SCREENING AND IDENTIFICATION

CAGE, RAPS4, RAPS4-QF and AUDIT Screening Tests for Men and Women Admitted for Acute Alcohol Intoxication to an Emergency Department: Are Standard Thresholds Appropriate?

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Abstract — Aims: A number of screening instruments are routinely used in Emergency Department (ED) situations to identify alcohol-use disorders (AUD). We wished to study the psychometric features, particularly concerning optimal thresholds scores (TSs), of four assessment scales frequently used to screen for abuse and/or dependence, the cut-down annoyed guilty eye-opener (CAGE), Rapid Alcohol Problem Screen 4 (RAPS4), RAPS4-quantity-frequency and AUD Identification Test (AUDIT) questionnaires, particularly in the sub-group of people admitted for acute alcohol intoxication (AAI). **Methods**: All included patients [AAI admitted to ED (blood alcohol level ≥0.8 g/l)] were assessed by the four scales, and with a gold standard (alcohol dependence/abuse section of the Mini International Neuropsychiatric Interview), to determine AUD status. To investigate the TSs of the scales, we used Youden's index, efficiency, receiver operating characteristic (ROC) curve techniques and quality ROC curve technique for optimized TS (indices of quality). **Results**: A total of 164 persons (122 males, 42 females) were included in the study. Nineteen (11.60%) were identified as alcohol abusers alone and 128 (78.1%) as alcohol dependents (DSM-IV). Results suggest a statistically significant difference between men and women ($P < 0.05$) in performance of the screening tests RAPS4 (≥1) and CAGE (≥2) for detecting abuse. Also, in this population, we show an increase in TSs of RAPS4 (≥2) and CAGE (≥3) for detecting dependence compared with those typically accepted in non-intoxicated individuals. The AUDIT test demonstrates good performance for detecting alcohol abuse and/or alcohol-dependent patients (≥7 for women and ≥12 for men) and for distinguishing alcohol dependence (≥11 for women and ≥14 for men) from other conditions. **Conclusion**: Our study underscores for the first time the need to adapt, taking into account gender, the thresholds of tests typically used for detection of abuse and dependence in this population.

INTRODUCTION

Relatively high rates of frequent heavy and problem drinking have been found among Emergency Department (ED) populations (Cherpitel 1993a,b; Whiteman *et al.*, 2000; Allely *et al.*, 2006). In France, a study carried out at the Centre General de Montbéliard emergency services found that 17.4% of admitted patients had positive blood alcohol test results, and ~83% of these had blood alcohol level ≥0.8 g/l (Allemand *et al.*, 1990). Otherwise, Reynaud *et al.* (2001) have shown that 80% of patients admitted for acute alcohol intoxication (AAI) in a French ED were suffering from alcohol-use disorders (AUD), suggesting that patients admitted to emergency services with AAI should not be assumed to be moderate drinkers. Despite the high prevalence of alcohol dependence among these patients, distinguishing between 'accidental' acute intoxication, abuse and dependence, is a challenge for ED practitioners because it determines the orientation of the intervention: Patients with accidental acute intoxication will require information about alcohol provided by emergency providers, while abusers will require brief motivational intervention provided by an alcohol health worker (AHW) in ED and dependent patients must be referred for a more intensive alcohol treatment programme (Johansson *et al.*, 2005; Daeppen, 2008; Freyer-Adam *et al.*, 2008; Saitz, 2010). For dependent patients, it is conventionally seen as difficult to send them to

treatment or refer them for problem drinking. These could be more acceptable if a AHW provided a brief motivational intervention and particularly if their admission was related to their alcohol use (DiClemente *et al.*, 1999; Nordqvist *et al.*, 2005; Rubak *et al.*, 2005).

Thus, the type of AUD determines the type of intervention most likely to motivate the patient to become involved in the care process. This makes it very important to distinguish, as precisely as possible, the gravity of the condition: serious dependence, moderate dependence or abuse/harmful/hazardous drinking. Comprehensive and detailed diagnoses are recognized as difficult under ED conditions of an enormous daily flow of patients. In general, for clinical (ED) populations, early distinction of AUD relies on screening approaches (Bernardt *et al.*, 1982; Whitney, 1983; Skinner *et al.*, 1984; Yates *et al.*, 1987; Cherpitel, 1995a; Aertgeerts *et al.*, 2001). A number of relatively short screening instruments have been developed for identifying AUD. Multiple studies have shown that the cut-down annoyed guilty eye-opener (CAGE) questionnaire (Ewing, 1984; Rueff *et al.*, 1989) has the advantage of being fast, simple and it performs well (Liskow *et al.*, 1995). AUD Identification Test (AUDIT) is also commonly used to identify AUDs in clinical settings (Saunders *et al.*, 1993) and a French version is also available (Gache *et al.*, 2005). The Rapid Alcohol Problem Screen 4 (RAPS4) is a screening instrument more recently developed for use in the ED (Cherpitel, 1995b, 2000). It identifies the optimal item subset from several brief

screening instruments, including the CAGE and AUDIT. The addition of two quantity-frequency (QF) items was intended to increase sensitivity of the RAPS4 for alcohol abuse and harmful drinking (RAPS4-QF) (Cherpitel, 2002).

The use of the CAGE, RAPS4 and AUDIT tests has been recognized in EDs as effective for detecting AUD in circumstances of an increased prevalence of this condition (Cherpitel, 1993a,b; Whiteman *et al.*, 2000; Kelly *et al.*, 2004). Several authors have seen the need to target populations to be assessed by focussing on those who present with the greatest number of risk factors for alcohol-related pathologies (surgical emergencies, psychiatric emergencies and acute alcoholic intoxication, etc.) (Cherpitel *et al.*, 2004; Touquet and Brown, 2009) and by using the shortest screening tests because in the ED setting, diagnostic assessment for AUDs may not be feasible, even if targeted only towards very high-risk patients (Barrett and Vaughan Williams, 1989; Whiteman *et al.*, 2000; Vitale *et al.*, 2006). These tests, which are much less costly in time than the diagnosis approach, are classically or systematically used by AHW to help us to distinguish accidental acute intoxication, abuse and dependence. They also provide information on damage induced by alcohol misuse, which is discussed with the patient during brief motivational interventions (Cherpitel and Bazargan, 2003; Cherpitel *et al.*, 2004; Rubak *et al.*, 2005).

Little data exist about the properties of these screening tests in the ED, and, to our knowledge, there are no data concerning optimal thresholds scores (TSs) that can be used for detecting and distinguishing alcohol abuse and dependence in the subset of patients admitted to the ED for AAI, nor is there certainty about the appropriateness of these tests in these patients (Reinert and Allen, 2007).

Given the prevalence of AUDs in emergency services settings, we chose to compare, taking into account gender, the performance of four screening instruments (CAGE, RAPS4, RAPS4-QF and AUDIT) for identifying alcohol abusers and alcohol-dependent patients among intoxicated patients in a French emergency service site. Data on the comparative performance of different screening instruments to identify AUDs in patients admitted for drunkenness in the ED are reported here for the first time. The main objective was to identify the optimal TSs for detecting different degrees of AUDs (alcohol abuse/harmful drinking and dependence) for each of the scales, to allow informed choices on clinical management to be made.

METHODS

Sample

This study was conducted from 1 March to 1 May 2008 at the 24 h ED of the Centre Hospitalier Universitaire (CHU) Gabriel Montpied in Clermont-Ferrand, France. It included 18 to 80-year-old patients admitted with AAI as principal or additional diagnosis (DSM-IV criteria; American Psychiatric Association, 1994) and blood alcohol level ≥0.8 g/l, measured using the automated alcohol dehydrogenase enzyme method (Modular, Roche®, Meylan, France), which was a routine part of the examination for these patients. Most of these emergencies were handled by general practitioners, ambulance personnel or police officers. The experimental protocol had previously been approved by the Committee for the

protection of individuals (ID RCB: 2007-A00920_53). Persons who were affected by serious medical conditions and who declined consent were excluded from the study. When subjects were capable of being interviewed (clear-headed, no signs of AAI per DSM-IV criteria), the study was fully explained to them, and written informed consent was obtained. Data collection resulted in 164 completed interviews, representing an 86% response rate. Reasons for non-interview were refusal (3%), the patient's condition (9%) and other matters (2%).

Data collection and instruments

Examination of each patient included recording social, demographic and medical history data and clinical measures, including diagnostic interviews and administration of the alcohol screening questionnaires.

Interviews were conducted in confidence in a private area of the ED by qualified interviewers (J.G., N.C., B.A. and G.B. who had previously been trained in the use of these scales) using a structured interview schedule lasting ~50 min on average.

Patients were given French versions of the screening instruments for AUD (CAGE, RAPS4, RAPS4-QF and AUDIT).

The CAGE questionnaire was originally developed by Ewing (1984) and was designed to detect life-time alcohol dependence. CAGE is an acronym of four questions:

(a) Have you ever felt you should cut down on your drinking? (b) Have people annoyed you about your drinking? (c) Have you ever felt bad or guilty about your drinking? and (d) Have you ever had a drink first thing in the morning to steady your nerves or to get rid of a hangover (eye opener)? Two or more positive answers are a common TS for detecting AUD (Ewing, 1984).

– The AUDIT was developed by the World Health Organization (Babor *et al.*, 1992) to identify problem drinkers in primary care settings. This 10-item scale includes questions to assess alcohol intake, alcohol dependence and alcohol-related problems. A score of 8 or more indicates an AUD (Allen *et al.*, 1997).

– The RAPS was developed by Cherpitel (1995b), to detect current alcohol dependence and consists of the following four items: (a) During the last year, have you had a feeling of guilt or remorse after drinking? (Remorse), (b) During the last year, has a friend or family member ever told you about things you said or did while you were drinking that you could not remember? (Amnesia, also called Blackouts), (c) During the last year, have you failed to do what was normally expected from you because of drinking? (Perform) and (d) Do you sometimes take a drink in the morning, when you first get up? (Starter, also called eye opener). A positive response on anyone of the four questions is considered positive on the RAPS4 (Cherpitel, 1995b). The RAPS4-QF includes the RAPS4 items plus two additional questions: (a) During the last year, have you had five or more drinks on at least one occasion? (Quantity), (b) During the last year, do you drink as often as once a month? (Frequency). A positive response on any one of the four RAPS4 items or both of the QF items is considered positive on the RAPS4-QF (Cherpitel, 2002).

The RAPS4 and RAPS4-QF were translated into French using the well-recognized forward–backward translation technique (Guillemin *et al*., 1993).

For all screening instruments (CAGE, RAPS4, RAPS4-QF and AUDIT), patients were questioned about the last 12 months.

– Alcohol misuse diagnostic was measured by the Mini International Neuropsychiatric Interview, French version 5.0.0 (MINI, Lecrubier *et al*., 1997). According to the MINI, alcohol dependence was established from a positive response in three or more of the seven domains on DSM-IV diagnostic criteria of dependence (American Psychiatric Association, 1994), while harmful drinking/abuse was established from a positive response on one or more of the four consequence items related to harmful drinking on DSM-IV for individuals who did not meet the criteria for dependence.

Data analysis

To conduct the statistical analysis, we used version 15.0 of the SPSS software. Parametric (Student's *t*-test), non-parametric (Mann–Whitney for non-normal distributions) and χ^2 statistical tests were used to conduct between-group comparisons (men vs women), for demographic and drinking variables and/or for comparisons of means of the four scales scores. To protect against chance findings based on multiple comparisons, we applied the Bonferroni correction on *t*-tests. Within men and women, statistical correlation analysis was conducted by non-parametric methods (Spearman's ρ).

To investigate TSs that optimized the sensitivity (proportion correctly classified as having the condition) and specificity (proportion correctly classified as not having the condition) of the scales (CAGE, RAPS4, RAPS4-QF and AUDIT), to detect alcohol abuse and/or dependence for each scale and for three groups (total sample, men and women), we used four measures: (a) Youden's index [1–(sensitivity + specificity)]; (b) the efficiency [defined as the probability that test and diagnosis agree: (true positive + true negative)/total]; (c) the receiver operating characteristic (ROC) curve technique and (d) the quality ROC curve (QROC; Kraemer, 1992). The ROC curve is a graphical representation of the relation between the sensitivity and specificity of a test calculated for each possible threshold value. The QROC curve is a graphical representation of the relation between quality of the sensitivity (Se) and quality of specificity (Spe). This curve allows the measurement of the quality of sensitivity $k(1,0)$ [(Se–Q)/Q′; where Q is the level of the test (subjects with positive test/number total of subjects) and $Q' = 1–Q$] and the quality of specificity $k(0,0)$ [(Spe–Q′)/Q]. The choice of the optimized threshold score was made by calculating the indices of quality, the optimal χ^2 score [χ^2 = number total of subjects × $k(1,0)$ × $k(0,0)$] (Kraemer, 1992).

In order to obtain information about the comparative effectiveness of these tests between men and women, we compared the area under the curves (AUC) values for each scale (CAGE, RAPS4, RAPS4-QF and AUDIT) between the total sample, men and women using version 11.0.0.0 of the MedCalc® software (for more details about this statistical analysis and software, see Stephan *et al*., 2003; Delacour *et al*., 2005). Comparisons of fixed sensitivities and specificities at optimized and classically used thresholds were also provided between men and women by calculating partial index of ROC curves [ε: (sensitivity + specificity)/2, Park *et al*., 2004; Delacour *et al*., 2005] for each scale. Finally, for each scale, we compared optimized and classically used thresholds for each sample (total men and women) by using the ε index.

In order to investigate the optimal TS for RAPS4-QF in our population, we decided to study this scale by creating a series of scores corresponding to different TSs on an incremental scale (as for the other scales). Consequently, the analysis of this scale was provided from a total score created by awarding and adding together a point for each positive response on the RAPS4-QF questionnaire (RAPS4-QF[1]).

RESULTS

Demographic and drinking characteristics

The study included the 164 patients (122 men, 42 women) admitted for AAI in the ED of CHU Gabriel Montpied in Clermont-Ferrand in the study period. Their mean age was 46 years (SD = 11.6). One half ($n = 82$) lived alone, and one-third were unemployed. About two-thirds of these patients (64.63%) had a history of receiving treatment for alcohol-related disorders. There was no demographic difference between men and women except for employment status ($P = 0.007$). Alcohol abuse alone was diagnosed in 19 patients (11.6%, 14 males, 5 females) and alcohol dependence in 128 (78.05%, 98 males, 30 females, Table 1).

Table 1. Demographic characteristics of population

	Total *n* (%)	Men *n* (%)	Women *n* (%)	*P*-value*
Number	164	122 (74.39)	42 (25.61)	NS
Age	45.7 (11.6)[a]	45.6 (12.0)[a]	46.0 (10.5)[a]	NS
Marital status				
Married	50 (30.49)	32 (26.23)	18 (42.86)	NS
Single/never married	52 (31.70)	43 (35.25)	9 (21.43)	NS
Divorced	53 (32.31)	41 (33.60)	12 (28.57)	NS
Other	9 (5.49)	6 (4.92)	3 (7.14)	NS
Education				
Primary + Secondary	126 (76.83)	99 (81.15)	27 (64.29)	NS
Tertiary	38 (23.17)	23 (18.85)	15 (35.71)	
Employment				
Unemployed	60 (36.60)	42 (34.43)	18 (42.86)	NS
Retired	10 (6.10)	8 (6.56)	2 (4.76)	NS
Manual workers and unskilled labour	26 (15.85)	25 (20.49)	1 (2.38)	0.007
Administrative staff	33 (20.12)	24 (19.67)	9 (21.43)	NS
Other	35 (21.34)	23 (18.85)	12 (28.57)	NS
History				
Treatment for alcohol	106 (64.63)	74 (60.66)	32 (76.19)	NS
Alcohol-use disorders				
Abuse	19 (11.60)	14 (11.48)	5 (11.90)	NS
Dependence	128 (78.05)	98 (80.33)	30 (71.43)	NS

[a]Standard deviation.
*$P < 0.05$ (χ^2 for categorical data).

Table 2. Population characteristics, alcohol consumption and mean RAPS4, RAPS4-QF, CAGE and AUDIT scores

	Total ($n = 164$) Mean (SD)	Men ($n = 122$) Mean (SD)	Women ($n = 42$) Mean (SD)	P-value*
RAPS4	2.3 (1.27)	2.19 (1.27)	2.62 (1.21)	NS
RAPS4-QF[1]	3.99 (1.40)	3.93 (1.46)	4.19 (1.23)	NS
CAGE	2.95 (1.20)	2.95 (1.19)	2.95 (1.23)	NS
AUDIT	21.62 (9.85)	21.80 (9.62)	21.07 (10.59)	NS
Alcohol (g/l)	3.04 (1.00)	3.17 (0.96)	2.74 (1.02)	NS

*Unpaired *t*-test for continuous data.

Seventeen patients (10 males, 7 females) were neither abusers nor addicts.

General characteristics of scales

Mean scores

The mean scores for CAGE, RAPS4 RAPS4-QF[1] and AUDIT were respectively 2.95, 2.30, 3.99 and 21.62. Theses scores did not differ between men and women (Table 2). Mean blood alcohol level on arrival at the ED was 3.04 g/l (median = 2.52, range 0.81–5.11).

Correlations

The item/total correlation procedure [Spearman's r (ρ)] revealed that there was a correlation between RAPS4 and RAPS4-QF[1] (0.93, $P < 0.05$), AUDIT (0.73, $P < 0.05$) and CAGE (0.58, $P < 0.05$), between RAPS4-QF[1] and AUDIT (0.77, $P < 0.05$) and CAGE (0.58, $P < 0.05$) and between AUDIT and CAGE (0.63, $P < 0.05$).

For men, there was a correlation between RAPS4 and RAPS4-QF[1] (0.95, $P < 0.05$), AUDIT (0.79, $P < 0.05$) and CAGE (0.54, $P < 0.05$), between RAPS4-QF[1] and AUDIT (0.81, $P < 0.05$) and CAGE (0.55, $P < 0.05$) and between AUDIT and CAGE (0.58, $P < 0.05$).

For women, there was a correlation between RAPS4 and RAPS4-QF[1] (0.88, $P < 0.05$), AUDIT (0.61, $P < 0.05$) and CAGE (0.73, $P < 0.05$), between RAPS4-QF[1] and AUDIT (0.68, $P < 0.05$) and CAGE (0.70, $P < 0.05$) and between AUDIT and CAGE (0.77, $P < 0.05$).

Determination of the TSs (Fig. 1)

Alcohol abuse and/or dependent patients

Specificity, Sensitivity, Youden's index, efficiency, quality of sensitivity, quality of specificity of screening instruments for detecting alcohol abuse/harmful drinking and/or dependence and comparison between AUC for optimal thresholds are presented in Table 3. ROC curves of most effective screening tests (defined by and optimal indices of quality) for detecting alcohol abuse/harmful drinking and/or dependence for men and women are reported in Fig. 1a–e.

Based on the indices of quality [χ^2 = number total of subjects $\times k(1,0) \times k(0,0)$], the optimal threshold for the RAPS4 was ≥1 for men ($\chi^2 = 66.11$, $P < 0.001$) and ≥2 for women ($\chi^2 = 9.91$, $P < 0.01$). For the RAPS4-QF[1], the optimal threshold was ≥2 for men ($\chi^2 = 70.68$, $P < 0.001$) and ≥4 for women ($\chi^2 = 12.47$, $P < 0.001$). In the case of CAGE, the optimal TS was ≥3 for men ($\chi^2 = 22.37$, $P < 0.01$) and ≥2 for women ($\chi^2 = 28.37$, $P < 0.001$), while the optimal TS for the

AUDIT was ≥12 for men ($\chi^2 = 44.48$, $P < 0.001$) and ≥7 for women ($\chi^2 = 28.38$, $P = 0.001$).

Based on the analysis of AUC and partial index of ROC curves (ε), each optimized and usual TS of each screening measure performed similarly well between men and women for detecting AUDs with the exception of the RAPS4 at TS ≥1 [better performance for men: ε 0.93 for men vs 0.61 for women, ($P < 0.05$)], CAGE at TS ≥2 [better performance for women: ε 0.76 for men vs 0.86 for women, ($P < 0.05$)] and RAPS4-QF[1] at TS ≥2 [better performance for men: ε 0.80 for men vs 0.49 for women ($P < 0.05$)]. Among men, all TSs of optimized and usual screening measures performed similarly except for the AUDIT at TS ≥12 [better performance than TS ≥7 and TS ≥8 ($P < 0.05$)]. Among women, the CAGE at TS ≥2 performed better than the CAGE at TS ≥3 ($P < 0.05$), the RAPS4-QF[1] at TS ≥4 performed better than the others TSs ($P < 0.05$) and the AUDIT at TS ≥7 performed better than the others TSs ($P < 0.05$).

Alcohol-dependent patients

Specificity, Sensitivity, Youden's index, efficiency, quality of sensitivity, quality of specificity of screening instruments for detecting alcohol dependence and comparison between AUC for optimal thresholds are presented in Table 4. ROC curves of the most effective screening tests (defined by optimal indices of quality) for detecting alcohol dependence for men and women are reported in Fig. 1f–j.

Based on the indices of quality, the optimal TS for the RAPS4 was ≥1 for men ($\chi^2 = 26.81$, $P < 0.001$) and two for women ($\chi^2 = 13.44$, $P < 0.001$). For the RAPS4-QF[1], a TS ≥3 was found for men ($\chi^2 = 30.44$, $P < 0.001$) and ≥4 for women ($\chi^2 = 13.59$, $P < 0.001$). For the CAGE, a TS ≥3 was found for both men ($\chi^2 = 24.42$, $P < 0.001$) and women ($\chi^2 = 17.01$, $P < 0.001$). For AUDIT, an optimal TS ≥18 was found for the total sample ($\chi^2 = 51.31$, $P < 0.001$), and ≥14 for men ($\chi^2 = 32.52$, $P < 0.001$) and ≥11 for women ($\chi^2 = 21.00$, $P < 0.001$).

Based on the analysis of AUC and the partial index of ROC curves (ε), each optimized and usual TS of each screening measure performed similarly well between men and women for detecting alcohol dependence. Among men, all TSs of all screening measures performed similarly. For women, all TSs of all screening measures performed similarly except for RAPS4 at TS ≥2, which performed better than others thresholds ($P < 0.05$).

DISCUSSION

In this study, we have focused on exploring the psychometric qualities of the CAGE, RAPS4, the RAPS4-QF and the AUDIT screening tests in a population of emergency room patients admitted for AAI (and who were no longer intoxicated when the tests were administered). Abusers made up 12% of the group and 78% were alcohol-dependent; these proportions are close to those previously reported 10 years earlier in the same emergency service by Reynaud *et al.* (2001). As is typically reported in the literature, such cases are mostly (74%) male, unemployed and one in three lives alone (Whiteman *et al.*, 2000; Allely *et al.*, 2006). This is, to our knowledge, the first study reporting performance of
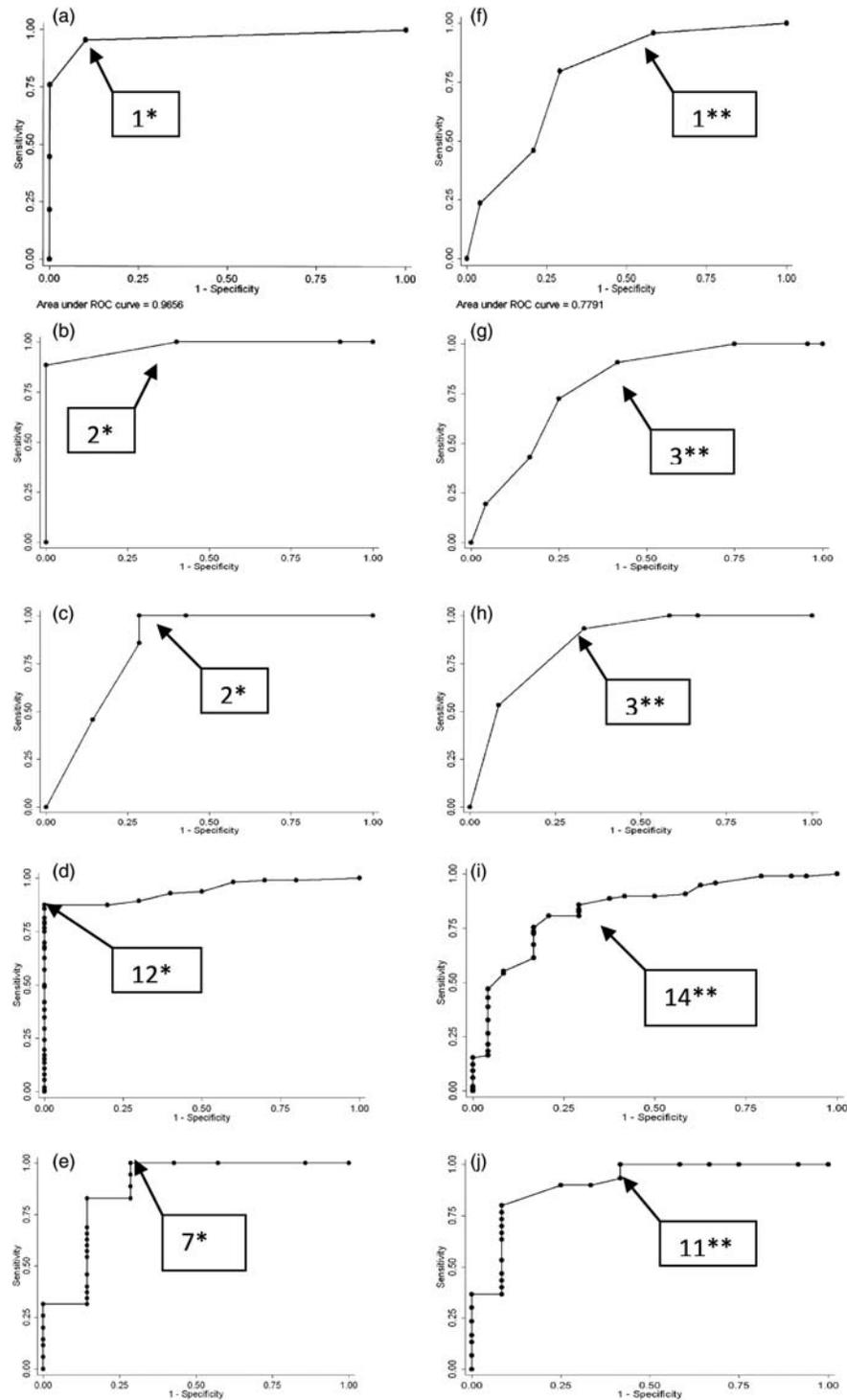
Fig. 1. ROC curves of RAPS4, RAPSQF1, CAGE and AUDIT for men and women admitted for drunkenness. *Optimal threshold scores (by calculating the indices of quality [number total of subjects × $k(1,0)$ × $k(0,0)$]. for detecting alcohol abuse/harmful drinking and/or alcohol dependence. **Optimal threshold scores (by calculating the indices of quality) for detecting alcohol dependence. Alcohol misuse diagnostic was measured by the MINI (Lecrubier *et al.*, 1997). According to the MINI, alcohol dependence was established from a positive response in three or more of the seven domains on DSM-IV diagnostic criteria of dependence, while harmful drinking/abuse was established from a positive response on one or more of the four consequence items related to harmful drinking on DSM-IV for individuals who did not meet the criteria for dependence. (**a**) ROC curve of RAPS4 (men) for detecting alcohol abuse/harmful drinking and/or alcohol dependence, (**b**) ROC curve of RAPSQF1 (men) for detecting alcohol abuse/harmful drinking and/or alcohol dependence, (**c**) ROC curve of CAGE (women) for detecting alcohol abuse/harmful drinking and/or alcohol dependence, (**d**) ROC curve of AUDIT (men) for detecting alcohol abuse/harmful drinking and/or alcohol dependence, (**e**) ROC curve of AUDIT (women) for detecting alcohol abuse/harmful drinking and/or alcohol dependence, (**f**) ROC curve of RAPS4 (men) for detecting alcohol dependence, (**g**) ROC curve of RAPSQF1 (men) for detecting alcohol dependence, (**h**) ROC curve of CAGE (women) for detecting alcohol dependence, (**i**) ROC curve of AUDIT (men) for detecting alcohol dependence and (**j**) ROC curve of AUDIT (women) for detecting alcohol dependence.

Table 3. Sensitivity (Se) and specificity (Sp), AUC and partial index of ROC curve ε, of the screening instruments (RAPS4, RAPS4-QF[1], CAGE and AUDIT) for detecting alcohol abuse/harmful drinking or alcohol dependence

Test	Total $n=164$: abuse = 19; dependents = 128; non-abuser or dependent = 17							Men $n=122$: abuse = 14; dependents = 98; non-abuser or dependent = 10							Women $n=42$: abuse = 5; dependents = 30; non-Abuser or dependent = 7						
Threshold	Spe	Se	Y	Eff.	k (0,0)	k (1,0)	AUC/ ε	Spe	Se	Y	Eff	k (0,0)	k (1,0)	AUC/ ε	Spe	Se	Y	Eff	k (0,0)	k (1,0)	AUC/ ε
RAPS4							0.84							0.97							0.7
≥1	**0.65**	**0.95**	**0.6**	**0.92**	**0.6**	**0.57**	**0.8**	**0.9**	**0.96**	**0.86**	**0.95**	**0.89**	**0.61**	**0.93**[b]	0.29	0.94	0.23	0.83	0.21	0.4	0.61
≥2	0.82	0.8	0.62	0.8	0.76	0.24	0.81	1	0.76	0.76	0.78	1	0.2	0.88	**0.57**	**0.91**	**0.49**	**0.86**	**0.49**	**0.49**	**0.74**
RAPS4-QF[1]							0.89							0.98							0.81
≥2	0.35	0.99	0.34	0.93	0.32	0.84	0.67	**0.6**	**1**	**0.6**	**0.97**	**0.58**	**1**	**0.80**[b]	0	0.97	−0.03	0.81	−0.02	−0.2	0.49
≥3	**0.77**	**0.89**	**0.66**	**0.88**	**0.71**	**0.38**	**0.83**[a]	1	0.88	0.88	0.89	1	0.38	0.94[b]	0.43	0.91	0.34	0.83	0.33	0.4	0.67
≥4	0.88	0.73	0.62	0.75	0.82	0.19	0.81[a]	1	0.69	0.69	0.71	1	0.15	0.84	**0.71**	**0.89**	**0.6**	**0.86**	**0.64**	**0.47**	**0.80**[a]
CAGE							0.86							0.88							0.84
≥2	0.65	0.94	0.59	0.91	0.6	0.5	0.79	0.6	0.92	0.52	0.89	0.54	0.35	0.76	**0.71**	**1**	**0.71**	**0.95**	**0.68**	**1**	**0.86**[ab]
≥3	**0.76**	**0.84**	**0.61**	**0.84**	**0.7**	**0.29**	**0.8**	**0.8**	**0.84**	**0.64**	**0.84**	**0.75**	**0.25**	**0.82**	0.71	0.86	0.57	0.83	0.62	0.4	0.79
AUDIT							0.91							0.94							0.88
≥7	0.53	0.99	0.52	0.94	0.5	0.8	0.76	0.4	0.98	0.38	0.93	0.37	0.64	0.69	**0.71**	**1**	**0.71**	**0.95**	**0.68**	**1**	**0.86**[a]
≥8	0.58	0.94	0.53	0.9	0.53	0.47	0.76	0.5	0.94	0.44	0.9	0.45	0.36	0.72	0.71	0.94	0.66	0.9	0.66	0.66	0.83
≥12	**0.88**	**0.88**	**0.76**	**0.88**	**0.85**	**0.39**	**0.88**[a]	**1**	**0.88**	**0.88**	**0.89**	**1**	**0.36**	**0.94**[a]	0.71	0.89	0.6	0.86	0.64	0.47	0.8

Y, Youden's index (sensitivity + specificity−1); Eff, the efficiency [defined as the probability that test and diagnosis agree: (true positive + true negative)/total]; AUC, area under the curve (technique ROC); k(0,0) quality of the specificity k(1,0) quality of sensitivity.

The choice of the optimal threshold score (bold) is based on index of quality, which is the optimal χ^2 QCROC's score [χ^2 = total number of subjects $\times k$ (1,0) $\times k$(0,0)].

RAPSQF [1]: score by implementation.

[a] ε: significance ($P<0.05$) between optimized and classically used thresholds (downer threshold is the reference) for each sample (total/men/women) and each scale.

[b] AUC and ε: significance ($P<0.05$) between men and women for the same thresholds.

Table 4. Sensitivity (Se) and specificity (Sp), AUC and partial index of ROC curve ε of screening instruments (RAPS4, RAPS4QF[1] CAGE and AUDIT) for detecting alcohol dependence

Test	Total $n=164$: abuse = 19; dependent = 128; non-abuser or dependent = 17							Men $n=122$: abuse = 14; dependents = 98; non-abuser or dependent = 10							Women $n=42$: abuse = 5; dependents = 30; non-abuser or dependent = 7						
Threshold	Spe	Se	Y	Eff	k (0,0)	k (1,0)	AUC/ ε	Spe	Se	Y	Eff	k (0,0)	k (1,0)	AUC/ ε	Spe	Se	Y	Eff	k (0,0)	k (1,0)	AUC/ ε
RAPS4							0.76							0.78							0.78
≥1	0.36	0.96	0.32	0.83	0.28	0.64	0.66	**0.42**	**0.96**	**0.38**	**0.85**	**0.34**	**0.64**	**0.69**	0.25	0.97	0.22	0.76	0.17	0.65	0.61
≥2	**0.64**	**0.84**	**0.47**	**0.79**	**0.51**	**0.39**	**0.74**[a]	0.71	0.79	0.5	0.78	0.58	0.33	0.75	**0.5**	**0.97**	**0.47**	**0.83**	**0.4**	**0.8**	**0.73**[a]
RAPS4-QF[1]							0.79							0.8							0.82
≥3	**0.53**	**0.92**	**0.45**	**0.84**	**0.43**	**0.56**	**0.72**	**0.58**	**0.91**	**0.49**	**0.84**	**0.49**	**0.51**	**0.75**	0.42	0.97	0.38	0.81	0.32	0.77	0.69
≥4	0.69	0.77	0.47	0.76	0.54	0.31	0.73	0.75	0.72	0.47	0.73	0.6	0.25	0.74	**0.58**	**0.93**	**0.52**	**0.83**	**0.47**	**0.69**	**0.76**
CAGE							0.82							0.8							0.86
≥2	0.42	0.96	0.38	0.84	0.34	0.68	0.69	0.41	0.95	0.37	0.84	0.34	0.59	0.68	0.42	1	0.42	0.83	0.34	1	0.71
≥3	**0.61**	**0.89**	**0.5**	**0.83**	**0.5**	**0.5**	**0.75**	**0.58**	**0.88**	**0.46**	**0.82**	**0.47**	**0.43**	**0.73**	0.67	0.93	0.6	0.86	0.56	0.72	0.8
AUDIT							0.86							0.84							0.91
≥8	0.42	0.97	0.39	0.85	0.34	0.73	0.69	0.33	0.96	0.29	0.84	0.26	0.58	0.79	0.58	1	0.58	0.88	0.5	1	0.79
≥11	0.53	0.92	0.45	0.84	0.73	0.34	0.81	0.5	0.9	0.4	0.82	0.39	0.43	0.81	**0.58**	**1**	**0.58**	**0.88**	**0.5**	**1**	**0.94**
≥14	0.69	0.87	0.56	0.83	0.59	0.48	0.86	0.71	0.86	0.57	0.83	0.61	0.44	0.88	0.67	0.9	0.57	0.83	0.55	0.62	0.93
≥18	**0.83**	**0.8**	**0.64**	**0.81**	**0.75**	**0.42**	**0.82**	0.79	0.81	0.6	0.8	0.7	0.38	0.8	0.92	0.8	0.72	0.83	0.86	0.51	0.86

Y, Youden's index (sensitivity + specificity−1), Eff: the efficiency [defined as the probability that test and diagnosis agree: (true positive + true negative)/total]; AUC, area under the curve (technique ROC), k(0,0) quality of the specificity k(1,0) quality of sensitivity.

The choice of the optimal threshold score (bold) is based on index of quality, which is the optimal χ^2 QCROC's score [χ^2 = total number of subjects $\times k$ (1,0) $\times k$(0,0)].

RAPSQF[1], score by implementation.

[a] ε: significance ($P<0.05$) between optimized and classically used thresholds (downer threshold is the reference) for each sample (total/men/women) and each scale.

screening alcohol tests in patients admitted to the emergency service for acute drunkenness. Our analysis using ROC and QROC curves and index of quality (Kraemer, 1992) allows us to detect optimal TSs for the identification of abuse and/or dependent patients and for both men and women. Main findings of this study in this ED population of patients admitted for AAI are: good sensitivity and poor specificity of

the screeners at usual TSs, the necessity of increasing TSs to obtain adequate specificity while simultaneously maintaining good sensitivity, differential performance between screening tests relative to gender and the good performance of the AUDIT.

In this population of patients admitted for acute drunkenness, CAGE maintains very good sensitivity (0.94) at

threshold score ≥2 for detecting abuse and/or dependence; the sensitivity of the CAGE has been found to range from 72 to 91% and its specificity from 77 to 96% (Bernardt et al., 1982; Bush et al., 1987; Beresford et al., 1990) in clinical populations. The French version of the CAGE (diminuer, entourage, trop, alcool), with a threshold score ≥2, showed a sensitivity of 83% and a specificity of 96% for AUD (Rueff et al., 1989). The sensitivity of CAGE in our study was superior to the value reported in the Aertgeerts et al. (2004) meta-analysis (0.71) and to the values reported in a French hospitalized population by Malet et al. (2005) (0.61 for abuse, 0.82 for dependence) though the specificity was lower in our study (0.65). Raising the TS to three leads to an increase in specificity for the detection of abuse (e.g. from 0.60 to 0.80 in men) and dependence (from 0.42 to 0.62 in the total population) while maintaining good sensitivity (>0.80). Similarly, for RAPS4 (TS ≥1) and AUDIT (TS ≥8) for detecting alcohol abuse and/or dependence, sensitivities of RAPS4 and AUDIT were superior to the values reported by Cherpitel and Bazargan (2003) in a population of patients admitted to an emergency room, although the specificity was lower. One explanation of higher sensitivity and lower specificities of the screening tests conducted in this study compared with other studies that explored AUDs in EDs is the fact that the population in this study consisted exclusively of drinkers, 90% of whom met the criteria for an AUD, while in others studies all patients admitted to the ED are investigated. For example, recently Cremonte et al. (2010), in studying three distinct ED populations, showed that specificity of RAPS4 and CAGE decreased while prevalence of alcohol-related disorders increased, and conversely for sensitivity.

Our study provides information about the optimal TS for each test highlighting differences between men and women. For example, RAPS4, at TS ≥1, shows an optimal index of quality for detecting abusers and/or dependent patients among men, and shows an area under the curve significantly different between men and women ($P < 0.05$). In sum, the RAPS4 and RAPS4-QF[1] seem to possess better psychometric properties than the CAGE in men, while the CAGE seems more adapted to female populations. Several studies have reported gender differences in performances of these screening instruments, including the better performance of the CAGE in female populations and of the RAPS4 in males (Bradley et al., 1998; Cherpitel and Bazargan, 2003; Cherpitel et al., 2005). This finding could be explained by the fact that items in the RAPS4 may be more centred on masculine issues such as performance.

The AUDIT test thus demonstrates good performance for detecting alcohol-abuse patients and/or alcohol-dependent patients among intoxicated people in the ED and in men, but at higher TS (≥12) than the TS traditionally used (≥8) (Conigrave et al., 1995). Indeed, a review of the performance of the AUDIT has found sensitivity ranged from 38 to 94%, and specificity from 66 to 90% with a TS ≥8 (Allen et al., 1997). In women, the recommended TS ≥7 (Reinert and Allen, 2007) is confirmed in the present study for identifying AUDs. For the purpose of detecting alcohol dependence, AUDIT displays good performance at the TS ≥14 in men, ≥11 in women and ≥18 for both. These TSs are close to those found by Gache et al. (2005) (≥13) for discrimination of dependent patients in the general population with the

French version of the AUDIT. The differences between men and women for TSs are compatible with the recommendation of Rumpf et al. (2002), who have proposed to use adjusted cut-offs for this screening test depending on the study population. Thus, in our study population of individuals admitted for AAI, the higher TS of AUDIT for detecting alcohol-related disorders compared with the TS classically used for the general population of persons admitted to the emergency service is in agreement with that reported by Conigrave et al. (1995), who advised a TS ≥15 (sensitivity: 0.73, specificity: 0.84) for patients whose admission to emergency care was associated with AAI. The different TSs proposed for the AUDIT are also compatible with the approach of Rubinsky et al. (2010) who recently suggested different risk intervals depending on the TSs on the AUDIT.

In summary, for patients admitted to ED for AAI, we propose choosing the RAPS4 at TS ≥1 for detecting alcohol abuse and/or dependence in men and the CAGE at TS ≥2 and/or AUDIT at TS ≥7 in women.

With respect to the detection of dependence in this population, the AUDIT at TS ≥14 seems to be the best detector among men; the CAGE at TS ≥3 and the AUDIT at TS ≥11 seem to be the best detectors among women.

Finally, given the well-documented high prevalence of AUD in this population, it could be argued that screening tests may have limited utility among patients admitted to the ED for AAI; such patients are already known to have an 80% probability of having an AUD. This is why, despite this limitation, it must considered that: (a) diagnosis of AUD is not practically realistic in the ED; (b) patients should be directed towards an appropriate treatment, depending on the gravity of the misuse, which necessitates a screening process; (c) AHW who is regularly involved in ED work is necessary to administer the screening tests, to distinguish misuse and to support interventions. The impact of screening tests in the management of the disease is based on these criteria.

Our study has some limitations. Firstly, the size of the sample is relatively small for this type of study. Further, the sample is primarily composed of alcohol-dependent patients (78.05%). In this work, we have identified differences between men and women in the performance of screening tests. These differences related to the genre have been pointed out in other specific populations (Bradley et al., 1998; Cherpitel and Bazargan, 2003; Cherpitel et al., 2005), and they should be confirmed in a larger work. For example, this study could lead to other studies that seek to verify whether the results we report are a consequence of cultural factors (e.g. a French population) or clinical factors (patients admitted for acute drunkenness) in our population. Also, differences between scales can raise doubts about and suggest further investigation of the homogeneity of what we measure. The high correlation coefficients between the different scales underscore the coherence of the screening measures used, as has been reported in the literature (Cremonte et al., 2010).

To the best of our knowledge, this is the first study that seeks to assess the psychometric properties of these four instruments in a population of patients admitted for acute alcoholic intoxication in ED. Other studies will be necessary to define, with the help of these scales, different risk intervals, to allow targeted and appropriate interventions to be proposed. It would also be desirable to replicate this study in

other French hospital emergency services. Finally, the different approach of the RAPS-QF[I] test with assessment of the TS with the incremental score as we proposed should be investigated in other studies.

CONCLUSION

The creation of a screening test is not an end in itself (Grimes and Schulz, 2002). Screening for alcohol abuse and dependence is an essential item of care, given the high prevalence of alcohol-related problems seen in emergency services. Patients are often favourably disposed to receiving specialist care when they have been identified as needing it, once they are convinced of the necessity. Unfortunately, emergency services are increasingly overloaded and intensive screening of AUDs is difficult in this setting. In the future, it will therefore be necessary to identify patients for whom screening may be most productive, and this should become regular practice for patients admitted for alcohol intoxication in the ED, (90% of whom had an AUD in this study). Further, we now know that the type of AUD determines the type of intervention most likely to motivate the patient to become involved in the care process. This makes it important to distinguish as precisely as possible and with the help of classical screening tools, the gravity of the condition: serious dependence, moderate dependence or abuse/harmful/hazardous drinking. In this highly selected population of patients admitted for AAI, it might be interesting to characterize the seriousness of their dependence and to determine the capacity of the AUDIT to provide a graduated evaluation of the dependence.

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