



## Statistics Notes: Diagnostic tests 1: sensitivity and specificity

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are successful doctors may then be prepared to invest more time in them. **Downloaded from <http://www.bmj.com/> on 12 September 2009** 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.

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- 1 Blot W. Alcohol and cancer. *Cancer Res* 1992;52 (suppl):2119-23S.
- 2 Cancer Research Campaign. *Factsheet 14: oral cancer*. London: CRC, 1993.
- 3 Secretary of State for Health. *Health of the Nation: a strategy for health in England*. London: HMSO, 1992. (Cm 1986.)
- 4 Anderson P. Reducing alcohol consumption. In: Fowler G, Anderson P, Gray M, eds. *Prevention in general practice*. Oxford: Oxford University Press, 1993:136-47.
- 5 Anderson P. Effectiveness of general practice interventions for patients with harmful alcohol consumption. *Br J Gen Pract* 1993;43:386-9.

#### Selected additional references

- Anderson P. Alcohol as a key area. *BMJ* 1991;303:766-9.
- Anderson P. The interaction between research and policy—alcohol and general practice in the United Kingdom. *Addiction* 1993;88:1215-75.
- Anderson P. Population and high-risk approaches both necessary to reduce population harm. *Addiction* 1993;88:170-4.
- Anderson P, Cremona A, Paton A, Turner C, Wallace P. The risk of alcohol. *Addiction* 1993;88:1493-508.
- Anderson P, Wallace P, Jones H. *Alcohol problems: practical guides for general practice*. Oxford: Oxford University Press, 1988.
- Anderson P, Scott E. The effect of general practitioners advice to heavy drinking men. *Br J Addict* 1992;87:891-900.
- Babor TF, Grant M. *WHO Collaborating Investigators Project on identification and management of alcohol related problems. Combined analyses of outcome data: the cross national generalisability of brief interventions. Report on phase II: a randomised clinical trial of brief interventions in primary care*. Copenhagen: WHO, 1992.
- Bien TH, Miller WR, Tonigan JS. Brief interventions for alcohol problems: a review. *Addiction* 1993;88:315-36.

- Doll R. The prevention of cancer: opportunities and challenges. In: Heller T, Peto J, eds. *Reducing the risk of cancers*. London: Hodder and Stoughton, 1989:14-25.
- Effective Health Care. *Brief interventions and alcohol use*. Nuffield Institute for Health, University of Leeds; Centre for Health Economics, University of York; Research Unit, Royal College of Physicians, 1993.
- Health Education Authority. *Cut down on your drinking pack*. London: HEA, 1991.
- International Agency for Research on Cancer. *IARC monographs on the evaluation of carcinogenic risks to humans: alcohol drinking*. Lyons: IARC, 1988.
- Medical Council on Alcoholism. *Hazardous drinking: a handbook for general practitioners*. London: MCA, 1987.
- Office of Population Censuses and Surveys. *General household survey 1992*. London: HMSO, 1994.
- Prochaska J, DiClemente C. Toward a comprehensive model of change. In: Miller WR, Heather N, eds. *Treating addictive behaviors: processes of change*. New York: Plenum, 1986:3-27.
- Rollnick S, Heather N, Gold R, Hall W. Development of a short "readiness to change" questionnaire for use in brief, opportunistic interventions among excessive drinkers. *Br J Addict* 1992;87:743-54.
- Royal College of General Practitioners. *Alcohol—a balanced view*. London: RCGP, 1986.
- Royal College of General Practitioners. *Alcohol and drugs*. London: RCGP, 1991.
- Royal College of Physicians. *The medical consequences of alcohol abuse: a great and growing evil*. London: Tavistock, 1987.
- Reid ALA, Webb GR, Hennrikus D, Fahey PP, Sanson-Fisher RW. Detection of patients with high alcohol intake by general practitioners. *BMJ* 1986;293:735-7.
- Rose G, Day S. The population mean predicts the number of deviant individuals. *BMJ* 1990;301:1031-4.
- Saunders JB, Aasland OG, Babor TF, De La Fuente JR, Grant M. Development of the alcohol use disorders identification test (AUDIT): WHO Collaborative Project on Early Detection of Persons with Harmful Alcohol Consumption—II. *Addiction* 1993;88:791-804.
- Scott E, Anderson P. Randomised controlled trial of general practitioners intervention in women with excessive alcohol consumption. *Drug and Alcohol Review* 1990;10:313-2.
- Wallace P, Cutler S, Haines A. Randomised controlled trial of general practitioners intervention in patients with excessive alcohol consumption. *BMJ* 1988;297:663-8.
- Wallace P, Haines A. The use of a questionnaire in general practice to increase the recognition of patients with excessive alcohol consumption. *BMJ* 1985;290:1949-53.

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

## Statistics Notes

### Diagnostic tests 1: sensitivity and specificity

Douglas G Altman, J Martin Bland

This is the third in a series of occasional notes on medical statistics.

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 inspection.<sup>1</sup> How good is the liver scan at diagnosis of abnormal pathology?

Relation between results of liver scan and correct diagnosis<sup>1</sup>

Liver scan	Pathology		Total
	Abnormal (+)	Normal (-)	
Abnormal (+)	231	32	263
Normal (-)	27	54	81
Total	258	86	344

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  $54/86=0.63$  respectively. These two proportions have confusingly similar names.

**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, based on the sample studied, we would expect 90% of patients with abnormal pathology to have abnormal (positive) liver scans, while 63% 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.<sup>2</sup>

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 at predicting abnormality. In other words, what proportion of patients with abnormal test results are truly abnormal? This question is addressed in a subsequent note.

- 1 Drum DE, Christopoulos JS. Hepatic scintigraphy in clinical decision making. *J Nucl Med* 1972;13:908-15.
- 2 Gardner MJ, Altman DG. Calculating confidence intervals for proportions and their differences. In: Gardner MJ, Altman DG, eds. *Statistics with confidence*. London: BMJ Publishing Group, 1989: 28-33.

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