Introduction to the Refresher Course on Respiratory Physiology

L. Britt Wilson
Department of Pharmacology, Physiology, and Neuroscience, University of South Carolina School of Medicine, Columbia, South Carolina

Submitted 15 July 2008; accepted in final form 11 August 2008

The fundamental function of the respiratory system is to bring O2 into the body from the environment and rid the body of the CO2 produced by tissue metabolism. This exchange of gases occurs across alveoli of the lungs and is paramount for maintaining homeostasis. While this basic function is critical for homeostasis, the underlying physiology is complex and requires a basic understanding and application of physics and biochemistry. This makes respiratory physiology very "concept" based rather than "fact" based, which is oftentimes very challenging for students at all levels. Thus, helping students understand respiratory physiology represents a challenge for educators. The Refresher Course in Respiratory Physiology, presented at the 2008 Experimental Biology meeting in San Diego, CA, was designed to aid educators charged with teaching this topic. The articles in this issue of Advances in Physiology Education provide a written treatise of these talks, and the four speakers have a wealth of experience teaching this topic. In addition, the powerpoint images for these talks can be found on the American Physiological Society website (http://www.the-aps.org/education/refresher/index.htm). The purpose of this introduction is to highlight the topics discussed in the subsequent articles and provide some rationale as to why these topics were chosen. Although these talks primarily focus on medical education, it is hoped that educators responsible for teaching this topic at various other levels of higher education will benefit as well.

For the Refresher Course, respiratory physiology was divided into four topics. To understand respiratory physiology, one must understand how air moves into and out of the lungs. The first topic, Mechanics of Breathing, describes this process. In his article (9), Dr. West emphasizes how understanding the important underlying physical principles is paramount for understanding the mechanics of breathing. Two of these important concepts are 1) the relationship of pressure, flow, and resistance; and 2) compliance, which defines the pressure-volume relationship. A firm grasp of these concepts suberves many functions in the education of health professionals (8). First, it is the foundation for comprehending the mechanics of breathing. Second, these two concepts are an important foundation for understanding cardiovascular physiology. Because these concepts are critical for respiratory and cardiovascular physiology, reinforcing the relationship of pressure, flow, and resistance and the concept of compliance in both sections of a physiology course is good educational practice. Third, pathological alterations in these physical principles form the basis for the two classes of pulmonary disease: i.e., obstructive and restrictive pulmonary diseases. Obstructive disease is characterized by increased airway resistance, and one of the important diagnostic features is limitation of airflow. Restrictive disease is characterized by alterations in lung and/or chest wall compliance with the resultant decrease in lung volumes and capacities. Diagnostic data such as forced expiratory volume in 1 s, forced vital capacity, and forced expiratory flow between 25% and 75% of vital capacity and their changes to pharmacological interventions are clinical applications of these principles. Peak inspiratory pressure and plateau pressure data recorded from patients on ventilators represent another example of clinical data applying these concepts. Thus, the fundamental principles of pressure, flow, resistance, and compliance are not only important for understanding respiratory physiology but are used on a daily basis by a variety of healthcare workers including anesthesiologists, surgeons, emergency room physicians, respiratory therapists, and critical care nurses and physicians.

Dr. DiCarlo (3) provides several models to assist in teaching the second topic: alveolar ventilation. Alveolar ventilation represents the volume of air entering or leaving the alveoli per minute, which is not the same as the volume entering or leaving the mouth per minute (minute ventilation) because of anatomic dead space. This "fresh air" provided to alveoli is crucial because alveoli are the site of gas exchange, and, thus, alveolar ventilation provides the required O2 and expels the waste product, CO2. As indicated in his article (3), models for students to work with, touch, and manipulate can be a powerful educational tool. Oftentimes students fail to grasp important concepts via words and pictures, but suddenly things “fall into place” when given hands on models.

Since the cardiovascular system actually delivers O2 to the tissues of the body and CO2 to the alveolus, the respiratory and cardiovascular systems are intimately intertwined. This is exemplified by ventilation/perfusion (V/̇A/Q) matching in the lung, the third topic. In his article (4), Dr. Glenny describes his use of a bathtub analogy to help students grasp this difficult but very important topic. The matching of ventilation and perfusion is a crucial component of the fundamental function of the respiratory system, because alveolar and thus arterial blood gases are ultimately tied to V/̇A/Q matching. The importance of this interplay between ventilation and perfusion is not intuitive for the vast majority of students; hence, this topic can be very frustrating for many. Analogies such as the one described can make a marked difference for many students, and understanding this topic is an important component of the education of healthcare workers. V/̇A/Q mismatch can cause arterial hypoxemia, resulting in inadequate O2 delivery to the tissues of the body and a host of cellular problems, thereby disrupting homeostasis. In the clinical arena, one may ask “Is my patient getting O2?” Proper V/̇A/Q matching is central for ensuring...
adequate oxygenation. In addition, $V_{A}/Q$ mismatch could lead to CO$_2$ retention with a resultant respiratory acidosis. Thus, this topic can serve as a segue for teaching acid-base balance. Alternatively, one can briefly revisit $V_{A}/Q$ matching when teaching acid-base balance later in the course, thereby helping to solidify the student’s understanding of this topic.

For the final topic, Dr. Levitzky (6) describes how obstructive sleep apnea can be used as a basis for integrating cardio-pulmonary function. The body is integrated, and physiology represents the study/understanding of this integration. It is one body, and too often students get bogged down on the details related to a given topic, thus failing to recognize and understand the interplay of the various organs as it relates to whole body homeostasis; in short, they lose the forest for the trees. As indicated above, the respiratory and cardiovascular systems are intimately intertwined, and this lends itself to a discussion integrating the two. In my experience, finding topics that illustrate this kind of interaction greatly aids in the understanding of physiology.

Dr. Levitzky’s article (6) also illustrates that the use of a disease or clinical syndrome can be particularly effective in medical education for several reasons (1, 2, 5, 7). First, it plays to students’ interest (4). Second, it makes it relevant to them and their future education, and we, as educators, should always strive to make our teaching relevant to our audience. The students, rightfully so, deserve this. Finally, it puts the information in a proper context, one they are likely to see again and again. This repetition, from different sources looking at clinical entities from slightly different vantage points, helps solidify their overall understanding of the disease and the underlying physiology. While using a clinical syndrome is not requisite when attempting to teach the integrative aspects of physiology to medical students, it is usually quite effective and should be attempted wherever possible.

REFERENCES