The impact of disease prevalence on the predictive accuracy of a diagnostic procedure can be calculated using the Bayes theorem. In general, there is an inverse relation between the prevalence of disease and the predictive accuracy of the diagnostic test. However, at high prevalence of the disease, the diagnostic accuracy of other means of diagnosis is so great (that is, typical exercise-rest relation of angina in a middle-aged man with several coronary risk factors) that there may be little clinical value in performing the test.

**Limitations of Bayesian approach.** The limitations and pitfalls of using the Bayesian approach to analyze clinical decision-making have been thoroughly discussed in a delightful essay by Alvan R. Feinstein entitled, "The Haze of Bayes, The Aerial Palaces of Decision Analysis, and the Computerized Ouija Board" (1). Feinstein summarized the many disparities between the mathematical simplicity of the Bayes formula and the realities of clinical reasoning and clinical data. Among these are the fact that the formula computes a numerical probability that is too vague and uncertain for the demands of modern diagnostic precision. If a patient has angina and *it is the judgment of the clinician that the diagnosis of coronary artery disease must be established*, coronary arteriography will be selected. This test will reliably exclude the absence of coronary disease (so that its probability is nearly 0) or confirm its existence (probability = 100%). One cannot insert the need to establish the diagnosis in the Bayesian formula. In addition, Bayesian clinical logic is aimed at diagnosis and it contains no provision for the situation where clinical reasoning terminates with a trial of nitroglycerin, rather than additional diagnostic tests.

Assessment of cost-effectiveness of diagnostic tests. In this issue of the Journal, Patterson et al. (2) have analyzed the cost-effectiveness of different clinical approaches to diagnose coronary artery disease. Probability values of various test modes were determined from data in their own institution and were based on specificity and sensitivity of the tests in the diagnosis of coronary disease. These probability values are undoubtedly specific for their institution and may not apply to another. No matter, say the authors, one can adjust the probability values depending on the experience in one's institution. This, of course, poses a problem because most clinicians do not have ready availability of such data.

Patterson and colleagues extend their Bayesian analysis one step further to the assessment of cost-effectiveness. Therein lies a whole set of new assumptions. Effectiveness is defined as "either the number of patients with coronary disease diagnosed or as the number of quality-adjusted life years (Qaly) extended by therapy after the diagnosis of coronary disease." This was calculated as the number of life years extended by therapy over a 10 year follow-up period \( \times \) the adjusted quality of life, expressed as a fraction of full health without symptoms. It was estimated that \( \Delta \text{Qaly} \) was increased by 2 years in the patients correctly diagnosed as having coronary disease. This analysis was based on the assumption that patients correctly diagnosed were given the benefit of surgical therapy, and this was a major factor in the \( \Delta \text{Qaly} \) in this group (see their Fig. 6). The hypothesis that the annual mortality rate of patients with stable ischemic heart disease is less after coronary artery bypass surgery in patients with mild stable angina has not been verified by the data of the Coronary Artery Surgery Study (CASS) (3). The CASS study is probably applicable to the patient population study of Patterson et al. since they limited their analysis to patients with stable angina who could exercise to at least 85% of their maximal anticipated heart rate and, therefore, are likely to have good left ventricular function. There are other assumptions in this paper that could be questioned, but space does not permit a full analysis.

**Applications of the study.** Why should one be critical of an honest and thoughtful attempt to assess the difficult problem of cost-effectiveness of various approaches in the diagnosis of coronary artery disease? One of the stated objectives of this analysis is to present an approach to the problem because of the impact of coronary disease on the total health care budget and rising health care costs. It is evident that there will be a need for physicians to become increasingly cost-conscious regarding the diagnosis and treatment of this disease. Experienced cardiologists will have no difficulty in recognizing which diagnostic approaches to select for the individual patient, but will the health care administrator who may use published data on cost-effectiveness and who decides whether reimbursement for services is appropriate be able to recognize the many uncer-

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*Editorials published in *Journal of the American College of Cardiology* reflect the views of the authors and do not necessarily represent the views of JACC or the American College of Cardiology.*

From the University of Arizona College of Medicine, Tucson, Arizona. Manuscript received April 17, 1984; accepted April 23, 1984.

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tainties and variables that go into decision-making? For this reason, one must be able to recognize the limitations of studies that purport to analyze cost-effective approaches to the delivery of health care.

Undoubtedly, controversy will continue regarding the utility of the Bayesian approach to clinical decision-making. Feinstein (1) stated, “I know of no clinical setting or institution in which Bayesian diagnostic methods are being regularly used for practical diagnostic purposes in a routine or even specialized manner. I know of no specific, constructive, practical diagnostic decision involving real-world patients, data and doctors, in which Bayesian methods have made a prominent contribution that could not have been achieved just as easily without Bayes’ formula.’’

References