Decision-making: A Comparison of Referral Practice and Primary Care

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Background. Should care by subspecialist physicians be more costly than care by primary care physicians? This article addresses diagnostic testing, one element of the answer to this question.

Methods. A theoretical analysis was conducted of the sequences of testing, treatment, or watchful waiting in patients with low, intermediate, or high probabilities of disease. This was followed by a reanalysis of data from a previously published study of patients with chest pain from two referral populations and two primary care populations. The study used a chest pain score as a summary measure of the number of suggestive findings.

Results. The analysis of sequences of testing, treatment, and watchful waiting suggests that patients with intermediate probabilities of disease are most likely to be referred. The study of patients with chest pain shows that the probability of disease for a given chest pain history score is higher in referred patients than it is in primary care patients, as is the proportion of patients with intermediate and high chest pain scores. This result is direct evidence that referral physicians get more patients with suspect but often uncertain histories. In general, the probability of disease given a particular history will be lower in primary care patients, and hence testing will be less fruitful.

Conclusions. Subspecialists are more likely to see patients who represent a diagnostic puzzle and have intermediate probabilities of disease. Since patients with intermediate probabilities of disease are most likely to benefit from testing, a per capita rate of testing that is higher than in a primary care practice might be appropriate in a subspecialist's practice.

Key words. Decision-making; primary health care; referral and consultation; Bayes' theorem. (*J Fam Pract 1996; 42:155-160*)

A very important question of our day is whether care by subspecialist physicians is more costly than care by primary care physicians, and, if so, whether differences in the spectrum of patients justify differences in expenditures. Few comparisons of resource utilization by primary care physicians and referral physicians adequately adjust for differences in the degree of illness of the patients. The Medical Outcomes Study took great pains to adjust for functional status, comorbidity, and degree of illness and compared the care of patients with four diagnoses.[1] The subspecialty physicians in the Medical Outcomes Study ordered more tests than did primary care physicians, although the differences were not large. Putting aside the possibility that the Medical Outcomes Study investigators failed to adjust fully for differences in the patients' degree of illness, it is fair to ask if the observed differences are due to some inherent characteristic of subspecialist physicians, or whether they were responding appropriately to the characteristics of the patients that they saw.

The setting of care and the relationship between physician and patient affect decision-making. Features of primary care practice and referral practice that affect decision-making appear in Table 1. The purpose of this article is to focus on one of these features, the spectrum of patients, as reflected in the probabilities of a specific disease, coronary artery disease, in patients with chest pain,

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Table 1. Characteristics of Physicians That May Affect Decision-making Style

Primary Care Physician	Referral Physician
• Deals with multiple problems and diffuse complaints	• Asked to focus on one problem
• Longitudinal partnership	• Brief relationship
• Knows the patient's character	• Relative strangers
• Knows the psychological setting of illness	• Asked to solve the problem
• Knows pattern of health complaints	• Intermediate to high probabilities of disease
• Can tolerate uncertainty	
• All probabilities of disease	

in the two types of practice. The spectrum of disease in referral practice and primary care differs because the primary care physician sees everyone who is seeking help, while the specialist sees referrals from primary care physicians and self-referred patients. Referral patients are the subset of a primary care practice that have not responded to therapy or who require further diagnostic evaluation. The central hypothesis of this article is that the spectrum of illness affects the probabilities of disease, which in turn determine whether diagnostic tests are indicated and how to interpret the results.

The Spectrum of Patients in Primary Care and Referral Practice

A Theoretical Argument

Consider the sequence of events for the patient who presents to the primary care physician with a symptom. After performing a history and physical examination, the physician must choose between treating, testing, or watchful waiting. The initial action should depend on the probability of disease.

Low Probability. If the probability of disease is low enough, the physician will simply observe the patient with the expectation that the problem will resolve spontaneously (Figure 1). If the symptoms fail to resolve, the probability of disease increases, and the physician may order a diagnostic test. If the test is negative, the primary physician may be reassured and continue to observe the patient. If the test is positive, the physician may begin treatment for the disease. If the test is equivocal, the physician may refer the patient to a specialist. The result is that the specialist will see patients in whom events raised an initially low probability of disease to within the intermediate range.

Intermediate Probability. Because an intermediate probability of disease implies considerable diagnostic uncertainty, the physician may begin by doing a test (Figure 2). If the test result is abnormal, the primary physician is likely to start treatment. If the test result is negative, the physician is likely to observe without treating. If the test result is equivocal or if the symptoms do not resolve with observation or treatment, the physician may refer the patient to a specialist. The specialist will therefore see patients with an intermediate probability of disease.

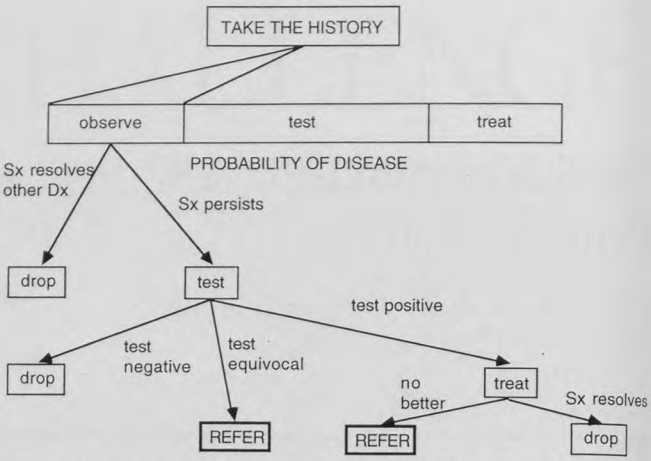

Figure 1. Theoretical sequences of testing for a disease, treatment of the disease, and observation in patients with a low probability of the disease. Sx denotes symptoms; dx, diagnosis.

High Probability. With a high probability of disease, the physician may treat without testing (Figure 3). If treatment fails to resolve the symptoms, the physician may revise downward the estimate of disease probability, admit to diagnostic uncertainty, and order a diagnostic test. Depending on the results of the test, the physician will observe or re-treat. If the symptoms do not resolve, the physician may refer the patient.

This analysis suggests that a referral practice should be enriched for patients with an intermediate probability of disease. These patients often pose diagnostic dilemmas,

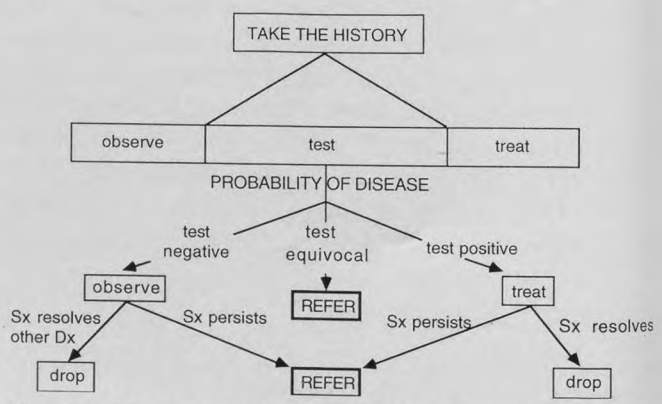

Figure 2. Theoretical sequences of testing for a disease, treatment of the disease, and observation in patients with an intermediate probability of the disease. Sx denotes symptoms; dx, diagnosis.

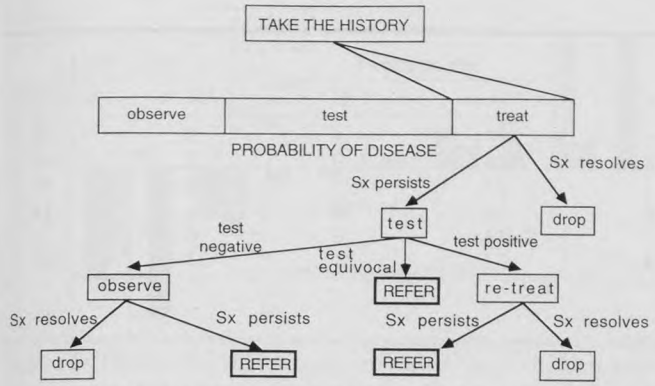

Figure 3. Theoretical sequences of testing for a disease, treatment of the disease, and observation in patients with a high probability of the disease. Sx denotes symptoms.

their diagnosis is uncertain, and they often require diagnostic testing. The analysis further suggests that the initial management of many primary care patients will be either watchful waiting or treatment without prior testing. As a result, primary physicians are likely to do fewer diagnostic tests than subspecialists.

Empirical Observation

The foregoing analysis suggests that referral patients are likely to represent diagnostic enigmas who have an intermediate probability of disease and provoke testing to resolve diagnostic uncertainty. Conversely, in many primary care patients, the diagnosis, or recognition that diagnosis is not necessary, is obvious from the history and physical examination. Empirical evidence suggesting this presupposition is found in a study of the history of chest pain in patients seen in primary care practice and in referral practice.[2] In this study, Sox and colleagues studied patients from four different patient populations: 289 self-referred patients of an HMO (self-referral group 2), 404 self-referred patients at a Department of Veterans Affairs hospital (self-referral group 1), 211 patients admitted to Stanford for coronary arteriography (referral group 1); and 170 patients referred for coronary arteriography to either Stanford or its affiliated Department of Veterans Affairs hospital (referral group 2). Table 2 shows the characteristics of the patient populations. A physician, nurse practitioner, or research assistant took a standardized chest pain history of all patients, and each patient received a final diagnosis established by either arteriography or long-term clinical follow-up. The authors used the chest pain history of the patients in the first set of 211 coronary arteriography patients to calculate a logistic model to predict the results of the arteriogram. Table 3 shows the logistic model. Because the chest pain score increases with increasing number of predictors, the chest pain score is

Table 2. Characteristics of the Study Populations

Population	No.	% with CAD	% Female	Mean Age, y
Referral-1	211	76	23	57
Referral-2	170	72	15	57
Self-referral-1	404	33	4	55
Self-referral-2	289	3	49	41

CAD denotes coronary artery disease.
From Sox HC, Hickam DH, Marton KI, et al. Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices. Am J Med 1990; 89:7–14. Adapted with permission of the American Journal of Medicine.

considered a standardized measure of the strength of the history. Using each patient's responses to seven questions, the authors calculated a chest pain score on each patient. The chest pain score placed each patient in one of five chest pain score subgroups. The authors then calculated the prevalence of coronary artery disease in each population-specific subgroup in each of the five chest pain score groups (Table 4).

Probability of Disease. Figure 4 shows that as the chest pain score increases, so does the probability of coronary artery disease (CAD). Therefore, a strong history is associated with a high probability of disease, a finding consistent with many studies in which, prior to arteriography, a physician classified the patient's chest pain history as atypical chest pain, atypical angina pectoris, or typical angina pectoris.[3]

The History as a Predictor of Disease in Different Populations. In each population, there is a clear trend of increasing probability of disease with increasing chest pain score as a measure of the strength of the history (Figure 4). However, the probability of disease for a given chest pain history score is lower in the self-referred patients than in the referred patients. Thus, if two patients have the same history, the interpretation of the history depends on the population to which the patient belongs.

Referred Populations with a History Suggestive of CAD. The most important new finding in this article is the within-population distribution of chest pain scores

Table 3. Chest Pain Logistic Function

Attribute	Coefficient	Rounded Coefficient
Age >60 y	+2.85	+3
Pain is exertional	+4.26	+4
Pain causes patient to stop all activities	+2.76	+3
History of myocardial infarction	+3.90	+4
Pain relieved within 3 minutes by nitroglycerin	+1.93	+2
≥20 pack-years smoking	+3.93	+4
Male gender	+5.37	+5

From Sox HC, Hickam DH, Marton KI, et al. Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices. Am J Med 1990; 89:7–14. Adapted with permission of the American Journal of Medicine.

Table 4. Distribution of Chest Pain Scores

Chest Pain Score*	Referral-1		Referral-2		Self-referral-1		Self-referral-2	
	CAD, n	No CAD, n	CAD, n	No CAD, n	CAD, n	No CAD, n	CAD, n	No CAD, n
0–4	1	9	1	6	0	4	0	98
5–9	13	20	4	13	9	139	7	118
10–14	33	16	31	13	27	99	4	35
15–19	77	8	49	10	64	26	6	14
20–26	34	0	37	6	33	3	6	1
All	158	53	122	48	133	271	23	266

Higher scores correspond to a history that is highly suspect for coronary artery disease (CAD).
CAD denotes coronary artery disease.
From Sox HC, Hickam DH, Marton KI, et al. Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices. Am J Med 1990; 89:7–14. Adapted with permission of the American Journal of Medicine.

(Figure 5). The distribution of chest pain scores in the referral populations differs from that in the primary care populations. The proportion of patients with intermediate and high chest pain scores is higher in the referral populations than in the primary care populations. This result is direct evidence that referral physicians see more patients with suspect but often uncertain histories.

Accuracy of the Chest Pain History

A possible explanation for differences in test ordering is a difference in the accuracy of the history of chest pain, which might lead to greater reliance on testing in referral practice. The best way to compare the accuracy of the history in different populations is to compare the likelihood ratios of the history in these populations. The likelihood ratio is the best summary measure of the accuracy of a test result. A likelihood ratio close to 1.0 means that the odds of disease change little when the finding is present. A likelihood ratio much less than 1.0 means that the odds decrease substantially. Thus, the likelihood ratio is a measure of the predictive accuracy of the clinical data.

A chest pain history expressed as a chest pain score also has a likelihood ratio. It is possible to calculate a likelihood ratio for each chest pain score in each of the four populations mentioned earlier by using the data in Table 4. Figure 6 shows that the likelihood ratio increases in all four populations as the chest pain score increases. However, within a specified range of chest pain scores (eg, 5 to 9), the likelihood ratio does not vary systematically as one compares primary care populations with referral populations. This statement is true across the entire range of chest pain scores, which shows that as the chest pain becomes increasingly indicative of coronary artery disease, its accuracy in primary care populations remains the same as in referral populations. In other words, a given combination of history findings changes the probability of disease by the same amount in both primary care and referral practices.

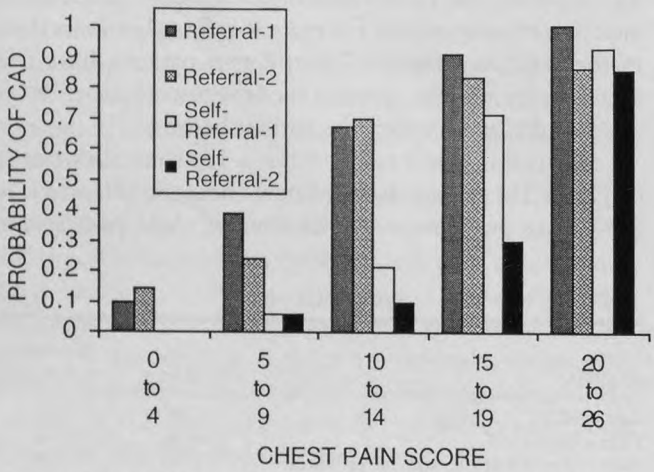

Figure 4. Probability of coronary artery disease (CAD) for patients with similar histories of chest pain (chest pain score within-group comparison) and different histories of chest pain (chest pain score across-group comparison). From Sox HC, Hickam DH, Marton KI, et al. Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices. Am J Med 1990; 89:7–14. Adapted with permission of the *American Journal of Medicine.*

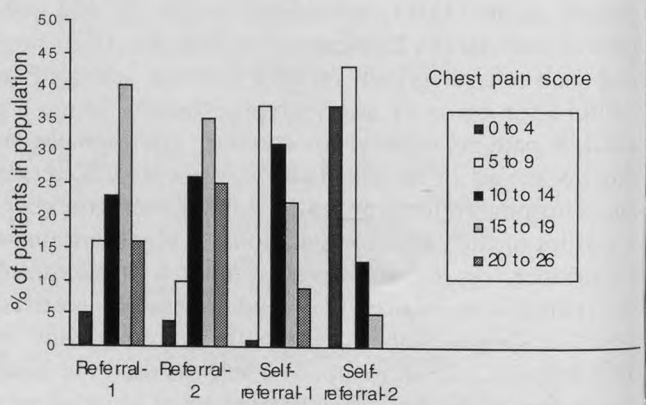

Figure 5. Distribution of chest pain scores in different populations of patients with chest pain. The chest pain score is a proxy for the patient's history of chest pain, with larger scores corresponding to a history that is highly suspect for coronary artery disease.

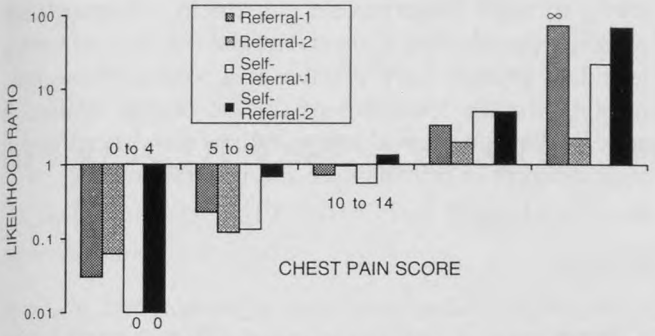

Figure 6. The likelihood ratio of a specified range of chest pain scores compared across different populations of patients with similar chest pain scores. Note that the vertical axis is a logarithmic scale.

Why does the interpretation of a patient's chest pain history depend on the population to which the patient belongs (Figure 4)? Based on the set of clinical findings that determines a patient's chest pain score, patients from primary care populations have a lower probability of disease. The likelihood ratios within each range of chest pain scores do not vary systematically across the populations (Figure 6). It follows from Bayes' theorem* that the probability of CAD prior to taking the history, which is its overall prevalence in the population, is responsible for the between-population differences in the probability of disease within a range of chest pain scores. The major factor that determines the differences in probability of disease associated with a particular history is the overall prevalence of disease in the population. Here, the overall prevalence of a disease (Table 2), which is another important difference between primary care and referral populations, determines the interpretation of the history in each setting.

In general, given a particular history, except one that is highly indicative of CAD, the probability of disease will be lower in primary care patients, and testing will be less fruitful.

The Spectrum of Patients and Indications for Diagnostic Testing

As a general rule, patients at both extremes of probability of disease benefit least from testing. An example that illustrates this point uses a hypothetical test whose likelihood ratio is 10.0 when the test is positive and 0.2 when the test is negative.

Very Low Probabilities of Disease. If the test is negative, which is the most likely result when the pretest probability is low, a low pretest probability becomes an even lower post-test probability, a result that is unlikely to change management unless the pretest probability was above but close to the threshold probability for deciding to treat. If the test is positive, the post-test probability may still be quite low. For example, suppose the pretest probability of disease is 0.09 and there is a positive result on a test with a likelihood ratio of 10.0 when positive. The post-test probability is only 0.50. If the pretest probability had been only 0.01, the post-test probability would have been 0.09.

Very High Probabilities of Disease. If the test is positive, which is the most likely result when the pretest probability is high, a high pretest probability becomes even higher, a result that is not likely to change treatment. An increase in probability from 0.90 to 0.99 is not very useful. If the test is negative, the post-test probability may still be quite high. For example, suppose the pretest probability of disease is 0.91, and there is a negative result on a test with a likelihood ratio of 0.2 when negative. The post-test probability is still 0.67.

Intermediate Probabilities of Disease. When the pretest probability of disease is high enough to be worrisome, eg, 0.50, but not high enough to inspire confidence in the diagnosis, the physician feels in greatest need of help. For example, suppose the pretest probability is 0.50, ie, the patient is just as likely to have the disease as not to have it. If there is a negative result on a test with a likelihood ratio of 0.2 when negative, the post-test probability is 0.16. If there is a positive result on a test with a likelihood ratio of 10 when positive, the post-test probability is 0.91. The physician's confidence in the diagnosis, or lack of it, is changed a great deal by these test results when the pretest probability is intermediate.

Discussion

The reader should observe some cautions in reading this study. Because it included only one diagnostic problem, chest pain, the results may not be generalizable to other diagnostic problems and to referral relationships, which are more complex than depicted here. Nonetheless, the theoretical analysis would apply to any referral relationship in which the primary physician would refer the patient in order to obtain a diagnostic procedure, a description which characterizes procedure-intensive subspecialty disciplines, such as cardiology, pulmonary disease, and gastroenterology. One could interpret the theoretical argument as implying that some findings always imply the need for referral, which simply is not so in the real world of practice. Similarly, the theoretical argument presupposes that the only way to be seen by a subspecialist is by

*Bayes' theorem (odds ratio format): post-test odds = pretest odds × likelihood ratio.

referral from one's primary care physician. Self-referral to a subspecialist also occurs, but the frequency of self-referral will likely diminish in as the managed care model of practice becomes increasingly prevalent.

Conclusions

Patients referred from a primary care physician are more likely to represent a diagnostic puzzle and have intermediate probabilities of disease. Using the problem of chest pain, two different lines of reasoning lead to this conclusion: one theoretical and one empirical. Since patients with intermediate probabilities of disease are most likely to benefit from testing, a higher per capita rate of testing might be expected in a referral practice. This higher rate would not reflect ill on the subspecialist, who is simply trying to make diagnoses for patients in a diagnostically puzzling population. Conversely, the low rate of testing found in primary care practice is a logical, thoughtful response to the spectrum of disease in this setting. It appears that the use and integration of tests are appropriately different in primary care and referral practice.

References

1. Greenfield S, Nelson EC, Zubkoff M, Manning WG, Rogers W, Kravitz RL, et al. Variations in resource utilization among medical specialties and systems of care. JAMA 1992; 267:1624–30.
2. Sox HC, Hickam DH, Marton KI, et al. Using the patient's history to estimate the probability of coronary artery disease: a comparison of primary care and referral practices. Am J Med 1990; 89:7–14.
3. Weiner DA, Ryan TJ, McCabe CH, et al. Exercise stress testing: correlation among history of angina, ST-segment response, and prevalence of coronary artery disease in the Coronary Artery Surgery Study (CASS). N Engl J Med 1979; 301:230–5.