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IDENTIFYING HAZARDOUS OR HARMFUL ALCOHOL USE IN MEDICAL ADMISSIONS: A COMPARISON OF AUDIT, CAGE AND BRIEF MAST

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Abstract — Two hundred and forty new medical inpatients received the Alcohol Use Disorders Identification Test (AUDIT), CAGE and brief Michigan Alcoholism Screening Test (brief MAST) questionnaires. Sensitivities when identifying weekly drinkers of >14 units (women) or >21 units (men) were 93, 79 and 35%, respectively ($P < 0.001$). Sensitivities to >21 units (women) or >28 units (men) were 100%, 94% and 47% Routine screening of medical admissions with the AUDIT (cut-off score 8) is recommended.

INTRODUCTION

Eleven per cent of women and 27% of men (Office of Population Censuses and Surveys, 1995) report a weekly alcohol intake above the safe maximum recommended by the Royal Colleges of Physicians, Psychiatrists and General Practitioners (1995) of 14 units for women and 21 units for men. (One unit contains 8–10 g of pure ethanol.) These drinkers are over-represented in age-matched hospital populations (Chick *et al.*, 1986). However, as there are more hospitalized elderly (with fewer drinking problems), overall, 6.5% of female and 22.5% of male general medical admissions are 'risk drinkers' (Orford *et al.*, 1992). In December 1995, the British government (Inter-Departmental Working Group, 1995) recommended an increased 'benchmark' maximum of 21 units (women) and 28 units (men). However, Edwards (1996) quickly re-affirmed the original safe limits, re-iterating the mainstream view that these represent 'a prudent but not overcautious interpretation of complex evidence'.

Routine clinical assessment frequently fails to identify problem drinking. In a study of British medical admissions (Feldman *et al.*, 1987), house officers were found to miss 60% of patients with an alcohol problem, referring only 4.5% for alcohol-specific intervention. Moore *et al.* (1989) screened a Baltimore general hospital sample of 2002 with the short Michigan Alcoholism Screening Test (SMAST: Selzer *et al.*, 1975) and CAGE (Mayfield *et al.*, 1974) followed by physician interview. They found the detection of screen-positive alcoholism was <25% in surgery and obstetrics/gynaecology, 50–75% in medicine and neurology and >50% in psychiatry. The extent to which physicians intervened while the patient was hospitalized correlated with the patient's reported change in alcohol use after admission. Cyr and Wartman (1988) noted that the typical screening questions of 'How much do you drink?' or 'How often do you drink?' (often asked by physicians) yielded low sensitivities of 34 and 47%, respectively against the 25-item MAST (Selzer, 1971) in an outpatient sample. The two questions 'Have you ever had a drinking problem?' (yes/no) and 'When was your last drink?' (positive if within the last 24 h) had a combined sensitivity of 92%. Routine blood tests (mean cell volume and gamma-glutamyl transferase) are also insensitive to problem drinking even in men drinking >70 units of alcohol per week (Chick *et al.*, 1981).

Validated brief screening instruments which could be used to improve the identification of problem drinkers include the brief Michigan Alcoholism Screening Test (brief MAST: Pokorny *et al.*, 1972) and the CAGE. However, the brief

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Table 1. Key previous studies of CAGE, brief MAST and AUDIT sensitivity and specificity

Test/reference	Subjects	Case score	Sensitivity (%)	Specificity (%)	Case criterion
CAGE					
Bush *et al.* (1987)	521 medical and orthopaedic patients (USA)	1+	85	89	DSM-III alcohol misuse
Chan *et al.* (1993)	390 primary care patients (USA)	2+	100	68	DSM-IIIR (current) alcohol dependence
		2+	73	65	>3 drinks/day (women) >5 drinks/day (men)
Brief MAST					
Lockhart *et al.* (1986)	104 medical patients (UK)	6+	46	99	Detailed clinical assessment
Taylor *et al.* (1986)	1628 general hospital patients (UK)	6+	78	94	Alcohol-related physical disease
Chan *et al.* (1993)	390 primary care patients (USA)	6+	78	80	DSM-IIIR (current) alcohol dependence
		6+	73	77	>3 drinks/day (women) >5 drinks/day (men)
AUDIT					
Fleming *et al.* (1991)	989 college students (USA)	8+	94	66	DSM-IIIR (lifetime) alcohol misuse
		10+	88	50	
Barry and Fleming (1993)	287 rural primary care patients (USA)	8+	61	90	DSM-III (current) alcohol misuse/dependence
		10+	46	95	
Claussen and Aasland (1993)	310 homeless people (Norway)	10+	94	85	DSM-III alcohol misuse/dependence
Russell *et al.* (1993)	2477 inpatients (USA)	10+	100 (w) 89 (m)	83 (w) 81 (m)	Case-note scrutiny, ICD-9 discharge code, or DSM-IIIR (lifetime) alcohol misuse
Saunders *et al.* (1993)	913 primary care, alcoholics excluded (six countries)	8+	92	93	Combined index of hazardous or harmful drinking
		10+	80	98	
Bohn *et al.* (1995)	65 known alcoholics 187 medical patients (USA)	8+	98	34	≥280 g alcohol/week (men)
		10+	87	75	≥140 g alcohol/week (women)

w = women; m = men.

MAST is insensitive to milder levels of problem drinking (see e.g. Bell, 1991) and the CAGE yields an excessive number of false positives (see e.g. Wallace *et al.*, 1988). Indeed, both were created to detect established *harmful* drinking (where secondary alcohol-related problems have developed: see Table 1), rather than milder *hazardous* drinking (where alcohol-related problems are not present despite drinking over the safe limit).

The World Health Organization Alcohol Use Disorders Identification Test (AUDIT) includes consumption items to identify milder 'hazardous' drinking (Programme of Substance Abuse, 1993). Like the CAGE and brief MAST, it takes <2 min to complete. Studies reporting the sensitivity and specificity of the AUDIT are listed in Table 1, including the large multinational study of

Table 2. Typical weekly alcohol intake (obtained from drinking diaries)

Alcohol intake	(n = 240) χ^2 = 145.0, df = 3 P < 0.001
Nil (0 in typical week)	112
'Safe' (1–14 units/week: women) (1–21 units/week: men)	100
'Hazardous' (15–35 units/week: women) (22–50 units/week: men)	23
'Harmful' (≥36 units/week: women) (≥51 units/week: men)	5

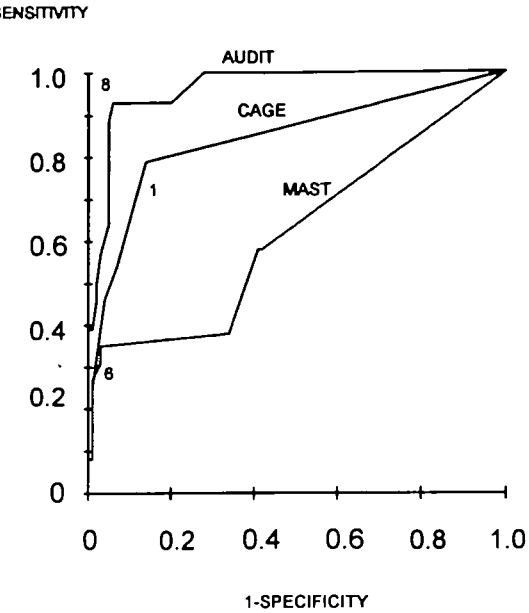

Fig. 1. Receiver operating characteristic analysis for AUDIT, CAGE and brief MAST.
For case criterion: 'typical week' alcohol intake >14 units (women)/>21 units (men). Optimal case cut-off scores for each test are presented adjacent to their location on the curve.

Saunders *et al.* (1993), from which the AUDIT was developed. The AUDIT has been recommended for routine screening (e.g. Chick *et al.*, 1993; Bohn *et al.*, 1995). However, it has not previously been validated in a British sample.

The present study compared the abilities of the AUDIT, CAGE, brief MAST and clinical diagnosis to discriminate between safe and hazardous/harmful drinking among new general medical admissions.

METHODS

Subjects were recruited from St John's Hospital, Livingston, a 600-bed general hospital serving the west Lothian (mainly urban) population of 150 000. Over an 11-week period (February to May 1995), new admissions to the acute medical receiving ward, aged 17 or over, were asked to complete (by self-report) three alcohol screening tests: AUDIT (Saunders *et al.*, 1993), CAGE (Ewing, 1984) and brief MAST (Pokorny *et al.*, 1972). They were also asked 'How much do you

Table 3. Primary diagnosis on admission

Diagnostic category	Nil/safe drinking mean age: 55.4 (SD: 18.9)	Hazard/harm drinking mean age: 46.0 (SD: 15.6)	P values: age difference: 0.006*
Alcohol-related	0 (0%)	4 (14%)	<0.00001†
Overdose or self-harm	10 (5%)	2 (7%)	NS
GI or liver	26 (12%)	4 (14%)	NS
Respiratory	52 (25%)	7 (25%)	NS
Cardiovascular	57 (27%)	2 (7%)	0.023‡
Diabetes mellitus	3 (1%)	2 (7%)	NS
Other	64 (30%)	7 (25%)	NS

Subjects are classified as 'other' only if no specific category applies.
* t-test: t = 2.53, df = 38.4; † Fisher's exact test; ‡ χ^2 = 5.2, df = 1; NS = not significant.
GI = gastrointestinal.

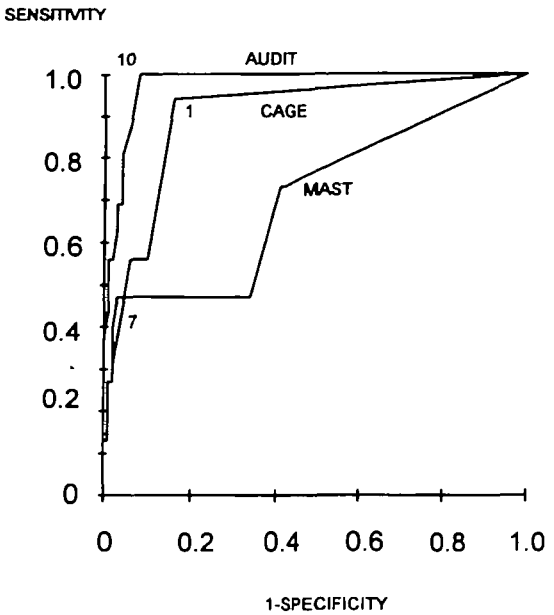

Fig. 2. Receiver operating characteristic analysis for AUDIT, CAGE and brief MAST.
For case criterion: 'typical week' alcohol intake >21 units (women)/>28 units (men). Optimal case cut-off scores for each test are presented adjacent to their location on the curve.

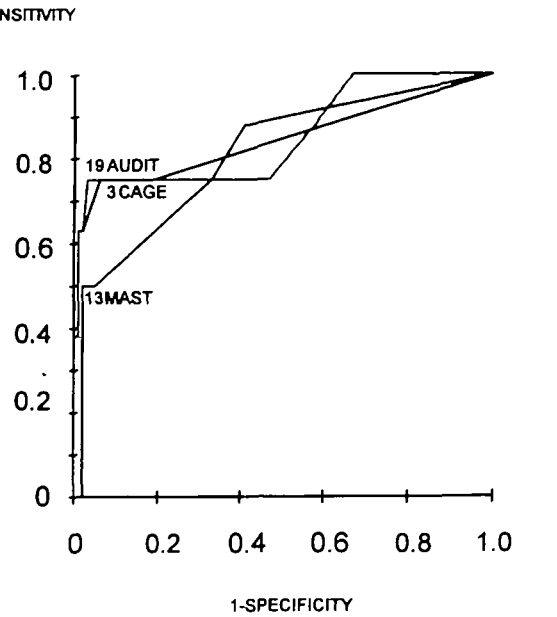

Fig. 3. Receiver operating characteristic analysis for AUDIT, CAGE and brief MAST.
For case criterion: 'clinical diagnosis'. Optimal case cut-off scores for each test are presented adjacent to their location on the curve.

drink in a typical week?' A column for each day of the week was provided while number and type of drink were recorded in rows. The wording 'typical week' was used to avoid reporting of atypical drinking during the presenting illness. Weekly alcohol intakes of >14 units (women) or >21 units (men) and >21 units (women) or >28 units (men) were used as 'case' criteria.

The International Classification of Disease, 9th Revision (ICD-9) diagnoses of all patients, recorded routinely after admission, were examined. With reference only to the primary diagnosis, ignoring other listed secondary diagnoses, patients were grouped into one of seven diagnostic categories: alcohol-related, overdose/self-harm, gastrointestinal/liver, respiratory, cardiovascular, diabetic, or 'other'. ICD-9 codes for alcohol abuse, delirium tremens and alcohol-induced hepatic complications (291.0, 291.8, 303.9, 305.0, 571.1–3 and 977.3) made up the 'alcohol-related' category. Alcohol abusers identified in routine clinical practice (i.e. all those with one or more of these alcohol-related codes, whether as a primary or secondary diagnosis) made up the (alcohol abuse) 'clinical diagnosis' group for comparison with the screening tests. This 'clinical diagnosis' follows intensive assessment at admission. Positive cases may therefore represent an important sub-group with more severe illness, likely to use more services and be in greater need of immediate intervention. As it would be important for this group not to be missed by the screening tests, 'clinical diagnosis' was also used as a case criterion.

Receiver operating characteristic (ROC) analysis (Murphy *et al.*, 1987) was used as a measure of the ability of each test to discriminate between cases and non-cases (predictive power). ROC analysis also determines the optimal test score (case cut-off) on or above which subjects should be considered positive cases. Test sensitivity and specificity were compared using the Cochran Q test which is designed to compare different case yields within the same population. It has a similar

Table 4. Sensitivity, specificity, accuracy and positive predictive value (PPV) of the AUDIT, CAGE, brief MAST, and 'clinical diagnosis'

Case criterion	Test	ROC-derived case score	Sensitivity (%)	Specificity (%)	Accuracy (%)	PPV (%)
Units/week (by self-report)						
women: >14	AUDIT	8+	93* (26/28)	94† (198/211)	94	74 (26/35)
men: >21	CAGE	1+	79* (22/28)	86† (178/206)	78	44 (22/50)
	brief MAST	6+	35* (9/26)	97† (201/208)	69	69 (11/16)
	Clinical diagnosis	–	12* (4/28)	99† (209/212)	56	57 (4/7)
Units/week (by self-report)						
women: >21	AUDIT	10+	100** (16/16)	92†† (206/223)	96	48 (16/33)
men: >28	CAGE	1+	94** (15/16)	84†† (183/218)	86	30 (15/50)
	brief MAST	7+	47** (7/15)	96†† (211/219)	72	47 (7/15)
	Clinical diagnosis	–	25** (4/16)	98†† (230/234)	62	50 (4/8)
ICD-9 alcohol-related clinical diagnosis (on admission)	AUDIT	19+	75*** (6/8)	97††† (225/231)	86	50 (6/12)
	CAGE	3+	75*** (6/8)	93††† (211/226)	84	29 (6/21)
	brief MAST	13+	50*** (4/8)	98††† (221/226)	74	44 (4/9)

Note: Accuracy = (sensitivity + specificity)/2.
* Cochran Q = 41.1, df = 3, $P < 0.0001$.
** Cochran Q = 24.6, df = 3, $P < 0.0001$
*** Cochran Q = 4.0, df = 2, $P = 0.135$ (not significant).
† Cochran Q = 39.6, df = 3, $P < 0.0001$.
†† Cochran Q = 50.6, df = 3, $P < 0.0001$.
††† Cochran Q = 10.4, df = 2, $P = 0.005$.

distribution to a chi-square.

RESULTS

Of the 887 patients, 314 either died, went home or were transferred from the medical admissions ward (largely owing to demands on acute beds), prior to presentation of the study questionnaire. Thus a sample of 572 remained. Of these, 64 refused and 161 were unable to complete the questionnaire owing to their physical condition or poor mental function. Thus, 347 subjects remained. The mean age was 54 (SD = 19.0, range = 17–91); sex ratio: (m:f) 183:164 and socio-economic group breakdown: I = 12, II = 34, III = 66, IV = 34, V = 32 (by occupation as specified by the [British] Office of Population Censuses and Surveys, 1995).

For the screening test performance comparisons: 26 subjects were removed because their 'typical week' drinking diaries reported drinking less or more than their responses to the screening test consumption questions. A further 81 failed to provide sufficient data in their drinking diaries to calculate weekly intake or omitted items from the

screening tests. Thus, 240 remained. This final sample was younger, with a shorter length of stay than the original 887 patients, but there was no significant difference in the sex ratio or prevalence of alcohol-related primary clinical diagnosis: (mean ages: 54.0 ± 18.8 years and 60.1 ± 19.7 years, $t = -4.12$, df = 885, $P < 0.001$; mean lengths of stay: 4.9 ± 10 days and 8.6 ± 19.3 days, $t = -2.80$, df = 884, $P = 0.005$; sex ratio: $\chi^2 = 0.12$, df = 1, $P = 0.73$; alcohol-related primary diagnosis: $\chi^2 = 1.12$, df = 1, $P = 0.29$).

Six (5%) of 114 women and 22 (18%) of 126 men reported drinking >14 (women) or >21 (men) units weekly. Three (3%) and 13 (10%) respectively drank >21 units (women) or >28 units (men). Table 2 shows the distribution of alcohol intake. Most unsafe drinkers fell within the 'hazardous' range. The primary admission diagnoses are listed in Table 3. Hazardous/harmful drinkers were significantly younger than safe drinkers. Significantly fewer heavy drinkers were diagnosed with cardiovascular problems.

The ROC analyses of the screening tests are shown in Figs 1–3. The test score furthest from the 45° line is the case cut-off which provides the best predictive value. To identify women drinking >14 units and men drinking >21 units (Fig. 1), these were AUDIT: 8; CAGE: 1; and brief MAST: 6. The areas under the curves provide a measure of the discriminant capacity of each test. These were respectively 0.96, 0.85 and 0.63. To identify women drinking >21 units and men drinking >28 units (Fig. 2), optimal case cut-offs were AUDIT: 10; CAGE: 1; and brief MAST: 7. The areas under the curves were respectively 0.99, 0.91 and 0.70. Using 'clinical diagnosis' as criterion (Fig. 3), optimal case cut-offs were AUDIT: 19; CAGE: 3; and brief MAST: 13. The areas under the curves were respectively 0.86, 0.83 and 0.81. Table 4 lists test performances, using case cut-offs identified by ROC analysis. The AUDIT was significantly more sensitive and specific than the other assessment methods for all case criteria, except sensitivity to 'clinical diagnosis'. The tests were more accurate against the higher drinking diary case criterion (>21 units, women; >28 units, men). However, at this level, at least half of cases identified by each test were actually non-cases. The sensitivities against ICD-9 clinical diagnosis (bottom cell of Table 4) were unchanged by lowering cut-offs to those identified for the most sensitive case criterion (AUDIT: 8; CAGE: 1; and brief MAST: 6). Each test missed two subjects with alcoholic cirrhosis, one was also diagnosed as alcohol dependence syndrome. The latter reported drinking only eight units per 'typical week', the other was recently abstinent. The brief MAST missed a further two: one with alcohol dependence syndrome, the other with non-dependent alcohol abuse.

DISCUSSION

The AUDIT questionnaire was sensitive to those drinking >14 units/week (women) and >21 unit/week (men). The brief MAST and CAGE were insensitive to this level of alcohol intake. Routine clinical assessment alone led to only 12% of these unsafe drinkers receiving an alcohol-related diagnosis on admission. Unsafe drinkers were not readily identifiable: most were drinking in the lower 'hazardous' range, few of whom would have developed clinical evidence of alcohol-related harm, or signs of alcohol dependence. They were indistinguishable from safe drinkers in terms of physical diagnostic categories. However, those drinking above the safe limit were significantly less likely to present with cardiovascular complaints. While consistent with the cardioprotective effect of alcohol (Gronbaek *et al.*, 1995), the diversion of many (typically younger) patients away to the coronary care unit and the significantly older age (with higher cardiovascular morbidity) of the safe drinkers could also have led to this difference. Furthermore, some with heart disease may have cut down or ceased drinking because of their illness.

Of 887 patients, only 240 entered the screening test discriminant validity assessment. Although this sample was significantly younger, there was no difference in the sex ratio or prevalence of primary alcohol-related diagnoses. The patients removed were those who would typically also be omitted from screening in routine clinical practice: those too ill or refusing to complete the questionnaire and those who were processed in an accelerated manner. The sample was therefore a reasonable cohort, given that the screening tests were under scrutiny rather than the nature of the inpatient population. None the less, higher case ascertainment would have been desirable.

Weekly alcohol intake was perhaps a poor 'gold

standard' as patients may underreport their level of drinking (Keso and Salaspuro, 1990). None the less, the study prevalence of unsafe drinking by this method (18% of men and 5% of women) was typical of that previously reported in general medical wards (Chick *et al.*, 1986; Lockhart *et al.*, 1986; Feldman *et al.*, 1987; Moore *et al.*, 1989; Orford *et al.*, 1992) and reported intake is itself more sensitive and specific than brief screening when compared to a detailed clinical assessment (Lockhart *et al.*, 1986). Indeed, failure to acquire an adequate drinking history has been cited as the main reason for the failure of junior doctors to identify these patients (Barrison *et al.*, 1980).

The AUDIT contains items on the quantity and frequency of recent alcohol consumption; the MAST and CAGE do not. The AUDIT time frame is the past year, while the MAST and CAGE relate to lifetime symptoms. This reflects the intended purposes of the tests. The study results are therefore, in a sense, tautologous. Indeed, when used to identify only those attracting a clinical alcohol-related diagnosis, the AUDIT had no advantages over the MAST or CAGE. Studies in the United States in primary (Barry and Fleming, 1993) and secondary (Bohn *et al.*, 1995) care also found that the AUDIT and MAST identify this group with equal case/non-case discrimination.

The ability of the AUDIT to identify milder 'hazardous' drinking with greater sensitivity and specificity than the MAST has been reported (Bohn *et al.*, 1995; case criterion: >280 g alcohol/week for men, or >140 g/week for women). The present study replicated the AUDIT high discrimatory power at low levels of unsafe drinking (cf. Table 1).

The CAGE low positive predictive value (many false positive cases) was consistent with its low correlation with alcohol consumption (Bartu *et al.*, 1991). While some false positives are those who minimize intake but admit some problems, others are perhaps of strict moral or religious belief in near-abstinence who feel guilty. Of course, some CAGE (and MAST) 'false' positives relate to previous problem drinking. It appears that using a CAGE cut-off of 2 provides good case/non-case discrimination for alcohol-dependent subjects (see Table 1), but lowering the cut-off to 1 to detect lower levels of problem drinking introduces many false positives which render the instrument impractical.

The brief MAST ROC analysis curves returned towards the 45° line for a score of 4. This is because teetotal or low-drinking subjects often answered 'no' to questions 1 and 2, each scoring 2 for a negative response ('Do you feel you are a normal drinker?' and 'Do friends or relatives think you are a normal drinker?'). These items may need modification if the brief MAST is used to screen populations with low drinking individuals.

Chan *et al.* (1994) compared the brief MAST across three populations: alcoholics in treatment, clinical outpatients and the general population. Against a DSM-IIIR-based alcohol-related diagnosis in the past year, sensitivities were respectively 99, 61 and 28% (case score 6+). The present study (and those listed in Table 1) also suggest that the brief MAST is best reserved for the detection of alcohol dependence.

A drinker not receiving an alcohol-related admission code would have been considered unrecognized clinically by the study. None the less, as only an eighth of the hazardous/harmful drinkers were alcohol-coded, it seems likely that many went unrecognized, consistent with previously reported low clinically identified case yields (Barrison *et al.*, 1980; Feldman *et al.*, 1987).

If the government-recommended safe drinking limits were adopted, then these brief screening tests would yield many false positives. However, many of these 'false positives' would have persistent alcohol-related social and medical problems (Conigrave *et al.*, 1995*a*), be ready to reduce their alcohol intake (Dent *et al.*, 1995), and could be helped through brief counselling (Freemantle *et al.*, 1993).

The AUDIT, used routinely to screen medical admissions, could identify otherwise covert (Schuckit *et al.*, 1993) hazardous drinkers. It can be recommended for this purpose and the authors would suggest that nurses ask patients to complete it during the routine admission procedure. Conigrave *et al.* (1995*b*) found AUDIT cut-off points of 7–8 maximized discrimination in the prediction of trauma and hypertension at 2–3-year follow up. Higher cut-offs (12 and 22) provided better discrimination in the prediction of alcohol-related social problems and of liver disease or gastrointestinal bleeding, but high specificity was offset by reduced sensitivity. They concluded that a case

cut-off score of 8 was 'a reasonable approximation to the optimal for a variety of end-points'. The present study supports this cut-off in terms of currently recommended safe limits.

If used for routine screening of medical admissions, brief counselling interventions, by identifying an alcohol problem early in its natural history (when drinking behaviour is less entrenched), may reduce the frequency of progression to established alcohol-related harm. Of course, admission to hospital may occur some years after the onset of heavy drinking when alcohol-related harm is already established (Schuckit *et al.*, 1993) and, as the present study showed, screening can miss significant morbidity. The AUDIT, therefore, is an adjunct (rather than an alternative) to obtaining additional information from informants, records or a full clinical assessment. Outcome studies of the routine use of the AUDIT are now required.

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