4. NATRELLA MG: *Experimental Statistics,* National Bureau of Standards Handbook 91. Washington, U.S. Govt Printing Office, 1963

Reply

Dr. Collé is, of course, correct in his explanation of the measurement theorist's definition of the terms *accuracy* and *precision;* I was taught these many years ago by Dr. Eisenhart at the National Bureau of Standards. But I also realize that all definitions are arbitrary; e.g., most dictionaries use "precise" as a synonym for "accurate".

I used these same words to draw a distinction, often ignored by researchers, that *precision* relates to variability whereas *accuracy* is associated with lack of bias. The problem with using the definitions advocated by NBS and others is that because of the interrelationship between the two words, a technically accurate explanation tends to obscure rather than clarify precisely the distinction that I wanted to draw.

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Editor's Comment

(In the minds of many people, including those who edit dictionaries, the words "accurate" and "precise" are nearly alike. Since most of us who work with statistics are not 'purists,' perhaps a simple remedy would be the use of words that are more descriptive. Possibly "repeatability"would be an improvement over "precision," and certainly the difference between "repeatability" and "accuracy" is appreciably more obvious. Editor).

Re: Scintigraphic, Electrocardiographic, and Enzymatic Diagnosis of Perioperative Myocardial Infarction in Patients Undergoing Myocardial Vascularization

I read with interest the study by Burdine and coworkers in the July issue of the *Journal of Nuclear Medicine* (*1*), in which they conclude that Tc-99m pyrophosphate myocardial imaging (TcPPi) is "probably the most valuable means of diagnosing perioperative myocardial infarction."

However, the study design is handicapped because of the lack of external determination of the end point. The authors use combinations of the predictor variables to determine the outcome "myocardial infarction."

Further, the particular combinations of predictor variables to define the outcome event appears to bias the study against the possibility that enzyme elevation is the most valuable variable. By requiring both enzyme elevation and TcPPi to be positive for "definite myocardial infarction," "positive" cases cannot be classified by enzyme elevation alone. To qualify as "probable myocardial infarction," the authors require that enzyme elevation must be accompanied by persistent electrocardiographic changes—usually the least sensitive factor in myocardial infarction.

To illustrate the concerns, I have prepared a hypothetical table of data wherein the "truth" is known. Test A represents the least sensitive test and Test B the most sensitive, with Test C intermediate in sensitivity.

Using the "truth," the sensitivity of Tests A, B, and C are 0.621, 0.947 and 0.800, respectively. The specificity of the three tests are 0.989, 0.994, and 0.994. The predictive value of the three tests when positive (PVP) are 0.855, 0.947, and 0.938. The predictive

Group	n	"Truth"	Test results A	B	C	A or (B + C) positive
1	895	−	−	−	−	−
2	5	−	+	−	−	+
3	5	−	+	−	+	+
4	17	+	−	+	−	−
5	3	+	−	−	+	−
6	2	+	+	−	+	+
7	2	+	+	+	−	+
8	16	+	−	+	+	+
9	55	+	+	+	+	+

TABLE

value of the negative tests (PVN) are 0.961, 0.994, and 0.979, respectively. Thus, B is the most sensitive test; B and C are equally specific. B has the highest predictive values for both positive and negative tests.

In contrast, when the criteria A or (B + C) are used, the following figures result. Sensitivity for Tests A, B, and C: 0.812, 0.859, and 0.918. Specificity with these criteria are 1.00, 0.981, and 0.997, respectively. The predictive value of a positive test for the three tests are 1.00, 0.811, and 0.963. Predictive value of negative tests are 0.983, 0.987, and 0.992. Using this analysis, C appears to be preferable to B by each measure of test utility.

The numbers in this example were quickly assembled to illustrate the point that predictor variables should not be used to define the outcome measure. I did attempt to make the incidence of events comparable to those of perioperative myocardial infarction, to make Test A resemble electrocardiographic diagnosis in being the least sensitive of the three methods, and to have Test B with a slight advantage over Test C. The example is not intended to prove that enzyme elevation is the most valuable means of diagnosing perioperative myocardial infarction, although this may be true. Rather, it is to illustrate that, given the approach used by the authors, I cannot conclude that they have demonstrated that TcPPi myocardial imaging is the most valuable means of diagnosing perioperative myocardial infarction.

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REFERENCE

1. BURDINE JA, DEPUEY EG, ORZAN F, et al: Scintigraphic, electrocardiographic, and enzymatic diagnosis of perioperative myocardial infarction in patients undergoing myocardial revascularization. *J Nucl Med* 20: 711-714, 1979

Reply

We agree with Dr. Davidson that the use of predictor variables to determine outcome is less than optimal, but we emphasize that there is no definitive procedure short of necropsy to diagnose perioperative myocardial infarction (POMI). Postoperative assessment of regional wall motion adds valuable information, but is still less than definitive, particularly when damage is confined to the subendocardium. This problem of a lack of a satisfactory "gold standard" hampers all such comparative studies.

While we therefore agree with Dr. Davidson's concerns, we nevertheless believe that he is incorrect in his conclusions. In view