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Interpreting PPV and NPV of Diagnostic Tests with Uncertain Prevalence

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Abstract

Objective Medical decision making is often uncertain. Positive Predictive Value and Negative Predictive Value are conditional probabilities characterizing diagnostic tests and assessing diagnostic interventions in clinical medicine and epidemiology. PPV is the probability that a patient has a specified disease, given a positive test result for that disease. NPV is the probability that a patient does not have the disease, given a negative test result for that disease. Both values depend on disease incidence or prevalence which may be highly uncertain for unfamiliar diseases, epidemics, etc. Probability distributions for this uncertainty are usually unavailable. We develop a non-probabilistic method for interpreting PPV and NPV with uncertain prevalence.

Methods Uncertainty in PPV and NPV is managed with the non-probabilistic concept of robustness in info-gap theory. Robustness of estimates of PPV or NPV is the greatest uncertainty (in prevalence) at which the estimate's error is acceptable.

Results Four properties are demonstrated. Zeroing: best estimates of PPV or NPV have no robustness to uncertain prevalence; best estimates are unreliable for interpreting diagnostic tests. Trade off: robustness increases as error increases. This trade off identifies robustly reliable error in PPV or NPV. Sub-optimal estimates: Sometimes sub-optimal PPV or NPV estimates are more robust to uncertain incidence or prevalence than optimal estimates, motivating use of the sub-optimal estimate. Trade off between specificity and robustness to uncertainty: the robustness increases as test-specificity decreases. These properties underlie the interpretation of PPV and NPV.

Conclusions PPV and NPV assess diagnostic tests, but are sensitive to lack of knowledge that generates non-probabilistic uncertain prevalence and must be supplemented with robustness analysis. When uncertainties abound, as with unfamiliar diseases, assessing robustness is critical to avoiding erroneous decisions.

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