

# Cognitive Bias in Medical Decision Making

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**Received Date:** October 18, 2021; **Accepted Date:** December 27, 2021; **Published Date:** April 23, 2021

**Citation:** Rateesh Sareen (2022). Cognitive Bias in Medical Decision Making *International J. of Biomed Research*. 2(3); DOI: 10.31579/IJBR-2021/051

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## Abstract

Cognitive bias is well known recognized factor that causes many diagnostic errors. Such errors hampers with quality patient care in medical practice. This paper focuses on various biases that may affect decision making and idea flow. Growing awareness for such biases is need of hour as only then de biasing techniques could be adopted to prevent such cognitive errors.

**Key words:** cognitive errors; medical practice; bias

One cannot shy away from the fact that there is uncertainty in medicine [1]. The effect of cognitive bias in field relating to decision making ability is well documented [2]. There have been growing concerns for cognitive errors in clinical practice [3]. The errors due to cognitive bias could affect any step in medical practice from diagnosis, information gathering and processing [4].

Cognitive bias is also known as 'heuristics' which refers to cognitive short cuts that help in our decision making. Cognitive bias is universal in presence and is unrelated to intelligence [5]. In the formal test batteries for evaluation of bias, it is indeed ironical that doctors boosting their unbiased decision making skills score poorly [6, 7].

The landmark work by Graber et al [8] elaborately described diagnostic errors due to faculty cognition. The diagnostic errors resulted in higher morbidity leading to over hospitalization, improper medication and waste of resources that eventually result in no benefit to the patient [9, 10, 11]. There is an explosion in the use of artificial intelligence methods in medicine [12, 13]. The decision making theories have been used by robotic models but their practical usefulness in medicine is yet to be established. Systemic analysis plays a pivotal role in such decision making models. The branches of medicine like internal medicine, family medicine and emerging medicine are most susceptible to diagnostic uncertainty [9, 10]. Laboratory medicine is no exception as the interpretation and diagnosis heavily relies on cognitive ability to analyze data. Cognitive errors in such circumstances could be devastating for patients. In spite of their recognition and availability of extensive literature on cognitive bias in medical decision making there is significant inertia that prevails for reducing errors. These errors are impalpable and often go unreported [14]. Once the cognitive errors are detected then de biasing techniques could be employed for better patient care. The greater the acuteness of situation or emergency, more the chances of cognitive errors in decision making that bring impact patient's care negatively to an extent that sometimes they bring law suits of medical negligence against doctors. [15, 16]

The paper describes various cognitive dispositions that may lead may lead to diagnostic errors. A tired body and mind attributes to cognitive errors. Excessive work, long duty hours, heavy patient load and overconfidence of treating doctor contributes to cognitive malfunctioning leading to error in diagnosis [17, 18]. A great number of errors that occur in the diagnosis and treatment in medicine are due to faulty clinical reasoning. [19] The errors in clinical reasoning are attributed to biases or heuristics [20, 21]. In developing countries with enormous patient load, limited resources, high expectation of patient for quick relief, pressure on clinician and diagnostics to offer rapid diagnosis along with limitation in the choice of available investigations, prompts the health care professionals to adopt diagnostic short cuts and in most of the cases reach correct diagnosis as well [22,23]. The short cut approach at times could be devastating. Let us examine the various biases that arise in clinical decision making with illustrative examples.

## Pearls become pitfalls

The entire medical literature stress on the notion that common disease occur more often or put in other words 'the rare diagnoses are rarely correct'. These could lead to erroneous conclusions. The clinician refrains from thinking out of box which impairs cognitive abilities of diagnostician.

## Syndromophilia

Medical science has numerous syndromes which are often described by constellation of signs and symptoms. The catchy names and easy memory recap of few syndromes create bias as they come frequently while thinking of differential diagnosis. For instance, consider a female with signs and symptoms of iron deficiency anemia complaining of difficulty in deglutination. This might prompt clinician to think of Plummer Vinson syndrome and without elaborate work out could prompt an erroneous diagnosis. The above patient was also found to have painful joints and subsequent investigations lead to diagnosis of multiple sclerosis.

## Availability bias

Let us understand this bias with an illustration – a pathologist came across a rare case of disseminated histoplasmosis seen on bone marrow examination recently. He started suspecting them and sent five more such similar cases next week for culture and none was found to be positive for histoplasmosis. Availability is the bias that arises due to feeling that things are more frequently occurring if they readily come in mind. The converse is, the situation where under diagnosis is done due to lack of encounter with a particular disease.

## Framing effect

In this scenario the decision maker assembles elements which support a diagnosis i.e framing of findings to reach a diagnosis. Framing effect is seen for instance an assumption of symptoms to be malarial in nature in any patient who has a history of travel to Africa.

## Aggregate bias

Sometimes physician belief that the clinical guidelines developed in relation to a disease in question are based on aggregated data that do not apply to their individual patients. They create an aggregate fallacy and often order investigations that are not supported by guidelines. A patient with history of weight loss, night sweats and fever suspected of HIV infection but the diagnostician thinking HIV to be infrequent in their population orders for tuberculosis investigations.

## Anchoring bias

It refers to error in decision making due to maintenance of one's initial impression despite evidence pointing to the contrary. There is lack of adjustment of probabilities as new disconfirming information becomes available. [24] Anchoring to the belief by patient that arthritis symptoms worsen in winter seasons although it could be attributed to worsening of disease process itself.

A 30 year old male in flu season presents with nausea, vomiting and abdominal pain. On examination the abdomen is soft, mildly tender with normal bowel sounds. There was absence of diarrhea and the clinician diagnosed it as gastroenteritis. The patient revealed an inflamed appendix of Ultrasonography at a later stage and then diagnosis of appendicitis was made. Here the physician was anchored to the diagnosis of flu that dictated him from not ordering an Ultrasonography and missing appendicitis.

## Ascertainment bias

The experience in the field of diagnostics and medicine sometimes becomes a two edged sword because it influences physician's thought process by expectations. What one does repeatedly over year's results in stereo typing? The association of diseases with specific gender is yet another example of ascertainment bias. Occasionally, mere because the cause and action were juxtaposed in time, a belief arises about their casual relationship, this belief is illusionary but it definitely creates a bias.

## Base rate neglect

Every disease has prevalence and possibility of disease in any patient is governed by Bayesian reasoning [25]. Sometimes clinician distorts Bayesian reasoning there by consciously or deliberately either inflating or reducing the base rate i.e prevalence of disease. It is best seen in situation where clinician works on strategy of 'ruling out worst case scenario' to avoid missing a rare but significant diagnosis. A young male with cold, sore throat and fever advised corona virus (Yuhan) testing.

## Commission bias

'Beneficence' to patient is the driving force to many physicians which prompts them to go for active interventions in patients over inaction. The

clinicians are swung into action in order to avoid any regret in latter time for not giving treatment to patient or a procedure even when the expected effectiveness is seriously questionable.

It is seen where over investigations and over treatment is contemplated as in the treating back pain or screening for pre diabetes and thyroid disorders [26, 27].

It is best illustrated where a clinician orders a d-dimer test in a patient that is unlikely of pulmonary embolism just for the sake that nothing is missed out in the patient.

## Confirmation bias

This type of bias is best explained as when the health care provider involved in making the diagnosis tends to interpret the information gained from the patient ( during examination, clinical history and personal history) during consultation to fit to their pre conceived diagnosis rather than converse [28, 29 ].

For example, while suspecting infection in a patient a raised WBC count found on investigational workup is taken as proof of infection overlooking other causes of raised WBC count.

## Diagnosis momentum

Diagnosis momentum is accepting a previous diagnosis without sufficient skepticism. The moment diagnostic labels are attached to patient, they become heavier and sticky as a result what initially began as a diagnostic possibility by junior residents, paramedics, nursing and even patient themselves during the process of evaluation gathers more momentum until it becomes definitive and makes other possibilities overshadowed.

## Feedback sanction

This type of bias is seen in emergency medicine. Feedback sanction refers to the concept that there occurs a time delay until one sees the consequences of cognitive error or in worst situations might never see the consequences at all which results in reinforced cognitive error. Thus, lack of feedback vanishes scope of improvement and results in repeated error in other words a sort of ignorance trap.

## Group thinking or Band wagon effect

Bandwagon phenomena can be attributed to psychological factor where people start doing something because everybody else seems to be doing it. It was initially seen in politics where people vote for candidate who appears to be winning or popular as they want to be a part of majority. It has disastrous effect on clinical decision making and patient care. The following lustration will make it clearer. A 25 year old female was suffering from somatoform disorder. She complains of abdominal pain in subsequent visits. Fortunately the doctor did an Ultrasonography revealing impeding appendix rupture. Here the bandwagon phenomena were aborted resulting in diagnosis of acute appendicitis with later planned surgery took place.

## Fundamental attrition error

It is best seen in situations where the decision maker becomes judgmental and starts blaming patients for their illness rather than focusing on the current factors and circumstances that could have been responsible for them. The psychiatric discipline often encounters such bias.

## Gamblers fallacy

The other name for this bias is 'Monte carlo fallacy' as the fallacy originated with gambling and so derives its nomenclature from the Monte Carlo casino. The heart of the bias rests on erroneous belief that if a particular event occurs more frequently than normal during the past it is less likely to happen in the future, although it has been firmly established

that the probability of happening of event is unrelated to what happened in the past.

The following illustration will make it clearer, consider a chest physician who frequently attends an emergency clinic where he daily encounters patients with chest pain and diagnose most of them with acute coronary artery syndrome. He then starts presuming that the sequence of the diagnosis in question would not continue in next patient and starts thinking of alternative diagnosis in new patient. Now in this case his perception that the next patient would be something else apart from acute coronary syndrome just as he has diagnosed many patients is faulty.

### Hindsight bias

It is the tendency of people to overestimate their ability for predicting an outcome. In medicine it is detrimental to learning. It could lead a diagnostician to either underestimate by illusion of failure or overestimate by illusion of control, their own decision making abilities. Let us consider the example for understanding hindsight bias, - A letter is received in mail to an individual informing that he is selected for the job, an interview he appeared a month back, when he tells his mother she replies, "I knew you will get it" ( Even though mother has expressed doubts to his father early the week).

### Ego bias

Ego bias occurs when a clinician unnecessarily overestimates prognosis of one's own patients compared with that of a population of similar patients. It is in part reflection of Dunning –Kruger effect where there is bias of illusionary superiority, partly attributed to lack of knowledge. On the other side of curve lies the more experienced senior diagnostician who suffers from reverse ego bias as they tend to be less optimistic rather more grounded in terms of patient's prognosis.

### Multiple alternative biases

The presence of multiple differential diagnosis of a disease might lead to conflict and uncertainty leading to this type of bias.

### Familiarity bias

Familiarity with a fact resulting in its preference leads to this type of bias, best seen in making choice of drugs for any disease. As the clinician is familiar with certain drugs, combinations, trade names at times they prescribe the familiar drugs without making effort for search for newer congeners.

### Omission bias

Omission bias is a tendency of 'non action' that is deeply rooted in principle of non –malfeasance. The philosophy of doing no harm at times causes psychological inertia and the person starts judging the harmful actions as worse or immoral. To understand it lets consider a situation where the patient requires anticoagulant therapy, the physician refrains from prescribing anticoagulants for the fear of intracranial bleed. In this situation the clinician starts thinking on worst scenario and omits to perform the necessary intervention.

### Order effect

This effect is encountered in all fields especially in didactic lectures, presentations where the audience remember the beginning part and the concluding part, losing the other relevant information transmitted during the session. It is 'U' function flow of knowledge resulting from serial positioning. Applying the principle in medicine, the diagnostician fails to capture and assimilate all information shared by the patient that is necessary for arriving at correct diagnosis. The loss of information is attributed to serial positioning, resulting in so called 'order effect'.

### Outcome bias

Some clinicians tend to make those diagnosis that have better outcome rather than those that have poor outcome resulting in serious diagnosis been marginalized. The outcome bias results due to over optimistic attitude of the clinician.

### Overconfidence bias

The tendency of diagnostician to act on incomplete information and intuitions where diagnostician places larger emphasis on his intuitions rather than on evidence leading to inflated diagnostic abilities causing errors.

### Playing the odds

The signs and symptoms of common benign disease mimic more serious rare disorders. There can be tendency to opt for benign diagnosis on the basis that it is more frequent leading to error. It is the opposite of base care neglect where physicians work out to rule out worst case scenario.

### Posterior probability error

In this scenario, the physicians estimate for likelihood of disease is unduly influenced by preceding events occurring with the patient.

### Premature closure

It is tendency to reach decision before verification of complete facts. The maxim 'when the diagnosis is made, the thinking stops', aptly describes the effect of this bias. A patient attended a party and after dinner complained of sudden headache, vomiting and abdominal pain. Patient thinks its food poisoning. The physician performed general examination and accepts food poisoning as the cause. The condition of patient worsens in future and eventually a leaking cerebral aneurysm is diagnosed. The premature conclusion of the cause resulted in missed diagnosis.

### Psych-out error

It's seen in the psychiatric patients where the medical conditions are overlooked and sometimes a mis diagnosis is made with unnecessary labeling the patient of a psychiatric condition.

### Representativeness restrain

Representativeness restrain drives the diagnostic team into looking for prototypical manifestations of disease. *If it looks like duck, walks like a duck. Quacks like a duck, it is a duck.*

### Reactance bias

It is the tendency to do something different, different from the rules, regulations and protocols results in this form of bias. Eg- A goggle diagnosis by the patient is undermined by doctor as doctor thinks that his/her clinical acumen is challenged.

### Search satisfying

It's a universal tendency to call off the search when something is found. This bias especially in radiology prompts the radiologist to stop looking at other possibilities once they have found pathology. A road traffic accident victim is brought in emergency, he has spleen rupture and immediately taken for surgery. Fortunately he survives. The complaint of lower abdominal pain got masked with pelvis fracture diagnosis although it was seen on CT at the time of arrival of patient.

### Self serving bias

It is the tendency to claim more responsibility for success than for failures. Clinicians may overestimate their brilliance, their diagnosis and fail to remember missed or wrong diagnosis.

### Sutton's slip

Sutton's slip derives name from the story of Brooklyn bank robber Willie Sutton who when asked by the judge regarding why he robbed the bank to which his reply was that as there the money lies. In medicine it refers to diagnostic strategy of going for the obvious where other possibilities are not given sufficient consideration.

### Semmelweis reflex

The bias took name from the reaction of medical community to Semmelweis, a Hungarian physician who proved that hand washing with antiseptic solution before delivery reduced puerperal sepsis in mother.

Semmelweis reflex is described as a tendency to reject newly gathered knowledge as it contradicts existing normal and beliefs. It is a sort of resistance to new learning.

### Triage cueing

Health care system adopts triage process under which the more serious patients are considered first. Many times after the patient has been assigned to a specialist, specific discipline, there is a bias within that discipline to look at the patient only from specialist's perspective this is also referred as *deformation professionelle*.

### Unpacking principle

Unpacking principle refers to failure to capture all relevant information in establishing a differential diagnosis of patient.

### Vertical line failure

Stereotype routine tasks lead to economic and efficient diagnosis. They may at times hinder lateral thinking style and opportunity to diagnose unexpected rare diagnosis is lost.

### Ying yang out

It is tendency to believe that nothing further can be done to illuminate a dark area, where if any diagnosis resides for patient, so physician is let out of further diagnostic effort. To adopt such strategy at the onset is faulty.

Example: patient subjected to exhaustive investigations have been said to be worked up in yang yan.

### Zebra retreat

Putting up rare diagnosis prominently on differential diagnosis and later retreating from it due to inertia from performing expensive tests, under confidence, fear of being unrealistic, clinical environment, coercive pressure from team members, lack of time and unfamiliarity with disease diagnosis. For example, consider the case of a young female on oral contraceptive pills (OCPs) had a fall in garden and presents with severe calf pain. She is diagnosed with calf muscle sprain but dies a few days after due to pulmonary embolism. Although muscle sprain is common after injury but Deep vein thrombosis (DVT), a rare diagnosis should not have been overlooked.

### Occam's razor

In the realm of diagnostics the most simple of diagnosis is preferred without needless multiplications that further add to the existing problem. For example where there are multiple possible options the simplest should be preferred.

*Num quam ponenda est pluralitas sine necessitate.* Plurality must never be posited without necessity. Applying in medicine, new assumption should not be conflated with additional diagnosis. We explain patient's presenting signs and symptoms with three or four common or related disorders rather than one extremely rare disease. Diagnostician should not introduce an entirely new disease or condition merely to explain each

individual sign or symptom of patients. Therefore, with a common diagnosis the burden of new assumption violation of principle of parsimony is less.

### Selection bias

Berkson bias [53] is a type of selection bias and arises when the sample is taken not from general population but from subpopulation. It is also known as admission rate bias, the concept underlying this bias is that the patients with more than one disease or condition are more likely to be hospitalized than patients with only one disease condition. Neyman bias [54] is another type of bias where very sick or very well individuals are erroneously excluded from the study. The bias affects results which may be skewed in either of the two directions.

### De biasing strategies

We have seen that cognitive biases affect clinical reasoning leading to errors in diagnosis of disease and ultimately compromise in patient management [1, 24]. These errors add to patient dissatisfaction [30, 31, and 32].

The first and foremost strategy to reduce cognitive errors in medical practice aims to create awareness among medical graduates and post graduates [33]. This awareness will bring change in the mind set although it will require strong commitment from medical institutions, policy makers and general public [34, 35]. The educational strategies include discussions to mitigate effect of bias through tutorials and stimulation training. The studies by Jenkins MM et al on pediatric patients and Sherbino et al on adult patients in Canadian emergency department [2-40] didn't prove effectiveness of these strategies for de biasing.

Work place strategies like slowing down and Meta cognition have showed promising results in cutting down cognitive errors. Mamede S et al [36] and Sherbino J [37] showed improved diagnostic accuracies by slowing down the cognitive process in trial settings. However other studies have not shown the beneficial effect of slowing down process [38]. Slow down techniques include planned brief time out before any surgical procedure [1,39], presence of decision algorithms & support system in electronic medical record [40] and the introduction of various checklists like surgical safety checklist [41] as well as checklist for controlling blood infections [42]. The result of surgical time out technique adoption has helped to reduce wrong site surgery errors as evidenced in literature studies [1, 31]. Checklist prompts the user to think in a more orderly manner [43, 44]. Checklists are easy to adopt, cost effective and could be instilled in controlled environment with greater ease. Shimizu et al [45] have shown that efficacy of differential diagnosis checklist is useful for improving diagnostics.

The checklist strategy overlaps with another de biasing technique – Meta cognition. Metacognition is insight into one's own thought process. It prompts the diagnostician to ponder over 'why' they are thinking in a particular direction. This technique is time consuming but has been quite effective in reducing anchoring bias [46, 47] and overconfidence bias [48].

The incorporation of teaching of statistical methods has also shown to be effective in reducing bias [49, 50] although in limited few studies from literature. There is urgent need of hour for devising new methods of learning in medical education that incorporates bias modifications [51, 52]. Current literature is limited in terms of experimental work but the actual challenge will be application of these experimental trials in real patient scenarios.

Biases cannot be underestimated or eliminated fortnightly, we need to have a pragmatic approach in tackling them so that patient's care in unaffected.

## Conclusion

There is not an iota of doubt that diagnostic biases are common in clinical practice. It is imperative that health care professionals are aware of such biases for making prudent unbiased decision making. The actual problem will cognitive errors are that they are difficult to find and so we have to recognize them, create awareness and devise effective methodology to minimize them. How apt are Shakespeare's wordings in this context, "The fool doth think he is wise, but the wise man known himself to be a fool".

## Conflict of interest

Nil

## Sources of funding

Nil

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