Educational Obstacles to Learning Diagnosis

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Formal teaching of the observational skills needed in diagnosing illness is a time honored part of medical education. The analytic skills which follow diagnostic observations, however, are often obscure and poorly taught. Much of this deficit may be due to the special character of the teaching context. The Flexnerian marriage of medical education to medical research and its substrate, the referral hospital, may have had consequences which confound the understanding and teaching of diagnosis. This paper explores four possibilities: inappropriate use of the inductive method; overemphasis on mechanistic paradigms; preoccupation with disease, the diagnostic endpoint; and truncation of the analytic process occasioned by referral.

Diagnostic competence is a major goal of medical training. Important aspects of diagnosis, however, are vaguely taught. Structured teaching in physical diagnosis courses is devoted to observational skills, while the more crucial analytic skills are acquired during clinical clerkships more by chance than by design. Too often, clinical teachers baffle students by never articulating the analytic part of diagnosis. This paper explores four features of the educational context that may obstruct the teaching of this fundamental part of diagnosis.

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The Primacy of Inductive Problem Solving

Post-Flexnerian clinical education has been closely linked to medical research. As a result, the inductive method of research often serves as a model for clinical problem solving. Flexner himself implied that the bench side and bed side approaches were equivalent.[1] However, clinical medicine, as are other applied sciences, is basically deductive in nature.[2] An inductive approach may therefore be an obstacle to a cogent explication of the analytic process.

All investigation begins with observation and proceeds through hypothesis formulation to hypothesis testing and reformulation. Inductive hypothesis formulation typically occurs only after numerous observations of an uncharted phenomenon. A research scientist must usually collect extensive data before he/she is able to see a pattern or build a paradigm. His initial hypothesis arrives as an intuitive synthesis, often quite unexpectedly. In like manner, physicians in training are taught to make an extensive set of standard observations prior to attempting a hypothesis. A prime example of this approach is the problem oriented medical record, which specifies the collection of a complete data base prior to problem assessment.[3] Again, the hypothesis occurs as an intuitive synthesis of diverse observations, an insight into a pattern or common causal denominator. Because intuition springs from the subconscious, diagnostic hypothesis formulation becomes a nebulous part of the art of medicine. Since students have no explicit guidance, their only access to the art is trial and error practice.

After hypothesis formulation, inductive testing of the hypothesis can occur only by demonstrating its implications. Each new implication of a hypothesis that a scientist documents increases its adequacy, but no observation or finite set of observations can ever establish its truth. The possibility is ever present that his next observation will refute it or that genius will one day create a better paradigm. Inductive hypothesis testing is therefore open ended. An inductive approach to diagnosis can likewise lead to unbounded testing. Because the strength of an inductive hypothesis increases with each new observational challenge it survives, a physician may multiply tests to bolster his case.

Deduction, on the other hand, starts with the presupposition that certain empirically tested paradigms are true. From such a base, a physician can formulate diagnostic hypotheses after *single* observations. Indeed, the first symptom that a patient reports implies a set of hypotheses, a differential diagnosis. This set of possible diseases derives not from an intuitive synthesis of multiple observations, but from a comprehensive knowledge of tested associations or causal pathways between the symptom and various diseases. Because knowledge is the origin, deductive hypothesis formulation can be taught.

Physicians do, in fact, formulate hypotheses after very few observations.[4] These early hypotheses permit departure from the traditional comprehensive observational approach by guiding subsequent observation. The physician can eliminate many irrelevant and low-yield directions of search and seek only those data that will test and refine his differential diagnosis.

Deduction also provides a more discriminating and powerful way to test hypotheses. Testing need not be extended to all data that a hypothesis implies, but can be restricted to data known to imply the hypothesis. Not only does this shift from logical consequences to antecedents permit a bounded, often small number of tests, but positive tests can have the force of proof. For example, by documenting two Jones criteria, a physician can deduce the diagnosis, acute rheumatic fever. Deduction, therefore, enables teachers to give more focused guidance in hypothesis testing.

From the outset, deductive diagnosis proceeds as an alternating sequence of hypothesis revision and contingent testing. This hypothetico-deductive schema has been outlined by McWhinney.[5] It is linear, analytic, and explicit, whereas induction is comprehensive, synthetic, and intuitive. Deduction better fits the reasoning from paradigms to particulars that characterizes clinical medicine, and it is much easier to explicate than induction.

The Primacy of Mechanistic Paradigms

A second consequence of the research environment of medical education has been a preoccupation with mechanisms. A large part of clinical teaching is given to explaining illnesses in terms of underlying disease mechanisms, but usually after the mechanisms have been identified. Less attention is given to how or whether knowledge of mechanisms influences the analysis that leads to their identification.

Although mechanistic paradigms undoubtedly guide diagnostic analysis, epidemiologic paradigms would seem to better serve primary level diagnosis. Primary care physicians first see illness at the periphery of an arborizing causal cascade. Between a disease mechanism and its manifestation as illness, an intricate array of variables intervenes. Pathologic internal stimuli enter a patient's awareness after being filtered and processed by the most complex variables of all, an individual cerebrum and psyche. In addition, the occasion and manner in which a patient reports his symptoms to the physician is modulated by a highly variable network of social sanctions and supports.

Using the instruments of medical technology, a tertiary care physician can penetrate this peripheral layer of illness to its mechanistic core. The constancy of mechanistic paradigms enables him to reason with mathematical precision from measurements to mechanisms. At the level of symptoms, however, intervening variables are too numerous and complex for a primary care physician to trace with precision a causal sequence back to its source. He must use probabilities in leapfrogging from a symptom to a set of disease hypotheses.

Physicians do, in fact, reason with probabilities when they choose and rank the diseases in a differential diagnosis.[4] Probability ranking further aids discriminating hypothesis testing. The most probable hypothesis can be the first tested.

Mechanistic paradigms may be a source of these diagnostic probabilities. The plausibility of possible causal pathways could be translated to disease probability. The more contrived a pathway from disease to symptom, the more improbable the disease. However, subjectivity is the limitation of probabilities based on mechanistic paradigms. Assigning magnitude or rank would be an arbitrary exercise.

The frequencies of epidemiologic paradigms are the only source of objective and precise diagnostic probabilities. Epidemiologic research generates percentages from which a physician can deduce individual probabilities. Two key percentages in diagnostic testing are positive predictive value and negative predictive value.[6] Positive predictive value would indicate the probability that a disease is present when an element of illness (symptom, sign, or laboratory abnormality) is sought and found, whereas negative predictive value would indicate the probability that a disease is absent when an illness element is sought and not found. These two epidemiologic based probabilities, when they approach 100 percent, become powerful deductive tools for testing diagnostic hypotheses. When the positive predictive value of an illness element for a disease is close to 100 percent, a positive observation, for all practical purposes, implies the disease; and when the negative predictive value of an illness element for a disease is close to 100 percent, a negative observation, for all practical purposes, implies the absence of the disease.

Positive and negative predictive value provide objective bases for assessing the power of diagnostic tests. Tests of high positive predictive value would be used to establish the probable, while tests of high negative predictive value would be used to exclude the serious—different but not always separate diagnostic strategies.

A second important source of the frequencies used by a physician obtains from his own experience with numerous illnesses from the undifferentiated beginning of the diagnostic process. Not only does his experience with many personalities teach him to estimate the likelihood that patients accurately perceive and report particular features of their illnesses, but also his experience with the relative frequencies of various diagnoses, given a particular symptom or sign, is a basis for formulating and ranking the probability of a manageable set of working hypotheses. A physician's experience comprises a growing "personal epidemiology," which has a predictive value of its own. Although the probabilities that grow from practice are roughly defined, they are, nevertheless, the basis for a discriminating search in the direction of likely yield.

Because epidemiology is of little value in explaining illness, it takes second place to mechanisms in preclinical curricula; and during clinical clerkships, epidemiology is rarely applied to diagnosis. When clinical teachers do use probabilities in their analysis of illness, the probabilities tend to be subjective, vague, and tacit. Students are, therefore, left groping for the logic of observational sequencing and test selection.

The Primacy of Disease

The traditional dominance of disease in both research and education can lead to an oversimplified view of diagnosis. Most clinical learning is disease centered. This preoccupation with the diagnostic end point obscures the great variability of the starting point, a unique illness. Indeed, it establishes an illusory identity between the illness occurrence and the disease paradigm. Such "misplaced concreteness" reduces diagnostic deduction from a complex probabilistic sequence to a simple syllogistic act. When the pattern of every illness is held to match the pattern of some disease, diagnosis can occur by comparing the illness to a large number of memorized disease patterns. After first fleshing out the pattern by an exhaustive set of illness observations, a physician reasons ac-

cording to one of the following simple syllogisms:
1. All illnesses with clinical pattern A are disease B. Illness X has clinical pattern A. Therefore, illness X is disease B.
or
2. All cases of disease C have clinical pattern D. Illness Y does not have clinical pattern D. Therefore, illness Y is not disease C.

Like most oversimplifications, this one leads to a false certainty. Uncertainty is assumed to arise from insufficient knowledge of disease, not from probabilities inherent in illness variability. In the referral hospital, where the stakes are usually high, this simple model appeals especially to students. Faced with the major consequences of error, they cannot abide uncertainty.

Pattern diagnosis also simplifies teaching by circumventing the complexities of sequential analysis. The above syllogisms are so self-evident that teaching them would be superfluous. Students need only be taught observational precision and an exhaustive knowledge of disease.

The Primacy of Referral Practice

Other obstacles to learning diagnosis are due to the specialty care setting of medical training. By the time patients reach the tertiary level, the referring physician has obtained sufficient data for a diagnosis or a limited differential diagnosis. Referral is necessary to treat the disease or to further refine the diagnosis. In many instances, the medical center diagnostician simply confirms the presenting data, bypassing the linear sequence of observation and inference used in its acquisition. Moreover, he begins with a data mosaic, which predisposes to intuitive, synthetic hypothesis formulation.

The primary diagnostic instrument of a referring physician is the interview. Not only does he obtain a description of symptoms, but also he gains a knowledge of social and psychological variables that influence the reliability of patient perception and reporting. An effective interview is more than passive listening; it is dynamic communication in which the physician uses the patient as an instrument of detection. He directs the patient's attention to specific elements of an illness that may have been experienced as an undifferentiated whole, and he sends delicate signals to minimize the patient's tendencies to distort, ie, he seeks to "tune" this temperamental initial instrument to optimize its gain.

The student diagnostician never sees this part of diagnosis. The personhood of the patient, for him incidental to completing the diagnosis, fades from view. Because he seldom applies the interview to a bona fide problem, his skill may advance little beyond a recital of the textbook interview script.

Such a rigid approach is insensitive to affective and social influences, which distort a patient's perception and reporting. Even if these influences are recognized, communication may be so programmed that responses to lessen exaggeration or denial are impossible. Indeed, interview clumsiness may aggravate inaccuracies. Because interview acuity is dull, subsequent data collection is unfocused. Exhaustive observation replaces the more discriminating observation of a skilled interviewer.

Another obstacle to learning diagnosis in a specialty care setting is the bias introduced by referral. In a referral center, a student's experience is limited to a physician referred clinical population, quite different from the self-referred clinical population he/she would encounter in the field. The relationship of illness occurrence to disease category differs in the two populations. The probabilities implied by symptoms and signs depend on frequencies of association with various diseases, and these frequencies vary with the character of the clinical setting. Many diseases common in the field are rarely seen in the referral center because they are diagnosed and treated at the primary level, and many diseases rarely seen by the field physician are common in the referral center because of the focusing effect of referral. Thus, the predictive value of a symptom for a disease in a tertiary care setting may bear no resemblance to its predictive value in a primary care setting. Consequently, an investigative algorithm learned in the medical center may be totally inappropriate in the field. Students must be taught that practice denominators are as important to diagnostic probabilities as population denominators.

New Approaches

Of all the obstacles to learning diagnosis during clinical training, the most fundamental would seem to be the absence in the curriculum of any conceptual model of the analytic process and inadequate attention to psychosocial factors that condition the perception and reporting of illness. Needed are a more precise definition of the variables that influence symptoms as they are experienced and expressed at the outset of diagnosis, and an objective, epidemiologic based formulation of diagnostic deduction applicable in primary care settings.

Such a formula would not gainsay the contribution of intuitive synthesis and mechanistic understanding to achieving the diagnostic goal. Successful diagnosis certainly occurs without explicit use of probability formulae, and the best diagnosticians are probably those who go beyond formal linear approaches and creatively attack from multiple directions, especially when illness complexity defies statistical precedent. Nevertheless, diagnosis without some formula or system for proceeding in the direction of most probable payoff loses efficiency and subjects patients to needless inconvenience. And in the end, intuitive diagnosis cannot be taught. Only formal models of the process can be explicated and followed.

After conceptual learning, students should have an authentic context for testing and practice. The most appropriate setting for learning diagnosis is primary care, where patients present with virgin illnesses and with unrehearsed scripts. Medical training must continue to redress the imbalance between time in tertiary and primary care clerkships.

References

1. Flexner A: Medical Education in the United States and Canada. Report to the Carnegie Foundation for the Advancement of Teaching, Bulletin No. 4. Boston, Updyke, 1910, pp 54-55
2. Murphy EA: The Logic of Medicine. Baltimore, Johns Hopkins University Press, 1976, p 177
3. Weed LL: Medical Records, Medical Education, and Patient Care. Cleveland, Case Western Reserve University Press, 1970, pp 15-24
4. Elstein AS, Kagan N, Shulman LS, et al: Methods and theory in the study of medical inquiry. J Med Educ 47:85, 1972
5. McWhinney IR: Problem-solving and decision-making in family practice. Can Fam Physician 25:1473, 1979
6. Galen RS, Gambino SR: Beyond Normality: The Predictive Value and Efficiency of Medical Diagnoses. New York, John Wiley, 1975, pp 32-33