A medical history serves to record the patient’s complaints and translate them into clear-cut, medically defined symptoms. A poorly defined symptom loses most of its discriminative power as a diagnostic test for a medical work-up. If physicians are uncertain about the exact meaning of a symptom, they have to account for the possibility of multiple competing interpretations for the identical set of complaints. Multiple possible interpretations of a single symptom diminish its value as a diagnostic test and result in test degeneracy. The physician needs to help his patients to phrase their complaints in a fashion that limits the number of possible interpretations. A poor medical history diminishes the opportunity to establish a diagnostic suspicion with a high probability early on. The subsequent medical work-up has to rely on many more tests to confirm the presence of a diagnosis. The poor medical history exposes the patient, therefore, to more test-related risks, and prolongs the diagnostic process. All these downsides of a poor history ultimately increase medical resource utilization and healthcare expenditures.

Keywords: Bayes’ formula, medical decision analysis, medical diagnostics, outcome research, sensitivity, specificity, test characteristics

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For the sake of brevity, throughout this article we use the examples of a male physician and a male patient, although all arguments would apply similarly to both gender groups.

**Introduction**

In addition to the physician’s own knowledge base, a diagnostic process is crucially dependent on the patient’s accurate description of his history of present illness [1,2]. The physician’s ability to resolve a diagnostic puzzle is rendered easier as a patient relates a more precise set of well-characterized complaints. The physician can then associate this set with a known pattern of a particular disease. Unfortunately, many patients fail at this initial step and provide the physician with a scanty and vague history that causes the physician to call them ‘poor historians’. The physician could be blamed for being a poor historian himself, as he fails to analyse the cause and impact of a poor history in sufficient depth to allow for remedies and adjustments. In taking a medical history, the physician translates the patient’s complaints into medically interpretable symptoms and formulates a diagnostic suspicion based on the presence of characteristic symptoms. A poor description of complaints compromises the physician’s ability to interpret the patient’s narration in terms of unique and well-defined symptoms. Because the benefit of a symptom as a diagnostic tool diminishes with the number of its potential interpretations, ambiguous symptoms lack discriminative power in predicting a medical diagnosis. Poorly characterized symptoms are less effective in raising disease probability and prolong the diagnostic work-up.

This short review is centred around the implications of poor medical histories and how they confound the decision making in gastroenterology. The aim of the article is to analyse the mechanisms that reside on the patient’s side and that lead to a poor history, as well as the role of the physician in translating vague sensations into medically useful and operational terms or symptoms. We also try to quantify the effects of a poor history on the diagnostic process and show how one could adjust a diagnostic probability for the imprecision spawned by a poor history.

**The patient’s problem**

At the onset of disease, a patient experiences new sensations, whose causal relationships are not clear to him. A patient with reflux symptoms, for instance, would need to understand first that this new and strange discomfort behind his chest bone is real and not just a funny or short-lived delusion. To reach an understanding and communicate to a physician effectively, he would need to observe the symptom over time and extract its behavioural patterns over time and locality.
Does the discomfort stay localized or migrate? If it migrates, then how far and where does it go? When does it occur, how often does it occur, and how long does it last? The patient would need to establish an association with other external and internal events. Does anything precipitate or alleviate the sensation behind the chest bone? How do common circumstances, such as body movements, exercise, sleep, food intake or defecation, affect the pain? Are belching and the acidic taste different diseases or part of the same disease process? What about headaches and a rash on the left leg – are they related to the other symptoms? Did a recent fall from a ladder or a trip to Africa contribute to this new disease?

It takes quite an intellectual effort to appreciate accurately the new experience in all its detail. First and foremost, the patient is required to note a bodily change in comparison with the unaltered past. The multiple new sensations may not appear simultaneously. They need to be sorted and grouped by magnitude, locality or time, and they need to be checked for their various associations with other events. This mental process relies on our inborn ability to extract rules and causal relationships from observing temporal and local associations in the natural phenomena that affect and surround us [3]. Prior knowledge, memory capacity and general intelligence greatly improve its success. Patients whose social background, culture or language are different from those of the physician will not be able to communicate their observations as effectively as people more similar to their physician. As people age, they seem to lose some of their inborn ability to observe accurately and extract causal relationships from their observations. This failure may stem, in part, from an age-related loss in memory that prevents patients from reliable bookkeeping and mental averaging-out of repetitive patterns of occurrence. Older people also lose some of the ability for the unbiased observation and mental uptake of new facts.

Patients may not remember the most striking details, or they may inundate their physician with too many details because they are unable to summarize or sort them by their relevance. Some patients are completely unable to extract a common pattern and fail to generalize their experience. Asked about the usual frequency and appearance of their bowel movements or abdominal pains, for instance, these patients report only a single most recent event. For the medically uninitiated, it is especially difficult to differentiate between associations that do or do not reflect on the disease process. Where does the disease begin and where does it end? Where are its outer borders, and what does not belong or relate to the disease process? Because they find it difficult to delineate the disorder in a medical or even pathophysiological sense, some patients tend to indulge in associative speculations, which they present as real relationships.

**The physician’s role**

Occasionally, the label of being a ‘poor historian’ reflects unjustified arrogance on the physician’s side. The physician may look at the patient from the perspective of knowledge and forget the arduous path it has taken the science of medicine to delineate a particular disease or symptom, extract its key features, ignore redundancy or noise that accompany its occurrence, account for its variability, and sort out its multiple clinical and pathophysiological associations. In previous versions of the International Classification of Disease, for instance, duodenal ulcer and ulcerative colitis, and cancer of the stomach and liver, were grouped together as two rather than four separate disease entities [4,5]. It has taken generations of physicians to establish the facts of clinical knowledge that render present-day physicians so seemingly clever and knowledgeable. While the physician only needs to recognize an already established disease pattern, every patient is called upon to rediscover his disease. It is the obligation of the physician to help the patient in this endeavour.

In asking pointed questions and adding to the patient’s incomplete description, the physician tries to extract a more detailed and comprehensive picture of the patient’s ailment. To be able to complement the patient’s narration, the physician must have stored a mental pattern of the symptom that he tries to apply to the patient’s own words. The physician functions as a mediator who translates the patient’s vague experiences and sensations into medically defined terms. Unless he has some medical background, a patient may not, for instance, describe his reflux symptoms in terms of ‘heartburn’ or ‘acid regurgitation’ [6]. While the patient is requested not to forget important details about his complaints, and to recall their associations in a reliable fashion, the physician is called upon to absorb the provided information in an open-minded and unbiased fashion. Since he lacks medical knowledge, the patient will convey an incomplete and fuzzy picture that the physician is forced to clarify. In his attempts at clarification, the physician needs to add missing features, accentuate contours, and exaggerate contrasts. Through repetitive questioning during this process of history taking, the physician checks with the patient whether these simulations and changes agree with the patient’s own experience. Obviously, in translating the patient’s complaints into medically meaningful symptoms, the physician needs to find a balance between helping the patient to reconstruct his complaints and forcing upon the patient the physician’s own concepts. Some physicians may be too generous in adding or highlighting suspected characteristics. Others may form an opinion
Correct translation of complaints into symptoms

Many clinicians approach their new patients with a touch of apprehension. This feeling never vanishes fully, even in the most experienced physicians. It reflects their lingering doubts of whether they will be able to translate truthfully the new patient’s complaints into medically meaningful symptoms and then assemble the correct diagnosis from the array of symptoms. The translation of a complaint into a medically correct symptom will be successful depending on the patient’s description and the physician’s insight. With respect to the example used above, a pain behind the chest bone could be associated with gastro-oesophageal reflux disease (GORD), oesophageal motility disorder, peptic ulcer, aortic aneurysm, angina, myocardial infarction, or any of the many other diseases involving the heart, lung, mediastinum and musculoskeletal system. Each disease process would be associated with different pain characteristics, and unless the physician differentiates clearly between the various types of symptoms and then assigns the correct symptom to the patient’s complaints, the diagnostic pursuit could be headed in the wrong direction.

Especially in gastroenterology, some key symptoms are associated with a large list of potential differential diagnoses. Textbooks and review articles list over 50 differential diagnoses for jaundice, abdominal pain, diarrhoea and constipation [7–10]. A physician could easily confuse closely related but, nevertheless, clearly distinct types of symptoms. For instance, the complaints associated with pelvic outlet obstruction versus colonic inertia are distinct, although both might be labelled as constipation. Similarly, the diarrhoea associated with vagotomy occurs shortly after eating and results in painless, small, loose bowel movements without blood or mucus. In contradistinction, the diarrhoea of ulcerative colitis is characterized by frequent bowel movements that are spread throughout the day and night and frequently contain blood and pus. Other such examples abound. In translating the patient’s complaints into medically meaningful symptoms, the physician has to consider the different appearances of each symptom and choose the correct subtype among a multitude of options.

A decision in favour of a particular diagnosis is made based on the results of multiple tests. A typical clinical laboratory test is exemplified by the serology of an enzyme or antibody. As the concentration or the titre varies over a scale, it is read as being abnormal once it exceeds or falls below a predefined cut-off value. With respect to a particular diagnosis, the normal and abnormal values could both be false or true. For instance, an elevated alkaline phosphatase would be true positive with respect to choledocholithiasis and false positive with respect to reflux disease. In the diagnostic process, the absence or presence of a particular symptom also functions as a test in that it helps to shift the probability in favour or against a given diagnostic suspicion. Similarly to a serological test, a symptom can provide a false or true positive or negative result.

In contradistinction with a one-dimensional serological test, however, a symptom represents a multidimensional test. The distinction between true and false applies not only to the result but also to the whole test itself. In the differential diagnosis of chest pain in a patient with reflux disease, the symptom of heartburn could be true or false. In addition to the true/false options regarding the presence of such symptom, however, the type of chest pain itself would convey a false description for a patient with achalasia or myocardial infarction. Heartburn will be less sensitive and specific in describing other oesophageal, mediastinal or cardiac diagnoses. Different from a serological test, a ‘symptom test’ resembles more closely the interpretation of computerized tomography (CT) scans or mucosal changes during endoscopy. In addition to the false or true presence or absence of endoscopically visible lesions, for instance, the endoscopic appearance of reflux oesophagitis could be misread as ischaemic or infectious oesophagitis.

Influence of test degeneracy on diagnostic probability

Bayes’ formula represents the standard means to quantify how a test result affects diagnostic probability [11,12]. In case of a positive test, the pre-test disease probability \( P_1 \) is changed to the post-test probability \( P_2 \) depending on the fraction of true positive tests among all positive tests. The prevalence of true positive tests corresponds to the pre-test disease probability \( P_1 \) multiplied by the fraction of true positive tests \( TP/P_1 \). The prevalence of all positive tests corresponds to the prevalence of true positive plus false positive tests. The prevalence of false positive tests is given by the probability of disease absence \((1–P_1)\) multiplied by the fraction of false positive tests \( FP/P_1 \). Hence, the fraction of true positive over all positive tests corresponds to:

\[
P_2 = \frac{\text{true positive tests}}{\text{all positive tests}}
= \frac{P_1 \times TP}{P_1 \times TP + (1–P_1) \times FP}
\]

Bayes’ formula can be used repetitively to calculate the
increase in disease probability conferred by multiple positive test results. Each new test provides its own set of test characteristics, i.e. sensitivity and specificity. The updated disease probability $P_2$ is used instead of $P_1$ to calculate the next new post-test probability $P_3$. In the formula for the second test, the new TP and FP values represent the characteristics of the second test. This process of updating a disease probability can be repeated an unlimited number of times. In the presence of sensitive and specific tests, the repetitive use of Bayes’ formula very soon leads to probability values that are close to 100%. Provided that its sensitivity and specificity are known, the presence or absence of a symptom can be used to update the disease probability calculated by Bayes’ formula just like any other test. The upper curve of Figure 1 shows the hypothetical example of increase in disease probability as a function of the number of utilized (tests or) symptoms. The initial probability is chosen to be $P_1 = 1\%$, and the sensitivity and specificity of each test are assumed to be 80%. Despite the low starting value, only five symptoms suffice to raise the diagnostic probability above 90%.

So how does an incorrect translation of a patient’s complaints affect the relationship between symptom characteristics and the diagnostic probability, as outlined by Bayes’ formula? Since an imprecise symptom can be interpreted in multiple ways, its true and false positive outcomes relate not only to one but also to multiple interpretations. The prevalence of true positive symptoms corresponds to the initial disease probability $P_1$ multiplied by the sensitivity values associated with all possible symptom interpretations. Similarly, the prevalence of false positive symptoms corresponds to the probability of disease absence $(1-P_1)$ multiplied by the sum of false positive outcomes of all possible symptoms interpretations. Bayes’ formula changes to:

$$
P_2 = \frac{P_1 \times \sum_i TP_i}{P_1 \times \sum_i TP_i + (1-P_1) \times \sum_i FP_i}.
$$

where $i$ is the number of possible interpretations of the symptom in question. In the first example of GORD, $P_1$ would represent the a priori probability for a given patient to harbour reflux disease. The true positive values $TP_i$ represent the sensitivity values of heartburn-type, ulcer-type, myocardial infarction-type, aneurysm-type, etc. symptoms for GORD. Obviously, the other interpretations besides heartburn would have a low sensitivity and specificity for GORD. A burning feeling rising from the stomach towards the chest is far more sensitive and specific for GORD than a crushing, steady, left-sided chest pain that cuts off breath and radiates to the left arm. If a physician can rule out all but one interpretation, then equation (2) reverts the original Bayes’ formula as depicted by equation (1).

More than one potential interpretation of a patient’s complaints results in test degeneracy, because lower sensitivity and specificity values are associated with the other test interpretations. The more interpretations left open by a poor medical history, the more degenerate and less valuable the individual symptom becomes. In a hypothetical example, the unbiased and unique interpretation of a symptom is again assumed to be associated with a sensitivity and specificity value of 80%. The upper curve of Figure 2 shows the post-symptom probability plotted as a function of the pre-symptom probability using equation (1). For instance, the presence of a characteristic symptom raises a pre-symptom probability from $P_1 = 50\%$ to a post-symptom probability of $P_2 = 80\%$. For illustrative purposes, the sensitivity and specificity values of all secondary interpretations are assumed to be 50\%. The second and third curves represent the test performance in the presence of two or three potential interpretations using equation (2). As the number of interpretations increases, the curve approaches the diagonal, which represents a diagnostically worthless test that does not change disease probability. The lower curve of Figure 1 shows the increase in disease probability as a function of the number of degenerate symptoms utilized. In the
example shown, each symptom is assumed to be associated with three possible interpretations, the sensitivity and specificity of all secondary interpretations being 50%. As shown by the second curve, poorly characterized symptoms lead to a much slower increase in disease probability, and many more tests or symptoms are needed to confirm a suspected diagnosis beyond reasonable doubt.

Conclusion
A medical history serves to record the patient’s complaints and translate them into medically useful terms. A poorly defined symptom loses most of its discriminative power in establishing a medical diagnosis. If a physician is uncertain about the exact nature of a symptom, then he has to account for the possibility of multiple competing interpretations of the identical set of complaints. The diagnostic value of a symptom diminishes with the number of its potential interpretations, and an overly indistinct complaint needs to be ignored altogether. The physician should help his patients to phrase their complaints in a fashion that limits the number of possible interpretations. Some patients are helped by being offered a variety of ‘canned’ symptom descriptions that they are encouraged to choose from. Cultural and language training provides the physician with better skills to interpret patients’ complaints. The cultural diversity of our patient population needs to be reflected by our physician population, and patients should be given the option to choose a physician with a similar background as their own. An even further stretch of this line of thought would suggest that patients, in general, should be educated in medical matters. This could happen in primary or secondary schooling rather than at a much later stage through expensive and ineffective one-to-one education by physicians. A poor medical history diminishes the opportunity to establish a diagnostic suspicion with a high probability early on. The subsequent medical work-up has to rely on many more tests to confirm the presence of a diagnosis. The poor medical history exposes the patient, therefore, to more test-related risks and prolongs the diagnostic process. All these downsides of a poor history ultimately increase medical resource utilization and healthcare expenditure.

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