

## Bias and Noise in Medicine : Case of Diabetes

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### Groping for an answer

**W**e come across several health problems and seek medical advice. With certain symptoms you might have visited a doctor who advised you to get operated. Under this situation it is quite possible that you go to another doctor for a second opinion. It may so happen that the second doctor feels that the problem can be managed with medicines only; operation is not required.

Both the doctors had the same information about the patient but their decisions differed. So, one of the two doctors was correct and the other doctor was wrong or less correct. The patient might think that the first doctor did an intentional mistake. Actually, this is not the case. In fact, diagnosis, therapy, investigation etc. all depend on the epistemological structure of the medicine or science as such. I'll give you an example in the context of diabetes.

It's a common belief that consumption of excess sweets leads to diabetes. Now, there are people who are not diabetic even after consuming lots of sweets throughout their lives. Again there are diabetic patients who don't eat sweets. Also some people who take lots of sweets don't go beyond the prediabetes stage (the stage before diabetes). So we are getting various options, not just for diabetes, but for any other disease.

There are instances of sugar level not being lowered down by the prescribed

medicine. Again in some cases sugar comes down without any medicine. So the question is whether one should take medicine in case of diabetes. If yes, which medicine is to be considered the most accurate by the doctor? In this connection, I would like to inform you that new edition of books on medical science comes out in every 1-2 years. These contain new theories, new ideas and new medicines. Sometimes doctors prescribe new medicines which have just come to market. Does it mean that the earlier medicines were wrong or the new one is better? If the new one is better, on which ground is it superior to the previous ones?

Same is the case with diseases. Doctors have certainly good knowledge and awareness regarding a particular disease, but no one knows the disease fully. We, the doctors, are always in the process of understanding, and decisions are to be taken out of this incomplete knowledge.

We can explain the above case in a compact way.

1. Things we are aware of and understand. For example, consumption of excess of sweets is to be avoided in case of diabetes.

2. Things we understand but are not aware of: I know that I have diabetes but don't know whether it might affect my kidney or my vision.

3. Things we are neither aware of nor understand. A classic example of this

category is the sudden appearance of corona virus.

4. Things we are aware of but don't understand. Suppose a person is very much aware that he is diabetic but he can't control the temptation of buying seasonal sweet fruits. He doesn't have this understanding that consuming this particular fruit is harmful for him; he has not been able to convince himself.

### Medicines

Medicines do not enter into all these complications. Medical practice is much simpler. We, the doctors, try to convert the 'things we are aware of but don't understand' to 'things we are aware of and understand' stage using various scientific tools, experiments etc. Science does it continuously resulting in invention of new medicines; new text books come into market, various new articles are being published in the journals. This knowing and understanding is always important.

We observe certain things. It has been found that diabetic patients have a tendency towards kidney failure. But this observation is never perfect. If the observation is not perfect, its interpretation also will not be perfect. So this route of epistemology is not smooth at all. All the questions are context-oriented. Treatment can be based on that particular person of the particular region. This context is very important. Suppose, a man's mother is diabetic and the person seeks a doctor's advice as to whether he should take sweets. 'No', could have been the easiest answer but it is a very general one. For a person with both the parents being diabetic, consumption of sweets may be really harmful. So the context becomes really very important. The available information is always incomplete whether it is for the patient or the disease. It is said that diabetes is increasing at an alarming rate in India. According to I.C.M.R. report, there are

nearly 7 crores of diabetics in India. Has anyone really counted it? Actually, no one counts. It is an extrapolated figure and hence not exact. While studying the prevalence of diabetes, we randomly visit some houses and enquire about the number of diabetic patients and for how long they have been suffering etc. This information is always confusing.

I'll share a personal experience with you. We had a medical camp in Murshidabad where an old lady started narrating her various problems. When we wanted to know her age, her reply was, 'Being a doctor, you are supposed to know my age. What will be your role if I tell you everything?' There are also instances of referring to someone's birth as the time of severe flood. In such cases, the information is always incorrect. So in medicine or in biomedical science, there is nothing called 'proven' as in case of mathematics. Medicine always talks about *probability*.

### Making up stories

Consumption of excess sweets may cause diabetes. Chances of diabetes in offspring are even more if the parents are diabetic. So the entire matter is just a probability; they might not develop any diabetes. Again, there are chances of kidney damage in case of diabetes, but it is not certain. Hence it is not at all wise to give statements like one particular disease will lead to another. Some people say that a particular item consumed only once can cure diabetes permanently. The fact is, diabetes is not curable; it can be managed and controlled. If anyone claims that diabetes can be cured completely, he/she is not talking scientifically and is not following the philosophy of medicine. Many a time, we are to make the matter very simple for an easier understanding. We do have a cognitive bias.

To know about evolution, we use a cartoon where it is shown that the human beings have come from apes. It is not the fact; just a story, a representation by means of cartoon to get some idea about evolution. But science has made one think differently. It is being thought that there were various ancestors, many apes. Out of those, some apes have produced new species through selection. These species might have produced even newer species, maybe after 100,000 years.

Both chimpanzees and humans had various species on earth. Humans had nearly 50 species; now only we, the *Homo sapiens* are alive, the rest are extinct. Many species of human had a common ancestor, so we haven't come from chimpanzee. Chimpanzee can at best be our cousin and not the ancestor. This understanding is different in science but it is not possible to have this type of analysis in our everyday life. Normally we make a short cut that, well, this is the case. If we don't do it and always keep thinking, life would become difficult.

Dr Daniel Kahneman, a psychologist, has worked in detail on this topic. In his famous book *Thinking Fast and Slow*, he has shown how people think. It has also been proved experimentally. He writes that 95% people in 95% cases take very quick decisions in a very simplistic way. According to him, we can't live in a state of perpetual doubt, so we make up the best story possible and we live as if the story were true.

In case of evolution also, we have made up a story which is easy to understand: the story of conversion of chimpanzee to human being. This is how our brain functions and it happens quite often.

Suppose you are crossing a road and see a bus at a distance coming your way. At that instant, you don't calculate the speed or

the momentum of the bus, nor do you calculate your speed needed to avert any collision. We have some perceptions that help us in most cases to cross the road safely. It is possible and life goes this way. This is exactly what Dr Kahneman said. While crossing the road, we don't have the perpetual doubt in mind; we somehow manage to cross it. He said that we make up the best possible story. Let me discuss the story. Many people believe that bitter gourd cures diabetes. This belief requires no evidence; based on this conviction, someone can regulate the lives of the family members.

### **Intuition and judgement**

Kahneman, in his book, assumed our brain to be composed of two structures: system 1 and system 2. The function of system 1 is based mainly on intuition and instinct. Our example of crossing the road comes under this system. Walking with two legs is not quite easy for the learners, kids fall a number of times initially. Similarly, while learning cycling, we lost balance and fell down several times. But once done, we hardly think of it. 95% of our life is spent based on this intuition and instinct. System 1 is very fast. Once we learn cycling properly, we do hardly think about balance etc.; cycle moves on. It's like automatic piloting. In the landing of a plane, its pilot has no role, it is done entirely by automation. We are also guided by a mode of automation. This is system 1, being followed by 95% of us in 95% cases.

Still there are people who can question and try to explore. We all have this portion in our brain. According to Kahneman, this is system 2, comprising 5% of the brain. System 2 is for rational thinking. But the problem with rational thinking is that it takes effort. It is slow, logical, lazy and indecisive. This involves meditation,

refreshing and revisiting the thoughts, looking back at oneself. The job is not quite easy and only few people can do it. Among those who mostly use this system are people who have gifted us something innovative.

Since we follow mainly system 1, we are bound to have some mistakes which result in bias and noise. To get a clear understanding of bias and noise, one may use the analogy of archery. If all the arrows shot by the archer hit the small circle in the centre, it is said to be accurate. The same is applicable to medical practitioners. If the arrows deviate to one side instead of reaching the centre, it is said to be 'biased'. If you visit one endocrinologist with some complications, he/she will focus on endocrine problems only. With the same ailment, if you go to a cardiologist, the doctor will focus on your heart only. This inherent bias is always there.

Another error is 'noisy'. The term 'noisy' implies the situation where the shots are all widely scattered. The situation I cited in the beginning where the two doctors differ in their opinions about whether the patient is to be operated upon or not is an example of noise. So, with the same knowledge and the same information about the patient, they opine differently. It is also possible that the error is both biased and noisy. All possibilities are there. Healthcare professionals often make different decisions when faced with similar information referred to as noise. It has been proved experimentally. We all have several cognitive biases and have more or less experienced it.

In order to arrive at accuracy from this bias and noise, we need unbiasing which is the most difficult task. This is probably a question of meditation, *sādhanā* or research; whatever it may be referred to as.

Biased approaches are intuitive, fast and irrational; and come under system 1. It is very difficult to come from this system 1 to system 2 which is analytical, slow and rational. I'm telling you these because you all have the mixed experience of visiting or even not visiting a doctor. Without a basic understanding of the operation of the medical science, the doctors might take incorrect decisions. In this context, I'll take up the case of diabetes to discuss about the types of error in the light of 'bias' and 'noise'.

### Understanding diabetes

Diabetes is a term we all are familiar with. There is a hormone named insulin which controls the blood sugar level. Sometimes our system cannot produce insulin or the produced insulin cannot function properly. In both the cases, blood sugar level increases. When sugar level increases, there are possibilities of many other organs being affected. It is a question of probability. This entire matter is referred to as 'metabolic syndrome'. Many of the diabetic patients have hypertension, have problems with cholesterol, heart or liver. Polycystic ovarian syndrome is also common among the diabetic women. Very aged people often have memory loss. So many diseases seem to be bound together, like a single disease with various manifestations. A single patient may have a combination of several problems. We'll try to understand this phenomenon in a simple way.

At our young age, say 25-30 years, pancreas produces sufficient insulin to keep our sugar level under control. In between 30-40 years of age, we normally gain weight. For Indians, the weight gain is nearly 15 kg during these 10-15 years. This entire 15 kg is fat because in adults, only fat increases and

nothing else. With the increase of body fat, insulin production also increases. Finally, pancreas totally stops insulin production. It causes blood sugar level to increase. This may occur early in some cases or may be late with others during nearly these 2 decades. At present, about 10-11% of adult Indians are diabetic. Again 10-15% of the remaining 90% are prediabetic. But it does not necessarily mean that 80% are safe; they may have other ailments like hypertension, heart problems etc.

We'll now try to understand the role of insulin. It distributes the blood sugar to different tissues so that blood becomes free from sugar. But if the system becomes insulin-resistant, blood cannot enter the tissues even though there is insulin. One of the various causes for this is weight gain. Insulin-resistance eventually leads to diabetes. Usually, insulin secretion increases with increase in weight. But the unfortunate person who cannot increase the insulin production after gaining weight becomes diabetic. So, all the fatty people are not diabetic. There are number of factors, but we don't know them all; we have incomplete information.

### **The case of India**

Among Indians, there are even more complications. Our country is a land of paradox. On one hand, there are obese people; on the other hand, there are people who are starving. We have both affluent as well as poor population.

Same is the case with diabetes. In Western countries, obese people are excessively over-weight (nearly 150-200 kg). In our country, obese people have an average weight of 80-90 kg. Even then, there are so many diabetics in our country. So, the occurrence of diabetes may not always be due to weight increase. A very

thin diabetic person with fasting sugar of 350 units once visited me.

There was an interesting article by two authors in *The Lancet* journal in 2004. One of them, Dr Yajnik, a diabetologist from Pune and his adviser Dr Yudkin (a non-Indian) had the same Body Mass Index (BMI). They had identical physique but the body fat of the Indian was 21% and that of Yudkin was only 9%. We, Indians, have less muscle and more fat. Even the newborn Indian babies have much more body fat than a Caucasian or a black baby. That Indians have excess fat in their body is evident from figures in the ancient sculptures which are all chubby or plump. In contrast, the Western sculptures reveal a muscular and chiselled body. From the sculptures, it is clear that our phenotype is very different from that of the Western people. Since we have more fat and less muscle, even a little increase in weight poses various problems.

We did a survey to understand the situation. With the available information of the diabetic patients all over India, we put those on Indian map. The entire coastal region starting from West Bengal was found to have diabetic patients. Maximum cases were in Tamil Nadu and Kerala, followed by Andhra Pradesh and then Odisha. People in this coastal region consume mostly rice. In regions like Punjab, Delhi, Haryana etc., high-energy rich food is taken. As a result, diabetes is also more. In central India, diabetics are comparatively less in number and they are mostly non-obese diabetics. In West Bengal also, some non-obese diabetics are found in North Bengal region. Rice consumption is now linked to diabetes since we have destroyed the quality of rice by removing the essential nutrients.

### **Types of diabetes**

The obvious question that comes to mind is whether diabetes is of only one

kind or not. So far, people used to think that diabetes is a disease caused by an increase in the blood sugar level. But now the pattern seems to be different. There are at least two types of diabetes. Further study showed that the rural male members who are mostly poor and thin have more chance to have diabetes. It's just a matter of possibility. It has also been found that rural women are much more protected than men against diabetes. For further study in rural areas, we decided to have centres in Machhlandapur near Bongaon and in Haldia. On analyzing the collected blood samples, we could get the interesting result that the thin people were unable to produce any insulin in their bodies. In India, nearly 50% of the diabetic patients are non-obese whereas 90% of the diabetics in the West are obese. In places like Vietnam, Malaysia etc., 60-70% of the diabetics are non-obese. A special type of diabetes exists in South-East Asia that does not fit into the framework of classical Western knowledge. It's different. As a thin person starts gaining weight, insulin production stops before his/her becoming obese. This insulin resistance is to be kept in mind while treating a diabetic patient. Considering the factors like food, life-style and stress, it can be said that there are at least two types of diabetes found among both obese and non-obese people. Now the question is, are there other types of diabetes than these two? A paper published in 2018 pointed out that there are quite a few sub-groups, at least 4-5 sub-groups of diabetes. In such case, treatment will also be of 4-5 types, there cannot be a common treatment for all.

As far as India is concerned, the situation of insulin not being produced is very important. The pattern of understanding diabetes is changing over the last 5-6 years.

There is a paradigm shift. We have started thinking differently resulting in therapeutic complications and other problems. A study has revealed that the major problem is that nearly 77% of the Indian diabetics are poorly controlled. This figure is 82% in Bangladesh. That means, sugar is not controlled properly even after taking sufficient medicine. The reason is that all the medicines were based on the western model of diabetes which talks about control of insulin resistance by reducing weight etc. In our case, the question of insulin resistance does not arise since insulin is not being produced. The cases being different, modes of treatment will also vary. We follow the protocol given in the prescriptions of the American Diabetics Association or the European Diabetic Association. This is a major reason why more than 75% of diabetes in India is not controlled. It was never thought before that insulin level is also to be tested along with fasting sugar and PP sugar. We analyzed the data obtained from the samples of the rural people with the idea that uncontrolled diabetes also has to be of several types if diabetes is of various types. We came across at least three different groups. In one of the groups, sugar was not controlled even after taking four anti-diabetes drugs. During the entire study, we followed the protocol of the American Diabetic Association. *This needs to be revisited.* Why are we so concerned about the increased sugar level? This is because the chances of other organs being damaged also increase with the rise in blood sugar. The chance of blindness increases 25fold and that of kidney failure increases 17fold as compared to a non-diabetic. The chances of heart attack and stroke are also increased. This is accompanied by limitations of treatment and huge cost of care.

The major problem is that 30% of the diabetics are likely to undergo amputation.

The fingers, feet or even the legs are to be removed. At present, in India, number one cause of amputation is diabetes. Neuropathy and other problems develop. The area gets infected and gangrene occurs. The patients are usually not concerned about this and come to the doctor at such a stage when no medicine works.

Diabetes complications are both macrovascular or the problems of the large blood vessels and microvascular which involves small blood vessels. The macrovascular complications include stroke, heart disease and hypertension, peripheral vascular disease and foot problems. Foot problems are of different types and patients

normally ignore these. Among the microvascular complications are retinopathy and cataract, renal disease and neuropathy. There are cases when a patient with gangrene feels no pain on feet since the nerves are permanently damaged. Treatment of diabetes is important to avoid these complications.

A new concept of treatment known as 'Personalized Medicine' has come up for diabetes and other diseases. As diabetes is of many types, we are to think of each patient separately. The treatment will differ from patient to patient based on the pattern of the disease. We hope to treat patients in a better way in future utilizing this concept of 'Personalized Medicine'. ■

\* Dr Partha Chakrabarti delivered this lecture at the RMIC on 11 May, 2023. The lecture was organized by the Vivekananda Science Circle of the Institute. Dr Chakrabarti is Principal Scientist, CSIR-Indian Institute of Chemical Biology.

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| <p>7 Angus Maddison, <i>Contours of the World Economy 1-2030 AD</i> (Oxford University, 2007), pp. 116-17, 176-77, 345, 382-83.</p> <p>8 <a href="http://en.wikipedia.org/wiki/Age_of_Enlightenment">Web:en.wikipedia.org/wiki/Age_of_Enlightenment</a></p> <p>9 <i>CW</i>, IV, p. 452.</p> <p>10 <a href="http://en.wikipedia.org/wiki/World-systems_theory">Web:en.wikipedia.org/wiki/World-systems_theory</a>; Francisco Ramirez, 'Comparative Social Movements,' <i>International Journal of Comparative Sociology</i>, (1981), p. 12.</p> <p>11 Sister Nivedita (Calcutta: Udbodhan Office, 1957), p. 21.</p> <p>12 Sri Ramakrishna, <i>The Gospel of Sri Ramakrishna</i>, ed. Mahendranath Gupta, tr. Swami Nikhilananda (New York: Ramakrishna-Vivekananda Centre, 1952), p. 831.</p> <p>13 Swami Saradananda, <i>Sri Ramakrishna and His Divine Play</i>, tr. Swami</p> | <p>Chetanananda (St. Louis: Vedanta Society of St. Louis, 2003), p. 76.</p> <p>14 <i>CW</i>, III, p. 243.</p> <p>15 <i>CW</i>, IV, p. 483.</p> <p>16 <i>CW</i>, IV, p.482.</p> <p>17 <a href="http://en.wikipedia.org/wiki/Medieval_university">Web:en.wikipedia.org/wiki/Medieval_university</a>; <a href="http://www.ourworldindata.org/data/education-knowledge/literacy/">www.ourworldindata.org/data/education-knowledge/literacy/</a></p> <p>18 <a href="http://en.wikipedia.com/wiki/History_of_education_in_Japan">Web:en.wikipedia.com/wiki/History_of_education_in_Japan</a></p> <p>19 A. R. Desai, <i>Social Background of Indian Nationalism</i> (Oxford University, 1948), pp. 24-28.</p> <p>20 <a href="http://www.thoughtco.com/cultural-hegemony-3026121">Web:www.thoughtco.com/cultural-hegemony-3026121</a></p> <p>21 <i>CW</i>, V, p. 507.</p> <p>22 <i>CW</i>, IV, pp. 155-56.</p> <p>23 <i>CW</i>, III, p. 277; IV, pp. 142, 401-02.</p> <p>24 <i>CW</i>, III, pp. 84-85; VI, p. 124.</p> <p>25 <i>CW</i>, III, p. 434.</p> |
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