Clinical accuracy data presented as natural frequencies improve dentists' caries diagnostic inference

Evidence from a randomized controlled trial

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ABSTRACT

Background. The authors assessed whether dentists' diagnostic inferences differ when test accuracy information is communicated using natural frequencies versus conditional probabilities.

Methods. A parallel, randomized controlled trial with dentists was carried out in Rio de Janeiro, Brazil. The dentists received a question on the probability of a patient having interproximal caries, given a positive bite-wing radiograph. This question was asked using information that was formulated into either natural frequencies or conditional probabilities.

Results. Only 14 (13.9%) of the dentists gave the correct answer; 13 in the natural frequencies group, and 1 in the conditional probabilities group ($P < .001$). There were 7 nearly correct answers in the natural frequencies group and none in the conditional probabilities group ($P = .005$).

Conclusions. Representing diagnostic test accuracy in natural frequencies substantially helped dentists make diagnostic inferences. Nearly twice as many dentists overestimated the presence of interproximal caries when given information in conditional probabilities.

Practical Implications. Our study findings show information shared using natural frequencies may be more accurately interpreted by dentists than that based on conditional probabilities. Patients will probably receive different standards of care depending on the format in which dentists receive diagnostic test accuracy information.

Key Words. Diagnosis; communication barriers; persuasive communication; health education; risk; probability.

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Health care professionals routinely use a wide variety of diagnostic procedures, and the accuracy of any diagnostic test can be expressed in a number of alternative ways, such as sensitivity, specificity, predictive values, likelihood ratios, and receiver operating characteristic curves. The way statistical information regarding diagnostic accuracy is presented affects understanding, that is, the same information presented in different formats can make health care professionals reach different conclusions.[1]

Using natural frequencies to display the accuracy of diagnostic tests seems to improve understanding not only among physicians and medical students, but also among laypeople, even those with low numeracy.[2] In this context, a natural frequency is a joint frequency of 2 events, such as the number of patients with disease and the number who have a positive test result. It is an alternative to presenting the same information in probabilities, such as sensitivities and specificities.[3]

A systematic review that evaluated the effects of using alternative statistical presentations of the same risks and risk reductions on understanding, perception, persuasiveness, and behavior of health care professionals, policy makers, and consumers found that diagnostic and screening test results were better understood when their accuracy was presented as a natural frequency rather than a percentage.[4]

Another systematic review assessed whether clinicians differ in how they evaluate and interpret different diagnostic test information.[5] This review also suggested that presenting probabilities as

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frequencies may improve the understanding of test accuracy information.[5] The studies in that review did not include dentists or dental students. We found only 1 study on this topic with dentists; it tested whether changing baseline prevalence of a disease would affect dentists' answers regarding the estimate of the likelihood that a patient described in a vignette had a specific pathogen. A wide range of diagnostic probability estimates were reported and participants gave undue weight to test evidence compared with baseline disease prevalence information.[6] To the best of our knowledge, there is no study assessing whether diagnostic test accuracy presented to dentists in different formats makes any difference to their understanding of the information given.

The aim of this study was to assess whether dentists' diagnostic inferences differ when information on test accuracy is communicated using natural frequencies versus conditional probabilities.

METHODS

Ethical aspects

The Ethical Committee of the Rio de Janeiro State University approved this study (CAAE 60115416.5.0000.5259) and all participants signed informed consent forms.

Study design

This study was a parallel, triple-blinded, randomized controlled trial which took place in Rio de Janeiro, Brazil, from July to December 2016.

Participants

We recruited a convenience sample from 3 postgraduate courses in Rio de Janeiro. To be eligible, the participant had to be a dentist enrolled in 1 of these 3 postgraduate courses.

Randomization

We performed randomization in blocks of 6 using a computer-generated random numbers table with an equal allocation ratio.

Intervention

We gave all participants written instructions on the aims of the study and asked them to answer a questionnaire asking for information on sex, date of birth, years since graduation, specialty degree, and place of work. Apart from that, we gave each participant a sequentially numbered but otherwise nonidentified sealed, opaque envelope containing a hypothetical diagnostic scenario and a question regarding the probability of a patient having interproximal caries given a positive bite-wing radiograph. They had 10 minutes to answer the question and return the envelope. The diagnostic test's (that is, the bite-wing radiograph's) accuracy was provided in the format of natural frequencies (test group) or in the format of conditional probabilities (control group). We provided the dentists with the hypothetical clinical scenario described in the box.

Outcomes

The main outcome was the probability that a patient would have interproximal caries as assessed by the dentist. This probability was categorized as a correct, a nearly correct, an underestimated answer, or an overestimated answer. A correct answer was a 50% probability of having a cavity, a nearly correct answer 40% to 49% or 51% to 60%, an underestimation less than 50%, and an overestimation greater than 50%.

Blinding

The outcome assessors and those applying the questionnaires were not aware of the group to which each participant had been assigned. Participants obviously knew the group that they had been assigned to but were not aware of the hypothesis being tested nor the comparisons under investigation. Therefore, all involved in the study (outcome assessor, investigator, and participant) were blinded.

Sample size

Based on an expected proportion of correct answers of 12% and 35% in the conditional probabilities and natural frequencies groups, respectively,[7] we calculated that we would need 51