are successful doctors may then be prepared to invest more time in them. Further consideration should be given to new ways that general practitioners can deliver and follow up lifestyle interventions, including implementing the process of change model and undertaking motivational interviewing. The role of practice nurses, health visitors, and specialist clinics may be important in enhancing a general practitioner's initial intervention.

I am grateful to Dr Peter Alderson for commenting on a draft of this article.


Selected additional references

Anderson P. Populations and high-risk approaches with women in need to reduce population harm. Alcohol 1993;16(3):72.

BMJ: first published as 10.1136/bmj.308.6943.1552 on 11 June 1994. Downloaded from http://www.bmj.com/ on 9 June 2023 by guest. Protected by copyright.

A complete list of references can be obtained from the author.

Statistics Notes

Diagnostic tests 1: sensitivity and specificity

Douglas G Altman, J Martin Blund

The simplest diagnostic test is one where the results of an investigation, such as an x-ray examination or biopsy, are used to classify patients into two groups according to the presence or absence of a symptom or sign. For example, the table shows the relation between the results of a test, a liver scan, and the correct diagnosis based on either necropsy, biopsy, or surgical intervention. How good is the liver scan, as a diagnostic test of abnormal pathology?

Relation between results of liver scan and correct diagnosis

<table>
<thead>
<tr>
<th>Pathology</th>
<th>Abnormal (−)</th>
<th>Normal (+)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abnormal (+)</td>
<td>251</td>
<td>32</td>
<td>283</td>
</tr>
<tr>
<td>Normal (−)</td>
<td>27</td>
<td>94</td>
<td>121</td>
</tr>
<tr>
<td>Total</td>
<td>278</td>
<td>126</td>
<td>404</td>
</tr>
</tbody>
</table>

One approach is to calculate the proportions of patients with normal and abnormal liver scans who are correctly "diagnosed" by the scan. The terms positive and negative are used to refer to the presence or absence of the condition of interest, here abnormal pathology. Thus there are 258 true positives and 86 true negatives. The proportions of these two groups that were correctly diagnosed by the scan were 231/258=0.90 and 86/126=0.68 respectively. These two proportions have converging limits.

Sensitivity is the proportion of true positives that are correctly identified by the test. Specificity is the proportion of true negatives that are correctly identified by the test. We can thus say that on the sample studied, we would expect 90% of patients with abnormal pathology to have abnormal (positive) liver scans, whilst 65% of those with normal pathology would have normal (negative) liver scans.

The sensitivity and specificity are proportions, so confidence intervals can be calculated for them using standard methods for proportions. Sensitivity and specificity are one approach to quantifying the diagnostic ability of the test. In clinical practice, however, the test result is all that is known, so we want to know how good the test is in predicting abnormality. In other words, what proportion of patients with abnormal test results are truly abnormal? This question is addressed in a subsequent note.