Statistical methods for the meta-analysis of full ROC curves

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Mai 04, 2016, 16:00 s.t.
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Meta-analyses and systematic reviews are the cornerstones of evidence based medicine and inform treatment, diagnosis, or prevention of individual patients as well as policy decisions in health care. Statistical methods for the meta-analysis of intervention studies are well established today. Meta-analysis for diagnostic accuracy trials, however, has been a vivid research area in recent years which is especially due to the increased complexity of diagnostic studies with their bivariate outcome of sensitivity and specificity. An even more increased complexity arises when single studies do not only report a single pair of sensitivity and specificity, but a full ROC curve with several pairs of sensitivity and specificity, each pair for a different threshold. Researchers frequently ignore this information and use only one pair of sensitivity and specificity from each study to arrive at meta-analytic estimates. Although methods to deal with the full information have been proposed [1-5], these are not without problems, e.g., they are two-step approaches where estimation uncertainty from the first step is ignored in the second step, the number of thresholds has to be identical across studies, or the concrete values of thresholds are ignored thus making impossible clinically relevant inference on sensitivity and specificity at given thresholds.

We propose two approaches for the meta-analysis of full ROC curves that use the information from all thresholds. The first approach simply expands the standard bivariate random effects model to a meta-regression model. The second approach uses the interpretation of an ROC curve as a bivariate time-to-event model for interval-censored data. This work is motivated by two systematic reviews on population-based screening for type 2 diabetes mellitus [6,7] which report on 38 single studies to assess the HbA1c as a diagnostic marker. Both reviews report only single pairs of sensitivity and specificity from each single study, but an intensified search yields 124 pairs of sensitivity and specificity for 26 different HbA1c thresholds from the 38 single studies.

References

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