Volume 58, No. 4
April 1983

THE JOURNAL OF Anesthesiology
THE AMERICAN SOCIETY OF ANESTHESIOLOGISTS, INC.

EDITORIAL VIEWS

Anesthesiology
58:305-306, 1983

In Defense of Double Negatives (as Exponents)

THE WISDOM of the current Journal policy requiring the use of negative exponents for expressing certain compound units has been questioned by some. Readers and authors may well wonder why the Journal has abandoned the old and familiar units expressed with multiple slant lines (the slant line is also called a solidus, virgule, diagonal, stroke, slash, or shilling mark) in favor of units expressed with negative exponents. Some examples will help explain. A common unit used for cardiac index is liters per minute per square meter or $l/min/m^2$, while vascular resistance often is expressed as millimeters of mercury per liter per minute or mmHg/l/min. But what do these expressions mean mathematically? Does one divide the first term by the second and then by the third (*e.g.*, 8/4/2 = 1)? Or does one divide the second term by the third and then the first by the quotient (*e.g.*, 8/4/2 = 4)? The answers to these two questions differ for the two examples above. In the case of cardiac index the first interpretation is correct, and in the case of vascular resistance the second interpretation is intended.

Clearly the use of multiple slant lines is ambiguous. Further, the ambiguity compounds itself when one attempts to use three slant lines (or more). For example, "indexed" vascular resistance can be found written as $mmHg/l/min/m^2$. What does that mean mathematically? In the case of this example, there are four possible interpretations. Even those who use such calculated values seem to disagree regarding the correct calculation (although all would agree that the expression as written above is "correct" not realizing perhaps that they agree only *because* of the ambiguity).

There are several solutions to this dilemma[1]—all of them unfamiliar (for most of us) and some more clumsy than others. The least clumsy solution (a matter of opinion) is achieved by the use of negative exponents. A negative exponent simply converts the unit to its reciprocal, thus $min^{-1} = 1/min$ or $m^{-2} = 1/m^2$. Now cardiac index can be unambiguously written $l \cdot min^{-1} \cdot m^{-2}$, while vascular resistance should be written $mmHg \cdot l^{-1} \cdot min$ (or $mmHg \cdot min \cdot l^{-1}$). Note that by reducing the compound fraction to a series of either multiplication or division (*i.e.*, multiplying by x^{-1}) steps, the sequence in which those steps take place no longer impacts upon the calculation (*e.g.*, $8 \cdot 4^{-1} \cdot 2 = 4^{-1} \cdot 8 \cdot 2 = 2 \cdot 8 \cdot 4^{-1} = 4$). As to "indexed" vascular resistance most users intend to mean $mmHg \cdot l^{-1} \cdot min \cdot m^2$ (that is, perfusion pressure divided by cardiac index) not $mmHg \cdot l^{-1} \cdot min \cdot m^{-2}$ (that is, perfusion pressure divided by cardiac output which is then divided by surface area). The former method will "correct" resistance values appropriately while the latter will do precisely the opposite.

As regards vascular resistance units it is interesting that all apparently accept the "cgs" compound unit written as $dyn \cdot s \cdot cm^{-5}$. For some reason this expression has become quite familiar, and none propose $dyn/cm^5/s$ as a substitute. It would be instructive, I suspect, to research the introduction of this compound term into standard medical texts. Whoever was responsible clearly recognized the ambiguity of double slant lines and from the beginning wrote the term correctly—it never had a chance of being abused.

When the compound unit consists of only two terms there can be none of the above ambiguity. Here there is no mathematical need for negative exponents, and the use of the more familiar slant line is permitted (but not required). Thus, one will find in this Journal such units as ml/min and $ml \cdot min^{-1}$ intermixed—there is no editorial requirement because there is no ambiguity in either expression, and the authors preference is honored.

In summary, those critics who believe the use of negative exponents obscures communication by introduc-

Accepted for publication October 7, 1982.

ing unfamiliar looking units should consider their position more carefully. In the case of double slant lines, familiarity breeds ambiguity (if not contempt) and because of their use future generations may find it impossible to "communicate" with our scientific literature.

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Reference

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