

The cacophony of alarm signals in operating rooms and intensive care units must be decreased. The International Organization for Standardization (ISO) Technical Committee 121, Subcommittee 3 on Ventilators and Related Equipment, is preparing the proposed draft specifications, "Anaesthesia and Respiratory Care Alarm Signals: Part 3. General Requirements" and "Anaesthesia and Respiratory Care Alarm Signals: Part 4. Guidelines on Application of Alarms." Recently, Hyman³ stated that "Operating Room and Intensive Care Alarms and Information Transfer" (ASTM STP 1152)² "should be required reading for anyone involved in designing operating or intensive care rooms, and the associated equipment. Similarly, biomedical engineering students . . . should read this book as part of their design classes as an introduction to the human factors component of the design problem."³ They also should read Wallace *et al.*'s study of how auditory alarms perform at present.¹ Much still needs to be accomplished in improving alarm technology.

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How Should Vascular Resistance Indexes Be Computed?

To the Editor:—Hemodynamic measurements such as cardiac output commonly are scaled by dividing them by body mass or body surface area (BSA) to help reduce interindividual variability. Less commonly appreciated, however, is the fact that resistances such as pulmonary vascular resistance (PVR) are not properly scaled by dividing by BSA. Physically, PVR primarily is determined by the number of vessels, their diameter and length, and the viscosity of the perfusate. Because the number of vessels increases as a function of body size, it is logical that scaling resistance measurements by BSA should result in a larger, not smaller, value.

I have read with great interest the excellent study by Puybasset *et al.*¹ on the influence of inhaled nitric oxide on PVR in patients with

acute respiratory distress syndrome. I wish to point out an error in the units for PVR and systemic vascular resistance (SVR) values in table 1, table 3, and figure 3. It is not apparent whether these are typographical errors or due to the use of an incorrect formula to scale resistances to BSA. If the authors divided PVR by BSA to compute PVRI, as their units would indicate, then the data are incorrect. The correct formula for computing PVR index (PVRI) is: $PVRI = PVR \times BSA$, with the units for PVRI being $\text{dyne} \cdot \text{s} \cdot \text{cm}^{-5} \cdot \text{m}^2$ (note the absence of a minus sign on the exponent of "m"). The formula for SVRI is analogous. However, if the authors calculated PVRI as $PVRI = \Delta P / CI$ (where ΔP is the pressure drop across the pulmonary resistance vessels and CI is cardiac index, where $CI = CO/BSA$), then the values

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for PVRI are correct, and only the units are printed incorrectly. Even if the resistances were computed incorrectly, I do not believe the important conclusions of the paper would be altered. In addition, a typographical error appears in figure 5, in which the units of heart rate are stated as beats/m² instead of beats/min.

Previously, I have reviewed the reasons for the apparently counterintuitive multiplication of SVR by BSA to compute SVRI,² but they are applicable to PVRI. To summarize, blood pressure is a physical measurement (its physical units are dyne · cm⁻²) that should not be scaled to BSA. Ohm's law for fluids states that $\Delta P = \text{flow} \times \text{resistance}$. The flow (physical units cm³/s), when divided by BSA generates a flow index (e.g., CI = CO/BSA). Yet, the product flow index \times resistance index must also equal ΔP . To restate this for the pulmonary circulation, $\Delta P = \text{CI} \times \text{PVRI}$. Dimensional analysis of this equation reveals that PVRI must be calculated as $\text{PVRI} = \text{PVR} \times \text{BSA}$, and the units of PVRI must be dyne · s · cm⁻⁵ · m². Because this error is still seen in the literature, I believe it deserves to be publicized more widely throughout the anesthesiology community.

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In Reply:—We agree with the comments made by Larach about the units of pulmonary vascular resistance index used in our recent paper.¹ Pulmonary vascular resistance index was calculated as ΔP divided by cardiac index or, in other words, as pulmonary vascular resistance times body surface area. Therefore, the units shown in table 1, table 3, and figure 3 are wrong because of a typographical error and should have been written as dyne · s · cm⁻⁵ · m². We have to thank Larach for his careful reading of our paper.

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Skeletal Muscle Relaxation in Patients Undergoing Electroconvulsive Therapy

To the Editor:—Like Beale *et al.*,¹ we found that applying the electrical stimulus for electroconvulsive therapy just after complete abolition of the adductor pollicis muscle response to ulnar nerve stimulation resulted in less-than-satisfactory attenuation of motor activity. We have had much better results using the posterior tibial

nerve. This nerve is easily stimulated by placing the electrodes posterior and inferior and posterior to the medial malleolus.² Stimulation causes plantar flexion of the toes.

Since we usually use one foot as an "isolated limb," it is a simple matter to uncover both feet, place the stimulator on one and a tour-