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# Numbing symptoms as predictors of unremitting posttraumatic stress disorder

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ABSTRACT

This prospective longitudinal study examined the ability of re-experiencing, avoidance, numbing, and hyperarousal symptoms to predict persistence of posttraumatic stress disorder (PTSD) in disaster workers followed for 2 years. Cluster analyses suggested that overall severity was the best predictor of PTSD at follow up, but for groups with PTSD of moderate severity, numbing symptoms were also associated with PTSD at the 2-year follow up. Regression analyses with all four symptom groups as independent variables found that only numbing and re-experiencing symptoms predicted PTSD at the 1 year follow up, and only numbing symptoms predicted PTSD at the 2-year follow up. Findings suggest that numbing symptom severity could be used as a risk index of very chronic PTSD, especially when the overall PTSD severity falls in the moderate range.



## 1. Introduction

In the wake of a disaster, a significant number of rescue and restoration workers develops very chronic posttraumatic stress disorder (PTSD), with a prevalence range of 8% (Difede, Roberts, Jayasinghe, & Leck, 2006; Epstein, Fullerton, & Ursano, 1998) to 13% (Center for Disease Control, 2004; McFarlane & Papay, 1992; North, McCutcheon, Spitznagel, & Smith, 2002) at 15–42 months post-exposure. Experts have noted the dearth of research following survivors beyond the first year post-disaster (Norris, 2006; North, 2004). Therefore, the broad goal of this study was to provide data on the long-term course of PTSD in disaster workers.

Identifying survivors at risk for PTSD presented a "real world" challenge for programs established after the 2001 World Trade Center (WTC) attack to screen rescue workers and defacto (untrained) restoration workers (CDC, 2004; Difede et al., 2006). The latter group included workers without disaster work training (construction, utility, truck drivers, etc.), who restored the area to enable businesses and residents to return. They represent an understudied population at risk for trauma exposure because of the need to restore communities after disasters. WTC restoration workers were exposed to stressors such as fearing further attacks in the area, discovering human remains, and evacuating unsafe structures.

Resources associated with evaluating large numbers of workers for years underscore the need for cost-effective ways to identify those at risk for PTSD, which is necessary to provide estimates of long-term mental health services. Prospective studies have identified PTSD risk factors such as psychiatric history and poor social support (Brewin, Andrews, & Valentine, 2000; Ozer, Best, Lipsey, & Weiss, 2003). However, deriving estimates from several disparate predictors is not always feasible, especially if resources limit the screening battery. One option is to use overall PTSD severity as a risk index, but research suggests that PTSD symptom groups (re-experiencing, avoidance, numbing, and hyperarousal) could also be used to enhance prediction of remission.

Hypothetical models of PTSD propose that avoidance and numbing symptoms maintain re-experiencing and hyperarousal symptoms because they interfere with emotional processing of the trauma and the extinction of conditioned fear responses (e.g., Foa, Riggs, & Gershuny, 1995; Keane, Fairbank, Caddell, Zimmering, & Bender, 1985). Foa and associates (1995) described a "vicious cycle" (p. 120) in which severe re-experiencing and hyperarousal symptoms beget more avoidance and numbing, which in turn maintain the re-experiencing and hyperarousal symptoms. If such a functional relationship exists, then avoidance and numbing symptoms should predict PTSD remission, and there is some evidence of this. Severity of numbing symptoms predicts PTSD at 3–6 months follow up (Feeny, Zoellner, Fitzgibbons, & Foa, 2000; Harvey & Bryant, 1998); and a greater prevalence of numbing symptoms distinguished trauma survivors with and without very chronic (several years duration) PTSD (Breslau, Reboussin, Anthony, & Storr, 2005). Avoidance (Perry, Difede,

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Musngi, Frances, & Jacobsberg, 1992) and re-experiencing symptoms (Schnyder, Moergeli, Klaghofer, & Buddeberg, 2001) predict PTSD at one year. A greater prevalence of avoidance and numbing symptoms also predicted reduced PTSD remission in disaster survivors (North, Tivis, et al., 2002; North et al., 2004). However, few studies have examined whether PTSD symptom groups predict PTSD beyond 1 year post-exposure, and there do not appear to be any studies with disaster workers. This was the specific study objective, to provide data germane to disaster mental health programs. We hypothesized that the initial severity of avoidance and numbing symptoms would predict PTSD at follow up.

## 2. Method

### 2.1. Participants

Participants were 270 defacto WTC disaster restoration workers assessed through the Weill-Cornell 9/11 Mental Health Screening Program (Difede et al., 2006). The Institutional Review Board of Weill Cornell Medical College approved use of the data for research. Data were analyzed from 270 (of 3350) workers diagnosed with PTSD (8%) at the initial evaluation.

### 2.2. Instruments

PTSD was assessed with the Clinician Administered PTSD Scale for DSM-IV (CAPS; Blake et al., 1998), a standardized clinical interview that assesses the frequency and intensity of each PTSD symptom. These dimensional symptom scores are summed to create a total PTSD severity score and scores for each symptom group. The CAPS was originally created using DSM-III-R criteria (Blake et al., 1990) and then updated to reflect DSM-IV criteria (Blake et al., 1998). It has been widely used in trauma research and is considered to represent the "gold standard" of PTSD assessment instruments (Weathers, Keane, & Davidson, 2001). However, diagnosis of PTSD remains controversial (Rosen & Lilienfeld, 2008; Rosen, Spizter, & McHugh, 2008); and because symptoms on the CAPS are scored dimensionally, it yields PTSD prevalence estimates that vary according to the type of rule used to score a symptom as counting towards a PTSD diagnosis (Blanchard et al., 1995; Fleming & Difede, 1999; Weathers, Ruscio, & Keane, 1999). In the present study, we applied the CAPS "Rule of 3" scoring method, in which a symptom counts towards a PTSD diagnosis if it is present at a minimum frequency score of one (once or twice/month) and a minimum intensity score of two (moderate) (Blanchard et al., 1995; Fleming & Difede, 1999; Weathers et al., 1999). This rule reflects a middle ground between the most lenient and most stringent scoring rules (Blanchard et al., 1995; Fleming & Difede, 1999; Weathers et al., 1999). In their comparison of nine different scoring rules for the CAPS, Weathers et al. (1999) suggested that the "Rule of 3" method was appropriate for mental health screening programs such as ours, in which it is more important to avoid false negatives rather than false positives. Our adoption of this scoring rule therefore reflected our giving priority to the clinical mission of identifying disaster restoration workers in need of treatment. PTSD was diagnosed according to DSM-IV diagnostic criteria (American Psychiatric Association, 1994). Analyses of inter-rater diagnostic reliability found a kappa coefficient of .94 (Difede et al., 2006), indicating good diagnostic reliability.

Depression, Panic Disorder, and Generalized Anxiety Disorder were assessed with the Structured Clinical Interview for the DSM-IV (SCID-I, First, Spitzer, Gibbon, & Williams, 1995). Trauma history was assessed with the Traumatic History Questionnaire (Green, 1993). Categorical variables were lifetime trauma exposure, childhood history of abuse or witnessing domestic violence, and exposure to trauma between the WTC attack and the evaluations.

### 2.3. Procedures

Participants were evaluated by psychologists at an initial evaluation (7/02 – 11/03) and 1 and 2 years later (Rounds 2 and 3, respectively).

### 2.4. Data analyses

The ability of symptom groups to predict PTSD was analyzed with two complementary strategies. Regression analysis averages symptoms across cases, cluster analysis averages cases across symptoms; and similar results across methods would provide evidence of the reliability of the findings. Caveats of cluster analysis include a lack of consensus on methodology (Overall, Gibson, & Novy, 1993). Results covary according to methods, and cluster analysis will create groups even where none actually exist. Therefore, the authors do not subscribe to the notion that cluster analyses reveal a singular, "true" underlying structure. Although traditionally used to derive typologies, in the present study cluster analysis was employed solely as a practical method to classify data. We recognize that there are many ways to classify data and believe that the utility of any classification is best evaluated in the context of a specific goal, which in this study was to compare outcomes for PTSD cases with different symptom profiles.

CAPS scores for each of the 17 PTSD symptoms were standardized and analyzed using two different methods of cluster analysis, Ward's (1963) hierarchical method and a *k*-means cluster method. Ward's method performs well at identifying clusters that correspond to known classifications (Overall et al., 1993; Wieczorek & Miller, 1992). However, hierarchical methods cannot rejoin clusters or cases separated at previous steps, and may not produce clusters with maximal between-cluster heterogeneity (Wieczorek & Miller, 1992). Ward's method is also sensitive to score elevations (Aldenderfer & Blashfield, 1985), including outliers. Analyses identified univariate high-score outliers for flashbacks (2.22%), amnesia (2.22%), and one low-score outlier (0.37%) each for distress at reminders, irritability, hypervigilance. Instead of excluding these cases, Ward's method was used to identify the number of clusters, using the squared Euclidean distance as a criterion for cluster membership, followed by a *k*-means cluster analysis. The *k*-means method is an iterative procedure that derives a pre-specified number of clusters by minimizing the sum of the squared distances from cluster centroids. It produces clusters with good between-cluster heterogeneity and is sensitive to profile shape (Wieczorek & Miller, 1992). The same procedure (Ward's, followed by *k*-means analysis) has been used by others (Deery & Fildes, 1999), including a study that classified PTSD cases based on treatment response (Taylor et al., 2000). It enabled us to utilize the benefits and minimize the limitations of each method. The *k*-means clustering, conducted with SPSS (SPSS Inc., 1989–2004), was allowed a maximum of 25 iterations to derive cluster centers. Convergence was achieved after 14 iterations, with a maximum absolute coordinate change of .027 for any center. The clustering procedure was then repeated with these centers used as seeds to derive the final classifications.

The regression analyses tested ability of total CAPS scores and the symptom groups (avoidance, numbing, re-experiencing, hyperarousal) to predict PTSD at follow up. For these analyses, Criterion C symptoms were classified as two variables: avoidance (avoidance of thoughts, emotions, conversations; and avoidance of people, places, or situations); and numbing (anhedonia, estrange-

**Table 1**
*k*-Means groups non-standardized mean Clinician-Administered PTSD Scale (CAPS) scores

| k-Means cluster analysis groups | | | | |
|---|---|---|---|---|
| Symptoms scores | Moderate | Numb-Moderate | Numb-Severe | Severe |
| Total CAPS | 41.46 (7.85)[a] | 46.14 (9.59)[b] | 62.92 (13.11)[c] | 66.55 (10.54)[c] |
| Re-experiencing | 8.79 (3.48)[a] | 7.30 (3.23)[b] | 14.08 (5.14)[c] | 16.88 (5.25)[d] |
| Avoidance | 8.17 (2.47)[a] | 4.81 (3.05)[b] | 8.41 (3.82)[a] | 8.92 (3.45)[a] |
| Numbing | 7.32 (3.05)[a] | 15.78 (4.75)[b] | 19.41 (6.21)[c] | 16.22 (4.60)[b] |
| Hyperarousal | 17.18 (5.58)[a] | 18.24 (5.80)[a] | 21.03 (6.26)[b] | 24.53 (4.89)[c] |

*Note.* Row values with different alphabetical superscripts differ significantly in descriptive ANOVAs, $p < .05$. The analysis clustered scores for each of the 17 symptoms; symptom subscales are shown for descriptive purposes.

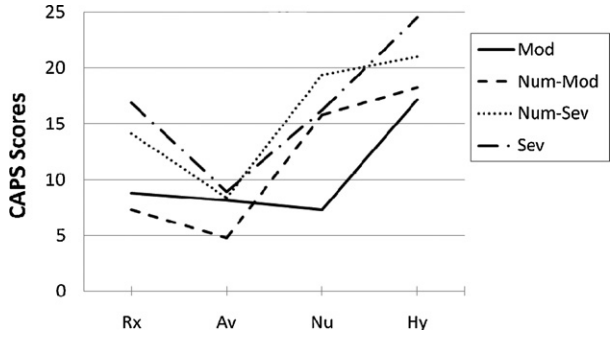


**Fig. 1.** Clinician-Administered PTSD Scale symptom group scores for each of the four *k*-means cluster groups. *Note.* Mod = Moderate PTSD group; Num-Mod = Numb-Moderate group; Num-Sev = Numb-Severe group; Sev = Severe group; Rx = re-experiencing; Av = avoidance; Nu = numbing; Hy = hyperarousal.

ment, restricted affect, feelings of foreshortened future, amnesia). This classification was based on a factor analysis of CAPS symptom scores of the entire sample of 3350 disaster workers (Palmieri, Weathers, Difede, & King, 2007). PTSD diagnosis at follow up was coded as a dimensional variable, where 1 = no PTSD; 2 = partial PTSD (symptoms met criteria for two of the three DSM-IV symptom criteria groups); and 3 = symptoms met DSM-IV criteria for full PTSD.

## 3. Results

### 3.1. Cluster analyses

Based on inspection of the Ward's method dendogram,[1] the *k*-means cluster analysis of each of the 17 PTSD symptoms specified four groups. CAPS scores for the four groups classified by the *k*-means cluster analyses are shown in Fig. 1 and Table 1. There was a "Moderate" and a "Severe" PTSD group, with total CAPS in the moderate and severe ranges, respectively. The other two groups were labeled "Numb-Moderate" and "Numb-Severe." Compared to the Moderate group, the Numb-Moderate group had higher numbing, lower re-experiencing and avoidance, and equally severe hyperarousal symptoms. Compared to the Severe group, the Numb-Severe group had a similar level of avoidance and total PTSD symptoms, less severe re-experiencing and hyperarousal, and more severe numbing symptoms.

#### 3.1.1. Demographics

Mean age ranged from 43.06, S.D. = 8.96–44.67, S.D. = 9.04 across the four groups, which also ranged from 92 to 95% male, 30 to 35% racial/ethnic minorities, 70 to 78% married/cohabitating, and 44 to 58% with at least some education beyond high school. Mean number of months post-attack ranged from 19.08, S.D. = 4.85–20.75, S.D. = 6.43 at index; 30.77, S.D. = 5.95–32.58, S.D. = 4.92 at Round 2; and 41.84, S.D. = 4.03–42.68, S.D. = 3.03 at Round 3. There were no significant differences in demographics or in months post-attack at any evaluation.

#### 3.1.2. PTSD diagnoses

PTSD diagnoses are shown in Table 2. Diagnoses were available for 82% and 58% of disaster worker at Rounds 2 and 3, respectively, with no significant group differences in attrition/missing data. There were significant differences in PTSD prevalence at Round 2, $\chi^2$ (3, $N = 220$) = 28.70, $p < .01$; and Round 3, $\chi^2$ (3, $N = 157$) = 12.90, $p < .01$. At Round 2, the two severe PTSD groups had a significantly higher prevalence compared to both of the Moderate groups, with no other group differences: Numb-Severe vs. Moderate, $\chi^2$ (1, $N = 90$) = 15.90, $p < .01$; Numb-Severe vs. Numb-Moderate group, $\chi^2$ (1, $N = 105$) = 9.05, $p < .01$; Severe vs. Moderate, $\chi^2$ (1, $N = 115$) = 19.60, $p < .01$; Severe vs. Numb-Moderate, $\chi^2$ (1, $N = 130$) = 11.94, $p < .01$. At Round 3, the Moderate group had a significantly lower prevalence compared to the other groups: vs. Numb-Moderate group, $\chi^2$ (1, $N = 89$) = 6.36, $p < .05$; vs. Numb-Severe group, $\chi^2$ (1, $N = 66$) = 11.80, $p < .01$; vs. Severe group, $\chi^2$ (1, $N = 78$) = 10.57, $p < .01$. The other three groups did not significantly differ.

#### 3.1.3. Trauma history, treatment, and comorbid diagnoses

Trauma history, treatment, and comorbid diagnoses are shown in Table 2. The groups did not differ in lifetime trauma exposure, but differed in endorsing a history of childhood abuse/witnessing domestic violence, $\chi^2$ (3, $N = 270$) = 8.64, $p < .05$. The Moderate group had a significantly lower prevalence compared to the Numb-Moderate group, $\chi^2$ (1, $N = 158$) = 8.27, $p < .01$; with a trend for a lower prevalence in the Moderate vs. the Numb-Severe group ($p = .06$). Data on trauma exposure after 9/11 and before the first evaluation were available for 52% of the sample; data on exposure between index and Round 2 were available for 56% of the sample; and data on exposure between Rounds 2 and 3 were available for 90% of the sample. Fisher's exact tests found no group differences in trauma exposure during these periods.

At index, there was a significant difference in history of mental health treatment, $\chi^2$ (3, $N = 258$) = 9.69, $p < .05$. The two "numb" groups had a significantly greater prevalence of members who had received treatment compared to the Moderate group: vs. Numb-Moderate, $\chi^2$ (1, $N = 151$) = 6.25, $p < .05$; vs. Numb-Severe, $\chi^2$ (1, $N = 108$) = 5.81, $p < .05$. There were no other significant differences in current or prior treatment at the time of any evaluation.

The groups differed in depression prevalence at the initial evaluation, $\chi^2$ (3, $N = 256$) = 22.82, $p < .01$. The Moderate group had a lower prevalence compared to the other groups: vs. Numb-Moderate, $\chi^2$ (1, $N = 150$) = 12.53, $p < .01$; vs. Numb-Severe, $\chi^2$ (1, $N = 107$) = 9.28, $p < .01$; and vs. Severe, $\chi^2$ (1, $N = 137$) = 21.89, $p < .01$. The Severe group also had a significantly greater prevalence

[1] Dendogram available from the authors upon request.

**Table 2**
Additional diagnoses, treatment, and trauma history for the four groups

| | Moderate *N* (%) | Numb-Moderate *N* (%) | Numb-Severe *N* (%) | Severe *N* (%) |
|---|---|---|---|---|
| Index evaluation: | | | | |
| Depression | 12 (17%)[a] | 36 (44%)[b] | 17 (45%)[b] | 38 (56%)[b] |
| Panic disorder | 7 (11%)[ab] | 6 (8%)[a] | 5 (13%)[ab] | 13 (19%)[b] |
| GAD | 11 (17%) | 9 (11%) | 5 (14%) | 15 (22%) |
| Prior treatment | 15 (21%)[a] | 32 (40%)[b] | 16 (43%)[b] | 18 (26%)[ab] |
| Current treatment | 4 (6%) | 8 (9%) | 3 (8%) | 5 (7%) |
| History of any trauma | 34 (49%) | 51 (62%) | 24 (65%) | 33 (48%) |
| Abuse/domestic violence | 14 (19%)[a] | 35 (41%)[b] | 14 (36%)[ab] | 22 (30%)[ab] |
| Trauma between 9/11/01 and index | 3 (8%) | 5 (12%) | 0 (0%) | 4 (10%) |
| Round 2: | | | | |
| PTSD | 8 (14%)[a] | 17 (23%)[a] | 17 (53%)[b] | 30 (53%)[b] |
| Depression | 4 (8%) | 11 (19%) | 6 (24%) | 12 (25%) |
| Panic disorder | 3 (7%) | 6 (10%) | 5 (21%) | 5 (11%) |
| GAD | 7 (15%) | 5 (8%) | 2 (9%) | 6 (13%) |
| Trauma between index and Round 2 | 2 (6%) | 4 (10%) | 2 (11%) | 5 (16%) |
| Round 3: | | | | |
| PTSD | 2 (5%)[a] | 13 (26%)[b] | 11 (39%)[b] | 14 (35%)[b] |
| Depression | 2 (5%)[a] | 5 (10%)[ab] | 7 (23%)[b] | 7 (17%)[ab] |
| Panic disorder | 0 (0%)[a] | 2 (5%)[ab] | 4 (20%)[b] | 4 (13%)[b] |
| Current GAD | 2 (5%) | 7 (16%) | 6 (21%) | 6 (17%) |
| Trauma between Rounds 2 and 3 | 0 (0%) | 2 (4%) | 2 (10%) | 2 (7%) |

*Note*. *N*s vary due to missing data. Row values with different alphabetical superscripts differ significantly, $p < .05$.

of Panic Disorder vs. the Numb-Moderate group, Fisher's exact $p < .05$. There were no other significant differences in diagnoses at index or at Round 2. At Round 3, Fisher's tests found a significantly lower prevalence of depression in the Moderate group vs. the Numb-Severe group, $p < .05$, and a significantly lower prevalence of Panic Disorder in the Moderate group vs. each of the severe groups, $p < .05$.

Partial correlations were examined to explore whether the difference in PTSD prevalence at Round 3 between the two moderate groups was due to more depression diagnoses in the Numb-Moderate group at the index evaluation. Depression at index and cluster group membership were significantly correlated, $r\,(87) = .32$, $p < .01$. Depression at index and cluster membership were each significantly correlated with PTSD at the 2-year follow up: $r\,(87) = .29$, $p < .01$, depression; $r\,(87) = .27$, $p < .05$, cluster group membership. Controlling for depression attenuated the correlation between cluster membership and PTSD to a trend, $r\,(87) = .19$, $p = .07$, suggesting that an initial diagnosis of depression contributed to the persistence of PTSD in the Numb-Moderate group at 2-year follow up.

### 3.2. Regression analyses

We conducted a series of regression analyses to test the ability of different combinations of PTSD symptoms to predict PTSD diagnoses at follow up. Each analysis tested a different set of independent variables, either (1) total CAPS score; or (2) each of the four symptom groups (avoidance, numbing, re-experiencing, hyperarousal); or (3) scores for one symptom group, and a composite score that was the sum of the other three groups. This last two-variable model enabled us to partially isolate the effect of a symptom group from that of overall severity.

Table 3 shows the results of the regression analyses comparing predictors of PTSD diagnosis at 1- and 2-year follow up, rank-ordered according to $R^2$ values. Regression analysis statistics for the model with the largest $R^2$ value at each follow up are shown in Table 4. Each combination of variables was essentially equivalent in significantly predicting PTSD diagnoses at 1 and 2-year follow up, accounting for 12–15% of the variance in diagnostic status at 1-year follow up and 13–17% of the variance at 2-year follow up.

**Table 3**
Regression analyses predicting PTSD diagnosis with models rank-ordered by $R^2$ value

| Independent variables | Variables in final model | *R* | $R^2$ | S.E. | Final model* *F*(d.f.)) |
|---|---|---|---|---|---|
| One-year follow up | | | | | |
| Two: Av, Com: Rx + Hy + Nu | Com: Rx + Hy + Nu | .38 | .15 | .87 | $F(1, 218) = 37.25$ |
| Four: Rx, Hy, Av, Nu | Rx, Nu | .37 | .14 | .88 | $F(2, 217) = 17.16$ |
| Two: Rx, Com: Hy + Av + Nu | Rx, Com: Hy + Av + Nu | .37 | .14 | .88 | $F(2, 217) = 17.28$ |
| Two: Nu, Com: Rx + Hy + Av | Nu, Com: Rx + Hy + Av | .36 | .13 | .88 | $F(2, 217) = 16.59$ |
| One: total CAPS | Total CAPS | .36 | .13 | .88 | $F(1, 218) = 32.88$ |
| Two: Hy, Com: Rx + Av + Nu | Com: Rx + Av + Nu | .34 | .12 | .89 | $F(1, 218) = 29.15$ |
| Two-year follow up | | | | | |
| Two: Nu, Com: Rx + Hy + Av | Nu, Com: Rx + Hy + Av | .41 | .17 | .80 | $F(2, 154) = 15.86$ |
| Two: Hy, Com: Rx + Av + Nu | Com: Rx + Av + Nu | .38 | .14 | .81 | $F(1, 155) = 25.74$ |
| Two: Rx, Com: Hy + Av + Nu | Com: Hy + Av + Nu | .37 | .14 | .81 | $F(1, 155) = 25.00$ |
| Two: Av, Com: Rx + Hy + Nu | Com: Rx + Hy + Nu | .37 | .14 | .81 | $F(1, 155) = 24.90$ |
| One: total CAPS | Total CAPS | .37 | .14 | .81 | $F(1, 155) = 24.83$ |
| Four: Rx, Hy, Av, Nu | Nu | .36 | .13 | .82 | $F(1, 155) = 23.62$ |

*Note*. Total CAPS = total Clinician-Administered PTSD Scale scores; Com = composite score; Rx = re-experiencing; Av = avoidance; Nu = numbing; Hy = hyperarousal.
* All models were significant, $p < .01$.

**Table 4**
Statistics for the best regression models at each follow up

| Follow up | Predictors | Unstandardized beta | S.E. | Beta | $P<$ | $r$ | Partial $r$ |
|---|---|---|---|---|---|---|---|
| One-year | Com: Rx + Hy + Nu | +.03 | .004 | +.38 | .01 | +.38 | +.38 |
| | Excluded: Av | – | – | −.04 | .50 | +.05 | −.05 |
| Two-year | Nu | .05 | .011 | +.33 | .01 | +.36 | +.34 |
| | Com: Rx + Hy + Av | .02 | .006 | +.20 | .01 | +.25 | +.21 |

*Note*. Com = composite score; Rx = re-experiencing; Av = avoidance; Nu = numbing; Hy = hyperarousal.

For the 1-year follow up, the largest $R^2$ value (.15) was found for the model with two predictors, avoidance symptom scores, and the composite score sum of numbing + re-experiencing + hyperarousal symptoms. However, in the final equation, only the composite score sum significantly predicted PTSD. Avoidance symptoms did not significantly predict PTSD in this or any other equation at either follow up. The regression analysis of the four symptom groups found that only re-experiencing and numbing symptoms significantly predicted PTSD. As shown, these two variables alone predicted essentially as much of the variance in diagnostic status (14%) as the composite score sums did, and slightly more of the variance than total CAPS scores did (13%). Hyperarousal symptoms scores did not significantly predict PTSD at either follow up evaluation. For the 2-year follow up, the largest $R^2$ value (.17) was also found for the two-predictor model, with numbing symptoms scores and the composite score sum of the other three symptom groups as significant predictors in the final equation. The analysis with each of the four symptom groups as independent variables found that only numbing symptoms significantly predicted PTSD. Numbing symptoms alone accounted for only slightly less of the variance (13%) as the composite score sums or the total CAPS scores did (14%).

## 4. Discussion

The broad goal of this study was to provide data on the long-term course of PTSD in WTC disaster workers. One-third of disaster workers had PTSD at 2 years post-attack and one-quarter had PTSD 3 years after the attack. These findings are consistent with previous studies of disaster workers (McFarlane & Papay, 1992) and support recommendation of long-term follow ups because of persistence of PTSD in a significant amount of survivors beyond the first year after a disaster (Norris, Murphy, Baker, & Perilla, 2004; North et al., 2004). The specific goal of the study was to examine the predictive validity of PTSD symptom groups. The results of the cluster analyses and the regression analyses suggest that numbing symptoms in particular could help to identify disaster workers at risk for very chronic PTSD.

Cluster analyses classified four groups, two with moderate levels of PTSD and two with severe PTSD. The Moderate PTSD group had the lowest total CAPS and the lowest numbing symptoms in the sample. Compared to the Numb-Moderate group, it had higher re-experiencing and avoidance, lower numbing and total CAPS, and hyperarousal symptoms of equal severity. The Numb-Moderate group had the lowest re-experiencing and avoidance symptoms in the sample, but numbing symptoms equal in severity to those of the Severe group. The Severe group had the highest re-experiencing and hyperarousal symptoms in the sample, and avoidance symptoms equal to the Moderate and Numb-Severe groups. The Numb-Severe group had the highest numbing symptoms in the sample, but lower hyperarousal and re-experiencing symptoms than the Severe group.

Overall severity was the best predictor of PTSD at 1-year follow up, with the two severe groups showing significantly less remission compared to the moderate groups. The two severe PTSD groups also presented with more depression at index and more Panic Disorder at 2-year follow up, compared to the Moderate group. At the 2-year follow up, overall severity and numbing symptoms were both associated with PTSD. Outcomes for the Numb-Moderate group and the Severe group exemplified equifinality, whereby the pathways of two initially disparate groups converge over time. Despite an initial 20-point difference in CAPS scores, but equally severe numbing symptoms, by the 2-year follow up workers in these two groups did not differ in PTSD prevalence. In contrast, outcomes for the Moderate and Numb-Moderate groups demonstrated multifinality, whereby the pathways of two initially similar groups diverge over time. Although these two clusters began with PTSD of similar severity, by the 2-year follow up PTSD persisted in more workers in the Numb-Moderate group.

Compared to the Moderate group, the Numb-Moderate group was also more likely to be diagnosed with depression at index, though not at any follow up, and partial correlations suggested that the greater prevalence of PTSD at 2 years was partially moderated by initial depression. Group differences in PTSD remission did not appear to be due to differences in attrition/missing data, or differential trauma exposure after the WTC attack. It is unclear why the two numb groups had a significantly greater prevalence of members who had received treatment compared to the Moderate group, but greater receipt of treatment did not appear to account for more remission in the Moderate group.

The regression analyses found that total scores and the various combinations of symptom groups all predicted a similar amount of the variance in diagnostic status at follow up. However, the symptom groups significantly differed in their ability to predict PTSD. Regression analyses with all four symptom groups as independent variables found that only numbing and re-experiencing symptoms predicted PTSD at the 1 year follow up, and that only numbing symptoms predicted PTSD at the 2-year follow up. Re-experiencing and numbing symptoms together predicted the lion's share of the variance in diagnostic status at 1-year follow up, with little differences in $R^2$ values for these two symptom scores, total CAPS scores, or composite scores sums with hyperarousal or avoidance symptoms. At the 2-year follow up, the model with numbing symptom scores and the composite score sum of the other three symptom groups predicted the most variance in diagnostic status. However, numbing symptom scores alone predicted nearly as much of the variance (4% less) and only slightly less of the variance (1%) as the total CAPS score or composite score sums did. Surprisingly, neither avoidance symptoms nor hyperarousal symptoms in isolation predicted PTSD at either follow up.

Results of this study were largely consistent with the association between reduced PTSD remission and a greater prevalence of avoidance and numbing symptoms (classified together) in other samples exposed to mass terrorism (North et al., 2004). The results were also concordant with the finding that of the four symptom groups, PTSD numbing symptoms are the strongest predictor of functional impairment in treatment-seeking trauma survivors (Kuhn, Blanchard, & Hickling, 2003; Malta, Levitt, Martin, Davis, & Cloitre, 2008). Our finding that avoidance symptoms were not strong predictors of PTSD was contrary to our hypothesis, but illustrates the advantage of treating avoidance and numbing symptoms as separate

constructs. Reasons why avoidance symptoms did not predict PTSD diagnosis at follow up in this study are unknown, but the finding might be related to the nature of the trauma and the sample. Foa et al. (1995) suggested that numbing symptoms occur when avoidance fails to contain distress associated with re-experiencing symptoms. Anecdotally, many workers reported that they tried to avoid reminders of the attack, but continued work in the area and media coverage made this impossible. Faced with such ineluctable exposure, disaster workers may have resorted to numbing as a way to manage distress. Reasoning along the same lines, the sample had very chronic PTSD, and it is possible that avoidance would demonstrate a stronger influence on the maintenance of PTSD earlier in the course of the disorder.

Future studies that assess survivors shortly after exposure and then follow them for a few years could test whether such a temporal–functional relationship exists. Some existing evidence to support our interpretation of the findings comes from a large cross-sectional study, in which PTSD symptom profiles with a greater prevalence of numbing symptoms differentiated trauma survivors with and without very chronic (several years duration) PTSD (Breslau et al., 2005). Our finding that numbing symptoms were a stronger predictor of PTSD at the 2-year follow up, compared to the 1-year follow up, and that these symptoms were more severe in groups with a greater prevalence of persons with a history of childhood abuse, are also consistent with the hypothesis that numbing symptoms develop when exposure to trauma or to trauma reminders is chronic and unavoidable.

More research is also needed to clarify whether numbing symptoms reflect the effect of coping with unremitting PTSD, or actually impede remission. This latter interpretation is supported by research showing that patients with more severe numbing respond less well to treatment (Jaycox, Foa, & Morral, 1998; Taylor et al., 2000). McMillen, North and Smith (2000) suggested that survivors with significant avoidance and numbing symptoms might require different interventions from those with primarily re-experiencing and hyperarousal symptoms. Our results suggest that PTSD treatments with interventions that specifically address numbing symptoms, such as behavioral activation (Blanchard et al., 2003; Jakupcak et al., 2006), might be of particular benefit to trauma survivors with very chronic PTSD.

We have noted limitations of cluster analyses, and note here that we did not interpret our results as evidence that a particular profile shape (for example, high numbing combined with low avoidance), *per se* predicts PTSD. However, the results suggest that characterizing the clinical presentation of PTSD in terms of the severity of specific symptom groups can be informative. In addition, our use of cluster analysis and multiple regression highlights the utility of using converging data analysis techniques, which enabled us, in addition to testing predictors, to examine outcomes for actual cases and to clarify the conditions under which symptom groups might help to improve the prediction of unremitting PTSD. We have also discussed the variability associated with different diagnostic methods using the CAPS (Blake et al., 1998) and note here that the results of the study might not generalize to samples in which PTSD was diagnosed with other instrumentation and/or CAPS scoring rules. Future studies should test whether the results replicate when PTSD is diagnosed using different methods. Additional limitations of the study include potential effects of additional trauma exposure on the sample's WTC attack-related PTSD. Although there were no significant differences in trauma exposure after the attack and between evaluations, these analyses were limited by missing data and we cannot definitively rule out this confound. In addition, concurrent PTSD secondary to other traumas was not evaluated. We gave priority to reducing the probability of a Type II error, and therefore did not control for inflated experiment-wise error. The sample resembled disaster workers in other studies (McFarlane & Papay, 1992; North, Tivis, et al., 2002), but the results might not generalize to disparate samples, samples not involved in disaster restoration, or those with less chronic PTSD. Lastly, although overall severity of PTSD and symptom groups predicted remission, amount of variance predicted was small, which indicates that disaster researchers should continue to explore efficient, cost-effective ways to screen for, and predict the persistence of, PTSD and other mental health conditions in the long-term aftermath of disasters.

## 5. Conclusions

Despite limitations of the study, converging results of the cluster and regression analyses suggest that severity of numbing symptoms, as well as overall PTSD severity, predict remission. To summarize evidence for this conclusion, the cluster analysis found that cases with severe PTSD and/or PTSD of moderate severity, but with prominent numbing symptoms, were less likely to remit at follow up, compared to cases with moderate PTSD and less severe numbing symptoms. Regression analyses found that numbing symptoms were the most consistent predictor of remission, and that numbing symptoms alone accounted for essentially as much of the variance in remission scores at did total PTSD symptom scores. Together, the findings suggest that numbing symptom severity may have prognostic utility, especially when the duration of PTSD is greater than 3 years post-exposure and the overall severity level is moderate. Screening programs for disaster restoration workers might be enhanced by using symptom group scores in addition to overall severity to identify persons at risk for very chronic PTSD.

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