See commentary by Friedman p1190

Longitudinal Analysis of Latent Classes of Psychopathology and Patterns of Class Migration in Survivors of Severe Injury

David Forbes, PhD; Angela Nickerson, PhD; Nathan Alkemade, PhD; Richard A. Bryant, PhD; Mark Creamer, PhD; Derrick Silove, MD, FRANZCP; Alexander C. McFarlane, MD, FRANZCP; Miranda Van Hooff, PhD; Susan L. Fletcher, PGDip(Psych); and Meaghan O'Donnell, PhD

ABSTRACT

Objective: Little research to date has explored the typologies of psychopathology following trauma, beyond development of particular diagnoses such as posttraumatic stress disorder (PTSD). The objective of this study was to determine the longitudinal patterns of these typologies, especially the movement of persons across clusters of psychopathology.

Method: In this 6-year longitudinal study, 1,167 hospitalized severe injury patients who were recruited between April 2004–February 2006 were analyzed, with repeated measures at baseline, 3 months, 12 months, and 72 months after injury. All patients met the *DSM-IV* criterion A1 for PTSD. Structured clinical interviews were used to assess psychiatric disorders at each follow-up point. Latent class analysis and latent transition analysis were applied to assess clusters of individuals determined by psychopathology. The Mini International Neuropsychiatric Interview (MINI) and Clinician-Administered PTSD Scale (CAPS) were employed to complete diagnoses.

Results: Four latent classes were identified at each time point: (1) Alcohol/Depression class (3 months, 2.1%; 12 months, 1.3%; and 72 months, 1.1%), (2) Alcohol class (3 months, 3.3%; 12 months, 3.7%; and 72 months, 5.4%), (3) PTSD/Depression class (3 months, 10.3%; 12 months, 11.5%; and 72 months, 6.4%), and (4) No Disorder class (3 months, 84.2%; 12 months, 83.5%; and 72 months, 87.1%). Latent transition analyses conducted across the 2 transition points (12 months and 72 months) found consistently high levels of stability in the No Disorder class (90.9%, 93.0%, respectively) but lower and reducing levels of consistency in the PTSD/Depression class (81.3%, 46.6%), the Alcohol/Depression class (59.7%, 21.5%), and the Alcohol class (61.0%, 36.5%), demonstrating high levels of between-class migration.

Conclusions: Despite the array of psychiatric disorders that may develop following severe injury, a 4-class model best described the data with excellent classification certainty. The high levels of migration across classes indicate a complex pattern of psychopathology expression over time. The findings have considerable implications for tailoring multifocused interventions to class type, as well as flexible stepped care models, and for the potential development and delivery of transdiagnostic interventions targeting underlying mechanisms.

J Clin Psychiatry 2015;76(9):1193–1199
dx.doi.org/10.4088/JCP.14m09075

Submitted: February 20, 2014; accepted July 14, 2014.
Online ahead of print: April 14, 2015.
Corresponding author: David Forbes, PhD, Australian Centre for Posttraumatic Mental Health, Department of Psychiatry, The University of Melbourne, Level 3, Alan Gilbert Building, 161 Barry St, Carlton VIC 3053, Australia (dforbes@unimelb.edu.au).

Epidemiologic studies report that most people are exposed to at least 1 potentially traumatic event in their lifetime.[1–3] These events are implicated in the development of an array of psychopathological outcomes, most commonly posttraumatic stress disorder (PTSD) and depressive, anxiety, and substance use disorders.[4–7] Furthermore, these studies report high levels of co-occurrence across disorders in people affected by trauma. However, as these studies examine the classification of disorders rather than the unification of people with similar psychiatric profiles, little is known about the manner in which patterns of these disorders differ across the trauma-exposed population. From a longitudinal perspective, while studies examining classes of adjustment following trauma have been conducted, these, too, have focused on a single disorder as the outcome measure to define their classes.[8–11] Given the tendency to focus on a single disorder, a better understanding of how disorders naturally cluster has the potential to inform interventions that are multifocused, addressing an array of symptoms and diagnoses. Further, how the clustering of these disorders changes over time and the extent of migration between them have not previously been examined. From a clinical perspective, a better understanding of common presenting typologies, how they present and transform over time, and patterns of migration between them is critical in driving screening practices, intervention planning, and service modeling.

To investigate the presence of clinical typologies across disorders, we are best served by latent class analysis (LCA), which categorizes groups of individuals based on designated variables, such as individuals with similar psychopathological patterns.[12] To date, 3 studies have utilized LCA to examine the heterogeneity of psychopathology associated with PTSD specifically.[13–15] However, there is a need to map the typologies of presentations across the range of mental disorders following trauma.

Critical also is an improved understanding of the longitudinal course of identified classes, examining the degree to which the typologies are stable over time and, importantly, the patterns of migration of individuals over time between these classes. Latent transition analysis (LTA) provides information about the clustering of potential outcomes for individuals in each class at each time point and sheds light on the movement of persons across classes over time. This study used LCA to identify classes of psychopathology in survivors of severe injury at 3 months post injury, and again at 12 months and 72 months post injury. It then used LTA to examine the temporal stability and transitions of survivors between these classes from 3 months to 12 months and 12 months to 72 months posttrauma.

Clinical Points

- Despite the array of psychopathology evident after severe injury, 3 classes best represent the patterns of psychiatric disorders identified, with alcohol use and depression as important as posttraumatic stress disorder.
- There is a high level of migration across the classes over the years following injury, including into and out of the No Disorder class.
- The findings have implications for ongoing screening and assessment and the potential for multifocused interventions tailored to class of psychopathology.

METHOD

Participants were injury patients recruited from 4 hospitals in 3 states of Australia from April 2004–February 2006. All patients were admitted into the trauma service for at least 24 hours and met the *DSM-IV* Criterion A1 for PTSD. Patients were selected randomly from a pool of injury patients using a computerized random selection procedure. Inclusion criteria for patients were (1) having experienced a severe injury that required admission in the hospital for greater than 24 hours, (2) aged between 16–70 years, and (3) a reasonable comprehension of English. Patients were excluded if they had a traumatic brain injury (TBI) that was more severe than mild using the American Congress of Rehabilitation Medicine definition[16] or if they were currently suicidal or psychotic. Written informed consent was obtained from all participants who were recruited over an 18-month timeframe. The research was approved by the Human Research and Evaluation Committees (HREC) in each hospital.

Of the 1,590 patients eligible for the study, 1,167 participants consented to participate. At 3 months, 987 persons completed the questionnaires for this study; at 12 months, 862; and at 72 months, 613 completed the questionnaires. Those who refused to participate in the current study did not differ from participators in gender ($\chi^2_1 = 1.50$, N = 1,590, $P > .05$), length of hospital admission ($t_{1,571} = 0.92$, $P > .05$), or injury severity ($t_{1,571} = 1.46$, $P > .05$). At 12 months, only 1 significant difference was found when comparing demographic variables: those lost to follow-up were younger (mean = 35.1 years) than completers (mean = 38.9 years; $t_{970} = -3.157$, $P = .002$). At 72 months, age was again a significant factor, with the lost to follow-up group being younger (mean = 36.2 years) than the completers (mean = 40.3 years; $t_{847} = -4.181$, $P < .001$). A Bonferroni adjustment was applied when completing analyses on the outcome measures, with significance conservatively reset to $P < .01$ (ie, ≈ .05/8). At 12 months, those lost to follow-up were more likely to have been diagnosed with depressive disorder at 3 months compared with those who participated again at 12 months ($\chi^2_1 = 8.35$, N = 987, $P = .004$ [25% vs 15.4%, respectively]). All remaining outcomes were nonsignificant at 12 and 72 months.

At 3 months, the majority of participants were male (n = 729, 73.9%), with 43% of participants experiencing a TBI. On average, participants spent 12.4 days (SD = 12.9) in the hospital, and 14% of participants had an intensive care unit (ICU) admission. The principal mechanism of injury was transport accidents (65.9%); 16.1% experienced falls, 6.3% were assaults, and 6.6% other.

Measures

Posttraumatic stress disorder was assessed using the Clinician-Administered PTSD Scale (CAPS).[17] This structured clinical interview has demonstrated excellent reliability and validity[18] and is one of the most widely used tools for diagnosing PTSD.

The Mini-International Neuropsychiatric Interview version 5.5 (MINI)[19] is a structured diagnostic interview based on *DSM-IV* and *ICD-10* classifications of psychopathology. The MINI has good diagnostic reliability for all diagnosis compared to the Composite International Diagnostic Interview.[19] The MINI is especially designed to be used in clinical trials and epidemiologic studies; it was used to identify major depressive episode, panic disorder, obsessive-compulsive disorder (OCD), social phobia, generalized anxiety disorder (GAD), alcohol abuse, and alcohol dependence.

All CAPS and MINI assessments were digitally audio-recorded and, to test interrater reliability, 5% were rescored by an independent rater who was blind to the original scoring. Overall, PTSD diagnostic percentage agreement was 99%; diagnostic percentage agreements for depression, panic disorder, social phobia, OCD, GAD, alcohol abuse, and alcohol dependence were 100%.

Statistical Analyses

Analyses involved a 3-step process. In the first step, we used separate LCAs on the 3-month, 12-month, and 72-month measurements to evaluate the number of classes at each time point. Latent classes were identified on the basis of 8 dichotomous indicators of psychological disorders (PTSD, panic disorder, social anxiety disorder, OCD, alcohol abuse, alcohol dependence, GAD, and depression). Full information maximum likelihood estimation was used to adjust for missing data on latent-class indicator variables. The most parsimonious model (1-class) was initially fitted at each time point, followed by successive models with increasing numbers of classes to determine the number of latent classes that best fit the data. We assessed comparative model fit using the following information criteria: Bayesian information criterion (BIC), sample size–adjusted Bayesian information criterion (SS-BIC), and Akaike information criterion (AIC). We also used entropy, an index of classification quality. Finally, we used the Lo-Mendell-Rubin–likelihood ratio test (LMR-LRT) and the bootstrap–likelihood ratio test of model fit (B-LRT). Each of these tests compares the fit of a model solution with k classes to the previous solution with k – 1 classes; thus, a significant LMR-LRT or B-LRT indicates that this model evidences better fit than the previous model. When deciding what constitutes the optimal class solution, we also took into consideration parsimony and interpretability.

In the second analytic step, we determined the level of measurement invariance that could be assumed for these data. Log-likelihood difference tests were employed to compare models in which all parameter estimates were held equal across measurements (full measurement invariance) or all parameter estimates were allowed to vary freely across measurements (full measurement variance). These analyses revealed no significant difference in model fit between the model with full measurement invariance and the model with full measurement variance. This allowed us to assume full measurement invariance, which was used in the subsequent LTA model.

In the third analytic step, we conducted an unconditional LTA.[20] Latent transition analysis evaluates the probability of transitioning from one class at a particular time point to another class at a later time point, as well as the probability of staying in the same class over time. The LCA models at each time point constitute the measurement model, which provides the symptom profiles associated with class membership and facilitates the estimation of change in profiles over time.

RESULTS

Table 1 reports the incidence rates of psychiatric diagnoses at each time point.

Cross-Sectional LCA Models

The goodness-of-fit indices for the 1 to 5 class models at each time point are presented in Table 2. Based on fit indices and interpretability of class solutions, a 4-class solution was selected as the optimal solution at each time point. When reviewing the log-likelihood, BIC, SS-BIC, AIC, LMR-LRT, and B-LRT, the 4-class model was consistently preferred compared with the 3-class solution. The only exceptions were the BIC at 12 and 72 months, the SS-BIC at 3 and 72 months, and the LMR-LRT at 72 months. Additionally, only the 4-class solution had 0.94 entropy levels at every time point. While the LMR-LRT and B-LRT indicated that the 5-class solution evidenced better fit at 12 months, the 4-class solution was preferred at 3 and 72 months. Additionally, compared with the 4-class solution, the entropy level dropped from 0.94 to 0.90 when the 5-class solution was selected at 12 months. Therefore, the more parsimonious 4-class solution was retained at each time point.

The proportion of individuals in each class at each time point is presented in Table 3. Conditional probabilities of each disorder for the optimal solution are displayed for the 3-month solution in Figure 1A, the 12-month solution in Figure 1B, and the 72-month solution in Figure 1C. These represent the percentages of members of each class who exhibit each disorder. Values ≥ .60 represent high probability that the symptom was present in this class, and probabilities ≤ .15 represent low probability that the symptom was present in this class.[21] Accordingly, we considered values ≤ .59 and ≥ .16 as representing moderate probability that the symptom was present in this class.

The 4 classes at each time point were named Alcohol/Depression, Alcohol, PTSD/Depression, and No Disorder. In the Alcohol/Depression class at 3 months, participants had a high probability of alcohol use, alcohol dependence, and depression and a moderate probability of all other disorders. At 12 months, panic disorder and GAD increased from a moderate to a high probability. At 72 months, these disorders returned to a moderate probability, while social phobia increased to a high probability. As seen in Table 3, the percentage of the sample in the Alcohol/Depression class reduced from 2.1% at 3 months to 1.1% at 72 months posttrauma.

In the Alcohol class at 3 months, participants had a high probability of alcohol abuse and dependence, a moderate probability of depression, and a low probability of all remaining disorders. At 12 months, depression moved to a low probability, with the remaining disorders unchanged. At 72 months, depression and GAD moved to a moderate probability with the remaining disorders unchanged from the 12-month results. As seen in Table 3, the percentage of

Table 1. Prevalence of Psychiatric Diagnoses at 3, 12, and 72 Months After Injury

	Prevalence (%)		
Disorder	3 Months	12 Months	72 Months
Posttraumatic stress disorder	9.4	9.5	7.7
Major depression	16.9	16.2	11.5
Generalized anxiety disorder	7.8	11.1	5.9
Panic disorder	5.7	5.7	2.0
Obsessive-compulsive disorder	2.4	3.4	4.8
Social phobia	5.3	6.7	4.1
Alcohol abuse	5.5	7.8	8.0
Alcohol dependence	3.5	4.4	5.7

Table 2. Goodness-of-Fit for Unconditional Latent Class Models at Each Time Point

						P Value	
Model Tested	Log-Likelihood	AIC	BIC	SS-BIC	Entropy	LMR-LRT	B-LRT
3 months							
1 Class	−1,958.74	3,933.47	3,972.65	3,947.24			
2 Class	−1,604.81	3,243.61	3,326.87	3,272.88	0.88	< .001	< .001
3 Class	−1,523.85	3,099.70	3,227.04	3,144.47	0.94	< .001	< .001
4 Class	−1,509.34	3,088.68	3,088.68	3,148.94	0.94	< .05	< .05
5 Class	−1,501.92	3,091.83	3,307.33	3,167.59	0.90	.13	.68
12 months							
1 Class	−1,879.98	3,775.95	3,814.08	3,788.68			
2 Class	−1,558.81	3,151.62	3,232.64	3,178.66	0.89	< .001	< .001
3 Class	−1,476.35	3,004.70	3,128.62	3,046.05	0.94	< .001	< .001
4 Class	−1,452.86	2,975.72	3,142.53	3,031.38	0.94	< .01	< .001
5 Class	−1,438.63	2,965.25	3,035.23	3,035.23	0.90	< .05	< .001
72 months							
1 Class	−1,104.08	2,224.15	2,259.50	2,234.10			
2 Class	−943.81	1,921.62	1,996.74	1,942.76	0.86	< .001	< .001
3 Class	−885.41	1,822.82	1,937.70	1,855.15	0.93	< .001	< .001
4 Class	−871.73	1,813.47	1,968.11	1,856.99	0.94	.1	< .001
5 Class	−864.44	1,816.88	2,011.60	1,871.60	0.94	.23	.122

Abbreviations: AIC = Akaike information criterion, BIC = Bayesian information criterion, B-LRT = bootstrap-likelihood ratio test of model fit, LMR-LRT = Lo-Mendell-Rubin–likelihood ratio, SS-BIC = sample size–adjusted Bayesian information criterion.

Table 3. Proportion in Each Latent Class Based on the Estimated 4-Class Model

	Proportion (%)		
Class	3 Months	12 Months	72 Months
Alcohol/depression	2.1	1.3	1.1
Alcohol	3.3	3.7	5.4
PTSD/depression	10.3	11.5	6.4
No disorder	84.2	83.5	87.1

the sample in the Alcohol class increased from 3.3% at 3 months to 5.4% at 72 months posttrauma.

In the PTSD/Depression class at 3 months, participants had a high probability of PTSD and depression; a moderate probability of GAD, panic disorder, and social phobia; and a low probability of OCD and alcohol abuse or dependence. The only change at 12 months was the increase in probability from low to moderate for OCD. There was no change at 72 months compared with 12 months in the ratings of disorder probabilities. The percentage of the sample in the PTSD/Depression class reduced from 10.3% at 3 months to 6.4% at 72 months posttrauma.

In the No Disorder class for each disorder, participants had a low probability of diagnosis at each time point, and the percentage of the sample in the No Disorder class increased from 84.2% at 3 months to 87.1% at 72 months.

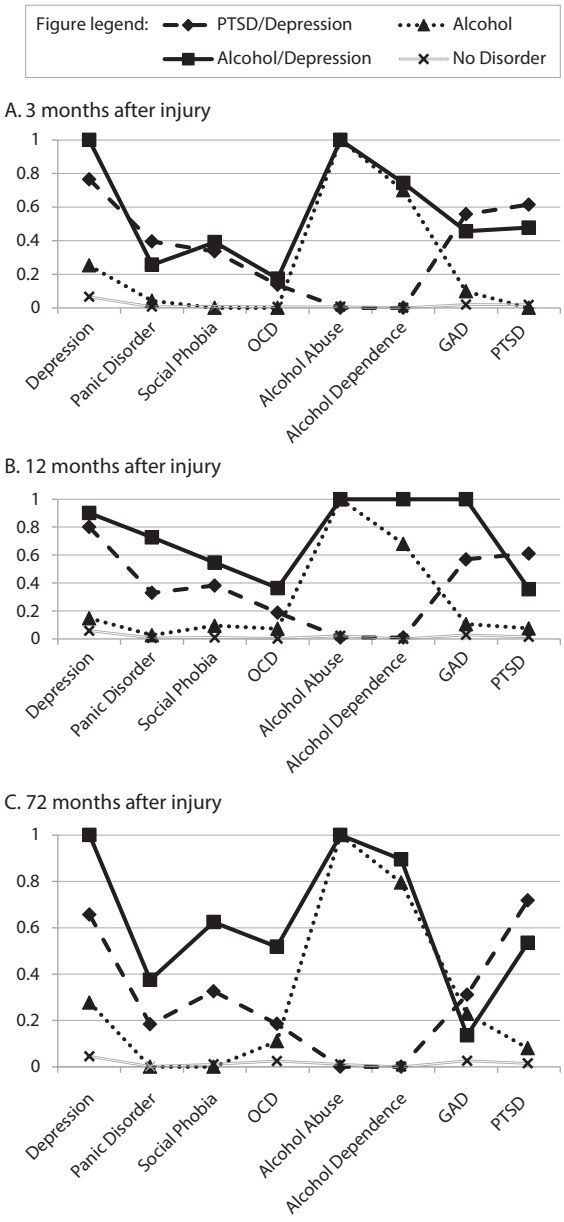
Latent Transition Analysis

We first evaluated measurement invariance for the latent transition model using a log-likelihood difference test. The unrestricted model did not evidence better fit than full measurement invariance (log-likelihood difference = 44.344, *df* = 64, *NS*). Thus, we retained full measurement variance for the subsequent LTA model.

The estimated transition probabilities from 3 months to 12 months and from 12 months to 72 months are presented in Table 4. The estimated probabilities on the diagonal of each table can be interpreted as coefficients of class stability. The highest level of stability was evidenced by the No Disorder class (3–12 months = .909 and 12–72 months = .930). Stability was relatively greater within PTSD/Depression class (3–12 months = .813 and 12–72 months = .466) compared with the Alcohol (3–12 months = .610 and 12–72 months = .365) and the Alcohol/Depression class (3–12 months = .597 and 12–72 months = .215). Noteworthy is that the stability from 12 to 72 months is poor in all the disorder classes.

Figure 2 shows the number of people who transitioned from each class starting at 3 months across the 12-month time point and concluding at the 72-month time point. At the first transition point, of the 30% who transitioned out of the Alcohol/Depression class, 86% moved into the PTSD/Depression class. The remainder moved into the Alcohol class. From the Alcohol class, 27% transitioned out during this phase, and all of these moved into the No Disorder class. Only 18 people (13%) transitioned out of the PTSD/Depression class with the clear majority (n=16) moving into the No Disorder class and the remaining 2 moving to the Alcohol/Depression class. Only 8 % moved out of the

Figure 1. Probabilities for Class Membership Based on Disorder at Each Time Point



Abbreviations: GAD = generalized anxiety disorder, OCD = obsessive-compulsive disorder, PTSD = posttraumatic stress disorder.

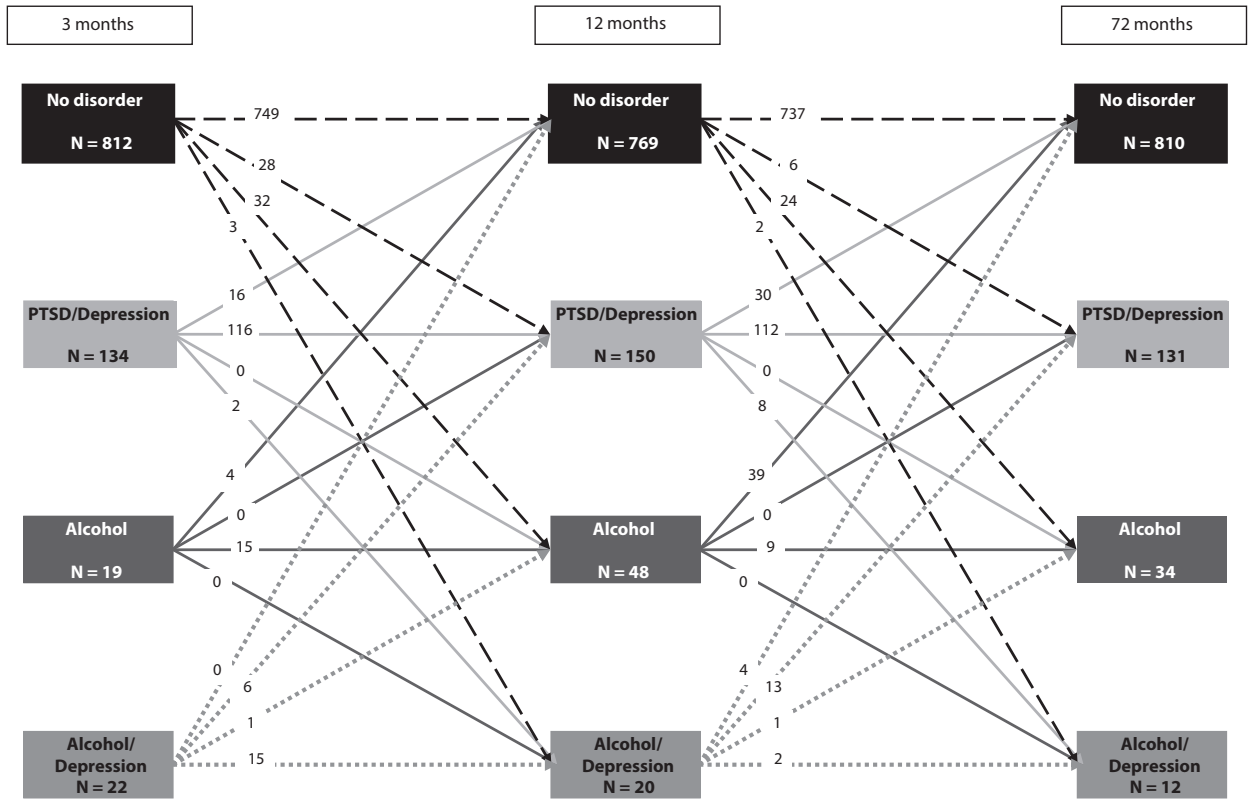
No Disorder class, and these were evenly spread between the Alcohol and PTSD/Depression classes, with a few cases (< 1%) moving into the Alcohol/Depression class.

At the second transition point, 90% of people from the Alcohol/Depression class transitioned into a different class, with the majority moving into the PTSD/Depression class followed by the No Disorder class and only 5% into the Alcohol class. Every one of the 81% who transitioned out of the Alcohol class went into the No Disorder class, which also occurred in transition point one. People who transitioned out of the PTSD/Depression class were most likely (79%) to move into the No Disorder class. Four percent of people

Table 4. Latent Transition Probabilities Based on the Estimated 4-Class Model

	Alcohol/Depression	Alcohol	PTSD/Depression	No Disorder
From 3–12 months				
Alcohol/depression	.597	.056	.347	.000
Alcohol	.000	.610	.000	.390
PTSD/depression	.036	.000	.813	.151
No disorder	.004	.042	.045	.909
From 12–72 months				
Alcohol/depression	.215	.106	.366	.314
Alcohol	.000	.365	.006	.629
PTSD/depression	.079	.001	.466	.455
No disorder	.009	.045	.016	.930

Figure 2. Transition Within and Across Classes Over Time, Depicting Both Transition Out of Classes at 3 and 12 Months and Transition Into Classes at 12 and 72 Months[a]



[a]Mplus algorithm accounts for missing values by predicting class membership, hence N = 987 at all time points.
Abbreviation: PTSD = posttraumatic stress disorder.

in the No Disorder class moved into a different class, and these mostly moved into the Alcohol class. The much larger number of participants in the No Disorder class compared with the Alcohol class makes this change substantial in real terms for the Alcohol class.

The majority of people who transitioned into the No Disorder class at 12 months came from the PTSD/Depression class (80%), while at 72 months, it was the Alcohol class that provided the highest proportion of new members (53%) into the No Disorder class. At each time point, the increase in the Alcohol class was almost completely accounted for by participants transitioning from the No Disorder class (97% of new people at 12 months and 96% of new people at 72 months).

DISCUSSION

Several important findings emerge from this study. First, despite the large number of psychiatric disorders assessed and reported, a simple 4-class model comprising 3 psychopathology classes and a No Disorder class best explained the profiles of psychiatric disorders in severe injury survivors 3 months postevent. The second key finding is the stability of this class structure over the course of 3 months to 72 months after trauma. The third finding is the extensive pattern of migration across classes. Finally, the study found that despite the prominence of PTSD in common conceptualizations of posttrauma psychopathology, it is both depression and alcohol use that appear to play crucial roles in the psychopathology classes defined.

In terms of the 4-class structure, the relatively small number of classes compared to the number of diagnoses reflects the considerable symptom overlap and shared features across these disorders.[22–24] Additionally, the finding that the No Disorder class comprised almost 85% of the sample reiterates the findings from past studies that most people adjust to a potentially traumatic event without developing psychopathology.[6]

The 3 psychopathology classes indicate that from 3 months posttrauma to 72 months, there are predominantly 3 types of clinical presentations: the PTSD/Depression class—those with PTSD, depression, and an array of pananxiety and phobic features without comorbid alcohol; a Depression/Alcohol class with secondary pananxiety features; and the Alcohol class that presented with little other psychopathology. The finding that PTSD was particularly prominent in only 1 of the classes also reinforces that research should not assume its primacy in posttraumatic psychopathology. Indeed, depression featured prominently in 2 of the 3 psychopathology classes.

A striking feature of the findings is the extent of migration across classes, informing us about changes in patterns of adjustment/maladjustment following trauma over time. The largest initial psychopathology class, the PTSD/Depression class, reduces over time from 10.3% to 6.4%. This reduction is largely accounted for by a significant proportion of trauma survivors shifting to the No Disorder class and a smaller number shifting to the Alcohol/Depression class. This shift toward adaptation after trauma is consistent with many findings of the decline of PTSD rates in the 12 months following trauma exposure.[25,26] However, there is also a substantial shift into the PTSD/Depression class from the No Disorder class. In contrast, there is an observed increase in the Alcohol class, where accrual of members comes almost exclusively from the No Disorder class. Therefore, a substantial proportion of those without mental health problems develops alcohol-specific problems over time and, by 72 months, comprises the majority of the Alcohol class members.

The last of the 3 psychopathology classes is the Alcohol/Depression class, which, by 72 months, had reduced to only 1% of the trauma-exposed population. Of note is that, by 72 months, the composition of this class is derived primarily from the PTSD/Depression class at 12 months, with only 17% of class membership at 72 months coming from this class at 12 months.

Data from this study indicate a large level of movement across classes over time after severe injury. These results suggest that when rates of disorders or classes are compared over time, assumptions should not be made that these categories are constituted by the same individuals at each time point. The extent of migration observed here indicates that more than half of the cases in a class may be comprised of new cases even when overall incidence rates decline. The migration between psychopathology classes also provides support for research examining common higher order features and unifying underlying vulnerabilities.[27,28] Such theories may explain the changes in manifest psychopathology expressed in response to the challenges and vicissitudes confronted by trauma survivors over time.

These findings have important implications for service design and delivery in the aftermath of trauma and disaster. It is reasonable to assume that the vast majority of trauma survivors who do not develop significant psychopathology require only low intensity public health interventions from a mental health perspective, with a focus on enhancing a return to normal social and occupational functioning. However, given the drift of a significant proportion of the No Disorder class to the psychopathology classes over 12 months (9%) and then further to 72 months (7%), some consideration should be given to low key monitoring and preventative interventions, both of which may include self-monitoring and self-management options. Prevention should be targeted not only at mental health problems such as anxiety, depression, and PTSD, but also, in the context of the current findings, at the risk for development of an alcohol disorder.

These variable trajectories of individuals who have suffered severe injuries also indicate the potential benefit of a stepped care model. In such a model, screening is conducted in an ongoing manner to identify individuals' risk for developing psychiatric difficulties and delivering interventions tailored to the nature and severity of difficulties identified.[29] Previous studies have found this approach to be effective with psychopathology developing in the aftermath of a severe injury.[30,31] The data from this study indicate that the ongoing assessment and flexible care delivery offered by a stepped care approach also needs to be focused not only on the development of disorder in those initially identified in the No Disorder class, but also in the potential to distinguish between classes to provide interventions tailored to these different types of presentation. Furthermore, such ongoing assessment needs to be primed for the potential shifting of patterns of disorder or class membership within previously identified individuals.

Given the clustering of disorders in the respective classes, as well as the similarity of evidence-based intervention approaches (both psychological and pharmacologic) across the PTSD/depression/anxious cluster of disorders, such interventions may be best devised as multifocused interventions to be applied across the range of anxious and depressive symptomatology or to have a modular structure to target particular psychopathological features. In addition, further exploration of transdiagnostic treatment[32] addressing mechanisms underlying groups of disorders could be considered. The significant proportion of trauma survivors presenting with alcohol disorders alone indicates that services will require a different set of evidence-based interventions to target the substance use directly.

Some limitations require consideration in interpreting these findings. First, the data are based on reports for severe injury survivors specifically and cannot necessarily be generalized to survivors of other forms of potentially traumatic events. Second, the numbers in each of the 3

psychopathology groups are comparatively small, with further attrition over the course of the 72 months of the study, making it difficult to comment definitively about changes in comorbidity within the groups over time. However, as the responder analyses found only 1 scenario where those who dropped out were predicted by a diagnosis at the previous time point (ie, depression at 3 months), there is little evidence to indicate that results were influenced by a systematic attrition of responders. Third, the follow-up assessments were conducted by telephone; it should be noted, however, that evidence suggests that telephone and face-to-face interviews have strong reliability.[33]

In summary, despite the array of psychiatric disorders reported following severe injury, a 4-class model best described the data with excellent classification certainty. The classes were understood as an Alcohol/Depression class, an Alcohol class, a PTSD/Depression class, and a No Disorder class. The 4-class model also demonstrated stability through to 72 months posttrauma. The study reinforces the prominence of depression in the conceptualization of posttraumatic psychopathology. Of note, however, are the increases in certain classes over time (Alcohol) and decreases in others (PTSD/Depression) and the considerable patterns of migration of survivors across these classes. The findings have implications for the tailoring of multifocused interventions to class type and the potential development and delivery of transdiagnostic interventions targeting underlying mechanisms.

Author affiliations: Australian Centre for Posttraumatic Mental Health and Department of Psychiatry, University of Melbourne, Melbourne VIC (Drs Forbes, Alkemade, Creamer, Fletcher, and O'Donnell); School of Psychology (Drs Nickerson and Bryant) and School of Psychiatry (Dr Silove), University of New South Wales, Sydney NSW; and Centre for Traumatic Stress Studies, University of Adelaide, SA (Drs McFarlane and Van Hoof), Australia.

Author contributions: The primary author 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.

Potential conflicts of interest: None reported.

Funding/support: Financially supported by an Australian National Health and Medical Research Council Program Grant (568970).

Role of the sponsor: The National Health and Medical Research Council were not involved in the design or completion of the study.

Acknowledgments: The authors gratefully acknowledge all the participants involved in this study.

REFERENCES

1. Breslau N. The epidemiology of trauma, PTSD, and other posttrauma disorders. *Trauma Violence Abuse*. 2009;10(3):198–210.
2. Creamer M, Burgess P, McFarlane AC. Post-traumatic stress disorder: findings from the Australian National Survey of Mental Health and Well-being. *Psychol Med*. 2001;31(7):1237–1247.
3. Vrana SR, Lauterbach D. Prevalence of traumatic events and post-traumatic psychological symptoms in a nonclinical sample of college students. *J Trauma Stress*. 1994;7(2):289–302.
4. Bryant RA, O'Donnell ML, Creamer M, et al. The psychiatric sequelae of traumatic injury. *Am J Psychiatry*. 2010;167(3):312–320.
5. Zatzick D, Jurkovich GJ, Rivara FP, et al. A national US study of posttraumatic stress disorder, depression, and work and functional outcomes after hospitalization for traumatic injury. *Ann Surg*. 2008;248(3):429–437.
6. Creamer M, McFarlane AC, Burgess P. Psychopathology following trauma: the role of subjective experience. *J Affect Disord*. 2005;86(2–3):175–182.
7. Mayou RA, Bryant B, Ehlers A. Prediction of psychological outcomes one year after a motor vehicle accident. *Am J Psychiatry*. 2001;158(8):1231–1238.
8. Bonanno GA, Kennedy P, Galatzer-Levy IR, et al. Trajectories of resilience, depression, and anxiety following spinal cord injury. *Rehabil Psychol*. 2012;57(3):236–247.
9. Bonanno GA, Mancini AD. Beyond resilience and PTSD: mapping the heterogeneity of responses to potential trauma. *Psychol Trauma*. 2012;4((1):74–83.
10. Bonanno GA, Mancini AD, Horton JL, et al; Millennium Cohort Study Team. Trajectories of trauma symptoms and resilience in deployed US military service members: prospective cohort study. *Br J Psychiatry*. 2012;200(4):317–323.
11. deRoon-Cassini TA, Mancini AD, Rusch MD, et al. Psychopathology and resilience following traumatic injury: a latent growth mixture model analysis. *Rehabil Psychol*. 2010;55(1):1–11.
12. Steenkamp MM, Nickerson A, Maguen S, et al. Latent classes of PTSD symptoms in Vietnam veterans. *Behav Modif*. 2012;36(6):857–874.
13. Forbes D, Elhai JD, Miller MW, et al. Internalizing and externalizing classes in posttraumatic stress disorder: a latent class analysis. *J Trauma Stress*. 2010;23(3):340–349.
14. Galatzer-Levy IR, Nickerson A, Litz BT, et al. Patterns of lifetime PTSD comorbidity: a latent class analysis. *Depress Anxiety*. 2013;30(5):489–496.
15. Wolf EJ, Miller MW, Reardon AF, et al. A latent class analysis of dissociation and posttraumatic stress disorder: evidence for a dissociative subtype. *Arch Gen Psychiatry*. 2012;69(7):698–705.
16. American Congress of Rehabilitation Medicine. Definition of mild traumatic brain injury. *J Head Trauma Rehabil*. 1993;8(3):86–87.
17. Blake DD, Weathers FW, Nagy LM, et al. The development of a clinician administered PTSD scale. *J Trauma Stress*. 1995;8(1):75–90.
18. Weathers FW, Keane TM, Davidson JR. Clinician-administered PTSD scale: a review of the first ten years of research. *Depress Anxiety*. 2001;13(3):132–156.
19. Sheehan DV, Lecrubier Y, Sheehan KH, et al. The Mini-International Neuropsychiatric Interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for *DSM-IV* and *ICD-10*. *J Clin Psychiatry*. 1998;59(suppl 20):22–33, quiz 34–57.
20. Farchione TF, Bullis JR. Addressing the global burden of mental illness: why transdiagnostic and common elements approaches to evidence-based practice might be our best bet. *Cognit Behav Pract*. 2014;21(2): 124–126.
21. Burstein M, Georgiades K, Lamers F, et al. Empirically derived subtypes of lifetime anxiety disorders: developmental and clinical correlates in US adolescents. *J Consult Clin Psychol*. 2012;80(1):102–115.
22. Forbes D, Fletcher S, Lockwood E, et al. Requiring both avoidance and emotional numbing in *DSM-V* PTSD: will it help? *J Affect Disord*. 2011;130(3):483–486.
23. Grant DM, Beck JG, Marques L, et al. The structure of distress following trauma: posttraumatic stress disorder, major depressive disorder, and generalized anxiety disorder. *J Abnorm Psychol*. 2008;117(3):662–672.
24. Spitzer RL, First MB, Wakefield JC. Saving PTSD from itself in *DSM-V*. *J Anxiety Disord*. 2007;21(2):233–241.
25. Blanchard EB, Hickling EJ, Barton KA, et al. One-year prospective follow-up of motor vehicle accident victims. *Behav Res Ther*. 1996;34(10):775–786.
26. Galea S, Ahern J, Resnick H, et al. Psychological sequelae of the September 11 terrorist attacks in New York City. *N Engl J Med*. 2002;346(13):982–987.
27. Krueger RF, Markon KE. Reinterpreting comorbidity: a model-based approach to understanding and classifying psychopathology. *Annu Rev Clin Psychol*. 2006;2(1):111–133.
28. Watson D. Rethinking the mood and anxiety disorders: a quantitative hierarchical model for *DSM-V*. *J Abnorm Psychol*. 2005;114(4):522–536.
29. O'Donnell ML, Bryant RA, Creamer M, et al. Mental health following traumatic injury: toward a health system model of early psychological intervention. *Clin Psychol Rev*. 2008;28(3):387–406.
30. Zatzick DF, Roy-Byrne P, Russo J, et al. A randomized effectiveness trial of stepped collaborative care for acutely injured trauma survivors. *Arch Gen Psychiatry*. 2004;61(5):498–506.
31. Zatzick D, Jurkovich G, Rivara FP, et al. A randomized stepped care intervention trial targeting posttraumatic stress disorder for surgically hospitalized injury survivors. *Ann Surg*. 2013;257(3):390–399.
32. Barlow DH, Farchione TJ, Fairholme CP, et al. *Unified Protocol for Transdiagnostic Treatment of Emotional Disorders: Therapist Guide*. New York, NY: Oxford University Press; 2011.
33. Aziz MA, Kenford S. Comparability of telephone and face-to-face interviews in assessing patients with posttraumatic stress disorder. *J Psychiatr Pract*. 2004;10(5):307–313.