Screening for Posttraumatic Stress Disorder

What Combination of Symptoms Predicts Best?

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Abstract: Several symptom screening instruments have been developed to identify trauma survivors at risk for chronic posttraumatic stress disorder, but few of these have been thoroughly evaluated to date. In this study, a range of symptom combination scoring rules derived from the literature were applied to the Posttraumatic Diagnostic Scale and evaluated in 4 different samples of trauma survivors (total $N = 522$) regarding their power to identify people with posttraumatic stress disorder. Results were replicated in a fifth sample ($N = 253$). Most scoring rules showed lower diagnostic efficiencies than in the original reports. The most stable results were obtained for cutoffs on the Posttraumatic Diagnostic Scale total scale and a new subset of 8 items. The results underscore the need to cross-validate findings before using screening instruments for clinical applications.

Key Words: Trauma, PTSD, screening.

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More than half of the population can be expected to experience at least 1 traumatic event in their lifetime (Kessler et al., 1995). Although the majority of trauma survivors experience some posttraumatic stress symptoms shortly after the event, most of them recover without treatment (Kessler et al., 1995; Rothbaum et al., 1992). However, chronic posttraumatic stress disorder (PTSD) is a persistent and disabling condition. The early identification and treatment of individuals at risk for chronic PTSD is thus an important clinical challenge. Offering brief interventions to all trauma survivors is not only costly, but has also shown negative results in randomized controlled trials (McNally et al., 2003). Thus, a criterion to select trauma survivors in need of early treatment is needed, suggesting a need for screening instruments that identify trauma survivors at risk for *future* PTSD (e.g., via screening at hospitals). A related clinical problem is the efficient detection of people in need of treatment for PTSD after mass trauma such as natural disaster or terrorist attacks. In this situation, screening instruments are needed to detect individuals *currently* suffering from PTSD among large traumatized populations.

A starting point in the development of screening instruments for PTSD is the observation that the initial severity of symptoms is a good predictor of the chronicity of PTSD symptoms (Rothbaum et al., 1992). Most of the screening instruments published to date use all or a subset of the 17 PTSD symptoms defined in *Diagnostic and Statistical Manual of Mental Disorders, 4th Edition* (DSM-IV; American Psychiatric Association, 1994). The main rationale for the selection of such subsets is the economy of administration. Furthermore, not all combinations of symptoms may be equally predictive of PTSD. For example, people may endorse amnesia for important parts of the trauma for reasons other than PTSD, e.g., alcohol intoxication or head injury. The inclusion of such ambiguous symptoms in self-report screening measures may increase error variance, and a combination of the most predictive symptoms may offer an overall better prediction than scales that include all PTSD symptoms. On the other hand, assessing the full range of PTSD symptoms allows for individual variations in symptom patterns and may provide the most reliable estimate of PTSD diagnosis. It is as yet unclear what symptom combination is the most predictive of current and future PTSD. Some studies suggest that re-experiencing symptoms predict PTSD best (Franklin et al., 2002; Simms et al., 2002), but this is not supported by others (e.g., Brewin et al., 1999).

A recent review identified 22 screening instruments that use various combinations of symptoms (assessed via self-report questionnaires) to predict PTSD (Brewin, 2005). All questionnaires showed acceptable to good diagnostic efficiency in detecting PTSD (as measured with structured diagnostic interviews) in the original studies. On average, they had a sensitivity of 0.83, a specificity of 0.85, and an overall efficiency (OE) of 0.86. One has to bear in mind that most of the studies reviewed by Brewin (2005) tested the ability of the symptom combinations to predict current PTSD. Studies of the prediction of future PTSD are rare (see Brewin, 2005)

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so that it remains unclear to what extent the screening instruments are applicable for early intervention programs. Furthermore, there are several reasons to be cautious about the widespread clinical application of the screening scales developed so far: (a) Cutoffs in the available studies were determined post hoc and most of the measures have not been cross-validated yet, suggesting that sensitivity and specificity may be different in other samples. (b) Very few studies to date have directly compared different screening rules within the same data sets. (c) Screening instruments were usually developed in samples with high base rates of PTSD, leading to high positive predictive power (PPP). When screening is considered for PTSD after traumas that affect large communities such as terrorist attacks or natural disasters, one can expect lower base rates than in these samples and thus possibly lower PPPs. Therefore, a replication of the findings in samples with lower base rates is desirable.

The aim of this article was to directly compare the diagnostic efficiency of different symptom combination scoring rules when screening for current and when screening for future PTSD. Different scoring rules suggested in the literature were applied to the Posttraumatic Diagnostic Scale (PDS), a validated and widely used self-report measure of PTSD symptom severity (Foa et al., 1997) and evaluated in 5 independent samples of trauma survivors. Specifically, we investigated whether (a) each symptom combination scoring rule showed sensitivity, specificity, and OE comparable to the original study in which it was developed; (b) screening could be optimized using different cutoff scores for each scale; (c) scores based on a small number of PTSD symptoms showed similar diagnostic efficiency as those based on all 17 PTSD symptoms; (d) the same or different scoring rules should be used to screen for current versus future PTSD; (e) how a short scale using the most predictive PDS items compares to the full scale in diagnostic efficiency; and (f) whether the symptom criteria give consistent results in samples with low versus high base rates of PTSD.

METHOD

Overview

All participants were trauma survivors who had been treated for their injuries at a local Emergency Department after a motor vehicle accident (MVA) or a serious physical or sexual assault. Participants were invited to participate in the study either in person while in hospital or by letter, with time between admission and invitation varying from study to study. Four independent samples (samples 1–4) were recruited for research purposes. We analyzed how well the symptom combination scores predicted current chronic PTSD, as measured by the Structured Clinical Interview for DSM-IV (SCID) (First et al., 1996). Two of the samples (samples 3 and 4) were assessed again at 6 months after the trauma, which allowed us to test how well the measures taken at 2 weeks after the trauma predicted future PTSD. An independent sample of MVA survivors (sample 5) was used to further cross-validate the best symptom combination scores from the previous analyses in a high base-rate sample.

Samples of Trauma Survivors

For all samples, written informed consent was obtained after the study had been fully described and questions had been answered. Demographic characteristics are shown in Table 1.

Sample 1 comprised 101 participants who had experienced an MVA 3 to 12 months before the study (Ehring et al., 2006). Twenty-two (21.8%) met DSM-IV criteria for current PTSD.

Sample 2 comprised 76 participants who had been seriously physically or sexually assaulted 3 months to 7 years before the study. Thirty (39%) met DSM-IV criteria for current PTSD.

Sample 3 comprised 140 MVA survivors who were interviewed and completed self-report measures at 2 weeks and 6 months after their accident (Ehring et al., In press). At the 6-month follow-up, 12.1% of the participants met DSM-IV criteria for PTSD.

Sample 4 comprised 205 survivors of serious physical or sexual assaults who were interviewed and completed self-report measures at 2 weeks and 6 months after the assault (Kleim et al., 2007). At 6 months postassault, 23.9% met DSM-IV criteria for current PTSD. In samples 3 and 4, screening for current PTSD was evaluated from the data collected at the 6-month follow-up. In addition, we tested how well symptom severities assessed at 2 weeks predicted future PTSD diagnoses at 6 months.

Sample 5 comprised 253 MVA survivors who were recruited in the first 3 months after the accident as part of a research project of early responses and interventions for PTSD (Ehlers et al., 2003). Participants completed self-report measures in the second month and at 3 months after their MVA, and completed a diagnostic interview at 3 months. One hundred sixty-two participants (64%) met criteria for PTSD at the 3-month assessment. The data included in the present analyses were collected before participants had received any treatment.

Measures

Diagnoses of PTSD

Presence of PTSD was assessed using the PTSD module of the SCID (First et al., 1996). DSM-IV trauma criteria (A1 and A2) were also assessed using the SCID and had to be fulfilled for a diagnosis of PTSD. Participants were instructed to answer the questions of the SCID in relation to the particular "index trauma" (i.e., the MVA or the assault). Interrater reliability for the SCID interviews was high; samples 1 to 4: $\kappa = 0.82$, $N = 56$ randomly chosen interviews, sample 5: $\kappa = 0.95$, $N = 40$ randomly chosen interviews.

PTSD Symptom Measures

Participants completed the Posttraumatic Diagnostic Scale (PDS) (Foa et al., 1997), which assesses the severity of each of the PTSD symptoms specified in DSM-IV. Each item is rated on a 4-point scale ranging from 0 (not at all or only 1 time) to 3 (5 or more times a week or almost always). Participants were instructed to answer the questions in relation to the particular index trauma (i.e., the MVA or the

TABLE 1. Sample Characteristics

	Sample 1 (N = 101)		Sample 2 (N = 76)		Sample 3 (N = 140)		Sample 4 (N = 205)		Sample 5 (N = 253)	
Variable	***N* or *Mean***	**% or *SD***	***N* or *Mean***	**% or *SD***	***N* or *Mean***	**% or *SD***	***N* or *Mean***	**% or *SD***	***N* or *Mean***	**% or *SD***
Female gender	44	43.6%	27	35.1%	45	32.1%	65	31.7%	158	62.5%
Age (yr)	34.95	10.60	34.3	10.74	35.25	9.49	34.96	11.53	36.89	11.93
Ethnic background										
White	77	76.3%	48	62.3%	97	69.3%	119	58%	219	86.6%
Black	18	17.8%	20	26%	30	21.4%	67	32.7%	8	3.2%
Other	6	5.9%	9	11.7%	13	9.3%	19	9.3%	26	10%
PTSD (SCID)	22	21.8%	30	39%	17	12.1%	49	23.9%	162	64%
Symptom scales										
PTSD from PDS (symptom cluster scoring)	33	32.7%	42	54.5%	2w: 48 6m: 30	34.3% 21.4%	2w: 104 6m: 70	50.7% 34.1%	1m: 147 3m: 157	68.8% 62.1%
PDS total score	12.28	11.16	18.71	12.91	2w: 12.58	11.48	2w: 19.31	12.57	1m: 24.5	10.99
					6m: 7.95	9.91	6m: 15.29	13.81	3m: 24.07	11.11
New 8-item PDS subscale	5.66	5.72	8.03	6.49	2w: 5.31	5.58	2w: 8.30	6.30	1m: 11.25	5.60
					6m: 3.41	4.87	6m: 6.85	6.84	3m: 10.79	5.82
TSQ	2.21	2.80	3.46	3.26	2w: 2.51	2.81	2w: 3.97	3.13	1m: 5.44	2.86
					6m: 1.10	2.22	6m: 2.76	3.31	3m: 5.27	3.01
SPAN	2.69	2.84	4.62	3.20	2w: 2.53	2.87	2w: 4.25	3.24	1m: 5.63	3.06
					6m: 1.78	2.54	6m: 3.50	3.49	3m: 5.60	3.01
BPTSD-6	4.61	4.21	6.68	5.03	2w: 4.47	4.34	2w: 7.04	4.61	1m: 9.00	4.10
					6m: 2.62	3.54	6m: 5.53	5.12	3m: 8.64	4.24
DRPST	2.80	2.39	4.08	2.33	2w: 2.59	2.36	2w: 4.12	2.22	1m: 5.18	1.90
					6m: 2.20	2.25	6m: 3.59	2.55	3m: 5.00	2.07
Lang and Stein (2005)—2 items	2.06	1.62	2.39	1.84	2w: 2.51	2.08	2w: 3.28	1.91	1m: 3.76	1.62
					6m: 1.17	1.41	6m: 2.14	1.91	3m: 3.58	1.62
Lang and Stein (2005)—6 items	5.03	4.51	7.12	4.93	2w: 5.22	4.54	2w: 7.61	4.88	1m: 9.85	4.31
					6m: 3.04	3.80	6m: 5.92	5.31	3m: 9.49	4.42

2w indicates assessment at 2 weeks posttrauma; 6m, assessment at 6 months posttrauma; PTSD, posttraumatic stress disorder; SCID, Structured Clinical Interview for DSM-IV; PDS, Posttraumatic Diagnostic Scale; TSQ, trauma screening questionnaire; SPAN, 4-item scale; BPTSD-6, 6-item brief PTSD DSM-IV questionnaire; DRPST, disaster-related psychological screening test.

assault) experienced. Of the 22-symptom combination scoring rules identified in Brewin's (2005) recent review, 5 are based on the PDS. Four additional criteria were originally based on other self-report questionnaires of PTSD symptom severity, but proxy measures can be derived from the PDS. Therefore, 9 different scores based on different combinations of PTSD symptoms were derived from the PDS and evaluated for their diagnostic efficiency. Table 2 gives an overview of which DSM symptoms are represented in each score. For the PDS total scale, additional cutoffs recommended in recent studies were also included (Coffey et al., 2006; Ehlers et al., 2003; Foa, 1995; Sheeran and Zimmerman, 2002). Thus, a total of 18 different screening rules were evaluated.

1. DSM symptom cluster scoring. In line with the DSM-IV symptom cluster criteria, PTSD was scored to be present when participants endorsed at least 1 re-experiencing symptom, 3 avoidance or numbing symptoms, and 2 arousal symptoms as present (i.e., at least "1" on the 0–4 response scale of the PDS) and endorsed either interference with overall level of functioning or 2 of the other 8 interference items (e.g., interference with work, household, or relationships) (Foa, 1995; Foa et al., 1997).
2. Total severity cutoff. A total PDS severity score was computed, and the following cutoffs suggested in previous research with MVA survivors, a mixed trauma group, or a sample of psychiatric outpatients were evaluated: 14, 15, 18, 20, and 27 (Coffey et al., 2006; Ehlers et al., 2003; Foa, 1995; Foa et al., 1997; Sheeran and Zimmerman, 2002).
3. Symptom cluster scoring plus total severity cutoff. Following suggestions by Foa (1998), the optimal way to identify PTSD may be to combine the PDS symptom cluster scoring method with a severity cutoff. This scoring rule was evaluated using the same cutoffs as described above.
4. Trauma screening questionnaire (TSQ). Following the suggestions by the authors (Brewin et al., 2002), the TSQ score was computed as the number of reexperiencing and arousal items from the PDS that participants endorsed with at least 2 on the 0 to 3 scale. The TSQ was originally

TABLE 2. DSM-IV Symptoms Represented in Different Symptom Combination Scoring Rules

Symptom	Symptom Cluster Scoring and Severity Cutoffs	New 8-Item PDS Subscale	TSQ	SPAN	BPTSD-6	DRPST	Lang and Stein 2 Items	Lang and Stein 6 Items
1. Intrusive thoughts/images	X	—	X	—	—	—	X	X
2. Dreams	X	X	X	—	X	X	—	—
3. Flashbacks	X	—	X	—	X	X	—	—
4. Distress when reminded	X	—	X	—	X	—	X	X
5. Physiological response when reminded	X	X	X	X	—	X	—	—
6. Cognitive avoidance	X	X	—	—	X	X	—	—
7. Situational avoidance	X	—	—	—	—	X	—	X
8. Amnesia	X	—	—	—	—	—	—	—
9. Loss of interest	X	X	—	—	—	X	—	—
10. Estrangement	X	X	—	—	X	—	—	X
11. Restricted affect	X	—	—	X	—	—	—	—
12. Foreshortened future	X	X	—	—	—	—	—	—
13. Sleep problems	X	—	X	—	—	—	—	—
14. Irritability	X	—	X	X	—	—	—	X
15. Difficulty concentrating	X	X	X	—	—	—	—	X
16. Hypervigilance	X	—	X	—	—	X	—	—
17. Startle	X	X	X	X	X	—	—	—

An "X" indicates that the PTSD symptom (row) is included the respective symptom combination scoring rule (column).
PDS indicates Posttraumatic Diagnostic Scale; TSQ, trauma screening questionnaire; SPAN, 4-item scale; BPTSD-6, 6-item brief PTSD DSM-IV questionnaire; DRPST, disaster-related psychological screening test.

derived from the PTSD Symptom Scale (Foa et al., 1993), the predecessor of the PDS. The original studies on assault victims and rail crash survivors suggested a cutoff of 6 symptoms endorsed (Brewin et al., 2002).

5. SPAN. The SPAN derives its name from the 4 PTSD symptoms startle, physiological reaction to reminders, anger, and numbing (Meltzer-Brody et al., 1999). It was originally computed from the Davidson Trauma Scale (Davidson et al., 1997) in a mixed trauma sample. In the original study, the items were answered on a 0 to 4 scale and a cutoff of 5 on the sum score was recommended. A proxy measure was derived as the sum of the PDS items 5, 11, 14, and 17.
6. Brief PTSD DSM-IV questionnaire (BPTSD-6). The 6-item measure (Fullerton et al., 2000) was originally derived from the Impact of Event Scale (Horowitz et al., 1979), where items are rated on a 0 to 3 scale. In this study, a proxy BPTSD-6 score was computed from the PDS items 2, 3, 4, 6, 10, and 17. The recommended cutoff is 5 and was originally derived in a sample of MVA survivors.
7. The Disaster-Related Psychological Screening Test (the DRPST). DRPST (Chou et al., 2003) is a 7-item measure assessing the presence versus absence of the PTSD symptoms nightmares, flashbacks, physiological arousal in response to trauma reminders, avoidance of thoughts, avoidance of situations, loss of interest, and alertness. In this study, a proxy measure for the DRPST 7-item sum score was computed by scoring how many of the PDS items 2, 3, 5, 6, 7, 9, and 16 were endorsed with at least "1." The recommended cutoff is 3 items endorsed and was originally derived in a sample of earthquake victims (Chou et al., 2003).
8. Lang and Stein's measures. Lang and Stein empirically derived a 2-item and a 6-item screening measure in 2 samples of primary care patients (Lang and Stein, 2005). The scales were originally based on the PCL-C (Blanchard et al., 1996), where items are rated on a 1 to 5 scale. In this study, sum scores were derived from the PDS items 1, 4, 7, 10, 14, and 15. The recommended cutoffs are 4 (2-item version) and 14 (6-item version).

Data Analyses

The diagnostic efficiency of each symptom combination scoring rule in samples 1 to 4 was assessed by computing the following indices: sensitivity (i.e., the probability that someone with a PTSD diagnosis will test positive on the screener); specificity (i.e., the probability that someone without a PTSD diagnosis will test negative on the screener); positive predictive power (PPP) (i.e., the probability that someone with a positive screening results has PTSD); negative predictive power (NPP, i.e., the probability that someone with a negative screening result does not have PTSD), and overall efficiency (OE) (i.e., percentage of cases correctly classified). We calculated these indices for both the cutoff that was recommended in the original studies and for the cutoff with the best balance between sensitivity and specificity for the present samples, based on receiver operating characteristics (ROC) analyses.

There are no universal criteria to decide what constitutes a good performance of an instrument in predicting diagnostic status (Baldessarini et al., 1983; Brewin et al.,

2003) as the relative importance of sensitivity and specificity depends on the nature of the diagnostic situation. In this article, we used the performance of the screening instruments reviewed by Brewin (2005) as a guide and evaluated whether each symptom criterion met minimum quality standards in predicting PTSD in each of the samples 1 to 4. These were defined as an OE of at least 0.80 and a minimum sensitivity and specificity of 0.75. These standards are within about 10% of the average performance of screening instruments reported by Brewin (2005). No quality standards were set for PPP and NPP as these are highly dependent of the base rate (see Baldessarini et al., 1983), but these indices were considered in evaluating the practical relevance of the scoring rules.

In addition to analyzing the samples separately, we calculated the mean diagnostic performance in predicting current PTSD across the 4 samples and compared it with the diagnostic efficiency reported in the respective original study. We also compared it with the average performance of screening instruments in Brewin's (2005) review (sensitivity 0.83; specificity 0.85; OE 0.86), and will refer to this comparison as above average, average, and below average performance.

To identify a subset of about half of the PDS items and compare it with the performance of the full scale, we calculated the diagnostic efficiency of each PDS item in predicting future PTSD in the combined samples 3 and 4 ($N = 343$; 17.3% of participants with PTSD); whereby symptoms were scored as either present (≥ 1) or absent (0). Results are shown at www.psychology.iop.kcl.ac.uk/downloads/ehringetal.JNMD.doc. We then selected the 8 items with the best OE in predicting future PTSD that had a sensitivity of at least 0.80.

The symptom combination scoring rules that performed well in samples 1 to 4 were then cross-validated in sample 5.

RESULTS

Descriptives

Table 1 shows means and standard deviations for the different scores in the 5 samples.

Screening for Current PTSD

The results for the diagnostic efficiency of the different scoring rules in identifying current PTSD are shown in Table 3.

Symptom Cluster Scoring

The symptom cluster scoring method showed high sensitivities (≥ 0.82) in identifying PTSD and met the mini-

TABLE 3. Screening for Current PTSD

	Sample 1					Sample 2					Sample 3					Sample 4					Mean Results Across Samples				
Scoring Rule	**Sens**	**Spec**	**PPP**	**NPP**	**O E**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**
PDS–symptom clusters	0.82	0.81	0.55	0.94	0.81	0.86	0.64	0.60	0.88	0.72	0.88	0.88	0.50	0.98	0.88	0.93	0.78	0.56	0.97	0.81	0.87	0.78	0.55	0.94	0.81
PDS																									
Cutoff 14	0.96	0.80	0.57	0.98	0.83	0.93	0.68	0.64	0.94	0.78	0.94	0.86	0.49	0.99	0.87	0.98	0.72	0.51	0.99	0.78	0.95	0.77	0.55	0.98	0.82
Cutoff 15	0.91	0.81	0.57	0.97	0.83	0.93	0.68	0.64	0.94	0.78	0.88	0.88	0.52	0.98	0.88	0.95	0.74	0.52	0.98	0.79	0.92	0.78	0.56	0.97	0.82
Cutoff 18	0.82	0.89	0.67	0.95	0.87	0.86	0.81	0.74	0.91	0.83	0.82	0.96	0.74	0.98	0.94	0.93	0.80	0.58	0.97	0.83	0.86	0.87	0.68	0.95	0.87
Cutoff 20	0.77	0.91	0.71	0.93	0.88	0.83	0.85	0.77	0.89	0.84	0.71	0.98	0.80	0.96	0.94	0.93	0.84	0.64	0.98	0.86	0.81	0.90	0.73	0.94	0.88
Cutoff 27	0.50	0.95	0.73	0.87	0.85	0.66	0.92	0.83	0.81	0.82	0.35	0.99	0.86	0.92	0.91	0.71	0.94	0.77	0.92	0.89	0.56	0.95	0.80	0.88	0.87
PTSD symptom clusters plus PDS																									
Cutoff 14	0.82	0.86	0.62	0.94	0.85	0.86	0.72	0.66	0.90	0.78	0.88	0.92	0.60	0.98	0.91	0.93	0.81	0.59	0.97	0.84	0.87	0.83	0.62	0.95	0.85
Cutoff 15	0.82	0.86	0.62	0.94	0.85	0.86	0.72	0.66	0.90	0.78	0.82	0.93	0.61	0.97	0.91	0.91	0.82	0.60	0.97	0.84	0.85	0.83	0.62	0.95	0.85
Cutoff 18	0.77	0.89	0.65	0.93	0.86	0.83	0.83	0.75	0.89	0.83	0.77	0.97	0.77	0.97	0.94	0.91	0.86	0.66	0.97	0.87	0.82	0.89	0.71	0.94	0.88
Cutoff 20	0.73	0.91	0.70	0.92	0.87	0.79	0.85	0.77	0.87	0.83	0.65	0.98	0.79	0.95	0.93	0.91	0.89	0.70	0.97	0.89	0.77	0.91	0.74	0.93	0.88
Cutoff 27	0.46	0.95	0.71	0.86	0.84	0.62	0.92	0.82	0.80	0.80	0.35	0.99	0.86	0.92	0.91	0.69	0.96	0.83	0.91	0.90	0.53	0.96	0.81	0.87	0.86
New 8-item PDS subscale cutoff 9	0.86	0.89	0.68	0.96	0.88	0.83	0.85	0.77	0.89	0.84	0.82	0.95	0.70	0.98	0.93	0.91	0.85	0.64	0.97	0.86	0.86	0.89	0.68	0.96	0.88
TSQ																									
Cutoff 6	0.59	0.95	0.77	0.89	0.87	0.62	0.94	0.86	0.80	0.82	0.41	1.00	1.00	0.92	0.93	0.76	0.92	0.74	0.93	0.89	0.60	0.95	0.84	0.89	0.88
Cutoff 3	0.86	0.81	0.56	0.96	0.82	0.93	0.75	0.69	0.95	0.82	0.88	0.94	0.68	0.98	0.93	0.93	0.80	0.58	0.97	0.83	0.90	0.83	0.63	0.97	0.85
SPAN cutoff 5	0.68	0.86	0.58	0.91	0.82	0.90	0.85	0.79	0.93	0.87	0.82	0.95	0.70	0.98	0.93	0.88	0.89	0.70	0.96	0.88	0.82	0.89	0.69	0.95	0.88
BPTSD6 cutoff7	0.86	0.89	0.68	0.96	0.88	0.79	0.81	0.72	0.86	0.80	0.53	0.96	0.64	0.94	0.91	0.91	0.83	0.61	0.97	0.85	0.77	0.87	0.66	0.93	0.86
DRPST																									
Cutoff 3	1.00	0.65	0.45	1.00	0.73	0.93	0.43	0.50	0.91	0.62	0.94	0.71	0.31	0.99	0.74	0.98	0.55	0.39	0.99	0.64	0.96	0.59	0.41	0.97	0.68
Cutoff 5	0.86	0.85	0.61	0.96	0.85	0.86	0.81	0.74	0.91	0.83	0.71	0.88	0.44	0.96	0.86	0.93	0.74	0.51	0.97	0.78	0.84	0.82	0.58	0.95	0.83
Lang and Stein																									
2 items cutoff 3	0.77	0.80	0.52	0.93	0.79	0.69	0.79	0.67	0.80	0.75	0.65	0.93	0.55	0.95	0.89	0.90	0.79	0.55	0.97	0.81	0.75	0.83	0.57	0.91	0.81
6 items cutoff 8	0.73	0.89	0.64	0.92	0.85	0.79	0.81	0.72	0.86	0.80	0.59	0.96	0.67	0.94	0.91	0.88	0.84	0.62	0.96	0.85	0.75	0.88	0.66	0.92	0.85

Sens indicates sensitivity; Spec, specificity; PPP, positive predictive power; NPP, negative predictive power; OE, overall efficiency; PTSD, posttraumatic stress disorder; PDS, Posttraumatic Diagnostic Scale; TSQ, Trauma Screening Questionnaire; SPAN, 4-item scale; BPTSD-6, 6-item brief PTSD DSM-IV questionnaire; DRPST, Disaster-Related Psychological Screening Test.

mum quality standard in all samples except sample 2, which showed low specificity (0.64). Mean performance across the samples was slightly below the average and similar to the original results reported by Foa et al. (1997), with the exception of a lower PPP (mean 0.55).

PDS Total Score

A cutoff of 18 on the PDS total score, but none of the other cutoffs tested, fulfilled the minimum quality standard in all 4 samples. The mean performance of this cutoff across samples was slightly above average. ROC analyses did not identify another cutoff with a better balance between sensitivity and specificity (area under the curve [AUC] = 0.90–0.96 in the different samples).

Symptom Cluster Scoring Plus Severity Cutoff

A cutoff of 18 in addition to the symptom cluster scoring but no other cutoff fulfilled the minimum quality standard in all samples. The mean performance of this cutoff across samples was average. ROC analyses did not show a better cutoff.

New 8-Item PDS Subscale

ROC analyses suggested a cutoff of 9 for the new subscale, which then performed as well as the best cutoffs of the full scale. Quality standards were met in all samples, and the mean performance was slightly above average.

Trauma Screening Questionnaire

The recommended cutoff of 6 (Brewin et al., 2002) showed high specificities comparable to those in the original report (0.92–1.00). However, sensitivities did not reach the threshold of 0.75 in samples 1 to 3. This cutoff led to a much lower mean sensitivity (0.60) than both in the original report (Brewin et al., 2002) and the average performance of screening instruments, whereas mean specificity (0.95) and OE (0.88) were high. ROC analyses identified a cutoff of 3 (AUC = 0.89–0.97), which fulfilled the minimum quality standard in all samples. This cutoff showed an average performance, although specificity and OE remained lower than in the original report (Brewin et al., 2002).

SPAN

When using the recommended cutoff of 5, the minimum quality standard was met in all samples except sample 1, which showed lower sensitivity (0.68). The mean performance across samples was average. It was also in line with the original report (Meltzer-Brody et al., 1999), with the exception of a lower PPP (0.69 vs. 0.81/0.89). ROC analyses did not identify a better cutoff (AUC = 0.89–0.97).

BPTSD

The cutoff of 5 used in the original study (Fullerton et al., 2000) was not applicable because of different response formats. ROC analyses suggested a cutoff of 7 (AUC 0.88–0.92). The minimum quality standard was fulfilled in all samples except sample 3, which showed low sensitivity (0.53). The mean performance across samples was below average, but comparable to results from the original report (Fullerton et al., 2000).

DRPST

When applying the suggested cutoff of 3 symptoms, minimum quality standards were not met in any of the samples because of low OEs and specificities (0.43–0.71). ROC analyses suggested a cutoff of 5 (AUC = 0.85–0.90). However, minimum criteria were met only in samples 1 and 2. The mean performance of the new cutoff across samples was comparable to the original report as well as the average performance in Brewin's (2005) review.

Lang and Stein's Symptom Scoring Rules

Cutoffs from the original study were not applicable because of different response formats (Lang and Stein, 2005). ROC analyses suggested cutoffs of 3 for the 2-item measure (AUC 0.82–0.90) and of 8 for the 6-item measure (AUC = 0.87–0.94). However, for the 2-item measure, minimum quality standards were fulfilled only in sample 4, with low OEs or sensitivities in the other samples as well as in the mean performance. For the 6-item measure, minimum quality standards were fulfilled in all samples except sample 3, where sensitivity was low (0.59). The mean performance across samples also showed lower sensitivity than the average in Brewin's (2005) review.

Screening for Risk of Future PTSD

Results for the prediction of chronic PTSD at 6 months from symptom levels at 2 weeks are shown in Table 4. As to be expected because of natural recovery in the first few months after trauma, sensitivities, specificities, and OEs were considerably lower than when screening for current PTSD. None of the criteria met the minimum quality standards in both samples. The best balance between sensitivity and specificity was found for the PDS symptom cluster scoring plus cutoff of 20, which met minimum quality standards in sample 3 and nearly met them in sample 4, where OE was only slightly below the 0.80 threshold (0.79). The mean performance of this criterion across samples met the quality standard; sensitivity, specificity, and OE were all 0.82. A PDS score of 20, the SPAN, and the new 8-item PDS subscale also performed close to quality standards.

Cross-Validation of Best Symptom Scoring Rules

Table 5 shows the results for the cross-validation in sample 5 for the symptom combination scoring rules that performed reasonably well in the previous analyses. When screening for current PTSD, all scoring rules yielded very high sensitivities of 0.90 and above, with the exception of the SPAN (0.79). However, specificities were lower than the 0.75 threshold (0.47–0.73) for all scores. The best results were found for the combination of the PTSD symptom cluster score and a severity cutoff of 18 and the new 8-item PDS subscale. Specificity was just below the 0.75 threshold, and OE was 0.84 for both scoring rules. When screening for future PTSD, the combination of PTSD symptom cluster scoring with a cutoff of 20 performed best overall and showed the best specificity. In addition, the PDS cutoff 20 and the new 8-item PDS subscale showed a reasonable

TABLE 4. Efficiency of Symptoms at 2 Weeks in Predicting PTSD at 6 Months

	Sample 3					Sample 4					Mean Results Across Samples				
Instrument	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**
PDS–PTS symptom clusters	0.77	0.72	0.27	0.96	0.72	0.93	0.58	0.39	0.97	0.65	0.85	0.65	0.33	0.97	0.69
PDS															
Cutoff 14	0.88	0.68	0.27	0.98	0.70	0.98	0.49	0.36	0.99	0.60	0.93	0.59	0.32	0.99	0.65
Cutoff 15	0.88	0.70	0.29	0.98	0.72	0.98	0.52	0.37	0.99	0.62	0.93	0.61	0.33	0.99	0.67
Cutoff 18	0.82	0.84	0.41	0.97	0.84	0.93	0.67	0.45	0.97	0.73	0.88	0.76	0.43	0.97	0.79
Cutoff 20	0.77	0.86	0.43	0.96	0.85	0.89	0.73	0.49	0.96	0.75	0.83	0.80	0.46	0.96	0.80
Cutoff 27	0.53	0.90	0.43	0.93	0.86	0.73	0.84	0.56	0.91	0.81	0.63	0.87	0.50	0.92	0.84
PTSD symptom clusters plus PDS															
Cutoff 14	0.77	0.76	0.31	0.96	0.76	0.93	0.65	0.43	0.97	0.71	0.85	0.71	0.37	0.97	0.74
Cutoff 15	0.77	0.77	0.32	0.96	0.77	0.93	0.66	0.44	0.97	0.72	0.85	0.72	0.38	0.97	0.75
Cutoff 18	0.77	0.85	0.42	0.96	0.84	0.91	0.75	0.51	0.97	0.78	0.84	0.80	0.47	0.97	0.75
Cutoff 20	0.77	0.86	0.43	0.96	0.85	0.86	0.77	0.51	0.95	0.79	0.82	0.82	0.47	0.96	0.82
Cutoff 27	0.53	0.90	0.43	0.93	0.86	0.70	0.84	0.56	0.91	0.81	0.62	0.87	0.50	0.92	0.84
New 8-item PDS subscale—cutoff 9	0.77	0.85	0.42	0.96	0.84	0.86	0.75	0.50	0.95	0.78	0.84	0.80	0.48	0.96	0.80
TSQ															
Cutoff 6	0.59	0.90	0.46	0.94	0.86	0.68	0.82	0.52	0.90	0.79	0.64	0.86	0.49	0.92	0.83
Cutoff 4	0.88	0.79	0.37	0.98	0.80	0.91	0.61	0.40	0.96	0.68	0.90	0.70	0.39	0.97	0.74
SPAN—cutoff 5	0.65	0.86	0.39	0.95	0.84	0.86	0.73	0.48	0.95	0.76	0.76	0.80	0.44	0.95	0.80
BPTSD-6—cutoff 7	0.65	0.84	0.36	0.95	0.81	0.91	0.65	0.44	0.96	0.71	0.78	0.75	0.40	0.96	0.76
DRPST															
Cutoff 3	0.77	0.59	0.20	0.95	0.61	0.98	0.33	0.30	0.98	0.48	0.88	0.46	0.25	0.97	0.55
Cutoff 5	0.71	0.82	0.35	0.95	0.81	0.96	0.66	0.45	0.98	0.73	0.84	0.74	0.40	0.97	0.77
Lang and Stein (2005)															
2 items—cutoff 5	0.71	0.85	0.40	0.96	0.84	0.65	0.76	0.46	0.88	0.74	0.68	0.81	0.43	0.92	0.79
6 items—cutoff 8	0.88	0.82	0.41	0.98	0.83	0.91	0.64	0.42	0.96	0.70	0.90	0.73	0.42	0.97	0.77

Sens indicates sensitivity; Spec, specificity; PPP, positive predictive power; NPP, negative predictive power; OE, overall efficiency; PTSD, posttraumatic stress disorder; PDS, Posttraumatic Diagnostic Scale; TSQ, Trauma Screening Questionnaire; SPAN, 4-item scale; BPTSD-6, 6-item brief PTSD DSM-IV questionnaire; DRPST: Disaster-Related Psychological Screening Test.

TABLE 5. Cross-Validation of Best Replicated Symptom Combination Scoring Rules in Sample 5

	Sample 5—Screening for Current PTSD						Sample 5—Screening for Future PTSD					
Scoring Rules	**Cutoff**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**	**Cutoff**	**Sens**	**Spec**	**PPP**	**NPP**	**OE**
PDS–PTSD symptom clusters	N/A	0.94	0.59	0.79	0.86	0.81	N/A	0.97	0.54	0.80	0.92	0.82
PDS total score	18	0.96	0.62	0.82	0.88	0.84	20	0.86	0.70	0.82	0.75	0.80
PTSD symptom cluster scoring plus PDS total cutoff	18	0.91	0.73	0.85	0.83	0.84	20	0.83	0.74	0.83	0.73	0.79
New 8-item PDS subscale	9	0.90	0.73	0.86	0.81	0.84	9	0.86	0.67	0.82	0.74	0.79
TSQ	3	0.93	0.47	0.76	0.78	0.77	4	0.88	0.50	0.75	0.71	0.74
SPAN	5	0.79	0.64	0.80	0.62	0.73	5	0.81	0.64	0.80	0.66	0.75
BPTSD-6	7	0.90	0.66	0.83	0.79	0.82	7	0.90	0.57	0.78	0.77	0.78

N/A = indicates criterion not evaluated; Sens, sensitivity; Spec, specificity; ; PPP, positive predictive power; NPP, negative predictive power; OE, overall efficiency; PTSD, posttraumatic stress disorder; PDS, Posttraumatic Diagnostic Scale; TSQ, Trauma Screening Questionnaire; SPAN, 4-item scale; BPTSD-6, 6-item brief PTSD DSM-IV questionnaire; DRPST: Disaster-Related Psychological Screening Test.

balance between sensitivity and specificity. The 3 scales all showed a similar diagnostic efficiency.

DISCUSSION

The article evaluated the diagnostic efficiency of a range of symptom combination scoring rules when screening for PTSD. The scoring rules were selected on the basis of a recent review (Brewin, 2005) and further criteria suggested in recent studies, and were applied to the PDS (Foa et al., 1997). The average performance of screening instruments for PTSD identified in Brewin's (2005) review guided this evaluation. Of the 18 scoring rules tested for the detection of current chronic PTSD, only 3 showed a mean performance across samples that was comparable to the mean results reported by Brewin (2005) and led to a fulfillment of the minimum quality standards of an overall diagnostic efficiency of 80%

and sensitivities and specificities of 0.75 in samples 1 to 4. These were a PDS total scale cutoff of 18 (Foa et al., 1997), the symptom cluster scoring plus a total scale cutoff of 18 (Foa, 1998), and a new 8-item PDS subscale comprised of the most predictive PDS items. Although the TSQ scoring rule did not perform well with the original cutoff of 6 (Brewin et al., 2002), a new cutoff of 3 was identified in ROC analyses that performed as well as the 2 PDS scoring rules using the cutoff of 18. The SPAN (Meltzer-Brody et al., 1999), the BPTSD-6 (Fullerton et al., 2000), and the symptom cluster scoring method (Foa, 1995) yielded a mean performance across samples that was comparable to the average performance of screening instruments in Brewin's (2005) review, but failed to fulfill minimum quality standards in 1 sample each. The symptom cluster scoring plus the total scale cutoff of 18 and the new 8-item PDS subscale replicated best among all scoring rules in sample 5. Because of the low base rate of PTSD in samples 1 to 4, which is not uncommon in screening situations, PPP was low for most scores when compared with the original reports and the average performance of PPP = 0.70 in Brewin's (2005) review. However, the best replicated scoring rules had acceptable PPPs of between 0.65 and 0.77 in samples 1 to 4 (average 0.71), and PPPs = 0.85 and 0.86 in sample 5, which had a higher base rate. Thus, these scoring rules performed well overall.

The study also considered another potentially important application of screening instruments, namely the early identification of people at risk for chronic PTSD. Only very few studies to date have evaluated PTSD screening measures for this purpose. When applying the different symptom combination scoring rules to predict future PTSD in our samples, sensitivities and specificities were considerably lower than when screening for current PTSD, and the minimum quality standards were not fulfilled for any of the scores. In addition, ROC analyses indicated somewhat higher cutoffs than those identified for the prediction of concurrent PTSD. This result is plausible as PTSD symptoms show natural recovery, especially in the initial months after trauma (Rothbaum et al., 1992). The best results in predicting future PTSD were found for the PDS total score of 20 and the symptom cluster scoring plus total scale cutoff of 20, replicating earlier analyses by Ehlers et al. (2003) that this cutoff was best in assessing need for treatment in MVA survivors. The new 8-item subscale also performed relatively well. These scoring rules also replicated well in sample 5. Depending on the base rate of PTSD in the samples, PPP ranged from 0.43 to 0.51 in the low base rate samples 1 to 4, and a PPP of 0.82 to 0.83 in the high base rate sample 5.

Overall, not surprisingly, scoring rules that used all 17 DSM-IV symptoms of PTSD generally performed better overall than those based on a smaller number of symptoms. The most likely explanation for this finding is the reduction of measurement error with longer scales. Furthermore, scores based on symptom severity ratings (e.g., total severity scores) generally performed better than scores based on mere symptom presence or absence. The scoring rules that are based on very few symptoms such as the DRPST and the Lang and Stein scores did not perform well and thus cannot be recommended for general application. Among the short measures, the SPAN, BPTSD-6, TSQ, and the new 8-item PDS subscale warrant further research.

In sum, most symptom combination scoring rules performed less well in our samples than in the original reports in identifying people with PTSD and there was substantial variation as to what score performed best in each sample. There are several possible reasons for this discrepancy. First, most earlier studies established cutoffs post-hoc and usually without cross-validation. This may have inflated the reported sensitivities and specificities. The present results thus underline the importance of replication and cross-validation when evaluating the performance of screening instruments for PTSD. Second, sample characteristics may have influenced the results. Participants in the present studies were tested mainly in the first year after a trauma, whereas most of the earlier reports were based on more chronic samples of trauma survivors. It may be more difficult to establish specificity in screening for recent-onset PTSD than for very chronic PTSD, as most trauma survivors initially show some posttraumatic stress symptoms. Furthermore, it remains to be tested whether the type of traumatic event or certain demographic or cultural variables may also be of importance.

Screening programs in different settings have different requirements, and will thus weigh some of the diagnostic efficiency criteria higher than others. For example, one may wonder whether or not to use the symptom cluster scoring criterion in addition to the overall cutoff on the PDS (18 for concurrent, 20 for future PTSD). Screening programs that aim to identify people in need of treatment among large populations of trauma survivors will usually be faced with low rates of PTSD, and it will be important not to miss survivors that may need treatment. In this scenario, sufficiently high sensitivities and NPP will be most important. Here, the simple total score cutoff may be preferable as it yielded somewhat better sensitivities. In treatment-seeking populations, however, it will be more important to determine whether a PTSD treatment program is appropriate or whether the patient seeks treatment for another disorder such as depression or phobia. In these samples, specificity and positive predictive values are important criteria for the usefulness of the screening instrument. Specificities in sample 5, which included respondents interested in a treatment program, were generally lower than in the other samples, which largely comprised nontreatment-seeking trauma survivors. In this scenario, it will usually be preferable to combine the symptom cluster scoring with the total score cutoff, as this method gave somewhat better sensitivities.

Future research will also have to critically evaluate the costs and benefits of producing short screening scales for PTSD. The 17-item PDS and similar PTSD symptom scales that are based on DSM-IV are economical and can be completed in less than 15 minutes. There may be a lower limit for the number of symptoms needed to obtain reliable diagnostic information as very short scales of 4 to 6 items generally did not perform well in our samples (with the possible exception of the SPAN). On the other hand, it has been argued that screening instruments should only comprise the minimum

number of items necessary for the identification of cases as short instruments are more likely to be successfully implemented in medical or primary care contexts (Brewin, 2005).

The present study had several limitations. First, the symptom combination scoring rules were all applied to a single instrument, the PDS (Foa et al., 1997). Some of the screening measures on which our analyses were based (SPAN, BPTSD-6, Lang and Stein's scales) were originally derived from other measures of PTSD symptom severity, e.g. the Impact of Event Scale or the Davidson Trauma Questionnaire. Although the content of the items is identical (as all scales assess the same PTSD symptoms), the wording of items was somewhat different so that results cannot be seen as a direct replication. Second, only symptom scoring rules that could be applied to the PDS were included in this study. Other screening measures, i.e., 6 of the instruments identified in Brewin's (2005) review, could not be included. Third, only 2 types of trauma victims were studied, namely MVA and assault survivors. It therefore remains to be tested whether the results obtained in these samples replicate to other types of trauma survivors. In addition, differences between the types of injuries included in our samples versus the original studies might account for some of the failures to replicate positive findings in this study. The role of the type of trauma experienced as well as demographic and cultural characteristics should receive more attention in future research, which might lead to the development of more specifically tailored screening criteria for different populations.

CONCLUSIONS

In conclusion, the study suggested that if the full PDS can be given, the symptom cluster scoring plus cutoffs of 18 and 20 performed best in predicting current and future PTSD, respectively. None of the shorter symptom combinations under investigation can be recommended as a gold standard without further evaluation because this study found lower diagnostic efficiencies than the original studies. Nevertheless, the SPAN, BPTSD-6, TSQ, and the new 8-item PDS subscale should be studied further so that the best cutoffs can be identified. It seems important to test the performance of screening instruments in samples with different base rates of PTSD, types of trauma, as well as cultural and demographic characteristics, before they are applied widely.

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