Poster Abstract ■

A New Metaphor to Display Critical Pulmonary Events during Anesthesia

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Background

The anesthesiologist is faced with a fire-hose of information in the operating room. Data from the patient monitors include numerical data, waveforms, control settings, and alarm conditions. During an unexpected event, the anesthesiologist must quickly assess available information in order to diagnose and treat the patient before the patient is injured. However, human error is associated with more than 80% of critical anesthesia incidents and more than 50% of anesthetic deaths.[1] In a recent study at the University of Washington, Department of Anesthesiology, 32% of the reported human error incidents were related to the airway and the pulmonary system directly.[2]

Integrated graphical monitors have been shown to better support the anesthesiologist.[3-6] Such monitors prevent inadvertent cognitive overload, with the design being simple, intuitive, and representative of the underlying data.[7] Using these principles, we have developed an integrated graphical monitor for the pulmonary system.

Methods

The pulmonary graphical metaphor was developed in three stages. First, a problem set of variables was defined. Second, the pulmonary events were devel-

oped through graphical representation. Third, the metaphor was improved through an iterative development cycle.

By examining current monitors, sensors, and machines as well as expert consultation, a list of measured and calculated respiratory variables was created. Next adverse pulmonary events were defined and associated with the variables from the list.[8] These variables, comprising the diagnoses of the pulmonary events, were considered to be part of the metaphor.

The design process began by simultaneously considering simple geometric objects to represent each variable and the overall picture of the pulmonary event. Simple geometric designs were chosen to provide an easily recognizable frame of reference, normal, and abnormal state. For example, a normal condition can be considered a geometrically symmetrical circle. Likewise, a distorted circle would depict an abnormal condition (see Figure 1).

In order to adequately represent the adverse pulmonary event, the simple shapes combined to form a picture that represents the anesthesiologist's mental image. Through an iterative design cycle, a balance between the complex anatomical pictures and simple geometric shapes was reached.
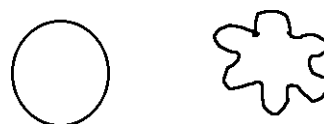

F i g u r e 1   Normal and abnormal states of a circle

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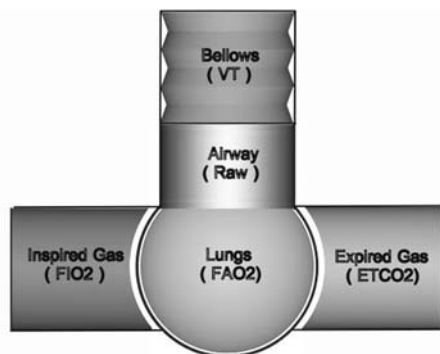
Figure 2 The pulmonary metaphor in a normal state. (Bellows—blue, inspired gas—green, lungs—green, expired gas—gray, airway—metallic.)

Results

The cumulative efforts of our interdisciplinary team (architecture, cognitive psychology, biomedical engineering, anesthesiology, computer science, and medical informatics) and expert opinion, resulted in our current design. (See figure 2) The design anatomically represents the lungs, airway, bellows, inspired gas, and expired gas. Corresponding to the appropriate anatomical component, the measurement values include fractional alveoli oxygen, airway resistance, tidal volume, fractional inspired oxygen, and end tidal carbon dioxide respectively. Future endeavors will formally test the intuitiveness and meaningfulness of this pulmonary metaphor in the arena of anesthesiology.

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