We have argued in an earlier paper (1) that it is the confidence method and not the prescribed Bayesian method which is employed for diagnosis in practice. In this paper, we shall provide a head to head comparison of these two methods to bring out the weaknesses of the Bayesian method and the strengths of the confidence method to show why the confidence method and not the Bayesian method is employed in practice.

1. In both methods, a disease is suspected from a presentation in a patient and formulated as a hypothesis.

2. In the Bayesian method, the prior probability of the suspected disease, based on the presentation, is derived from its prevalence in a population and attached to the hypothesis so that it represents a subjective prior degree of belief in the disease (2). In the confidence method, on the other hand, a prior probability is not attached to the hypothesis so that there is no prior degree of belief or prior evidence for the disease (3).

3. In the Bayesian method, a test is performed to seek evidence represented by a likelihood ratio (LR), which is combined with a prior probability to generate a posterior probability which updates the prior degree of belief to a final total degree of belief (2). In the confidence method, a test is performed to evaluate if a disease hypothesis is correct or not (3).

4. In the Bayesian method, a disease is inferred (diagnosed) from a posterior probability which represents a total degree of disease (2). In the confidence method, a disease is inferred from a procedure which is known to have a high probability (frequency) of leading to an accurate inference (3). This procedure consists of inferring the disease from the performance of a highly informative test result in leading to an accurate inference with a high frequency on repeated testing in different patients.

We shall now illustrate the weaknesses of the Bayesian method and strengths of the confidence method in diagnosis of one disease, acute myocardial infarction (MI) in practice.

It is well known that acute MI like any other disease occurs in different patients with varying presentations (highly typical to highly atypical) and therefore with varying prior probabilities which range from being very high to being very low. For example, it occurs in a 65 year old man with multiple cardiac risk factors presenting with highly characteristic chest pain in whom its prior probability is very high, say 86 percent. It occurs as well in a healthy 40 year old woman with no cardiac risk factor presenting with highly uncharacteristic chest pain in whom its prior probability is very low at 7 percent (4). Therefore experienced physicians suspect acute MI in a patient with a typical presentation (high prior probability) such as the 65 year old man as well as in a patient with an atypical presentation (low prior probability) such as the 40 year old woman.

Let us suppose, a physician suspects acute MI in the 65 year old man mentioned above. If he employs the Bayesian method, he would interpret the very high prior probability of 86 percent as very strong prior degree of belief in acute MI in this patient. Should he infer acute MI from this very strong prior degree of belief alone without testing or even if he performs a test, an EKG, should he satisfied with a test result such as non-specific T wave EKG changes with LR of 1, as it leads to a very high posterior probability of 86 percent (Appendix 1) from which acute MI would be inferred.

Let us suppose the same physician suspects acute MI in the 40 year old woman mentioned above. The very low prior probability of 7 percent in this patient, which he interprets as very strong prior degree of belief against acute MI may tempt him to rule it out without testing and even if he performs test, an EKG, he would require a test result with LR of 82 to generate a posterior probability of 86 percent (same as in the 65 year old man) (Appendix 2), from which he would infer acute MI in this patient.

There are several problems, in our view, with the Bayesian method of diagnosis in these two patients:

(a) First of all, it is not clear what useful function is performed by interpreting a prior probability as a prior degree of belief. We believe, this Bayesian notion tends to encourage diagnostic errors by failure to suspect or test a

disease with an atypical presentation (low prior probability) which have been reported in several studies (5,6).

(b) There is no distinction between a highly informative test result with a high LR and a worthless test result with LR close to 1 as a disease is inferred from a posterior probability in this method.

(c) It is not clear how high a posterior probability needs to be to diagnose acute MI conclusively in this patient. Is it to be in 80s or 90s? This, we believe, creates ambiguity leading to diagnostic errors.

(d) A Bayesian diagnosis of acute MI is not objective in the sense that different physicians would not agree with it as it is made from a posterior probability which represents a subjective degree of belief. For example, would any physician agree with the Bayesian diagnosis of acute MI from the posterior probability of 86 percent in the 65 year old man with non-specific T wave EKG changes?

(e) Most importantly, the diagnostic accuracy of a Bayesian diagnosis is unknown as it is made from a subjective degree of belief represented by a posterior probability which does not correspond to anything in our experience. Therefore, we believe, a Bayesian diagnosis cannot be considered reliable.

In the confidence method, acute MI would not be inferred (diagnosed) in the 65 year old man in practice, as the test result non-specific T wave EKG changes with LR of 1 is known to be worthless on repeated testing in different patients. On the other hand acute MI is inferred conclusively and accurately from acute ST elevation EKG changes alone (4), as this test result is known to diagnose acute MI accurately in 86 percent patients on repeated testing (7).

We shall now comment on strengths of the confidence method:

(a) A prior probability is not attached to a suspected disease as a hypothesis so that there is no prior degree of belief or prior evidence for or against the disease. All disease hypotheses in a differential diagnosis are on an equal footing regardless of their prior probabilities so that all of them are tested. This is the reason, we suggest, that a disease with a highly atypical

presentation (low prior probability) is nearly always diagnosed correctly in clinical-pathologic conferences (CPCs) and in clinical problem solving exercises (8,9)).

(b) In this method, a disease is diagnosed from known performance (85 percent or greater diagnostic accuracy) of a highly informative test result (LR greater than 10) (10), if a test capable of generating such a result is available, in any patient regardless of prior probability of disease. For example, acute MI is diagnosed from acute ST elevation EKG changes, LR 13 (11) and pulmonary embolism from positive chest CT angiogram, LR 20 (12) in this manner. Therefore a confidence diagnosis is highly reliable due to its known high diagnostic accuracy. Thus the diagnosis of acute MI is made with a high degree of confidence, both literally and figuratively, in a patient with acute ST elevation EKG changes due to the known high 86 percent (7) accuracy of this diagnosis on repeated testing in other patients.

(c) A confidence diagnosis is objective, with which everyone agrees, as it is made from an observed highly informative test result. Thus everyone would agree, we believe, with the diagnosis of acute MI in a patient with acute ST elevation EKG changes and of pulmonary embolism in a patient with positive chest CT angiogram.

(d) Making a confidence diagnosis is simple as, unlike the Bayesian method, it does not require any calculation like combining a prior probability and a LR. A confidence diagnosis is made directly as soon as a highly informative test result is observed.

The goal in diagnosis in practice is to achieve very high diagnostic accuracy so that a disease can be treated appropriately and a proper prognosis given for it. It is clear from the above discussion that this goal is achieved to a great extent by the confidence method only which is why it is employed in practice. The prescribed Bayesian method, on the other hand, is likely to lead to diagnostic errors, which is why it is not employed in practice despite its prescription.

It is not appreciated, it appears to us, that the Bayesian method has not been prescribed for diagnosis due to its diagnostic accuracy, but prescribed due to its coherence based on a betting argument (13) which does not translate into

diagnostic accuracy. What we find remarkable is that physicians in practice have developed a method of diagnosis on their own which leads to high diagnostic accuracy of 85 to 90 percent in practice (14) and that this method is identical to the frequentist confidence method, which is the other main method of statistical inference (other than the Bayesian method).

Appendix 1

Pr. prob. of 86 percent = Prior odds of 86/14

In odds form of Bayes' theorem, Prior odds x Likelihood ratio = Posterior odds

Thus 86/14 x 1 = 86/14 = Posterior prob. of 86 percent.

Appendix 2

Pr. Prob. Of 7 percent = Prior odds of 7/93

Post. Prob. Of 86 percent = Post. Odds of 86/14

In odds form of Bayes' theorem,

Likelihood ratio = Post. Odds/Pr ior odds

Thus Likelihood ratio = 86/14 / 7/93 = 82.

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