Sharing the Process of Diagnostic Decision Making

When a patient comes to see a physician, the patient often asks, “Doctor, what is happening to me?” Through experience, the clinician knows how to proceed and guides the patient through a process that, if all goes well, will yield an accurate diagnosis. This process can be improved through a refinement of diagnostic thinking on the part of the clinician, which in turn can help to guide choices by patients.

The process of making a medical diagnosis was studied in the 1970s in a landmark study by Elstein et al. These investigators found that expert diagnosticians used a combination of intuitive and analytical thinking skills just like decision makers in other domains. and these skills allowed them to make a medical diagnosis through hypothesis generation and verification. Within minutes of starting a diagnostic inquiry, experts developed 3 to 5 hypotheses—conjectures or provisional diagnoses—that provided the starting point for making a medical diagnosis. Norman et al and others have shown that as physicians gain experience, the speed and accuracy of early hypothesis generation improves.

Physicians often cannot fully explain how a diagnostic hypothesis occurs to them. As Simon, a cognitive scientist, stated, “intuition is nothing more and nothing less than recognition.” Children can recognize a dog before they can even say the word “dog.” It appears that physicians often use a similar intuitive skill, which comes from experiences with prior examples. Experiential knowledge gives them a sense of what diagnoses are possible and which is most probable. Engaging the patient, listening carefully, asking targeted questions, and thoughtfully examining the patient are all critical initial steps in optimally extracting baseline data.

In clinical practice, the diagnosis is frequently not obvious from the start. This means that the intuitive approach should be combined with an analytic approach, to develop a differential diagnosis by expanding the list of hypotheses. As more information is obtained, this dynamic list is contracted by the elimination of less likely hypotheses and the promotion of more likely hypotheses using an iterative process. Here, physicians are faced with a dual challenge: to apply quantitative science to the diagnosis of an individual patient, and to share with the patient a sense of the uncertainty that is part of the diagnostic process, thus allowing individual values and preferences to inform the choice of diagnostic strategy.

Anchoring and Adjusting
How do physicians proceed from multiple possible diagnostic hypotheses to zero in on the most probable diagnosis? With experience, clinicians develop an intuitive ability to assign subjective probability estimates to various possible diagnoses.

In the 18th century, Bayes derived a formula that has allowed calculation of what is known as conditional probability. In real life, however, few people make an overt mathematical calculation of conditional probability. Instead, a heuristic (a mental shortcut) known as “anchoring and adjusting” is used to intuitively estimate probability. The “anchor” is the ballpark estimate of initial or prior probability. Adjusting occurs as new information is used to revise the estimate and arrive at a more accurate updated estimate, which is known as the posterior probability. The weight of new evidence can be quantified and expressed as a likelihood ratio.

Recalibrating Intuition Using Likelihood Ratios
Patients come to clinicians seeking expertise. Expert intuition comes not only from personal experience but also by learning quantitative science from clinical research. Expert diagnosticians know that diagnostic tests have limitations and that well-formulated research is required to quantify a test’s strengths and weaknesses.

The ability of a diagnostic test to identify a patient with a truly positive or truly negative test result is defined by a test’s sensitivity and specificity. These terms, however, are hard to apply in practice. It is difficult for practicing clinicians to remember what these terms represent or to use them in the diagnostic process for individual patients. In our view, likelihood ratios are more intuitive because they are dimensionless numbers that are derived from sensitivity and specificity. Understanding likelihood ratios provides a way to incorporate clinical science into diagnostic decision making and to calibrate the intuitive use of the anchoring and adjusting heuristic.

The positive likelihood ratio is the true-positive rate (sensitivity) divided by the false-positive rate (1 – specificity). Similarly, the negative likelihood ratio is the false-negative rate (1 – sensitivity) divided by the true-negative rate (specificity). As a ratio, the likelihood ratio is a multiplier that can be used to calculate the degree to which the initial probability estimate should change, given a positive or negative test result. The positive and negative likelihood ratios of many clinical tests are well summarized in a series of articles, which have appeared in JAMA under the title “The Rational Clinical Examination.”

Positive likelihood ratios typically range from 1 to approximately 10, so such ratios could be thought of as a way to gauge the strength of a positive test result on a scale of 1 to 10. For example, a positive stress echocardiogram test result has a positive likelihood ratio of approximately 6 for coronary artery disease. Congestion...
on a chest radiograph has a positive ratio of approximately 10 for con-
gestive heart failure. The finding of a carotid bruit, on the other hand,
has a positive likelihood ratio of only roughly 1.6 for significant ca-
rotid artery disease.6(p1-9)

Negative likelihood ratios are fractions typically ranging from 1
down to approximately 0.1. A likelihood ratio of 1 would have no ef-
fect as a multiplier. The farther up from 1 for a positive likelihood ra-
tio and the farther down from 1 for a negative likelihood ratio, the
greater effect the test result should have on the clinician’s initial prob-
ability estimates for a particular diagnosis.

Communication With Patients
It is unlikely that clinicians would interrupt the rapid flow of clinical
practice to routinely perform probability calculations. However, like-
lihood ratios could be studied outside a clinical session to calibrate
the intuition and improve the use of the anchoring and adjusting heu-
ristic. Awareness of how likelihood ratios quantify the strength of a
test result could help clinicians convey to patients how test results
affect diagnostic reasoning.

Implied in the concept of likelihood is the fact that clinical test
results are almost never definitive. Further thinking about likely-
hood ratios leads to greater critical awareness of how dependent phy-
sicians are on the sensitivity and specificity measurements that lie
behind them. These seemingly objective measures of the perfor-
man ce of diagnostic tests are dependent on the populations in which
the tests are evaluated and on how they are used within diagnostic
pathways. Thus, even the likelihood ratio is not a substitute for care-
ful consideration of the clinical context of the individual patient.

Time pressures, cognitive biases, and inattention to detail can
sometimes lead to diagnostic error. This is the topic of a recent Na-
tional Academies of Science, Engineering, and Medicine report,
which called attention to the importance of emphasizing educa-
tion and training for improving the diagnostic process.7(pp1-18) Greater
public awareness of the methods, strengths, and limitations of the
diagnostic process should also help patients, as well as families and
caregivers, set expectations and participate in shared diagnostic de-
cision making.

Conclusions
Understanding the stepwise diagnostic process and developing
effective diagnostic skills lie at the heart of medical education. Mak-
ing a diagnosis is often uncertain and ambiguous; diagnostic tests
have limitations and, if used improperly, can be misleading. For cli-
nicians, thoroughly understanding each step can help them look
critically at their own practice, hone their skills, improve their per-
formance, and involve patients and families in the process.

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