

numbers and rates among both sexes were greater among 16-19 year olds than any other age group.<sup>3</sup> Overall attendances at sexually transmitted disease clinics have gradually risen since 1988, and increased use of services may have accounted for some of the 1994-6 rises, which continued into 1997.<sup>4</sup> However, it seems unlikely that the pronounced rise could be attributed solely to a sudden widespread increase in clinic use.

There is substantial sexual ill health among teenagers in England and Wales. This is distributed inequitably, and recent data are consistent with a worsening trend. The potential for health gain through primary behavioural prevention is considerable, and the United States, which has even worse teenage rates than the United Kingdom, has recently shown such an improvement.<sup>5</sup> Sexual health should be a priority for coordinated national and local health promotion among young people.

Contributors: AN collated the data, was the paper's main writer, and is the study guarantor. All the other authors were involved in the conceiving and drafting of the paper. MC was responsible for collection and analysis of data from sexually transmitted dis-

ease clinics along with GH, IS, and DT (for data on cases reported by Welsh departments of genitourinary medicine). SC assembled data on births and terminations in England and Wales with assistance from Michael Bland. Statistical analyses by GH and SC were assisted by Pauline Rogers of the Public Health Laboratory Service Statistics Unit. Development of the manuscript was supported by Virginia Walker. Gathering of genitourinary clinic reports was delegated to the Communicable Disease Surveillance Centre by the Department of Health and the Welsh Office in 1996, which continue to support the work.

Funding: None

Competing interests: None declared.

- 1 Dickson R, Fullerton D, Eastwood A, Sheldon T, Sharp F. Preventing and reducing the adverse effects of unintended teenage pregnancies. *Effective Health Care* 1997;3:1-12.
- 2 Cowan FM, Mindel A. Sexually transmitted diseases in children: adolescents. *Genitourin Med* 1993;69:141-7.
- 3 Simms I, Hughes G, Swan AV, Rogers PA, Catchpole M. New cases seen at genitourinary medicine clinics: England 1996. *CDR Supplement* 1998;8 (suppl 1):S1-12.
- 4 Hughes G, Simms I, Rogers PA, Swan AV, Catchpole M. *New cases seen at genitourinary medicine clinics: England 1997*. London: Public Health Laboratory Service, 1998. <http://www.open.gov.uk/cdsc/>
- 5 Trends in sexual risk behaviour among high school students—United States 1991-1997. *MMWR* 1998;47:749-51. (Accepted 30 October 1998)

## Reporting of precision of estimates for diagnostic accuracy: a review

Robert Harper, Barnaby Reeves

Department of Ophthalmology, Manchester Royal Eye Hospital, Manchester M13 9WH

Robert Harper, principal optometrist

Health Services Research Unit, London School of Hygiene and Tropical Medicine, London WC1E 7HT

Barnaby Reeves, senior lecturer

Correspondence to: Dr Harper robert.harper@man.ac.uk

*BMJ* 1999;318:1322-3

Diagnostic accuracy is usually characterised by the sensitivity and specificity of a test, and these indices are most commonly presented when evaluations of diagnostic tests are reported. It is important to emphasise that, as in other empirical studies, specific values of diagnostic accuracy are merely estimates. Therefore, when evaluations of diagnostic accuracy are reported the precision of the sensitivity and specificity estimates or likelihood ratios should be stated.<sup>1-3</sup> If sensitivity and specificity estimates are reported without a measure of precision, clinicians cannot know the range within which the true values of the indices are likely to lie.

Confidence intervals are widely used in medical literature, and journals usually require confidence intervals to be specified for other descriptive estimates and for epidemiological or experimental analytical comparisons. Journals seem less vigilant, however, for evaluations of diagnostic accuracy. For example, a recent review of compliance with methodological standards in diagnostic test research found that for the period 1978-93 only 12 of 112 studies published in the *New England Journal of Medicine*, *JAMA*, the *BMJ*, and the *Lancet* reported the precision of the estimates of diagnostic accuracy.<sup>3</sup> We have found that the reporting of 95% confidence intervals for estimates is somewhat better in a more recent 2 year interval for studies published in the *BMJ* but still far from ideal.

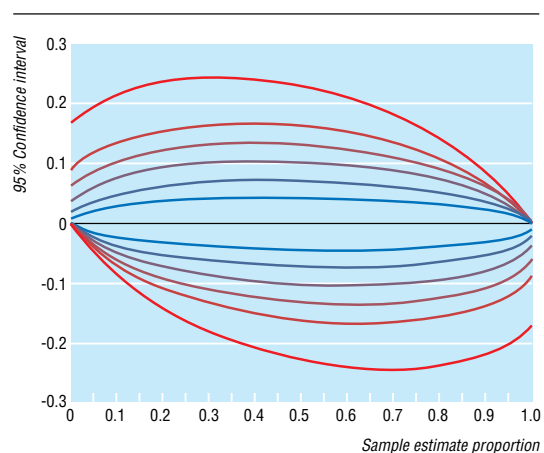
### Methods and results

We searched the Medline database (for 1996 and 1997) for reports of diagnostic evaluations in the *BMJ*. After

we excluded letters, case reports, and review or education articles we identified 16 studies (references supplied on request). Only eight (95% confidence interval 25% to 75%) papers reported precision for the estimates of diagnostic accuracy, with two of these studies providing confidence intervals only for either predictive power values or likelihood ratios but not for the sensitivity or specificity estimates also reported.

### Comment

Evaluations of diagnostic accuracy should be prescribed with confidence intervals. We have also recently reviewed the extent of compliance with the reporting of confidence intervals in the ophthalmic literature and concluded that evaluations of diagnostic tests in this specialty are similarly flawed.<sup>4</sup> The omission of the precision of estimates for diagnostic accuracy can make a considerable difference to a clinician's interpretation of the findings of a study. For example, an evaluation of the sensitivity and specificity of an imaging system for the optic nerve head for the detection of glaucoma reported estimates of 89% and 78%, respectively<sup>5</sup>; the 95% confidence intervals of these estimates (not reported in the paper) ranged from 80% to 98% for sensitivity and from 66% to 90% for specificity. For a test with poorer diagnostic accuracy, these 95% confidence intervals would have been even larger for an equivalent sample size because of the dependence of the standard error of a proportion on the proportion itself (figure). The figure shows how the precision of the sensitivity or specificity estimate varies



Breadth of exact binomial 95% confidence intervals as function of sample estimate of proportion of interest and sample size; from outside to centre, pairs of lines represent sample sizes of 20, 40, 60, 100, 200, and 500. Note 95% confidence interval is widest for proportion equal to 0.5 and narrows as proportion tends to 0 or 1. To use figure, read off upper and lower 95% confidence intervals and simply add and subtract sample estimate—for example, a sample estimate of 0.5, based on sample size of 100, has 95% confidence interval that ranges from 0.5–0.1 to 0.5+0.1 (0.4 to 0.6)

as a function of both the point estimate itself and the sample size.

Most statistical packages will generate exact binomial confidence intervals. Approximate confidence intervals can easily be calculated by using the formula for the SE of a proportion ( $\sqrt{pq/n}$ ), which is

based on a binomial approximation to the normal distribution and can be used to calculate 95% confidence intervals for sensitivity and specificity (for instance,  $p \pm 1.96\sqrt{pq/n}$ , where  $p$  represents either sensitivity or specificity,  $q = 1 - p$ ,  $n$  is the sample size, and where  $n \times p$  is  $> 10$ ).

To enhance the quality of information on diagnostic tests made available to clinicians we recommend that 95% confidence intervals are supplied with estimates of diagnostic accuracy. Referees and journal editors should enforce this requirement in the same way as they routinely do for other descriptive or comparative estimates.

Contributors: RH and BR both contributed to the idea and the methods. RH carried out the search and reviewed the papers, and BR performed the calculations to develop the figure. RH and BR jointly drafted and revised the paper and are both guarantors.

Funding: No external funding.

Competing interests: None declared.

- 1 Jaeschke A, Guyatt GH, Sackett DL, for the Evidence-based Medicine Working Group. Users' guides to the medical literature. III. How to use an article about a diagnostic test. A. Are the results of the study valid? *JAMA* 1994;271:389-91.
- 2 Jaeschke A, Guyatt GH, Sackett DL, for the Evidence-based Medicine Working Group. Users' guides to the medical literature. III. How to use an article about a diagnostic test B. What are the results and will they help me in caring for patients? *JAMA* 1994;271:703-7.
- 3 Reid MC, Lachs MS, Feinstein AR. Use of methodological standards in diagnostic test research: getting better but still not good. *JAMA*. 1995;274:645-51.
- 4 Harper R, Reeves B. Compliance with methodological standards when evaluating ophthalmic diagnostic tests. *Optom Vis Sci* 1998;75:78.
- 5 Mikelberg FS, Parfitt CM, Swindale SL, Graham SL, Drance SM, Gosine R. Ability of the Heidelberg retina tomograph to detect early glaucomatous visual field loss. *J Glaucoma* 1995;4:242-7.

(Accepted 15 December 1998)

### The doctor who changed my view How to drive away teenagers

I was 14 when I met the doctor who left me resolved never to see another GP for the rest of my days. Of course, eventually I not only saw GPs, but became one. I have never forgotten this fateful consultation, however, and I think that it shaped the way that I deal with that particularly difficult group, teenagers.

There were three of us children, aged 14, 11, and 8. We lived pretty rural lives and my mother knew what was what, so she was not particularly upset when we all had worms. However, in order to be treated, she was told by a dragon receptionist that we had to see the doctor. This was quite an event, as we had not seen a doctor since one had seen us with measles four years earlier.

When we reached the surgery a few days later the receptionist sat at a desk in a room like a school hall, where she loudly asked each patient what they had come for. It was a kind of trial by humiliation—if you could bear the embarrassment you got to see the doc. I don't suppose he treated very many people with sexually transmitted diseases. My mother whispered our diagnosis, but to my chagrin the receptionist repeated it clearly, and it echoed around the polished floor passing the news on ahead like jungle drums. Everyone seemed to be looking at us in disgust. Wanting to disappear, we sat on the hard chairs around the room, moving along from one to the next towards the doctor's door like caterpillars until we were next.

Once inside the doctor lined us up, all three, in front of his desk, my brother, my sister, and myself. Only my mother sat. He listened to what my mother had to say as we stood, heads hung, as if on trial. He did not address us directly, although he did look us up and down—perhaps, I thought afterwards, checking for signs of poor hygiene, scabies, or lice. Eventually he spoke.

"So," he said to my mother profoundly from behind his desk, "if these children have worms then it is because they put their

fingers into their noses and bottoms and then into their mouths. They should wash their hands. I will give you some medicine."

As humiliation it was supreme. At 14 I was physically mature, emotionally awkward, sensitive, self conscious, and easily embarrassed. Any chance he might have had of establishing any sort of rapport for my future care was lost. Moreover, after hearing my story none of my friends went to him with their acne, migraines, period troubles, or depression either. A year later I became seriously anorexic, but I would rather have died than gone back to him. Only at five stone and recurrently fainting did my mother drag me to a locum at another surgery. "She's too thin," he said to my mother, over my head, "She may have tuberculosis. Get her to eat more and we'll do an x ray examination." That was it, and that suited me fine—I no longer liked doctors.

Later, when I was at medical school I noticed through the medical press that the first GP had become something of a leading light in training in his area, which probably goes to show that even the best doctors can mishandle the odd patient from time to time. I'm sure I do it daily, but I know I'm always careful what I say to teenagers. It may be my one and only chance to earn a little trust.

Mary Selby, *general practitioner registrar, Bury St Edmunds, Suffolk*

We welcome articles of up to 600 words on topics such as *A memorable patient, A paper that changed my practice, My most unfortunate mistake*, or any other piece conveying instruction, pathos, or humour. If possible the article should be supplied on a disk. Permission is needed from the patient or a relative if an identifiable patient is referred to. We also welcome contributions for "Endpieces," consisting of quotations of up to 80 words (but most are considerably shorter) from any source, ancient or modern, which have appealed to the reader.