaging Lung Physiology,” will stir your imagination by enabling you to “see” the physiology of interest and encourage the imagers among you to imagine new and innovative ways of “seeing” the physiology of the lung.

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

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AUTHOR CONTRIBUTIONS

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REFERENCES