

MEDICAL JUDGEMENT IN DATA-LACKING CONTEXTS

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ABSTRACT

Medical judgements require doctor's belief based on the solid scientific evidence provided by empiric inductive experience. Yet, it is not infrequent that scientific data are unavailable, unreliable or controversial, such that the empirical evidence is not solid enough to allow doctors to build their own belief and make a final choice. Here we ask whether it is feasible to achieve a real and justified belief in medical affairs when scientific data are missing. We suggest a novel procedure to reach a quantifiable degree of belief which ultimately leads to medical judgement. To describe the state of medical affair under examination, we draw a sentence in the logical form "*if x, then y*" with just two possible answers: yes or no. Then, we examine five sources leading to doctor's belief, namely 1) Evidence-Based Medicine levels, 2) individual experience, 3) collective knowledge, 4) logical reasoning and 5) confounding factors like chance, emotivity, cognitive bias. Every one of the five factors contributing to formulate a medical judgement is supplied with a given value of belief, so that negative values stand for negative answers and vice versa. A single number is accomplished, such that a total value of belief below zero is counted as negative, above zero as positive. In conclusion, we provide a quantitative approach to cope with the frequent medical cases where qualitative factors like emotional issues, personal beliefs, wisdom of the crowds, confirmation bias, narrative fallacy are more influential than scientific evidence in driving doctors to gain belief and formulate judgements.

KEYWORDS: propositional knowledge; justification, diagnostic error, analytic thinking, theory laden.

INTRODUCTION

Medical judgements are based upon the beliefs that doctors build in their mind with the purpose of capturing the ways things are. To achieve a medical belief that is real and epistemically justified, a match is required between external world and mental judgement (Alston 1989). We contend that a pragmatist approach is mandatory during medical judgement (Peirce 1905). Since the quality of medical decisions depends on the accuracy of relevant quantities' estimates, there is no room for fuzzy interpretations, dynamic systems theory, network topology, nonlinear dynamics, skeptical stances (Hume 1739; DeRose Keith Warfield, 1999; Prasse and Van Mieghem, 2022). Various scientific and not scientific sources of knowledge can influence beliefs and the ensuing medical choice. Two dichotomously patterns of medical belief are considered here, namely internalist and externalist accounts:

- 1) Externalist accounts of justification examine the factors located outside the cognitive perspective of the believer's mind (Armstrong 1973; Goldman, 1986; Supriyanto 2023). For our purpose, we include here the solid evidence provided by scientifically sound literature. The best way to achieve medical judgement is the Evidence Based Medicine (henceforward EBM). Widely agreed medical practices and probabilistic accounts can also be included here.
- 2) Internalist accounts of justification examine the factors internal to the believer's mind (Feldman and Conee, 1985; Haack 1991). We include here the occurrence of both a justified belief not based on other justified beliefs (Chisholm, 1989) and a set of coherent beliefs that mutually support one each other (BonJour 1985). Internalist accounts also encompass doctors' perspectives, expert colleagues' opinions, views and concepts that sound logically reasoning (Supriyanto 2023). We include here also the confounding factors that influence the final medical choice, i.e., randomness, misinformation, false beliefs, cognitive bias, etc.

It is widely shared that the occurrence of (externalist) empirical, a posteriori knowledge can achieve a true and justified medical belief. When systematic reviews or at least widely agreed randomized trials are available, solid beliefs are easily achieved and the medical judgements are straightforward. The problem arises when ambiguity, controversy and disagreement occur throughout the process of medical judgement, impairing timely diagnoses and treatments (Meyer et al., 2021). Clinicians may experience opacity or complexity within the diagnostic path, increasing the uncertainty related to probability/risk (Meyer et al., 2021). Uncertainty involves also information gathering, interpretation, integration, creation of diagnostic safety nets (Meyer et al., 2021). In cases where empirical, a posteriori knowledge it is not available, an (internalist) non-empirical, a priori knowledge is required, like it or not. When scientific data are lacking, reliable scientific results are controversial, consensus cannot be reached among peers, doctors are required to make use of internalist ways of judgement, although less effective and scientifically sound.

We choose a very pragmatic approach that leaves apart theoretical claims and metatheoretical approaches, proposing a procedure to build beliefs and judgements in the frequent cases in which scientific knowledge is lacking in medical issues.

SCIENTIFIC APPROACHES

In the next chapters we will describe the sources that influence the doctors' beliefs and medical judgements. We start from the externalist accounts. The historical accomplishments of the empiric deductive approach underlying the scientific method are never too stressed. We especially emphasize the EBM approach, based on a heuristic hierarchy of evidence that ranks the relative strength of results obtained from medical research. Although fully aware of the limitations of EBM approaches, in which emulation differences, chance, and residual confounding can contribute to divergence in results (Wang et al., 2023), we contend that EBM is still the gold standard to make medical judgements. Many different hierarchies have been proposed for the assessment of medical evidence regarding screening, diagnosis, prognosis, treatment benefits, etc. Here we will use the broadly agreed Oxford Centre for Evidence-Based Medicine Levels redesigned in 2011 (OCEBM Levels of Evidence Working Group, 2011). We describe the first four levels that make up a descending scale of evidence strength:

- 1) Systematic review of randomized trials.
- 2) Randomized trials, (exceptionally) observational studies with dramatic effect.
- 3) Non-randomized controlled cohort/follow-up studies, non-consecutive studies, studies without consistently applied reference standards.
- 4) Case-series, case-control, historically controlled studies, poor or non-independent reference standard.

The strongest evidence is provided by systematic homogeneous reviews and meta-analyses of randomized clinical trials with definitive results (Greenhalgh 1997), followed by large-scale, epidemiological studies (Burns et al., 2011). Randomized clinical trials are also reliable, due to their uniform reporting that simplifies critical appraisal (Young et al., 2020). It has been argued that some non-randomized, real-world evidence studies describing medications in clinical practice could reach similar conclusions as the standard randomized clinical trials, especially the ones designed to emulate past randomized clinical trials (Wang et al., 2023). While raw data in their pure form are useless for the comparison of experimental results with theory, processed data are in some cases epistemically consistent (Antonioni 2021). Also, it must be considered that diagnostic and prognostic medical decisions are often guided by predicted probabilities regarding specific outcomes (Debray et al., 2023). We include among the empiric deductive approaches also a series of relatively objective factors like physical examination and medical tests.

In sum, scientific approaches, especially the ones associated with the EBM methodology, are the best way to reach a true and justified medical belief that is reliable enough to make a choice.

COLLECTIVE KNOWLEDGE

We include under the definition of "collective experience" factors like eminent people's and expert colleagues' opinions. Non-individual, widely agreed collective knowledge is required when coping with medical issues. Medicine is an inherently relational enterprise, in which the relationship between physicians is a constitutive component of the craft itself (Ben-Moshe 2019). Since claims about medical truths cannot be based on each doctor's point of view, it's up to collective doctors' belief to provide a widely agreed attitude towards a certain medical statement (Supriyanto 2023). However, it is not uncommon that differences in judgement between doctors are dictated by variable hypotheticals that do not have a fulfilled sense of true or false. By their own nature, variable hypotheticals cannot be negated, but only disagreed (Ramsey 1929a). When two different individuals meet the future with different habits, they disagree even if the actual future agrees with both. Therefore, the doctors' actions do not depend on their degree of probability, rather on their degree of beliefs (Ramsey 1929b). Since the human mind is naturally tailored to fit the belief of the regularity and stability of the external world, the problem arises when the facts collected by inductive reasoning lead to generalizations and to assert variable hypotheticals in terms of causal laws. Causal laws are not just a summary which describes certain facts, but also a forecasting attitude of expectation for the future (Ramsey 1929a).

According to the wisdom of crowds principle, accurate estimates can be obtained by combining the judgements of different individuals (van Dolder et al., 2018). It has been argued that the average of a large number of repeated judgements from the same person (within-person aggregation) is less accurate than the average of just two judgements from different people (between-person aggregation) (van Dolder et al., 2018).

In sum, medical beliefs achieved from many doctors are more accurate than medical beliefs from a single doctor. Unfortunately, both are less accurate than scientific approaches.

INDIVIDUAL EXPERIENCE

We include under the definition of “individual experience” the factors depending on the single doctor’s mind, namely memory, abstraction, accumulated knowledge, familiarity with the medical problem under examination. Although individual experience in one of the most frequent issues underlying diagnostic reasoning and accuracy (Rosenberg, 2002), it is plagued by many biases. It has been demonstrated that the exposure to a prior similar patient case improves the differential diagnosis’ accuracy just of pre-clerkship medical students, but not of experienced staff (Monteiro et al., 2020). The early diagnostic hypotheses advanced in the first few minutes of a clinical encounter determine the final diagnostic accuracy, while physical exam, diagnostic tests and review of the patient history contributes very slightly to diagnostic performance (Monteiro et al., 2020). Although widespread in life sciences, the ideas of self-control, self-observation and self-models cannot be empirically tested by the same systems that implement them (Fields et al., 2024). Adding observational, representational, or control capabilities to a meta-level component of a medical problem cannot, even in principle, lead to a complete meta-level representation of the medical problem as a whole (Fields et al., 2024).

Personal medical beliefs can be defined as the expectation with which the doctor meets the future (Misak 2020). While propositions with material implications (e.g., *if I do p, q will result*) can be true or false, variable hypotheticals (e.g., *if p, then probably q*) provide just a degree of expectation that varies among doctors according to their habit and leads to forecasting that guides active choices (Ramsey 1929c). However, the pictures doctors make to themselves are not pictures of the facts (Misak 2020). Indeed, their beliefs could not be strictly true, rather express an inference that doctors are at any time prepared to make based on their own degree of expectation (Ramsey 1929b).

In sum, the ultimate purpose of thoughts is to guide actions, and actions depend on the degrees of beliefs rather than the degrees of scientific probability. When doctors make use of ordinary beliefs, they trust variable hypotheticals as viable rules of judging to guide them in new instances in order to avoid all the medical experiences inconsistent with their belief. This “subjective side” must not be neglected or underestimated when coping with medical epistemological issues.

LOGICAL REASONING

We include under the definition of “logical reasoning” factors like deductive judgements, common sense, mechanism-based reasoning, data models. Sometimes theoretical hypotheses are not confronted with the raw results of an experiment, rather they are compared with models of data (Suppes 1960). With some limitations, healthcare decisions could be informed by clinical prediction models generalizable to patients in new settings, avoiding spurious data relationships and improving the explainability (Wan et al., 2022). It is noteworthy that, despite recent critiques regarding context-dependent trials’ outcomes (Chekroud et al., 2024), model-based statistical approaches could be able to predict patient outcomes with discrete accuracy, improving decision-making related to medical treatments.

Paraphrasing Giovan Battista Vico, we can state that logical reasoning is very powerful but does not give truth, rather gives certainty.

CONFOUNDING FACTORS

Underrated factors may influence the doctors’ individual and collective actual degrees of belief, leading to mistaken judgements. They include intuitive thinking, emotivity, chance, prudence and the norms that have been dubbed “the internal morality of medicine” (Ben-Moshe 2019). When the primary outcome of clinical trials provides non-statistically significant results, prespecified assumptions could influence and change practice, inadvertently and mistakenly placing ambiguous findings in the context of the existing relevant evidence (Young et al., 2020). Worth of mention are the false data, including scientific deception and fake news. In recent decades, popular medical frauds exerted deep influence over medical judgements and health policies. See, i.e., the infamous case of Wakefield et al. (1998).

Cognitive bias like confirmation bias, narrative fallacy and silent evidence (Taleb 2007) are other confounding factors able to impact medical judgement. Systematic thinking errors due to human processing limitations or inappropriate mental models result in diagnostic errors or delay in the acceptance of new scientific findings/new treatments (Hammond et al., 2021). Theory-ladenness emerges at different levels, depending on the purpose and strength for which background theory guides the overall experimental process (Antonioni 2021).

In sum, also a fully justified belief could be not true (Gettier 1963). The conscious and unconscious bias that influence the final choice must be taken into account before medical judgements are formulated.

FORMING BELIEFS: A PRACTICAL APPROACH TO MEDICAL JUDGEMENT

Here we describe a procedure to build the degree of belief that ultimately leads to medical judgement. Propositional knowledge is required, i.e., a knowledge expressed in terms of a declarative sentence describing a medical fact or state of affair (Chisholm, 1989). To standardize the approach, we suggest to use the standard logical form “*if x, then y*” (Carnap 1974). Since the sentence must refer to a series of useful expectations that may be pragmatically proven true or false (Misak 2020), the answer must be formulated just in the discrete form: yes or no. The factors leading to medical belief are summoned in a heuristic rank (**Table**). A given positive or negative value of belief is attributed to every factor, such that a negative value stands for a negative answer, and vice versa.

Factor	Answer: NO	Answer: YES
1) Systematic review	-1	+1
2) Randomized trial	-0.35	+0.35
3) Non -randomized study	-0.25	+0.25
4) Case-series, case-control	-0.2	+0.2
5) Collective knowledge	-0.2	+0.2
6) Individual experience	-0.15	+0.15
7) Logical reasoning	-0.1	+0.1

Table. Value of belief for every one of the seven factors contributing to formulate a medical judgement.

The factors 1-4 rank different levels in the EBM hierarchy of evidence obtained from medical experimental research. The factors 5-7 rank the values related with what we termed internalist knowledge. Note that the values 2-7 are deliberately kept very low because of the possible effects of confounding factors.

We provide a few examples of value attribution. When one of the seven factors is not accessible, it cannot contribute to build the final belief and a value corresponding to zero is assigned. For example, if a systematic review is unavailable while a randomized trial suggests to use a medical procedure, the value of belief will be zero for the systematic review and +0.35 for the randomized trial. When two or more randomized trials provide opposite results, the factor “randomized trial” will be rated as zero. To give another example, the individual experience of a pediatrician concerning diabetic ulcers in elders must be counted as zero. When judgements of expert clinicians about a rare clinical picture are impracticable to collect, the collective knowledge’s value of belief must be zero.

In sum, our procedure accomplishes a single number representing the total value of belief, i.e., the addition and subtraction of every positive and negative value. A total value of belief below 0 is counted as negative, above 0 as positive. To make an example, a total belief of degree -0.45 applies as a negative answer to the sentence “*if x, then y*”.

CONCLUSIONS

Science is primarily the means to discover the simplest descriptions of our world (McFadden 2023). This means that at least the possibility is required to connect the medical event with the doctor’s belief. During a medical judgement, the best option is the availability of a solid, widely agreed scientific literature together with a collective, straightforward belief shared between the medical community. However, this option is frequently missing due to unreliable, contradictory or controversial scientific data, or to poor state of the art. Here we suggest a method to cope with these data-lacking contexts in order to achieve the best feasible medical judgement. We understand that our choices of a split between externalist/externalist sources of belief may be debatable. Also, we accept that the value of beliefs given by us to every one of the seven factors could be controversial and are fully aware that our framework could be improved. Yet, our goal is reached, i.e., to suggest a quantitative approach to medical judgement that takes into account also qualitative factors like emotional issues, personal beliefs, wisdom of the crowds, cognitive bias.

DECLARATIONS

Ethics approval and consent to participate: This research does not contain any studies with human participants or animals performed by the Author.

Consent for publication: The Author transfers all copyright ownership, in the event the work is published. The undersigned author warrants that the article is original, does not infringe on any copyright or other proprietary right of any third part, is not under consideration by another journal, and has not been previously published.

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