

Everyone would agree, we believe, that the only goal in diagnosis is to determine accurately the disease causing illness in a patient with symptoms so that it can be treated and prognosticated properly. We have recently argued that the prescribed Bayesian method is not employed for diagnosis in practice as it is likely to cause diagnostic errors (1). It is hard for us to understand then why the Bayesian method, with its propensity to cause diagnostic errors has been prescribed for diagnosis in which the goal is achieving high diagnostic accuracy. In this paper, we shall examine why the Bayesian method has been prescribed in an effort to understand this paradox.

A notable early mention of probability in medicine is by Sir William Osler (2) in his famous aphorism, "Medicine is a science of uncertainty and art of probability". In our view, this comment merely highlights the role of uncertainty represented by probability in medicine (including diagnosis) without specifying how probability is or should be employed in diagnosis and treatment. Next, we find Ledley and Lusted (3) applying probabilistic (Bayesian) reasoning to the process of diagnosis in their well-known paper in *Science* in 1959. They propose this is how diagnosis is performed in practice due to uncertainty inherent in diagnosis. There is no hint of prescription of the Bayesian method in their paper, that is, they do not claim this is the normatively correct method for diagnosis in practice.

We believe the prescription of the Bayesian method for diagnosis occurred in the early 1960s due to a confluence of certain statistical and psychological ideas at that time. The American statistician, Leonard Savage (4) published his book, "The Foundations of Statistics" in 1954 to promote his subjective Bayesian theory based in part on earlier ideas of the British philosopher, Frank Ramsey (5) and the Italian probability theorist, Bruno deFinetti (6). In this book, a Bayesian inference from a posterior probability, interpreted as a degree of belief, was considered to be a bet placed with odds based on the posterior probability. This Bayesian inference was believed to be coherent as it prevented creation of a Dutch book, which is a series of bets which ensures betting loss, against the inferring agent.

Savage's subjective Bayesian approach to statistical inference became increasingly popular and appears to have caught the attention of prominent psychologists

such as Ward Edwards in the early 1960s at a time when the cognitive revolution overthrew the behavioral approach to studying reasoning (7). The psychologists seemed to view the subjective Bayesian approach as the normatively rational method of reasoning by human beings due to its coherence. This view about human reasoning gained widespread acceptance, in part due to a highly influential joint paper by Edwards and Savage on Bayesian reasoning published in *Psychological Review* in 1963 (8). It is around this time, we believe, the Bayesian method was prescribed as the normatively correct method for diagnosis (as a form of inference) due to its rationality based on coherence.

What is of interest about this prescription from the point of view of a practicing physician is that there is no mention or discussion about the diagnostic accuracy of the subjective Bayesian method. This may not be important to a Bayesian statistician such as Dennis Lindley (9), who has commented, “The Bayesian theory is about coherence, not about right or wrong”. But to a practicing physician, being ‘right or wrong’ (diagnostic accuracy) is all important, and we believe, if a method, Bayesian or any other method, cannot ensure diagnostic accuracy, it will not be employed for diagnosis in practice.

We and others have pointed out that the Bayesian method does not appear to have been employed for diagnosis in practice since its prescription in early 1960s.. For example, the eminent clinical investigator, Alvan Feinstein (10), noted in 1977, “I know of no clinical setting or institution in which the Bayesian diagnostic methods are being regularly used for practical diagnostic purposes in a routine or specialized manner”. And we also have noted that the Bayesian method is not employed for diagnosis in any of the hundreds of published diagnostic exercises in real patients such as in clinical-pathologic conferences (CPCs) and clinical problem solving exercises (11,12). The reason for this, as we have discussed recently (1) is that the Bayesian method would increase the likelihood of diagnostic errors if it were to be employed for diagnosis in practice.

In our view, the prescription of the Bayesian method for diagnosis has been a misstep because the method of prescribing it is incorrect. It has been prescribed without a careful study and analysis of the process of diagnosis in practice which

would have revealed that the goal in diagnosis of diagnosing a disease accurately in different patients with varying prior probabilities cannot be achieved by the Bayesian method with its notion, for example, of interpreting a prior probability as a degree of belief. The Bayesian method has been prescribed purely on the basis of its rationality based on its coherence, which is not of any great concern to practicing physicians. The key issue of diagnostic accuracy, which is the main concern of practicing physicians has been totally ignored in this prescription. It does not surprise us therefore that the Bayesian method is not employed for diagnosis in practice despite its prescription.

We find practicing physicians have devised a different method on their own to achieve high diagnostic accuracy. This method, which we have described in detail elsewhere (13), consists of formulating a suspected disease as a hypothesis without any prior probability attached to it so that it does not have any prior degree of belief for or against it. The disease hypothesis is evaluated by performing a test and inferred to be correct if a highly informative test result is observed, by employing a procedure which has a high probability in the form of a high frequency of inferring the disease accurately from this test result. This method has led to an overall high diagnostic accuracy rate of 85 to 90 percent in practice (14). We are amazed this method is identical to the frequentist confidence method of statistical inference developed by Neyman (15) in first half of twentieth century as we have pointed out recently (13).

In any case, we have over 50 years of experience now of the prescribed Bayesian method not being employed for diagnosis in practice. We believe it is time now to evaluate the suitability of this method for diagnosis as this has important implications at several levels including teaching of diagnosis to medical students.

References

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