An Inquiry About Clinicians' View of the Distribution of Posttest Probabilities: Possible Consequences for Applying the Threshold Concept

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A frequent clinical decision error consists of not treating a patient because a 100% diagnostic certainty or at least a high disease probability has not been reached.[1] This is a common occurrence for tuberculosis in developing countries, especially (but not exclusively) for extrapulmonary presentations such as pericarditis and meningitis. Why are clinicians reluctant to treat such cases if they are not sure of the diagnosis? Among other reasons, they are afraid that by lowering their required certainty for treatment (or ''threshold''[2]), they would treat a lot of patients who do not have the disease. In discussions during training in clinical reasoning, doctors often estimated that if the threshold is lowered (e.g., by half), they would correspondingly treat twice as many patients, of whom a lot would be without the disease. This seems to indicate that clinicians intuitively imagine a linear, flat distribution of posttest probabilities for a given disease in a given population of suspected patients.

Contrarily to intuition, this distribution is rather U-shaped, provided that tests with reasonable accuracy are available[3-5] (Figure 1). Once the diagnostic workup has been completed, most patients will fall into two opposite predominant groups: one will be composed of patients with a reasonable certainty, or a high posttest probability of the disease, that would be detected by a positive test or series of tests, while the other group will include patients with another final diagnosis and/or a series of negative tests that would reasonably exclude the disease. The higher the accuracy of the test or the combination of tests, the more patients will be separated in the two groups. Prevalence will further shape and locate the curve: for example, the lower the pretest probability, the more the U-curve will be shifted to the left.

Lowering the treatment threshold will have a very different effect depending on the shape of this distribution. If it were Gaussian, many more patients would be treated by even a moderate move. On the contrary, in a U-shaped distribution of a clinical series of suspected tuberculosis meningitis in Ecuador, lowering the treatment threshold from 0.8 to 0.2 would have caused only a few more treatments.[6]

The present study aims at documenting in a formal way the clinicians' anecdotal misconception about posttest probabilities.

METHODS

We asked 38 participants and 3 tutors in a 6-week workshop on clinical research and evidence-based medicine their idea about the distribution of posttest

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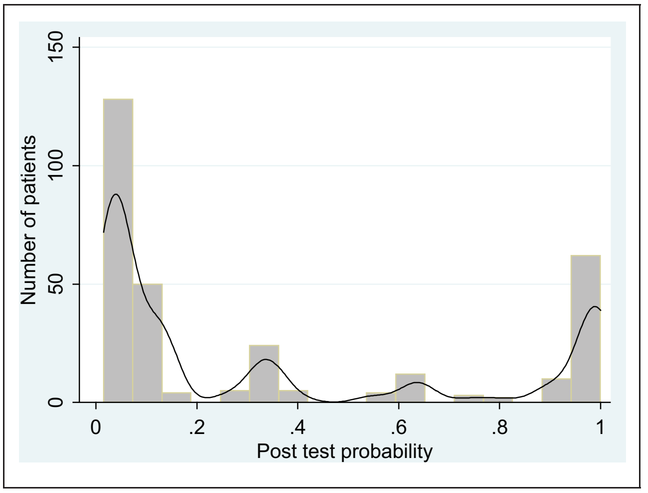

Figure 1 *Histogram of posttest probabilities of children suspected of tuberculosis, after diagnostic workup.*[3]

probabilities—that is, the number of patients in different posttest probability classes in a cohort after diagnostic workup. We proposed, as an example, patients with suspected pulmonary tuberculosis in a district ward of internal medicine somewhere in a developing country. The question was formulated as follows: ''After thorough workup, exhausting all locally available clinical and paraclinical tests, including microscopy and chest X-ray, what kind of distribution of suspected patients regarding their final posttest probability would you expect? The *x*-axis represents the posttest probability, the *y*-axis the number of patients''

Participants came from four continents. Forty were medical doctors or specialists, and 1 was a pharmacist; 23 were involved in academic teaching in their countries. All had recently reviewed the theory of diagnostic clinical epidemiology, including test accuracy, Bayes theorem, pre- and posttest probability, calculation of disease probability evolution with a series of tests, distribution patterns, and the threshold concept. Moreover, all were acquainted with diagnostic workup of pulmonary tuberculosis in district hospitals in low- to middle-income countries.

RESULTS

One participant proposed a flat distribution; 11 supposed a normal, Gaussian distribution; 12 skewed to the right and 15 skewed to the left. Only 2 of them designed a U-shaped distribution.

DISCUSSION

This inquiry suggests that most clinicians, even those with a formal training in clinical epidemiology, suppose a Gaussian distribution of posttest probabilities after thorough workup of patients. If the threshold concept were applied to the distributions that most participants proposed, lowering the threshold could indeed imply a lot of unnecessary treatments, with negative consequences both for the individual patients and for public health.

This study has some limitations. First, the shape of the posttest probability depends highly on the prior and the test accuracy. With very low or very high priors, the bulk of patients would be centered on the extremes. We chose an example that participants were well acquainted with; it has an intermediate prior and an acceptable test discriminative power. Extending the questionnaire to other priors and test accuracy would have made the inquiry far more complex and would have required a logarithmic scale. The conclusions do not necessarily apply to situations with high or low priors. Second, the relation between this misconception and certain reluctance to apply threshold theory has not been proven. Further studies should establish this, as well as examine other reasons.

We conclude that clinicians, even those trained in diagnostic clinical epidemiology, have misconceptions about posttest probability distributions. This might have a negative influence on the application of threshold and expected utility theory. We suggest including discussion of these distributions in training in medical decision making.

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