Is Gulf War Syndrome Due to Stress? The Evidence Reexamined

Robert W. Haley

Medical policy-makers have concluded that stress from wartime trauma and deployment constitutes an important cause of the chronic physical symptoms observed in US veterans who served in the Persian Gulf War. The author reviewed scientific articles from peer-reviewed journals referenced in the final report of the Presidential Advisory Committee on Gulf War Veterans' Illnesses and conducted a MEDLINE literature search. All reported prevalence rates of post-traumatic stress disorder (PTSD) in Gulf War veterans were defined by critical cutpoints on psychometric scales constructed by summing veterans' responses on standardized symptom questionnaires rather than by clinical psychiatric interviews. Observed PTSD rates varied from 0% to 36% (mean, 9%). Correcting for measurement errors with previously determined values of the sensitivity (range 0.77 to 0.96) and specificity (range 0.62 to 0.89) of the psychometric tests yielded estimated true PTSD rates of 0% for 18 of the 20 reported rates. Mean scores on the Mississippi PTSD scale in all subgroups of Gulf War veterans were within the range of values for well-adjusted Vietnam veterans (50-89) and far below that of Vietnam veterans with psychiatrically confirmed PTSD (120-140). Most PTSD and "stress-related symptoms" reported in studies of Gulf War veterans appear to represent false-positive errors of measurement reflecting nonspecific symptoms of other conditions.
sustained hypertension, fibromyalgia, and chronic fatigue syndrome (2, 3), is a theoretical and popular concept (7, 8) not supported by the preponderance of scientific evidence (9, 10).

In a study of Gulf War veterans from a US Navy mobile construction battalion (“Seabees”), my research group identified three syndromes associated epidemiologically with exposure to neurotoxic combinations of chemicals (11, 12). Although some veterans had elevated scores on a psychometric scale of PTSD, veterans with one or more of the three primary syndromes we identified had more evidence than matched controls of diffuse neurotoxic injury as the primary disease process (13). This led us to wonder whether the stress theory for the etiology of Gulf War-related illnesses might have been accepted prematurely.

MATERIALS AND METHODS

Diagnosis of PTSD

A definitive diagnosis of chronic PTSD requires that all six of the following features be present: 1) occurrence of a specific, severely stressful event beyond ordinary life experiences, 2) intrusive thoughts of re-experiencing the event (“flashbacks”), 3) persistent avoidance of reminder stimuli, 4) symptoms of increased arousal which may interfere with cognition and other mental and physical functions, 5) persistence for more than one month, and 6) impairment of general functioning (5). In contrast, acute stress disorder begins within 4 weeks of the traumatic event and lasts a maximum of 4 weeks (5).

The definitive diagnosis of PTSD is made from a psychiatrist’s or psychologist’s clinical interview, usually following a structured interview technique such as the Structured Clinical Interview for DSM-IV (SCID) (14) or the Clinician-Administered PTSD Scale (CAPS) (14–18). Various psychometric scales, calculated from symptom questionnaires filled out by patients, are used in conjunction with definitive clinical interviews, but these are not considered diagnostic per se (17, 18). Rational scales (i.e., those calculated from questions that ask directly about the symptoms of PTSD) include the Mississippi Scale for Combat-Related PTSD (M-PTSD) (17) the Impact of Event Scale (IES) (19, 20) and the PTSD questionnaire for DSM-IV criteria (D-PTSD) (5, 18). Empirical scales (i.e., those calculated from less specific questions on general test measures for other conditions and found statistically to predict PTSD) include the PK subscale (also called the Keane-Fairbank, or K-F subscale) calculated from items on the Minnesota Multiphasic Personality Inventory (MMPI) or the MMPI-2 (21–23), the War-Zone-Related PTSD scale (24), and the PTSD Checklist-Military (PCL-M) (25).

In 1992, the National Center for Posttraumatic Stress Disorder published a new version of the M-PTSD scale modified for Desert Storm veterans (M-PTSD-DS) (26). The changes involved altering the wording of questions to refer to traumatic situations specific to Operation Desert Shield/Desert Storm, adding three new 5-point questions, and making the wording applicable to both genders (26). The addition of 15 points from the new questions changed the range of the scale from 35–175 for the M-PTSD to 50–190 for the M-PTSD-DS; however, validation studies were not repeated, and cutpoints for defining PTSD were not uniformly moved up (26–30). Sutker et al. (28, 29) estimated that the change would cause a positive bias of eight points on the M-PTSD-DS scale.

Literature review

I reviewed the 16 studies from peer-reviewed scientific journals cited in the Presidential Advisory Committee’s final report in support of the possibility that the Gulf War syndrome was due to PTSD (2, 3). I also performed a MEDLINE search for articles indexed under the National Library of Medicine Medical Subject Headings (MeSH) “stress disorders, post-traumatic” and “stress, psychological” and the text phrase “Gulf War,” which netted three additional articles that addressed etiology. For each article, I recorded whether the subjects were a population- or unit-based sample, the size of the target population, the number and type of subjects studied, the method of subject selection, the participation rate and whether nonparticipants were studied further for possible selection bias, the use of comparison groups, the methods of detecting PTSD, the observed prevalence rates of PTSD, the mean values on the M-PTSD or M-PTSD-DS scales, potential biasing features, and the conclusions.

Estimating true rates

Because the measurement of all published PTSD prevalence estimates in Gulf War veterans involved psychometric PTSD scales, I reviewed the methodological studies in which the sensitivity and specificity of the most commonly used scales had been determined (17, 18, 24). I then estimated the true prevalence rates of PTSD in each study by correcting the observed estimates for the sensitivity and specificity of the psychometric scale used. The relation among these parameters is given by

\[ \hat{p} = pU + (1 - p)(1 - V), \]  

where \( \hat{p} \) is the observed prevalence rate of PTSD, \( p \) the true prevalence rate, \( U \) the sensitivity, and \( V \) the spec-
Ificity, all measured on a scale of 0 to 1 (31). For most diseases and populations where prevalence rates are low (far less than 50 percent), imperfect specificity, which influences the far larger quantity, $1 - p$, has a much greater biasing impact on the observed prevalence rate than the same value of sensitivity, which influences the far smaller quantity $p$.

Rearranging the equation to estimate the true prevalence rate as a function of the observed prevalence rate and the sensitivity and specificity of the scale gives

$$\hat{p}_c = \frac{\hat{p}_u - (1 - V)}{U + V - 1},$$

where $\hat{p}_c$ is the observed prevalence rate of PTSD corrected for known values of sensitivity and specificity, and $\hat{p}_u$ is the original observed value uncorrected for errors in measurement (31).

**Validation studies**

The published studies on PTSD in Gulf War veterans referenced three validation studies. These estimated the sensitivity and specificity for the diagnosis of PTSD for nine of the psychometric PTSD scales (table 1).

In their 1988 study of the M-PTSD scale, Keane et al. (17) administered the M-PTSD to three groups: 30 Vietnam combat veterans who had well-documented PTSD, 30 noncombat Vietnam-era veterans who were receiving inpatient care for nonpsychotic psychiatric illnesses, and 30 well-adjusted Vietnam veterans. They found that on the M-PTSD scale, which ranges from 15 to 175, a cutpoint score of 107 maximized classification accuracy, giving a sensitivity of 0.93 and a specificity of 0.89 (table 1). They found, however, that the distributions of scores in confirmed PTSD patients and in other populations overlapped substantially (figure 1). The further M-PTSD scores were below 107, the more they overlapped those of veterans with other psychiatric disorders and even those from well-adjusted veterans with only functional symptoms (17).

A 1991 publication by Kulka et al. (18) contained two further validation studies on the M-PTSD and

<table>
<thead>
<tr>
<th>Measure</th>
<th>Cutpoint defining PTSD</th>
<th>Keane et al. (17)</th>
<th>Kulka et al. preliminary validation study (18)</th>
<th>Kulka et al. NVRS* sample (18)</th>
<th>Weathers et al. (24)</th>
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<tbody>
<tr>
<td></td>
<td>$U^*$</td>
<td></td>
<td>$V^*$</td>
<td>$U$</td>
<td>$V$</td>
</tr>
<tr>
<td></td>
<td>$U$</td>
<td></td>
<td>$V$</td>
<td></td>
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<tr>
<td>Mississippi PTSD Scale (M-PTSD)</td>
<td>107 or 109†</td>
<td>0.93 0.89</td>
<td>0.94 0.80</td>
<td>0.77 0.83</td>
<td>0.83 0.83</td>
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<tr>
<td>Mississippi PTSD Scale (M-PTSD)</td>
<td>89</td>
<td></td>
<td>0.96 0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Structured diagnostic PTSD interview for DSM-III/IV symptoms (D-PTSD)/item sum</td>
<td>Not stated</td>
<td>0.96 0.73</td>
<td>0.87 0.73</td>
<td>0.22 0.98</td>
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<tr>
<td>Structured diagnostic PTSD interview for DSM-III/IV symptoms (D-PTSD)/DSM-III/IV rules</td>
<td>6 symptoms‡</td>
<td>0.90 0.69 0.72 0.82</td>
<td>0.78 0.78</td>
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<td></td>
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<tr>
<td>Keane-Fairbank subscale of MMPI*</td>
<td>14</td>
<td></td>
<td>0.92 0.62</td>
<td>0.78 0.78</td>
<td></td>
</tr>
<tr>
<td>Keane-Fairbank subscale of MMPI</td>
<td>26</td>
<td></td>
<td>0.78 0.78</td>
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<td></td>
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<tr>
<td>Impact of Event Scale (IES)</td>
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<td>0.92 0.62</td>
<td>0.78 0.78</td>
<td></td>
<td></td>
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<tr>
<td>War Zone-PTSD scale of SCL-90-R*</td>
<td>1.3</td>
<td>0.90 0.65</td>
<td>1.3</td>
<td>0.90 0.65</td>
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<tr>
<td>War Zone-PTSD scale of BSI*</td>
<td>1.3</td>
<td></td>
<td>0.89 0.65</td>
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<td></td>
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<tr>
<td>General Severity Index (GSI) of SCL-90-R (or of the BSI)</td>
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<td>0.86 0.67</td>
<td>1.1</td>
<td>0.86 0.67</td>
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<tr>
<td>25 randomly selected SCL-90-R items</td>
<td>1.1</td>
<td>0.85 0.65</td>
<td>1.1</td>
<td>0.85 0.65</td>
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<tr>
<td>F scale of MMPI</td>
<td>67</td>
<td></td>
<td>0.82 0.57</td>
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<td></td>
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<tr>
<td>Mississippi PTSD Scale-Revised for Operation Desert Storm (M-PTSD-DS)§,¶</td>
<td>89 or 97</td>
<td>0.82 0.57</td>
<td>89 or 97</td>
<td></td>
<td></td>
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<tr>
<td>PTSD Checklist-Military (PCL-M)¶</td>
<td>50</td>
<td></td>
<td>50</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* $U$, sensitivity; $V$, specificity; NVRS, National Vietnam Veterans Readjustment Study; DSM-III/IV, Diagnostic and Statistical Manual for Mental Disorders, 3rd and 4th revisions; MMPI, Minnesota Multiphasic Personality Inventory; SCL-90-R, Symptom Checklist for DSM-III-R; BSI, Brief Symptom Inventory of the SCL-90-R.
† Cutpoints 107 established by Keane et al. (17) and 109 by Weathers et al. (24).
‡ The DSM-III/IV definition requires one re-experiencing symptom, three avoidance symptoms, and two hyperarousal symptoms (5).
§ Wording changed to refer to Operation Desert Shield/Storm, three 5-point questions added, and wording adjusted to make it gender-appropriate; some studies used Kulka's cutpoint of 89 and others empirically increased the cutpoint to 97 to compensate for the increased scale. The revised scale has not been validated.
¶ No published validation study.
Figure 1. Mean scores and standard deviations for the Mississippi Scale for Combat-Related Posttraumatic Stress Disorder (M-PTSD) by diagnosis groups in Vietnam veterans (square markers) from Keane et al. (17) and mean M-PTSD scores from seven studies of Gulf War veterans (circular markers), i.e., Sloan et al. (26), Sutker et al. (28), Perconte et al. (30, 36), Wolfe et al. (33), Ross and Wonders (34), and Southwick et al. (38). PTSD = 30 Vietnam veterans with clinically confirmed post-traumatic stress disorder; PSYCH = 30 Vietnam veterans with inpatient, nonpsychotic psychiatric disorders; and WAV = 30 well-adjusted Vietnam veterans. Solid circles represent high-risk groups (e.g., high combat stress exposure, women) of Gulf War veterans (GWV), and open circles represent low-risk groups. The two highest values for Gulf War veterans were measured with the Mississippi Scale for Combat-Related PTSD modified for Desert Storm veterans (M-PTSD-DS), on which scores may be inflated by as much as 8 points (28, 30). The solid horizontal reference line represents Keane’s cutpoint for defining PTSD (sensitivity = 0.93, specificity = 0.89) (17, 24), and the dashed line represents Kulka’s cutpoint (sensitivity = 0.94, specificity = 0.80) (18).

RESULTS
Methodological differences

The 19 studies were performed in widely differing populations and settings (table 2). Five attempted to measure PTSD in one or more specified military units (28, 30, 32, 33, 38), although in two of these the size of the unit and the means of selecting subjects were not described (28, 33). Four surveyed larger defined veteran populations in Hawaii and Pennsylvania (42–44) and in Iowa (48). Ten studied treatment-seeking or otherwise biased groups of veterans (26, 27, 29, 34–36, 39–41, 45).

Participation rates in the unit- or population-based studies, which could be estimated in eight of the nine studies, varied from 25 percent to 76 percent (mean 41 percent), but none of these included surveys of non-participants to evaluate selection bias (table 2). Six studies compared groups who had been deployed to the Persian Gulf theater of operations with non-deployed veterans (30, 34, 36, 43, 44, 48), and three compared groups exposed to low and high levels of self-reported war zone stress (28, 30, 36).

Estimates of the PTSD rates were reported in 10 studies using eight different psychometric scales (table 2). Versions of the Mississippi PTSD scale were used to estimate PTSD rates in seven studies, and of these studies, four used the original M-PTSD scale (33, 34, 36, 38) and three used the M-PTSD-DS scale (26, 28, 30). Of the four studies that used the original M-PTSD, three used Kulka’s cutpoint of 89 (33, 36, 38), and one used Keane’s cutpoint of 107 (34). Of the three studies that used the M-PTSD-DS, one adopted a cutpoint of 107 (30), one used both 89 and 107 (26), and one raised the Kulka cutpoint of 89 to 97 to
attempt to adjust for the positive bias from added questions (28).

**Observed prevalence rates of PTSD**

In the seven studies that reported prevalence rates of PTSD, the 31 reported rates varied from 0 percent to 36 percent, with a mean of 9 percent (table 2). The magnitude of the prevalence rates was not statistically associated with the psychometric test or the cutpoint used.

**Estimating the true rates of PTSD**

In the seven studies that reported PTSD prevalence rates, 20 of the reported rates were calculated from validated psychometric PTSD scales (26, 28, 30, 33, 34, 36, 38). After using equation 2 to correct for the published values of sensitivity and specificity of the tests (17, 18, 24), I found that estimated true prevalence rates were 0 percent for 18 of the 20 rates (table 2). This suggests that virtually all of the PTSD reported in Gulf War veterans was due to false positive errors of measurement and that the true prevalence rates of PTSD were near zero.

There were two possible exceptions. Sutker et al. (28) found a PTSD prevalence rate on the M-PTSD-DS of 19 percent (corrected rate, 0 percent) in 215 veterans referred by unspecified criteria from five military units (containing possibly as many as 3,000 veterans) for study 4–10 months after the veterans returned from the war. In a subgroup of 110 veterans exposed to high war-zone stress measured by a self-report combat questionnaire administered at the same time as the M-PTSD-DS, the PTSD rate was 36 percent (corrected rate, 22 percent).

Perconte et al. (30) identified five cases of traumatic stress-related illness in 20 members of the 14th Quartermaster unit who survived the SCUD missile attack on their barracks and who were tested within a month of the traumatic event. Only one-third of the unit’s members volunteered to be tested; the psychometric testing followed a week of educational seminars that covered the causes and symptoms of PTSD; and the symptoms substantially diminished after a month of group psychotherapy.

**Mean PTSD scores**

Seven studies reported 16 mean PTSD scores measured by the M-PTSD or M-PTSD-DS (table 2) (26, 28, 30, 33, 34, 36, 38). Analysis of these scores suggested that the number of PTSD-related symptoms was higher in women (33) and in veterans who reported exposure to more war-zone stress (28, 30, 36). The studies, however, differed on whether higher mean scale values were found in veterans deployed to the war zone than in non-deployed veterans (30, 34, 36) and whether scores increased over time after veterans returned from the war (34, 38). The two highest mean PTSD scores for Gulf War veterans (figure 1) were measured with the M-PTSD-DS scale, on which scores may be inflated by as much as eight points (28, 30). Most importantly, the distribution of the 16 mean PTSD scores from studies of Gulf War veterans were entirely in the range found by Keane et al. to be typical of the nonspecific symptoms of well-adjusted Vietnam veterans (50 to 89) and were far below the range of scores (120 to 140) in Vietnam veterans with psychiatrically confirmed PTSD (17) (figure 1).

**DISCUSSION**

The studies reviewed in this paper constitute the main evidence in favor of the theory that physical symptoms in Gulf War veterans are caused by wartime stress (2). The reports of apparently high rates of PTSD and higher PTSD-related symptom scores in deployed veterans than in non-deployed veterans and in veterans exposed to more stressful war-zone experiences led to the belief that large numbers of Gulf War veterans must be suffering from PTSD as well as lesser stress-related symptoms (1, 3, 4).

My reanalysis of these studies, however, shows that, when the sensitivity and specificity of the psychometric scales used to measure PTSD rates were taken into account, virtually all of the apparent PTSD actually represents falsely positive errors of measurement. For example, if a survey of 100 veterans found that 15 veterans exceeded Kulka’s cutpoint of 89 on the M-PTSD (sensitivity of 0.94 and specificity of 0.80), one would expect to have overlooked no more than one veteran with true PTSD but to have falsely attributed PTSD to as many as 20 veterans with symptoms from other causes (equation 1) (31). This means that the apparent prevalence of 15 percent is probably due entirely to the falsely positive errors of measurement on the psychometric PTSD scale and that the true rate of PTSD is indistinguishable from zero (equation 2) (31).

Moreover, the mean scores on the Mississippi PTSD scales in various subgroups of Gulf War veterans were entirely in the range found in well-adjusted Vietnam veterans and far below the range expected in Vietnam veterans with psychiatrically confirmed PTSD (17). This was true not only in population samples of Gulf War veterans but also in subgroups who reported that they had the most combat experiences. Even the two highest mean scores from measurements made with the M-PTSD-DS scale, whose distributions were inflated by the addition of new questions tailored for Gulf War veterans (26, 28, 29, 34), fell just outside one standard deviation above the
<table>
<thead>
<tr>
<th>Study</th>
<th>Publication year</th>
<th>Population or unit-based sample</th>
<th>No. of subjects contacted</th>
<th>No. of participants (% of unit or population)</th>
<th>Studied nonparticipants?</th>
<th>PTSD-defining method/cutoff</th>
<th>Observed PTSD rate (%)</th>
<th>True PTSD rate (%)</th>
<th>Estimating SEM* or M-PTSD*</th>
<th>Mean ± SEM* or M-PTSD-DS*</th>
<th>Conclusions or potentially blinding features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labbate and Snow (32)</td>
<td>1992</td>
<td>Unit</td>
<td>97 in an infantry company</td>
<td>56 (58)</td>
<td>No</td>
<td>None</td>
<td>Yes/no questionnaire on nightmares, etc.</td>
<td>NS*</td>
<td>0</td>
<td>61.8 ± 0.3</td>
<td>67.7 ± 1.1</td>
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<td>Wolfe et al. (27)</td>
<td>1992</td>
<td>No</td>
<td>262 women ODS* veterans</td>
<td>76 (-)‡</td>
<td>Yes</td>
<td>None</td>
<td>Pre-war M-PTSD/DS-107 Post-war SCL-90-R,* VUF*</td>
<td>NS</td>
<td>0</td>
<td>66.0 ± 1.0</td>
<td>89.1 ± 2.3</td>
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<tr>
<td>Wolfe et al. (33)</td>
<td>1993</td>
<td>Units (no. in units not reported)</td>
<td>ODS Reunion Survey of units at Ft. Devens, Massachusetts</td>
<td>2,344 (-)</td>
<td>No</td>
<td>Men</td>
<td>M-PTSD/DS-89</td>
<td>4</td>
<td>9</td>
<td>4.9</td>
<td>0.94</td>
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<tr>
<td>Sutker et al. (28)</td>
<td>1993</td>
<td>Units (no. in units not reported)</td>
<td>306 referred from 5 units and 60 non-deployed volunteers</td>
<td>215 (-)</td>
<td>Yes</td>
<td>All deployed High war stress Low war stress High war stress Low war stress</td>
<td>M-PTSD-DS/97§</td>
<td>19</td>
<td>22</td>
<td>0</td>
<td>66.2 ± 1.5</td>
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<td>Sutker et al. (29)</td>
<td>1995</td>
<td>No</td>
<td>1,423 veterans who underwent a psychological debriefing</td>
<td>775 (-)</td>
<td>No</td>
<td>None</td>
<td>M-PTSD-DS/97§ or PCL-M/&quot;sufficient symptoms&quot;</td>
<td>17</td>
<td>0</td>
<td>76.4 ± 1.3</td>
<td>54.8 ± (NS)</td>
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<td>Ross and Wonders (34)#</td>
<td>1993</td>
<td>No</td>
<td>350 deployed 16 non-deployed</td>
<td>251 (-)</td>
<td>No</td>
<td>Deployed Not deployed</td>
<td>M-PTSD with 2 added questions/107</td>
<td>5</td>
<td>0</td>
<td>76.4 ± 1.3</td>
<td>54.8 ± (NS)</td>
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<td>Leastz et al. (35)#</td>
<td>1993</td>
<td>No</td>
<td>32 with post-Vietnam PTSD</td>
<td>32 (-)</td>
<td>No</td>
<td>None</td>
<td>IES*</td>
<td>–</td>
<td>–</td>
<td>76.4 ± 1.3</td>
<td>54.8 ± (NS)</td>
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<td>1993</td>
<td>No</td>
<td>Not stated</td>
<td>591 (-)</td>
<td>No</td>
<td>ODS Combat ODS Europe Not deployed</td>
<td>M-PTSD/DS-89</td>
<td>16</td>
<td>0</td>
<td>71.4 ± 0.9</td>
<td>62.1 ± 2.5</td>
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<td>Perconte et al. (39)</td>
<td>1993</td>
<td>Unit</td>
<td>75 members of 14 Quarter master unit</td>
<td>28 (37)</td>
<td>No</td>
<td>SCUD attack Guard duty Non-deployed</td>
<td>M-PTSD-DS/107 and interview with a psychologist</td>
<td>25</td>
<td>0</td>
<td>87.2 ± 5.2</td>
<td>63.3 ± 6.3</td>
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<td>Southwick et al. (37, 38)</td>
<td>1993</td>
<td>Units</td>
<td>240 in 2 units</td>
<td>62 (25)</td>
<td>No</td>
<td>None</td>
<td>M-PTSD/89 D-PTSD/6 DSM symptoms</td>
<td>6</td>
<td>8</td>
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<td>63.6 ± 1.9 (6 mo)</td>
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<td>Gender</td>
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<td>Specificity</td>
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<tr>
<td>Sloan et al. (28)</td>
<td>1995</td>
<td>No</td>
<td>None</td>
<td>66 veterans at a VAMC</td>
<td>M-PTSD-DS/107</td>
<td>0</td>
<td>0.93 ± 0.99</td>
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<td>M-PTSD-DS/89</td>
<td>3</td>
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<td>No</td>
<td>None</td>
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<td>Not stated</td>
<td>Not published</td>
<td>Not published</td>
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<tr>
<td>Iowa Study (48)#</td>
<td>1997</td>
<td>No</td>
<td>None</td>
<td>All of state's 28,968 veterans of 4,886</td>
<td>PCL-M/50</td>
<td>1.9–2.0</td>
<td>0.7–1.1</td>
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* U, sensitivity, and V, specificity, measured by Keane et al. (17), Kulka et al. (18), and Weathers et al. (24); SEM, standard error of the mean; NS, not stated; ODS, Operation Desert Shield/Storm (deployed veterans served in the ODS theater of operations and non-deployed veterans remained in the United States); M-PTSD, Mississippi Scale for Combat-Related PTSD (17); M-PTSD-DS, Mississippi Scale for Combat-Related PTSD, modified for Desert Storm veterans by making wording more specific to ODS, adding three questions and making wording gender-appropriate (26) (validation and establishment of critical cutpoint to define PTSD were not repeated after these changes were made); SCL-90-R, Symptom Checklist, a test of general psychological function from which nine scales of clinical disorders (e.g., somatization, obsessive-compulsive, depression, etc.) are calculated (24); VUF, Veterans Updated Form, a brief self-report measure of change in the PTSD symptoms: re-experiencing, avoidance/numbing, and hyperarousal (27); GSI/BSI, General Severity Index Is a measure of the current level of general psychologic distress and is calculated from the Brief Symptom Inventory (short version of SCL-90-R) (51); PCL-M, PTSD Checklist-Military, an empirical PTSD scale from questions routinely asked on the SCL-90-R (48); D-PTSD, PTSD questionnaire for DSM-III-R symptoms of PTSD; six PTSD symptoms required to diagnose PTSD (18), including one from the re-experiencing/intrusive group, three from the avoidance group, and two from the increased arousal group; IES, Impact of Event Scale, a measure of "intrusion" and "avoidance" (but not the hyperarousal component of PTSD) anchored to a specific life event, considered a measure of PTSD (19, 20); WRAIR-PTSD, Walter Reed Army Institute of Research PTSD scale, composed of PTSD questions from IES and BSI, with wording referring to ODS (it has not been validated) (44).

† From equation 2, i.e., corrected estimate of the true prevalence rate, $p_2 = (p_1 - (1 - V))(U + V - 1)$.

‡ Increased the original cutpoint of 69 up to 97 to compensate for the positive bias from three questions added in the revised M-PTSD-DS version.

§ The sensitivity and specificity estimates determined for the M-PTSD may not apply to its revised versions such as the M-PTSD-DS.

# Not cited in the final report of the Presidential Advisory Committee on Gulf War Veterans' Illnesses (2).

** A semi-structured Interview by a trained psychologist is considered to be highly accurate.
mean of well-adjusted Vietnam veterans’ scores, and adjusting the values to correct for the scale inflation would put their corrected means (approximately 80 and 81) well within the range expected with well-adjusted veterans (17).

Two studies reported PTSD rates that remained elevated after correcting for the accuracy of the measurements. The high rates in the initial study of Sutker et al. (28) in a subgroup that reported high levels of war-zone stress may have been due to preferential referral of symptomatic veterans for testing, because neither the referral criteria nor the participation rate were reported. The five cases of PTSD identified by Perconte et al. (30) in 20 members of the 14th Quartermaster unit were identified within one month of the missile attack on their barracks and improved within one month with treatment. This time course suggests an acute, self-limited stress disorder (5) rather than chronic PTSD. Because the psychometric testing followed a week of educational seminars that covered the types of traumatic experiences that cause PTSD and the symptoms to be expected, and because only one-third of the unit’s members were tested, the PTSD scores and rates may have been exaggerated by information bias (as acknowledged by Perconte et al.) and by selection bias.

If Gulf War veterans are not generally suffering from PTSD—and my reanalysis suggests that they are not—what symptoms are being measured by the mild to moderate elevations of the psychometric PTSD scales described in the 19 studies? In their original validation study of the M-PTSD scale, Keane et al. (17) demonstrated that M-PTSD values below 107 do not distinguish the symptoms of PTSD from those of nonspecific psychiatric illnesses and even from the functional symptoms of well-adjusted veterans (figure 1). In other words, the studies on PTSD covered in this review demonstrate only that deployed veterans continue to have more nonspecific symptoms than non-deployed veterans, a fact also demonstrated by the population studies of both physical and psychological symptoms in Gulf War veterans from Pennsylvania and Hawaii (42) and Iowa (48). The excess of symptoms in deployed veterans could just as well be due to chronic neurotoxicity from exposure to chemicals (11-13), which may mimic psychiatric conditions (12, 49, 50), as from a wide range of other medical or psychological etiologies.

Ever since the diagnosis of PTSD was added to DSM-III in 1980 (5), the number of disability claims filed under the workers’ compensation system that cite PTSD from stressful events in the civilian workplace has been increasing (6). Plaintiffs and their attorneys have tended to press claims that involve alleged traumatic events or stress-related symptoms which are insuffciently severe or specific to meet the DSM criteria for PTSD (5). In reaction to such obvious abuses, legislatures and courts have increasingly required formal diagnoses of PTSD from psychiatrists or psychologists who must adhere strictly to the DSM criteria (5, 6). In the debate over the etiology of illnesses in Gulf War veterans, we find the positions reversed. It is now the governmental interests that are invoking the PTSD explanation with sub-diagnostic criteria (1-4), while the veterans, analogous to the plaintiffs, are resisting it.

Finally, the argument for the stress theory by analogy to the postwar syndromes of past wars, made by Hyams et al. (1), must be challenged. Even though medical investigations into the causes of postwar syndromes following the American Civil War, World Wars I and II, and the Korean War may have been substantial for their day, conditions experienced in each war were different and researchers did not have access to the types of epidemiologic and neurobiologic research methods required to discover the nature and causes of those complex problems. Following the Vietnam War, meaningful epidemiologic research for physical causes was not undertaken until 10 years after the end of the war. Failing to find physical explanations with the primitive methods of the past and at remote time intervals from the wartime exposures, officials adopted psychological explanations by default. Undoubtedly those postwar “syndromes” represented complex mixtures of diverse conditions, perhaps some physical and others psychological, that were never disentangled. In my view, until plausible theories of physical causes are thoroughly studied, it is hazardous to jump to psychological explanations for the physical symptoms of Gulf War veterans on the basis of incompletely researched conclusions from prior wars.

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REFERENCES