The overall accuracy of diagnosis in practice has been reported to be very high at 85 to 90 percent (1). It is surprising the reason for this high diagnostic accuracy has not been studied so far while all attention appears to be focused on studying causes of diagnostic errors in 10 to 15 percent patients (2,3). In this paper, we shall examine the reason for this high diagnostic accuracy as it will help us pinpoint, we believe, the causes of diagnostic errors in practice.

The process of diagnosis in practice consists, as is well-known, of hypothesis generation and verification (4). In this process, a disease is suspected from a presentation as a plausible cause of illness in a patient and formulated as a hypothesis. This hypothesis is evaluated by a test and verified to be correct if a highly informative test result is observed. For example, the hypothesis of acute myocardial infarction (MI) generated by suspecting it from chest pain in a patient is evaluated by performing an EKG and verified to be correct if the highly informative test result, acute ST elevation EKG changes, is observed. If a highly informative test result is not observed, the corresponding disease hypothesis is abandoned and another one formulated which is evaluated by an appropriate test. This process continues till a highly informative test result is observed and the corresponding disease hypothesis verified to be correct and this disease diagnosed conclusively.

We suggest that the process of diagnosis by the hypothesis generation and verification method, henceforth called the hypothesis method for brevity, proceeds by what looks like trial and error till an accurate diagnosis is made. This method is highly effective as it leads to an accurate diagnosis in 85 to 90 percent patients in practice. Thus the reason for this very high diagnostic accuracy is the hypothesis generation and verification method which is employed for diagnosis in practice. This very high diagnostic accuracy achieved by the hypothesis method is not surprising, we believe, as this method is identical to the scientific method (5), which is universally acknowledged to be the most highly accurate method of investigation in any field (6).

The hypothesis or the scientific method appears simple and straightforward, but it is an extremely powerful method of enquiry that was developed after numerous fits and starts by some of the greatest thinkers in history over thousands of years. The formulation of a plausible explanation as a hypothesis for a natural phenomenon was known to the Greeks but the notion of verifying a hypothesis by experiments or tests escaped them (7). It was Galileo, over two thousand years later, who coupled hypothesis generation and verification in his studies on motion to introduce the scientific method (7). Since then, this method has been employed by every scientist from the greatest to the most humble to make discoveries in diverse fields which have increased our understanding of the natural world and led to major technological advances. In addition, the hypothesis or the scientific method has been routinely employed to investigate problems at a more mundane level as well, for example, in diagnosis in medicine and in investigation of accidents. For example, it was employed to investigate the cause of explosion of space shuttle Challenger in 1986 by the physicist Richard Feynman, as we have discussed elsewhere (5).

It is important to appreciate that scientific reasoning is very different from day to day reasoning which is unscientific as it does not employ hypothesis generation and verification. In day to day reasoning reasoning, a judgment is made directly from information that is provided, for example, judging a person to be a lawyer from a description of a typical lawyer being applied to him (8). The unscientific day to day reasoning has been shown to lead to erroneous judgments frequently due to rapid System 1 reasoning, heuristics and biases (9,10).

Thus there are two different types of reasoning; day to day, which is error prone and scientific, which is highly accurate. What has happened in recent years, it seems to us, is that findings from studies on day to day reasoning have been applied to diagnosis to claim that System 1 reasoning, heuristics and biases are important causes of diagnostic errors in practice (11,12)! This claim is unjustified, in our view, as diagnostic reasoning is scientific, as it employs the hypothesis generation and verification method, which is very different, as we mentioned above, from day to day reasoning. Therefore we are not surprised to find that numerous studies on diagnostic errors fail to show decisive evidence about System 1 reasoning, heuristics and biases being important causes of diagnostic errors in practice (13).

It is of interest that System 1 reasoning, heuristics and biases have not been claimed to be a source of faulty judgments in fields such as biology, engineering, physics which are clearly recognized as being scientific in which the hypothesis method is employed. We suggest, diagnosis be recognized as a scientific discipline as well, which is learnt after long years of training in hypothesis generation and verification of diseases to which findings from day to day reasoning are not applicable. The scientific or the hypothesis method, is employed in diagnosis and other fields, we believe, to overcome the obstacles created by System 1 reasoning, heuristics and biases of day to day reasoning.

We believe, the causes of diagnostic errors in practice should be sought in the framework of the method of hypothesis generation and verification which is employed for diagnosis in practice. In our view, a diagnostic error occurs when a disease is not suspected and formulated as a hypothesis or when it is not verified correctly by appropriate testing. A failure to suspect a disease with an atypical presentation has been reported as an important cause of diagnostic errors in several studies (14,15). This could be corrected, as we have suggested, by having novice physicians review presentations of a given disease such as pulmonary embolism in 50 to 100 consecutive patients seen at a medical center (16). In addition, increased use of electronic differential diagnosis generators could help in suspecting diseases with atypical presentations and formulating them as hypotheses. A failure to rule in a disease or erroneously rule it out while verifying a disease hypothesis may be due to lack of knowledge about informative content of various tests which could be remedied by education. Be as it may, we believe, diagnostic errors in 10 to 15 percent patients are likely to be reduced by research in hypothesis generation and verification which constitute the method of diagnosis in practice.

References

1.Berner ES, Graber ML. Overconfidence as a cause of diagnostic errors in medicine. Am J Med 2008; 121:S2-S23.

2. Graber ML, Franklin N, Gordon R. Diagnostic errors in internal medicine. Arch Intern Med 2005; 165: 1493-1499.

3. National Academies of Sciences, Engineering and Medicine, 2015. Improving Diagnosis in Health Care. The National Academies Press, Washington DC.

4. Brush JE, Sherbino J,Norman GR. How expert clinicians intuitively recognize a medical diagnosis. Am J Med 2017; 130: 629-634.

5. Jain BP. The scientific nature of diagnosis. Diagnosis 2017; 4: 17-19.

6. Whitehead AN. Science and the modern world. New York, Free Press 1997.

7. Butterfield H. The origins of modern science 1300-1900. New York: Free Press, Revised Edition,1966.

8. Tversky A, Kahneman D. Judgment under uncertainty: Heuristics and Biases. Science 1974; 185: 1124-1131.

9. Evans JS. Dual processing account of reasoning, judgment and social cognition. Ann Rev Psychol 2008; 59: 255-278.

10.Kahneman D. 2011. Thinking Fast and Slow. Farrar, Strauss, Giroux, New York.

11.Marcum JA. An integrated model of clinical reasoning: dual process theory of cognition and metacognition. J Eval Clin Pract 2012; 18: 954-961.

12. Croskerry P, Singhal G, Mamede S. Cognitive debiasing I: origins of bias and theory of debiasing. BMJ Qual Saf 22 (Suppl 2), ii 58-ii 64.

13.Norman GR, Monteiro SD, Sherbino J, Ilgen JS, Schmidt HG, Mamede S. The causes of errors in clinical reasoning: cognitive biases, knowledge deficits, and dual process thinking. Acad Med 2017; 92: 23-30.

14.Ely JW, Kaldjian LC, D'Alessandro DM. Diagnostic errors in primary care: lessons learnt. J Am Board of Fam Med 2012; 25: 85-97.

15.Singh H, Giardina TD, Meyer AN, Forjuoh SN, Reis MD, Thomas EJ. Types and origins of diagnostic errors in primary care settings. JAMA Intern Med 2013; 173: 418-425.

16.Jain BP. Letter in response to Vanstone paper on diagnostic intuition. Diagnosis 2021; 8: 125.