Association of Symptoms Following Mild Traumatic Brain Injury With Posttraumatic Stress Disorder vs Postconcussion Syndrome

Emmanuel Lagarde, PhD; Louis-Rachid Salmi, MD, PhD; Lena W. Holm, DrMedSc; Benjamin Contrand, MPH; Françoise Masson, MD; Régis Ribéreau-Gayon, MD; Magali Laborey, PhD; J. David Cassidy, PhD, DrMedSc

IMPORTANCE A proportion of patients experience long-lasting symptoms following mild traumatic brain injury (MTBI). The postconcussion syndrome (PCS), included in the DSM-IV, has been proposed to describe this condition. Because these symptoms are subjective and common to other conditions, there is controversy whether PCS deserves to be identified as a diagnostic syndrome.

OBJECTIVE To assess whether persistent symptoms 3 months following head injury are specific to MTBI or whether they are better described as part of posttraumatic stress disorder (PTSD).

DESIGN, SETTING, AND PARTICIPANTS We conducted a prospective cohort study of injured patients recruited at the adult emergency department of the University Hospital of Bordeaux from December 4, 2007, to February 25, 2009.

MAIN OUTCOMES AND MEASURES At 3-month follow-up, we compared the prevalence and risk factors for PCS and PTSD. Multiple correspondence analyses were used to assess clustering of symptoms and their associations with the type of injury.

RESULTS We included 534 patients with head injury and 827 control patients with other nonhead injuries. Three months following the trauma, 21.2% of head-injured and 16.3% of nonhead-injured patients fulfilled the DSM-IV diagnosis of PCS; 8.8% of head-injured patients fulfilled the diagnostic criteria for PTSD compared with 2.2% of control patients. In multivariate analysis, MTBI was a predictor of PTSD (odds ratio, 4.47; 95% CI, 2.38-8.40) but not of PCS (odds ratio, 1.13; 95% CI, 0.82-1.55). Correspondence analysis suggested that symptoms considered part of PCS behave similarly to PTSD symptoms in the hyperarousal dimension. None of these 22 symptoms showed any pattern of clustering, and no clear proximity with head or nonhead injury status could be found.

CONCLUSIONS AND RELEVANCE Persistent subjective symptoms frequently reported 3 months after MTBI are not specific enough to be identified as a unique PCS and should be considered part of the hyperarousal dimension of PTSD.
Mild traumatic brain injury (MTBI), or concussion, accounts for more than 90% of all TBIs and affects more than 600 of every 100,000 adults each year.1 Yet, we know little about the course and prognosis of this condition. This creates challenges for clinicians who are asked by insurance companies to determine whether persistent symptoms are attributable to the injury. Furthermore, there is little evidence about how to manage persistent post-concussion symptoms or what clinical resources should be allocated to this problem.

The term postconcussion syndrome (PCS) was coined to describe the occurrence of persistent subjective symptoms.2-5 The proportion of MTBI patients with PCS 1 year after trauma has been estimated to be from 10% to 20%.4,5 Several diagnostic criteria have been proposed for PCS. The DSM-IV,6 the International Statistical Classification of Diseases, 10th Revision (ICD-10),7 and the Rivermead Post Concussion Symptoms Questionnaire (RPQ)8 are the most commonly used diagnostic criteria. The latter is the only one that takes into consideration symptom severity. However, the choice of the diagnostic criteria results in major differences in the frequency of PCS in particular between the ICD-10 and DSM-IV.9

All symptoms cited as being potentially part of PCS belong to 3 domains: cognitive, somatic, and emotional.10-31 In a previous analysis, we showed that several of these symptoms were occurring more often among patients with MTBI than among patients with other injuries but the specificity remained low.10 Therefore, it is still a pending issue to decide whether those symptoms should be considered a syndrome, which is the association of several clinically recognizable features that more often occur together in a particular clinical context. Thus, the sufficient and necessary conditions for PCS would be: (1) occurring together more often than separately after concussion and (2) occurring more often after concussion than after any other traumatic event.

The interpretation of persistent symptoms after an MTBI should also take into consideration that injuries are often sustained during a psychologically distressing event. This can lead to a constellation of specific and persistent symptoms known as posttraumatic stress disorder (PTSD). This anxiety disorder may occur when a traumatic event, outside the range of usual human experience, is endured, resulting in intense fear and terror during a state of helplessness.12 Factor analysis shows that PTSD symptoms are grouped into 3 clusters that are considered 3 separate diagnostic criteria in the DSM-IV: (1) intrusion (ie, reexperiencing the event), (2) persistent avoidance and emotional numbing, and (3) increased arousal. More recent research13 suggests that avoidance and numbing are in fact 2 separate dimensions, which led to splitting these criteria into 2 separate ones in the DSM-5.

Postconcussion syndrome and PTSD share symptoms that belong to the PTSD hyperarousal dimension (eTable 1 in the Supplement). Even when overlapping symptoms are removed from the PTSD score, the association between PCS and PTSD remains strong, as was observed in studies from the United States14 and in UK veterans.15 Mild traumatic brain injury and PTSD are certainly closely related; however, the nature of their interaction remains to be better understood in particular in the civilian population where much fewer data are published and for which trauma experiences differ greatly from military blasts.

We conducted a prospective cohort study of injured patients recruited from the emergency department (ED) of the University Hospital in Bordeaux, France. Our aim was to test the hypothesis that persistent symptoms 3 months following a traumatic event could be regrouped in a syndrome specific to MTBI or concussion and to assess whether they would be already captured in 1 or more dimensions of PTSD.

Methods

Study Design and Population

Patients with mild traumatic injury, attending the adult ED of the University Hospital in Bordeaux, were consecutively included in a prospective cohort study from December 4, 2007, to February 25, 2009.16 The adult ED of this hospital treats 48,000 patients annually including 2500 with traumatic head injuries. This study site was also the tertiary neurosurgical center in a region of more than 3 million inhabitants. Written informed consent was obtained from all participants and, for participants aged 17 years or younger, written informed consent was obtained from a least 1 parent. The Comité de Protection des Personnes Sud-Ouest et Outre Mer III approved the protocol.

Selection of Participants

Patients aged 15 years or older with MTBI (MTBI group) or other mild traumatic injuries not related to the head (nonhead-injury group) were eligible to participate. Patients who had a head shock or a head wound but no severity criterion were excluded.

Mild traumatic brain injury was defined as an acute brain injury, resulting from mechanical energy to the head from external physical forces that (1) resulted in 1 or more of the following severity criteria: confusion or disorientation, loss of consciousness for 30 minutes or less, posttraumatic amnesia for less than 24 hours, or other transient neurological abnormalities such as focal signs, seizure, or intracranial lesion not requiring surgery and (2) had a Glasgow Coma Scale score between 15 and 13 at admission in the ED.

Recommended by the World Health Organization Collaborating Task Force, this definition is derived from recommended criteria of the Centers for Disease Control and Prevention MTBI Work Group and the American Congress of Rehabilitation Medicine.17

With regard to the nonhead-injury group, mild traumatic injury was defined as an injury with an Abbreviated Injury Score (AIS) between 0 and 2. That included patients with sprains, contusions, or fractures (except for a femoral fracture). Patients with intrathoracic or intraabdominal injuries were not considered for inclusion.

Trauma patients were excluded if they presented to the ED more than 24 hours after the event; if a severe injury was also
suspected (AIS >2); or if they had a nontraumatic neurologic disease, history of motor neuron disease, or a cerebral vascular accident.

Exclusion criteria for the follow-up were not living in France, being homeless, not speaking French, or being unable to answer the questionnaire for medical reasons.

Data Collection
Before enrollment of trauma patients, a medical examination was performed by an emergency physician in the routine context of care provided at the ED. Medical records were completed by the physician in charge, at the time of inclusion, and 6 and 24 hours after admission. Records included information about neurologic findings, level of consciousness, demographic characteristics, associated medical conditions, usual medications, circumstances of the trauma, and associated injuries.

During their stay in the ED, patients were interviewed using a brief questionnaire (ie, baseline questionnaire) on their quality of life and on preinjury symptoms.

Patients were interviewed at 3 months after their injury (ie, follow-up questionnaire) using telephone interviews to collect information on their health status and symptoms. Selected symptoms were those proposed as potential PCS symptoms in the DSM-IV, the ICD-10, and the RPQ, which includes 22 emotional, cognitive, behavioral, and physical symptoms. The severity of each symptom was self-reported on a 5-point Likert scale (0 = none to 4 = severe).

Statistical Analysis
Postconcussion syndrome was determined using 4 definitions each including a subset of the 22 symptoms (eTable 1 in the Supplement) including DSM-IV and ICD-10 diagnostic criteria, the RPQ criteria, and a definition including 8 symptoms identified to be specific to MTBI in the present data set10; difficulty concentrating, headache, dizziness, personality change, forgetfulness, taking longer to think, blurred vision, and problems tolerating stress. The RPQ criteria for PCS were defined as the report of at least 3 symptoms with a severity more than 2. The criteria for the diagnosis of DSM-IV PCS and ICD-10 PCS were defined as the report of at least 3 symptoms. We also proposed a fourth definition including all symptoms out of the 8 found to be specific to MTBI in the same sample.10 In this latter case, PCS was defined as having at least 4 of those 8 symptoms, and a threshold was identified comparing the number of symptoms and their self-reported impact assessment on everyday life.

Posttraumatic stress disorder was assessed using DSM-IV criteria based on exposure to a traumatic event resulting in fear, helplessness, or horror (criterion A); persistent reexperiencing of the event (ie, ≥1 symptom) (criterion B); avoidance of stimuli associated with the event (ie, ≥4 symptoms) (criterion C); and persistent symptoms of increased arousal (ie, ≥2 symptoms) (criterion D) (Table 1 in the Supplement). To be part of PTSD, symptoms had to be present for at least 1 month (criterion E) and result in clinically significant distress or functional impairment (criterion F). All potential symptoms, reported after the injury at the ED or during telephone interviews 3 months later, were assessed using a standardized questionnaire and not a clinical interview. Consequently, criteria A and F were not included in the PTSD definition because it is not possible to rely on subjective self-reports for these items. In addition, no cognitive testing was performed.

To be classified as having PCS, the patient’s symptoms had to fulfill 2 criteria: (1) they form the combination of symptoms that are the most specific to head trauma and (2) they are associated (ie, they occur together).

To assess these properties, the proportion of participants meeting the criteria of each of the 4 PCS definitions and the PTSD definition at 3 months postinjury were tabulated separately for head- and nonhead-injured participants. Determinants of DSM-IV PCS and PTSD were assessed and compared. Potential associated factors were collected in the ED and were related to the preinjury period, to the patient’s sociodemographic status, and to their current symptoms including severity criteria and head-injury severity proxies for patients with MTBI (eg, positive head imaging scan, Glasgow Coma Scale score, and S-100 B protein serum levels). Factors were selected with backward-selection logistic regression modeling. Interactions between variables were tested. The Hosmer-Lemeshow test was used to assess goodness of fit of all final multivariate models.

To check for symptom patterns, 3-month symptom occurrence and injury type (ie, MTBI or non-MTBI) were analyzed by multiple correspondence analysis to graphically assess potential clustering (expressed as the distance of symptoms to the axes intersection) and associations (expressed as angular proximity of symptoms). All statistical analyses were performed using SAS statistical software package version 9.3 (SAS Institute Inc).
Results

Inclusion Procedure and Population

Of the 2597 patients asked to participate, 255 were excluded because they had a history of cerebral vascular accident, neurological disease, or severe head trauma (Glasgow Coma Scale score <13) (Figure 1). An additional 199 did not complete the baseline questionnaire because they refused to continue in the study (n = 51) or could not answer any questions (n = 148). Of the 2143 participants who completed the baseline questionnaire, 1479 could be reached for interview at follow-up including 1361 who answered all questions related to PTSD and postconcussion symptoms. Among them, 534 had an MTBI at recruitment and 827 had another minor injury. The most frequent other injuries among patients with MTBI were located on the face (n = 118), skin (n = 97), and lower limbs (n = 38). In the nonhead-injury group, the most frequent injuries were located on the lower

<table>
<thead>
<tr>
<th>Table 1. Comparison of Included and Lost to Follow-Up Patient Characteristics and Preinjury Symptoms as Reported at the Emergency Departmenta</th>
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</thead>
<tbody>
<tr>
<td>Characteristic</td>
</tr>
<tr>
<td>Patient Characteristics</td>
</tr>
<tr>
<td>No. of patients</td>
</tr>
<tr>
<td>Age</td>
</tr>
<tr>
<td>15-39 y</td>
</tr>
<tr>
<td>40-69 y</td>
</tr>
<tr>
<td>&gt;69 y</td>
</tr>
<tr>
<td>Male</td>
</tr>
<tr>
<td>Causal event</td>
</tr>
<tr>
<td>Assault</td>
</tr>
<tr>
<td>Road crash</td>
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<tr>
<td>Fall</td>
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<tr>
<td>Other</td>
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<tr>
<td>MTBI</td>
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<tr>
<td>Nonhead trauma with AIS = 2b</td>
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<tr>
<td>Symptoms</td>
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<tr>
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<td>Convulsion</td>
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<tr>
<td>Amnesia</td>
</tr>
<tr>
<td>Confusion</td>
</tr>
<tr>
<td>Neurologic abnormalities</td>
</tr>
</tbody>
</table>

Abbreviations: AIS, Abbreviated Injury Score; MTBI, mild traumatic brain injury; NS, not significant.
a N = 2342.
b Patients with injuries with AIS greater than 2 were not eligible for the study.

Table 2. Causal Event in Head and Nonhead Injurya

<table>
<thead>
<tr>
<th>Variable</th>
<th>Head Injury</th>
<th>Nonhead Injury</th>
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<tbody>
<tr>
<td>Total No.</td>
<td>534</td>
<td>827</td>
</tr>
<tr>
<td>Assault</td>
<td>10.5</td>
<td>2.3</td>
</tr>
<tr>
<td>Road crash</td>
<td>23.8</td>
<td>15.5</td>
</tr>
<tr>
<td>Fall</td>
<td>50.4</td>
<td>33.7</td>
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<tr>
<td>Blunt object</td>
<td>8.8</td>
<td>14.2</td>
</tr>
<tr>
<td>Cutting object</td>
<td>0.2</td>
<td>12.7</td>
</tr>
<tr>
<td>Other</td>
<td>6.4</td>
<td>21.6</td>
</tr>
</tbody>
</table>

*a N = 1361.

Table 3. Proportion of Participants With PTSD and PCS at the 3-Month Follow-up

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Head Injury (n = 534)</th>
<th>Nonhead Injury (n = 827)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PCS</td>
<td></td>
<td></td>
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<tr>
<td>Rivermead*</td>
<td>28.7</td>
<td>22.9</td>
</tr>
<tr>
<td>DSM-IV*</td>
<td>21.2</td>
<td>16.3</td>
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<tr>
<td>ICD-10*</td>
<td>53.4</td>
<td>43.1</td>
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<tr>
<td>Laborey*</td>
<td>27.5</td>
<td>14.9</td>
</tr>
<tr>
<td>PTSD DSM-IV*</td>
<td>8.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Intrusion</td>
<td>33.7</td>
<td>25.2</td>
</tr>
<tr>
<td>Avoidance</td>
<td>20.4</td>
<td>6.9</td>
</tr>
<tr>
<td>Hyperarousal</td>
<td>24.7</td>
<td>18.5</td>
</tr>
</tbody>
</table>

Abbreviations: ICD-10, International Statistical Classification of Diseases, 10th Revision; PCS, postconcussion syndrome; PTSD, posttraumatic stress disorder.
* Symptoms included in the PCS and PTSD definitions are listed in eTable 1 in the Supplement. The Rivermead Post Concussion Symptoms Questionnaire PCS was defined as the report of at least 3 symptoms with a severity of greater than 2 on a scale from 0 to 4. The DSM-IV PCS and ICD-10 PCS were defined as the report of at least 3 symptoms. Laborey PCS was defined as the report of at least 4 symptoms. Posttraumatic stress disorder was assessed using DSM-IV criteria: exposure to a traumatic event resulting in fear, helplessness, or horror (criterion A); persistent reexperiencing of the event (criterion B); avoidance of stimuli associated with the event (criterion C); and persistent symptoms of increased arousal (criterion D).
limbs (n = 292), upper limbs (n = 285), and skin (n = 84). Other body parts represented fewer than 30 of all injuries.

Assessment of a Potential Selection Bias
In comparison with those included (n = 1361), patients who did not participate (n = 981) were older, male, more likely to be in the head-injury group, and victims of assault (Table 1). The proportions with nonhead trauma AIS score 2 injuries were similar in the 2 groups. Half of the head injuries were caused by falls and one-fourth by road crashes. One-third of nonhead injuries were caused by falls (Table 2).

Prevalence of PCS and PTSD
At 3 months following the trauma, the prevalence of PCS varied, largely depending on which definition was used (Table 3), from 21.2% to 53.4% among head-injured patients and from 14.9% to 43.1% among control patients. At the same interview, 8.8% of head-injured patients fulfilled the diagnostic criteria for PTSD compared with 2.2% of control patients. Among the 3 DSM-IV dimensions of PTSD, the greatest contrast between MTBI and nonhead-injured patients was observed for the avoidance dimension (20.4% vs 6.9%).

MTBI as a Strong Predictor of PTSD But Not of PCS
In the multivariate analysis, MTBI appeared to be a predictor of PTSD (odds ratio, 4.47; 95% CI, 2.38-8.40) and not of PCS (odds ratio, 1.13; 95% CI, 0.82-1.55) (Table 4). Women were more likely than men to report PTSD and PCS. Assault was a strong predictor of PTSD (odds ratio, 5.00; 95% CI, 1.88-13.28). Weaker predictors of PTSD were road crash and nonhead-injury AIS score of 2. Weaker predictors of PCS were assault and previous poor health. Amnesia was not a predictor of PCS or PTSD. The prevalence of PTSD in the MTBI group was 8.6% among the 325 patients with amnesia at admission and 9.1% in those without it.

Assessment of Symptom Clustering
Symptoms suggested as part of PCS clustered similarly in the correspondence analysis as the PTSD symptoms of hyperarousal (Figures 2 and 3). All 22 symptoms did not show any
pattern of clustering and no clear proximity with the head- or nonhead-injury status. The 2 other PTSD dimensions behaved differently. Symptoms of the avoidance dimension clustered close to head-injured patients when projected on dimension 3, except for avoidance of places and thoughts, while those of the intrusion dimension were close to nonhead-injured patients on the same dimension (Figure 3). In the avoidance dimension, “inability to recall an important aspect of the trauma” clustered in proximity with head injury on all 3 dimensions, as it is 1 of the criteria to define an MBTI (ie, amnesia). Finally, avoidance (ie, places and thoughts) PTSD symptoms clustered separately from numbing PTSD symptoms.

**Discussion**

We reported on 1361 injured patients recruited in an adult ED and followed up for 3 months. At follow-up, 21.2% of head-injury and 16.3% of nonhead-injury patients fulfilled the DSM-IV diagnosis for PCS. However, the contrast was greater for PTSD, which was present in 8.8% of patients with MTBI and 2.2% nonhead-injured patients. This result could not be explained by different causal events in the adjusted multivariate analyses; MTBI was a predictor of PTSD but not of PCS. Correspondence analysis showed that the symptoms of PCS behave similarly to PTSD symptoms of the hyperarousal dimension. None of these 22 symptoms show any pattern of clustering and no clear proximity with the variable indicating head- or nonhead-injury status.

We found 5 studies following up patients for 3 months or more that included a control group of patients with other injuries.19-23 All of them concluded that PCS symptoms did not appear to be specific to patients with MTBI. This was also one of the conclusions of the recently published systematic review by the International Collaboration on MTBI Prognosis.24 The authors noted that initial health status and psychological distress determine recovery to a greater extent than the type of injury (eg, MTBI vs other minor injuries). A study we conducted on the same data set showed that only 8 PCs symptoms were slightly more frequent among head-injured than among nonhead-injured patients.10 Finally, there is no rationale for the list of postconcussion symptoms proposed in the ICD-10, DSM-IV, or RPQ. Three of the 5 symptoms from the hyperarousal PTSD dimension are part of at least 1 of the symptom lists proposed for the diagnosis of PCS. For a proposed list of symptoms constitutive of a syndrome, a necessary condition is that they aggregate together. We observed that PCS symptoms and hyperarousal PTSD symptoms showed less clustering than symptoms of the intrusion and avoidance PTSD dimensions. The combi-
nation of weak specificity and no clear aggregation of symptoms led us to question the concept of PCS.

The psychological distress experienced during the injury event is a trigger for PTSD. In this respect, our finding of a 5-fold increase in PTSD risk among patients who had been assaulted is consistent with the literature and the underlying assumptions of PTSD causation. To a lesser extent, assault was also a predictor of the DSM-IV criteria for PCS, while available head-injury severity proxies (ie, positive scan finding, Glasgow Coma Scale score, and S-100 B protein serum levels) were not. This suggests that psychological stress, and not potential brain injury, causes these symptoms, reinforcing the idea that they should be considered part of PTSD and not PCS.

As shown in our multiple-component analysis, the inability to recall an important aspect of the trauma is a symptom strongly associated with MTBI. This is not surprising as one of the criteria for MTBI can be anterograde amnesia, and the relevance of including this symptom into the PTSD criteria definition should be questioned for patients with head trauma. Our results also found that amnesia induced by MTBI is not a protective factor for PTSD; amnesia was not a predictor in our multivariate model and the prevalence of PTSD in the MTBI group was not lower among 325 patients with amnesia. On the contrary, MTBI appeared to be the strongest predictor of PTSD, even when we adjusted for the causal event. We also showed elsewhere that head-trauma severity, as measured by admission Glasgow Coma Scale score, computed tomographic scan results, or S-100 B blood level, does not determine the risk for PTSD.10 This supports a scenario in which head injury is often a stressful event for which amnesia or other neurologic perturbations do not decrease the risk for PTSD. The criterion of avoidance and numbing is now split into 2 criteria in the new DSM-5: avoidance and negative alterations in cognition and mood to comply with the King et al25 model, which was suggested in 1998 and discussed since this work.13,26 This is perfectly reflected in the particular behavior of the 2 avoidance items available in our study, none of them appearing to cluster with other symptoms.

Our study was conducted in an ED where data collection is often impeded by unexpected events, leading to a substantial number of patients with missing data and, therefore, potential selection bias. Furthermore, 31% of the patients were lost to follow-up (ie, 664 of 2143 who completed the initial questionnaire) and a further 118 were contacted at 3 months but did not complete the questionnaire. As expected, patients older than 69 years of age were more likely to be lost to follow-up, which has the consequence of modifying the distribution of injury events in the study sample. In particular, the proportion of those with road crash was higher among those included in the study. This also explains why more head-injury patients were lost to

![Figure 3. Multiple Correspondence Analysis of Dimensions 1 and 3](image-url)

Two-dimensional projection of the variable coordinates on dimension 1 (22.1% of explained inertia) and dimension 3 (4.8% of explained inertia). The circles represent the variable modalities for the absence of the symptom. The filled symbols for postconcussion syndrome (PCS), avoidance, and intrusion represent the variable modalities for the presence of the symptom. InRecall indicates the inability to recall an important aspect of the trauma; MTBI, mild traumatic brain injury; Rest, restlessness. For full descriptions of the variables, see eTable 1 in the Supplement.
follow-up than nonhead-injury patients because older patients were more likely to be in the MTBI group. Similarly, those lost to follow-up were generally more likely to report any type of pre-injury symptoms (data shown in eTable 2 in the Supplement). This may have introduced selection bias if nonparticipants also were more likely to develop the outcome compared with participants who reported preinjury symptoms. By controlling for selection factors and, in particular, for age, we believe we reduced this bias. Another limitation was that the diagnosis of PTSD could not be made using a formal clinical examination. This led us to exclude criterion F from the DSM-IV PTSD definition. It should be noted that the preinjury symptoms that were necessary to assess PTSD criterion D (arousal increased compared with the preinjury period) were all reported at baseline immediately after the traumatic event. Therefore, it is possible that the prevalence of these symptoms may have been altered by patients’ stress levels. Similarly, it has been shown that premorbid symptoms reported during the emergency stay were more frequent than when answers were obtained 1 month later.27,28 Thus, it is often recommended to obtain preinjury information as soon as possible after the injury. In our study, the questionnaire was filled in at the ED, generally while the patient was waiting for radiological examination.

Another potential limitation warrants discussion. Symptoms of PCS and PTSD were measured in reference to 1 traumatic event, namely that leading to ED presentation. An unknown proportion of participants may have previously experienced other events that may have explained both pre-event and postevent symptoms. Adding prior trauma(s) in the equation would have been useful to identify those patients with past traumatic events but these data were only available for previous head injuries.

**Conclusions**

This prospective study of the 3-month PCS and PTSD symptoms of mild head- and nonhead-injured patients recruited at the ED showed that the rationale to define a PCS that is specific to head-trauma patients is weak. Our results also suggested that the misunderstanding related to the relevance of defining such a syndrome could be explained by the overlapping pattern with symptoms of the PTSD hyperarousal dimension. Further use of PCS in head-injury patients has important consequences in terms of treatment, insurance resource allocation, and advice provided to patients and their families. Available evidence does not support further use of PCS. Our results also stressed the importance of considering PTSD risk and treatment for patients with MTBI.

**ARTICLE INFORMATION**

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**Author Affiliations:** INSERM, ISped, Centre INSERM U897-Epidemiologie-Biostatistique, Equipe Prévention et Prise en Charge des Traumatismes F-33000, Bordeaux, France (Lagarde, Salmi, Masson, Ribéreau-Gayon, Laborey); Université Bordeaux, ISped, Centre INSERM U897-Epidemiologie-Biostatistique, F-33000, Bordeaux, France (Lagarde, Salmi, Contrand, Laborey); CHU de Bordeaux, Pole de santé publique, Service d’information medicale, F-33000, Bordeaux, France (Salmi); Division of Epidemiology, Institute of Environmental Medicine, Karolinska Institutet, Stockholm, Sweden (Holm); CHU de Bordeaux, Pole d’Anesthésie Réanimation, F-33000, Bordeaux, France (Masson); CHU de Bordeaux, Pole de Médecine, F-33000, Bordeaux, France (Ribéreau-Gayon); Institute of Sports Science and Clinical Biomechanics, Faculty of Health, University of Southern Denmark, Odense, Denmark (Cassidy); Division of Health Care and Outcomes Research, Toronto Western Research Institute, University Health Network, University of Toronto, Ontario, Canada (Cassidy); Division of Epidemiology, Dalla Lana School of Public Health, University of Toronto, Toronto, Ontario, Canada (Cassidy); Institute of Health Policy, Management and Evaluation, Faculty of Medicine, University of Toronto, Ontario, Canada (Cassidy).

**Author Contributions:** Dr Lagarde had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Lagarde, Salmi, Masson, Ribéreau-Gayon, Laborey. Acquisition, analysis, or interpretation of data: Lagarde, Salmi, Holm, Contrand, Ribéreau-Gayon, Laborey, Cassidy. Drafting of the manuscript: Lagarde, Masson, Laborey. Critical revision of the manuscript for important intellectual content: All authors. Statistical analysis: Contrand, Laborey, Cassidy. Obtained funding: Lagarde, Salmi, Ribéreau-Gayon. Administrative, technical, or material support: Ribéreau-Gayon. Study supervision: Lagarde, Masson.

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**REFERENCES**


