Predictive Value of a Test

The recent letter of George et al. (*1*) misconstrues the requirements for satisfactory decision making, and the beleaguered authors, Frick et al., were correct in their rebuttal. Nevertheless, they failed to explicitly state the real requirements for successful decision making, as I propose to do.

When a positive test result for some disease is obtained, what the nuclear medicine physician really wants to know is this: given a positive test, what is the likelihood that the disease is present in the patient, in this laboratory's experience? This question can be rephrased as follows: what fraction of *all* patients with a positive test have the disease in question? Knowing *only* the sensitivity of the test (the fraction of patients with the disease who have a positive test—"true positive") and its specificity (the fraction of patients without the disease who give a normal result—"true negative") will *not* give the required answer! One must *also* know the occurrence of the disease in the population under study. With this information, the predicitve value of any test is:

$$\text{P.V.} = \frac{\text{F} \times \text{sens.}}{\text{F (spec.} + \text{sens.} - 1) + 1 - \text{spec.}},$$

where F is the fraction of the total population who have the disease in question, spec. = specificity, and sens. = sensitivity, as previously defined. One can then calculate from the findings of Frick et al. that the predictive value of their test was only 67%, although the specificity was 84% and the sensitivity 92%. It is even easier to calculate the predictive value directly, since, by definition, it is the fraction of all patients with a positive test who have the disease (12/18 in the paper). I believe that the authors were justified in being less than euthusiastic about the value of the test in their laboratory.

It is obvious that if one is dealing with a rare disease (e.g., F = 0.01), or if the number of nondiseased patients is large, the predictive value of a positive test result could be low (say 16%) even if the specificity is 95% and the sensitivity 100%!

Interested readers—and there ought to be many—are referred to the original paper by Vecchio (*2*) and an excellent book on decision making by Lusted (*3*). I also covered this and related material in a lecture on "Logic in Nuclear Medicine" at a recent SNM annual meeting. The basis for rational action is available.

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3. LUSTED LB: *Introduction to Medical Decision Making.* Springfield, Ill., C. C. Thomas, 1968

Reply

We wish to thank Dr. Charkes for his explicit statements regarding his views on "satisfactory decision making."

Obviously, Dr. Charkes is correct in indicating that sensitivity and specificity do not completely characterize the value of a test. However, converting test results to predictive values requires knowledge of the prior probability or prevalence of disease in the group under study. The profound influence of this factor on predictive value has been recently discussed (*1,2*).

If we use Frick's data (Table 1) and disease prevalence (13/51), then the predictive value of a postive test is not great—P (D+|T+ = 0.67—whereas the predictive value of a negative test is very high—P (D−|T−) = 0.97. If the prevalence of rejection should decrease to 20%, these numbers become 0.59 and 0.98, and if it increases to 50% these numbers become 0.85 and 0.91.

Thus, while Dr. Charkes' point is correct, his emphasis on the predictive value of only the positive test is incorrect, and it is the negative test that is most useful to the pracicing physician over a realistic range of disease prevalence.

TABLE 1

Rejection

Test results	Present (D+)	Absent (D−)	Total
Positive (T+)	12 0.92 TP	6 0.16 FP	18
Negative (T−)	1 0.08 FN	32 0.84 TN	33
Total	13	38	51

TP = P(T+/D+) = 12/13 = 0.92 = sensitivity.
FP = P(T+/D−) = 6/38 = 0.16.
TN = P(T−/D−) = 32/38 = 0.84 = specificity.
FN = P(T−/D+) = 1/13 = 0.08.

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How Doth Stand the Liver Scan?

With colloid and camera an image that's static
Can help us evaluate problems hepatic.
But causes for defects abound; this profusion
Can lead oftentimes to a bit of confusion.