AN APPROACH TO UNDERGRADUATE MEDICAL PHYSIOLOGY: "Don't kiss me, I'm trying to breathe."

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A patient-oriented approach to the presentation of basic principles of physiology to first year medical students has been developed and modified by two years' experience at the University of Missouri-Columbia School of Medicine.

The philosophy for the development of the course has been for the staff to place themselves in the position of the medical student and repeatedly ask two questions: "What concepts are essential for understanding the clinical problem under consideration?" and "What would the student want to know next?" Klausmeier and Goodwin's learning models point out that both the relating of new material to what the student already knows and the sequencing of material facilitate the learning of new material, and that the application of information develops students' problem-solving abilities (1). The application of these three principles will be briefly outlined with a sample lecture, describing a patient with emphysema.

The students are given the following introduction: "Our goal for this week is to show how physiologic evidence is drawn upon to solve clinical problems. We will spend the entire week (5 class meetings) developing an understanding of a patient with respiratory disease. We will call upon basic concepts in respiratory physiology to provide insight. Specifically, a case report has been distributed which has been extracted from the records in this hospital. We will examine each of the findings point by point and in this sense the features of the case provide the outline of our studies together." More specific objectives are then presented, in agreement with the advice of Mager who has stressed the value of clearly stating the instructional objectives to the students early in their study (2).

Two important points are worth noting. First, in contrast to the usual clinical correlation, several hours during the week are devoted to a discussion of pertinent features of a single case. This amount of time is appropriate when students are exposed to concepts and clinical problems for the first time, and is necessary to develop fully the physiologic concepts involved. Second, the case abstract is carefully edited so that the concepts presented are general and can be readily perceived by the student as an extension of previous learning, and that laboratory data are internally consistent. Extraneous historical material and data pertaining to organ systems not under consideration act as detractors

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from the main goal for teaching basic concepts in physiology, although of course they will become important considerations for the students at a later stage of their development.

After the students have studied the case abstract, the patient is presented to the class. The interview is directed to emphasize particular aspects to define clearly a set of problems that could be explained by concepts in respiratory physiology. One such problem, the patient's severe limitation in developing an adequate expiratory flow, is demonstrated by her inability to blow out a candle. Furthermore, she described the compensatory mechanism of pursing her lips by stating that she pretended to whistle when walking while shopping. One of the questions posed for the students becomes how does pursing the lips provide a compensation? One student's analysis was entitled, "Don't kiss me, I'm trying to breathe."

The solution to the question involves a thorough understanding of the mechanics of respiration. Towards this end, the factors contributing to the development of pressure to move air out of the lungs are considered, such as the elastic recoil of the lungs and thorax, alveolar surface tension (including the role of surfactant), and the development of positive intrapleural pressure in forced expiration. The relative roles of these factors are considered in a summary example using approximate pressures calculated from factors considered in the discussion. Continuing with the logical organization of the forces coming into play as the rationale for sequencing, the movement of air in the airway is next considered with utilization of Poiseuille's and Bernoulli's laws as they relate to airflow in normal lungs and in lungs of patients with emphysema. It is noted that pressure becomes less in the airway than in the alveoli because of the frictional resistance to air flow. The change in pressure follows Poiseuille's law where

$$\text{change in pressure} = \frac{8 \text{ x flow x viscosity x length of airway}}{\pi\,(\text{radius of airway})^4}$$

(Note that abbreviations are avoided so that the meaning intended is not lost in translation from symbols where, for the example, the symbol r might become rate instead of radius in a student's notes). In the emphysematous patient, the pressure drop along the airway becomes considerably larger than normal due to a decreased radius of the bronchioles. Students are reminded that they had previously encountered one result of the loss of elastic tissue, which was a loss of elastic recoil, but are told that this elastic tissue serves another potentially more important function. The mesh of elastic tissue attached to the small airways tends to hold the airways open in opposition to the positive intrapleural pressure. When the elastic tissue is destroyed by the disease process the radii of the airways are not maintained. The decrease in radii of the fine tubes results in an increased pressure drop across this part of the airway. At this point Poiseuille's law is recalled from previous learning and the fact that the radius is taken to the 4th power in this relationship takes on a meaningful significance for the student.

The pressure-flow relationships are then extended to considerations of flow in flacid tubes. The narrowing of the airway will create a second effect that will increase the pressure drop - the Bernoulli effect. It is worth repeating the frequently made observation, emphasized by John Carroll, that students require differing amounts of time to learn the same material (3). For the case being described, material on the Bernoulli effect is repeated and summarized more frequently than would seem intuitively necessary, simply because some students generate questions about this concept long after other students have demonstrated an understanding of it. Students are now in a position to reconstruct by themselves the series of events in forced expiration that results in the collapse of the airway. Thus the solution to the first question, why the patient was unable to blow out a candle, is detailed in the lecture. The second question, why the patient pretends to whistle while shopping, was left to the students to unravel as a problem-solving exercise. References are provided to aid them in problem-solving to a solution that describes the compensatory mechanisms involved in pursing the lips (4, 5).

Considerable effort has been made in the development of the course to make the material meaningful. The example of increasing the mathematical readibility in the equation in Poiseuille's law has already been given. In addition, terms that would be new to most students are carefully defined and are illustrated by the example of the patient. The student is expected to bring a sufficient understanding of some terms from anatomy. Other terms, like "bleb," are defined in the context of presentation. To aid retention, and to assist students in organizing the material, repetition, advance organizers, and summaries are made throughout. Finally, the staff shows a sensitivity to the problems faced by the students in terms of the demands of learning large amounts of material and at the same time developing a thorough grounding by the application of this material in problem-solving situations.

REFERENCES

1. Klausmeier, H. J., and W. Goodwin. Learning and Human Abilities. 2nd Ed., New York: Harper & Row, pp. 235-278, 1966.
2. Mager, R. Preparing Instructional Objectives. Fearon, 1962.
3. Carroll, J. A model of school learning. Teacher's College Record, Vol. 64, 1963.
4. Fry, D. L., and R. E. Hyatt. Pulmonary Mechanics. Am. J. Med. October, pp. 672-688, 1960.
5. Comroe, J. H. Physiology of Respiration. Yearbook Medical Publishers, Inc., p. 245, 1965.

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