**RISK ILLITERACY AMONG CLINICIANS**

**And the ethical problems it generates**

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**INTRODUCTION**

Evidence-Based Medicine (making clinical decisions based on the best scientific evidence available and not on “common sense” or on your mentor’s opinion) has revolutionised and improved medical practice (Sackett *et al.*, 2007). However, it brought a challenge we have not been able to conquer successfully. That challenge is: medical doctors need to learn how to interpret probabilities and statistics because, of course, it is not possible to practice Evidence-Based Medicine if clinicians cannot understand or at least interpret scientific evidence.

To become a medical doctor, it is necessary to acquire knowledge and skills in many different subjects such as Physiology, Pharmacology, Public Health and Clinical Examination. Among these skills, statistical reasoning is critical not only because it is essential to analyse emerging evidence from all other biomedical sciences, but also because it is required for risk assessments at bedside and for advising patients.

Despite this, evidence shows that even top and experienced clinicians struggle with assimilating the differences and implications of fundamental statistical concepts such as odds ratio versus absolute risk and sensitivity vs positive post-test probability (Jenny, Keller and Gigerenzer, 2018). Moreover, useful concepts such as number necessary to treat/screen, intention to treat analysis and Bayesian probability are often overlooked when making clinical decisions and when explaining the implications of tests and treatments to patients (Whiting et al., 2015).

As a result, patients are frequently exposed to unnecessary risks, taxpayers’ money is wasted, and misinformation is widely spread. Even further, some studies report discrepancies between the interventions and treatments clinicians prescribe and the ones they undergo when they face the same diseases (Thomas J. Smith, 1998; Slevin et al., 1990).

This review intends to illustrate how risk illiteracy generates ethical problems in the patient-clinician relationship or in public health decision-making, and to summarise existing evidence about this problem. Finally, a set of recommendations for patients is provided to help them assess risk more efficiently and make informed decisions.

**HOW WE GOT HERE AND THE SIZE OF THE PROBLEM**

First, we should highlight that with very few (and sad) exceptions, most clinicians are very intelligent and hard-working people who genuinely do their best trying to help their patients. Although this problem does not originate in them, they are, in many ways, the victims of its consequences.

Gigerenzer and Gray (2011) propose “seven sins” to explain how we got here: biased funding, reporting in medical journals, patient pamphlets, reporting in the media, conflicts of interest, defensive medicine and medical curricula that fail to teach doctors how to interpret health statistics. A detailed description of how each one of these mechanisms contributes to clinicians’ risk illiteracy is outside the scope of this review. However, I would like to provide an example that will illustrate these problems.

Assume that a treatment reduces the probability of getting disease “A” from 10 to 5 in 1,000, while it increases the risk of disease “B” from 5 to 10 in 1,000. Very frequently, a journal article reports the benefit as a 50% risk reduction and the harm as an increase of 5 in 1,000, that is, 0.5%. According to Sedrakyan and Shih (2007), this kind of mismatch (reporting some things as relative risks while reporting others as absolute risks), is present in 33% of papers in top medical journals and influences the way clinicians assimilate these data.

One may think that a smart clinician would not miss these differences. However, most final-year students from a top medical school failed an exam evaluating their competence when applying these concepts in practical scenarios (Jenny, Keller and Gigerenzer, 2018). Or, one may think that experience will eventually teach clinicians how to interpret data correctly. However, senior gynaecologists also fail to interpret the real risk meaning that a mammogram result implies (Anderson *et al.*, 2014).

Alternatively, one may think that these problems concern exclusively new or infrequent diseases and treatments. However, evidence of misunderstanding risk by clinicians has been found in scenarios as frequent in everyday medical practice as cancer screening (Wegwarth and Gigerenzer, 2018).

**CLINICIANS’ RISK ILLITERACY EXPOSES PATIENTS TO UNNECESARY RISKS**

Cancer screening is an illustrative scenario to continue developing our previous example. Now, let us say – and this has already been argued in scientific publications – that performing breast cancer screening using mammograms has been reported to reduce breast cancer mortality by 20% (Elmore *et al.*, 2005).

Does this imply that we will save 1 out of every 5 women who undergo the test? Well, many clinicians think so (Anderson *et al.*, 2014). However, this is another example where reporting relative and not absolute risk reduction is misleading. It is indeed true that 20% is the relative risk reduction that corresponds to an absolute risk reduction from 5 to 4 out of every 1,000 women. However, saying the former sounds more impactful than the latter. In reality, we need to test 1,000 women to save 1 and some studies have estimated this number to be as high as 2,000 tests for every woman saved (Gøtzsche and Jørgensen, 2013).

Nonetheless, saving 1 woman in every 2,000 tests could still be considered a success because breast cancer is the most common cancer in women (Torre *et al.*, 2017). However, mammograms also have risks, of which the most important is overdiagnosis (Nelson *et al.*, 2016). Surprising as it may seem, it is almost 10 times more likely that a positive (abnormal) mammogram is a false positive than a true positive.

How is this possible?

For women in their 40s, the sensitivity of a mammogram is 75% and their false positive rate is 10% (Medical Advisory Secretariat, 2007).

Does this mean that if the test is positive, the probability of having cancer is 75%? No.

How likely you are to have a disease if you had a positive result in a test is known as the “positive predictive value”, which is not the same as how likely you are to test positive in a test if you have a disease. Positive predictive value is heavily influenced by how prevalent a disease is, in this case, 1.4% for women in their 40s, and is very often mistaken by clinicians as the sensitivity of a test (Whiting *et al.*, 2015).

In other words, in a group of 1,000,000 women, 14,000 have breast cancer. Therefore, 986,000 of them do not have breast cancer. Of the 14,000 women who have breast cancer, 75% (10,500) will be detected by the mammogram. However, of the 986,000 women without breast cancer, 10% (98,600) will be told they have breast cancer when they do not. Thus, after performing 1,000,000 tests, there will be 10,500 true positive and 98,600 false positive tests. Therefore, a positive result is almost ten times more likely to belong to the 98,600 group rather than to the 10,500 group.

Apart from stress and anxiety, a false positive test also entails biopsies, potential surgery, and even more false positive results. According to Elmore *et al. (*2015), pathologists (medical doctors who are experts in analysing biopsies and the current gold standard for diagnosing breast cancer) disagree 25% of the time when they analyse the same breast biopsies.

Prostate cancer screening is a similar scenario. The number necessary to screen to save 1 man is 1,254 (Loeb *et al.*, 2011), and 7-10 out of 100 men who undergo a biopsy will require to be hospitalised due to complications of the procedure (Brewster *et al.*, 2017).

Does this mean that breast and prostate cancer screenings are useless and that we should stop them? Of course not. If your mother and your aunts had breast cancer or if your father and your uncles had prostate cancer, getting screened could save your life.

This just means that even seemingly harmless procedures need to be assessed in terms of benefit/risk ratio; which, of course, is impossible if clinicians ignore the existence of such risks or do not understand the probabilities involved.

**CLINICIANS BECOME (OR ARE RELIED UPON BY) DECISION MAKERS**

*“I had prostate cancer five, six years ago,” Mr. Giuliani, a Republican presidential candidate, said in a speech that has been turned into the radio commercial. “My chance of surviving prostate cancer — and, thank God, I was cured of it — in the United States? Eighty-two percent. My chance of surviving prostate cancer in England? Only 44 percent under socialized medicine.” (Bosman, 2007).*

The difference between a five-year survival rate, mortality, lethality, and overall survival is very frequently misunderstood by decision makers (as in the example above) and by primary care physicians (Wegwarth *et al.*, 2012).

Yes, all of these concepts and indicators are related to death and cancer but they are not equivalent or even correlated because you can be diagnosed with cancer but die of something else. Additionally, tumours have very different rates of prognosis. You can falsely inflate five-year survival rates just by diagnosing earlier and without raising the number of people not dying of cancer.

The problems that arise from confusions like these go beyond the misuse of technical language. These indicators have confused decision makers about the net benefits of screening, and there are well documented examples of taxpayers’ money being misspent because decision makers did not understand these concepts (Iacobucci, 2018). Of course, this money could have been spent in more effective practices to prevent cancer-related deaths.

**RISK ILLITERACY MAKES CLINICIANS BREAK “THE GOLDEN RULE”**

*Treat others as you would like to be treated*

Studies show that clinicians often choose to be treated differently to the way they treat patients with the same diseases (Thomas J. Smith, 1998). Interestingly, clinicians who undergo the diseases that they typically treat change their practice significantly after they recover (Cen, 2015).

As most medical doctors genuinely want to help their patients, it is unlikely that they willingly mislead them when explaining treatments. At the core of these discrepancies in the treatments that are chosen, we find a different form of risk illiteracy. In this case, clinicians are not confused by statistical jargon, they simply cannot assess the risk/benefit ratio adequately due to the lack of patient-oriented evidence.

When designing clinical trials, we usually choose hard clinical outcomes as the primary objective of our study. We opt to look at survival rate, hospitalisation rate, and years in clinical remission, and often ignore softer outcomes such as patient satisfaction. Therefore, we tend to base our recommendations on evidence including clinically oriented outcomes and not patient-oriented outcomes.

An example of this is the very high regret rate of patients undergoing dialysis (Davison, 2010). We tend to recommend it based on the real and well documented clinical benefits without mentioning the also real and well-documented high proportion of patients who regret undergoing dialysis.

In other words, healthcare workers are treated differently because, when choosing treatments for themselves, they can (at least subjectively) weigh in these patient-oriented outcomes based on what they see in their practice (Slevin *et al.*, 1990). On the other hand, when advising their patients, clinicians cannot incorporate these factors in their risk assessments. They need to adhere to the available evidence, and patient-oriented outcomes are understudied or underreported.

**CLINICIANS CAN LEARN WHEN TAUGHT PROPERLY**

After documenting that most final-year students fail a “translating evidence into practice” test, researchers showed that the same students can ace a similar test after a short course (Jenny, Keller and Gigerenzer, 2018). Additionally, there is evidence suggesting that graphic aids improve the way surgeons communicate procedures’ risks and benefits (Garcia-Retamero *et al.*, 2016).

Thus, since clinicians are usually meticulous students and well-intended people, there is fertile ground to improve this situation. Again, Gigerenzer and Gray (2011), when launching “The century of the patient”, proposed seven goals: funding for research relevant for patients; transparent and complete reporting in medical journals, health pamphlets, and the media; incentive structures that minimize conflicts of interest; promoting better practice instead of defensive medicine; and doctors who understand health statistics.

Patients have little influence on the way research funds are allocated or on the way media displays scientific news. However, they can overcome most of the problems mentioned above by improving communication with their clinicians and by looking for critical information that is often overlooked.

[Missing: a concluding sentence—a single takeaway]

**ADVICE FOR PATIENTS**

1. Be an active patient, do not be afraid to do your own research on whatever illness or health question you may have.
2. Ask your clinician about reliable patient-education resources.
3. Ask your clinician to disclose risks and benefits as “the number necessary to” (i.e. number necessary to treat to help (or to harm) one person).
4. Ask if there is evidence about regret rate or would-do-it-again rate.
5. When undergoing any diagnostic test, ask about positive and negative predictive values, not about sensitivity or specificity.
6. Accept the fact that even in Evidence-Based Medicine, uncertainty is very common and sometimes, the best we have is “an educated guess”.
7. If your doctor is not open to questions or cannot admit that they do not know something, get a different one.
8. Be patient with your doctor, we do not have every piece of evidence at the top of our heads and we might struggle with counter-intuitive statistical concepts.
9. Be patient with scientists, you will find that many questions relevant to your specific case have not been answered yet. Volunteer for research whenever you can!
10. Be patient with yourself, being ill or being unsure about medical decisions is perfectly normal. Keeping a record of your questions and feelings can be very useful for you and your doctor when facing a difficult decision.

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**St Anne's Academic Review**

Title of the article: RISK ILLITERACY AMONG CLINICIANS

And the ethical problems it generates

(A Likert-type scale from 1 to 5 will be used)

ACTUALITY OF THE TOPIC 1 2 3  **4**  5

COMMENTS

In light of the covid-19 pandemic, evidence-based medical practice becomes more necessary.

SCIENTIFIC INTEREST 1 2 3 **4** 5

COMMENTS

In case the author is a practicing physician or soon to be one it would have been interesting to mention his own experience with evidence-based medicine during his training or studies (curricula)

ORIGINALITY 1 **2** 3 4 5

COMMENTS

The text is mainly a review with a guide at the end to be followed by the patients

SUBJECT MATTER KNOWLEDGE 1 2 3 **4** 5

COMMENTS

The author knows the subject but it would have been interesting if the author had presented many more cases of lack of understanding of risk probabilities in diagnosis or medical decision making. And all this with a pedagogical intention. A brief introduction to the standard of evidence-based medicine: randomized controlled trials, would have been interesting.

APPROACH TO WORK CONTENT 1 2 3 **4** 5

COMMENTS

The article is clear and concise. It presents the topic well

WORK METHODOLOGY 1 2 **3**  4 5

COMMENTS

It is mainly a review.

PRESENTATION OF THE TOPIC 1 2 3 **4** 5

COMMENTS

It presents the topic well.

LANGUAGE USED 1 2 3 **4**  5

COMMENTS

The language used is clear

TOPIC WRITING 1 2 3 **4** 5

COMMENTS

The presentation structure of the topic is clear and intuitive although I don't know if it's according to the journal´s instructions

LITERATURE USED 1 2 3 **4** 5

COMMENTS

The literature used is relevant, but in a subject like evidence-based medicine the findings or insights need to be updated constantly:

Djulbegovic B., Guyatt G.H. (2017). Progress in evidence-based medicine: a quarter century on. Lancet. 390:415–423

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Djulbegovic, B., & Guyatt, G. (2020). Evidence-based medicine in times of crisis. Journal of clinical epidemiology, S0895-4356(20)30673-9. Advance online publication. https://doi.org/10.1016/j.jclinepi.2020.07.002

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SUGGESTIONS FOR WORK IMPROVEMENT

COMMENTS

It would have been interesting for the author to make a comparison between heuristics-and-biases framework (Kahneman et al.) and the fast-and-frugal heuristics framework (Gigerenzer et al.) The author relies heavily on Gigerenzer´s analysis of risk illiteracy. While Gigerenzer considers intuition to be a form of unconscious intelligence, Kahneman and other behavioral economists who defend the dual-process theory of mind differentiate two systems: system 1 automatic and intuitive, and system 2 slow and deliberative. The latter is considered most effective and optimal. At first sight this second system seems to be in line with the mission and objectives of evidence-based medicine.

Another observation is that it would still have been necessary to introduce a handy statistical lexicon that medical practitioners can find useful in their daily activities.

Although the subtitle of the article refers to the ethical implications of risk illiteracy and a section mentions the “golden rule”, there is hardly any discussion about the ethical problems of not carrying out evidence-based medicine.

Another neglected aspect of the article is evidence and data: how to gather, analyse and communicate data. Evidence-based medicine is a good idea but when data or evidence is shaky we have problems.

FINAL DECISION

**The article is publishable**