Psychiatric Symptoms and Cognitive Appraisal following the Near Sinking of a Research Submarine

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Objective: This study assessed the stress reactions of a submarine crew forced to abandon their vessel in high seas after flooding and fire damaged their ship. Methods: The remaining crew members (n = 22) were surveyed 7 months after the incident regarding exposures, initial emotional responses, peritraumatic dissociation, subsequent life events, current safety appraisal, and current symptoms of posttraumatic stress disorder (PTSD) and depression. Results: At 7 months, 9.1% met criteria for PTSD and none met criteria for depression. Higher levels of depressive symptoms were associated with previous traumatic exposures, subsequent life events, and higher levels of PTSD symptoms; higher levels of PTSD symptoms were associated with greater peritraumatic dissociation and initial emotional response. Conclusion: Acute exposures of highly trained professionals to potentially fatal events may not result in high levels of posttraumatic symptoms. Previous and subsequent life events may play a more significant role in the level of postdisaster symptoms.

Introduction

Relatively few studies examine psychological reactions to severe traumatic events in individuals trained to respond to potential disasters associated with their occupation.[1,2] Multiple studies have assessed rates of posttraumatic stress disorder (PTSD) after prolonged combat.[3] However, studies of stress reactions in military members exposed to single, but potentially fatal, accidents during peacetime are limited. The role of previous and subsequent life events on the degree of psychological response to a single accident is also not frequently studied.

U.S. Navy personnel assigned to ships routinely receive specialized disaster response training, such as fire fighting and damage control. Those who work in high-risk environments such as the submarine service are rigorously screened for potential emotional difficulties, are extensively trained in the operating systems of their ships, and routinely practice responses to potential disasters specific to their shipboard environment. Research with this population is very limited, despite the dangers inherent in their operational responsibilities and the potentially hazardous nature of submarine escape procedures.[4]

Studies of Norwegian, U.S., and South African submarine personnel have indicated that personality traits and/or habitual coping styles may explain how submarine crew members are able to cope with chronic stress inherent to their occupation.[5-7] A Norwegian study of three submarine crews exposed to different peacetime maneuver accidents reported more posttraumatic stress symptoms in exposed subjects as compared with nonexposed crew members. The accidents involved collisions while submerged, but the crews did not have to abandon ship.[8]

Our study focuses on the crew of a U.S. Navy research submarine forced to abandon ship in heavy seas following flooding and shipboard fires. In May 2002, the *USS Dolphin* was surfaced during training exercises 100 miles off the California coast. The ship was traveling in 11-foot ocean swells when an equipment failure allowed approximately 80 tons of 57°F seawater to enter the crew spaces. Water shorted out electrical equipment, created electrical fires, and caused smoke and toxic fumes to spread throughout the ship. Electrical failures caused pumps to fail. Unable to breathe in the toxic air, the crew was forced to abandoned ship. Some members were swept overboard by high seas and some were in the water for extended periods of time. All members were rescued and medically assessed upon transport to shore. Some suffered from hypothermia and others from minor injuries and were treated acutely. No member required hospitalization and none was noted to have overt psychological symptoms requiring immediate treatment, based upon examination by the medical officer. A group critical incident (CI) debriefing of the crew was held 3 days after the incident, and all crew members attended. The debriefing was typical of what is offered to victims of civilian or medical disasters. No other CI services were performed.

To better understand the effects of this potentially fatal event at sea, we examined history of previous trauma, exposure at the time of the event, peritraumatic dissociation, initial emotional response, subsequent life events, and demographic factors as possible risk factors for PTSD, depression, and attitudes 7 months after the event.

Methods

Subjects

The *USS Dolphin* had a crew of 44 at the time of the incident. When the ship was returned to port for an extended period of repair, one-half of the crew were reassigned elsewhere based on overall U.S. Navy needs. These reassignments were not based on medical reasons or requests to transfer before the end of a tour. At 7 months following the event, 22 of the original crew remained. After review and approval by the Institutional Review Board, we contacted the remaining crew and offered them the opportunity to participate in the study. To preserve anonymity, the Institutional Review Board waived the requirement for written informed consent. Participants were informed that they might experience emotional difficulties recalling the events of

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the accident. They were provided several potential referral sources in the event they experienced significant distress. Participants completed the study anonymously on a computer in their work area. Data were collected via Internet transfer and entered into a database for analysis. We received 22 responses, all males. The average age was 29.95 years (SD = 8.13 years), the average length of assignment to the ship was 23.64 (SD = 15.13) months, and duration of active naval service was 10.50 (SD = 7.94) years. Ten (45.5%) individuals were married. The group was predominately Caucasian (n = 16, 72.7%). Most had a high school education or some college credits (n = 20, 90.9%); only one (4.5%) had a college degree, suggesting that approximately 95% were enlisted personnel.

Assessments

PTSD, Depression, and Present Attitudes of Safety and Retention

PTSD was assessed using the Impact of Events Scale Revised (IES-R), a well-validated and reliable measure.[9] Similar to others,[10–12] we created a binary PTSD "caseness" indicator based on endorsement of symptoms following the DSM-IV criteria indicating endorsement on the IES-R of one intrusion symptom, three avoidance symptoms, and two hyperarousal symptoms. This method of determining caseness is a modification from the original use of the IES-R and identifies those with subsyndromal symptoms of PTSD as well as those who would meet criteria during a clinical evaluation. The IES-R total score (range, 22–110) was also used to assess for association of PTSD symptoms with other variables for individuals who did not meet criteria for the disorder. Depression was assessed using the Patient Health Questionnaire Depression Scale (PHQ-9).[13] Caseness for depression is present when five or more of the nine symptoms have been present at least "more than half the days" in the past 2 weeks and one of the symptoms is depressed mood or anhedonia. Severity of depressive symptoms was measured with the sum of the responses to the PHQ-9 with nine items scored from 0 ("not at all") to 3 ("nearly every day"). A score of 10 or more indicates the potential need for treatment.

Current Attitudes Concerning Further Submarine Service

Perceived safety and retention attitudes were assessed using three questions: (1) What is the current level of safety in performing duties aboard the ship? (2) Did the incident lead you to consider a transfer? (3) Did the incident lead you to consider retirement or getting out of the Navy. Each item was scored on a 5-point Likert scale (1, "not at all" through 5, "extremely").

Trauma Exposure, Peritraumatic Dissociation, and Initial Emotional Response

Exposure during the event was assessed by three items: a sensory exposure scale, time for the subject to get onto the deck following the "abandon ship" order, and total time spent in the ocean before rescue by the other ship. The sensory exposure scale included seven items: (1) saw water pouring in through the hatch; (2) saw water pouring through your spaces; (3) saw/heard the electrical panels shorting, (4) inhaled smoke or gases before donning breathing apparatus; (5) found yourself in darkness, unable to fine your way around; (6) have difficulty finding your way off of the ship; and (7) were at any time trapped in a passageway, ladder, or hatchway. Each item was endorsed "yes" or "no," and the scale score was the sum of "yes" endorsements (scale range, 1–7). Peritraumatic dissociation at the time of the attack was measured using the 10-item Peritraumatic Dissociative Experiences Questionnaire,[14] with a scale range from 0 to 40. Initial emotional reaction to the attack was assessed by using the sum of the responses to three items: "During the incident did you feel" (1) frightened, (2) anxious, and (3) horrified. Each item was scored on a 5-point Likert scale from 1,"not at all" to 5,"extremely" (scale range, 3–15, Cronbach α = 0.74). Fear of death or serious injury was assessed by using the sum of "yes " responses to three questions: "During the incident did you" (1) feel in physical danger, (2) fear you would die aboard the ship, and (3) fear you would drown during the transfer/rescue (scale range, 0–3).

Previous Trauma Experience and Subsequent Life Events

Previous trauma was assessed using five items asking about previous life experiences that caused fear of death or injury (serious accident, natural disaster, threatened with a weapon, molested/raped, and previous fire, flooding, or collision at sea). Endorsement of any item represented previous exposure. Exposure to life events subsequent to the accident was assessed by a 17-item scale previously used to study the effects of common life events on the psychological symptoms reported by shipboard deployed Navy personnel.[15] Example questions included: "Which of the following have you experienced since the flooding incident": (1) detention in jail, (2) death of a close friend, and (3) marital separation. The life experiences scale is the sum of "yes" responses (scale range, 0–17).

Statistical Analyses

Potential risk factors for PTSD and depression were examined against categorical variables individually using binary logistic regression, with each variable entered into the model as categorical. The Mann-Whitney U test was used to evaluate differences in means for continuous variables. Pearson correlations were used where appropriate to assess relationships among continuous demographic, exposure, and initial response variables after examination to exclude the presence of outliers and evidence of a linear relationship. Significance level was set at p = 0.05. Statistical analysis was performed using SPSS for Windows (Chicago, Illinois).

Results

Seventeen individuals (77.3%) experienced at least one of the listed sensory exposures during the incident. The mean number of exposures was 3.14 (SD = 1.52). The mean time to abandon ship was 11.28 minutes (SD = 8.97) and the mean time in the water was 16.50 minutes (SD = 26.55). The mean of initial emotional response scale was 7.14 (SD = 2.39, scale range, 3–15). Thirteen individuals (68%) endorsed at least one perception of potential serious injury or death during the accident. The mean number of concerns was 1.04 (SD = 1.09, range, 0–3). The mean score on the Peritraumatic Dissociative Experiences Questionnaire was 2.67 (SD = 2.92, scale range, 0–40). Sixteen subjects (71.4%) reported at least one symptom of dissociation.

The most commonly reported symptom was a distorted sense of the passing of time, "things seemed to be happening in slow motion" (endorsed by 12 individuals (54.5%, mean score = 0.95, SD = 1.05, item scale range = 0–4). Two items (a changed sense of one's own body and feeling disoriented) were not endorsed by any subject.

Seven subjects (32%) endorsed at least one previous traumatic experience. The nature of previous exposures was as follows: five had been confronted with a weapon; four had been in a serious motor vehicle accident; one had been in a natural disaster; one had been in a fire, flooding, or collision at sea incident; and none reported previous rape or molestation. Eleven individuals (50%) endorsed at least one stressful life event in the period following the accident. The mean number of subsequent life events was 0.91 (SD = 1.11, scale range, 0–17).

Two individuals (9%) endorsed symptoms consistent with PTSD. The mean IES-R score of PTSD symptoms was 28.48 (SD = 8.14, scale range, 22–110). No individual met criteria for depression; the mean PHQ-9 score was 1.95 (SD = 2.37, scale range, 0–36).

Subjects with PTSD experienced fewer sensory exposures during the event (mean = 1.00, SD = 0.00) than those without the disorder (mean = 3.35, SD = 1.42, $U = 3.00$, $Z = -1.99$, $p = 0.047$). Comparisons of those with PTSD and those without the disorder revealed no association with the presence of any previous trauma exposure, peritraumatic dissociation, time trapped on the ship, time in the water, initial emotional response, concerns about death, severity of depressive symptoms, current perceived safety, consideration of transfer, retention, subsequent life events, age, length of service aboard the ship, or years of naval service.

Pearson bivariate correlations revealed associations between current PTSD symptoms and peritraumatic dissociation ($R = 0.66$, $p = 0.001$), initial emotional response ($R = 0.624$, $p = 0.003$), and severity of current depressive symptoms ($R = 0.588$, $p = 0.006$). There were no associations between current PTSD symptoms and previous exposures, exposures during the accident, concerns about death, time trapped on the ship, time in the water, subsequent life events, age, length of service aboard the ship, or years in the Navy.

Current depressive symptoms were associated with current PTSD symptoms ($R = 0.588$, $p = 0.006$), number of previous trauma exposures ($R = 0.543$, $p = 0.013$), and number of subsequent life events ($R = 0.464$, $p = 0.039$). There were no associations between current depressive symptoms and exposures during the accident, initial emotional response, peritraumatic dissociation, concerns about death, time trapped on the ship, time in the water, age, length of service aboard the ship, or years in the Navy.

Perception of current safety aboard the ship was negatively correlated with time of service aboard the ship ($R = -0.686$, $p < 0.0{,}005$). Consideration of potential transfer was correlated with minutes of exposure in the water ($R = 0.973$, $p < 0.0{,}005$). Consideration of leaving the Navy was correlated with previous trauma exposures ($R = 0.451$, $p = 0.035$) and subsequent life events ($R = 0.570$, $p = 0.006$). There were no other associations between these variables and the exposure, emotional response, symptom, and demographic variables outlined above.

Discussion

Although this group experienced high levels of exposures and concerns of possible death, these individuals endorsed surprisingly low rates of PTSD (including subsyndromal PTSD), levels of peritraumatic dissociation, and depression. Since we used a method of interpretation of the IES-R designed to maximize the sensitivity of the instrument, the actual rate of clinically significant PTSD would be even lower. Such unusually low rates may be attributable to several factors: the crew members were volunteers, highly selective, regularly drilled for this type of disaster and the experience occurred within a highly familiar environment. Previous studies indicate that both general disaster training and specialized training are associated with lower levels of psychological distress following subsequent disasters.[16] Platform-specific training within the U.S. Navy typically includes a disaster exposure component, both in vitro (as in simulators, videos, discussions) as well as in vivo exposures (such as smoke exposure, flooding, and confusion situations).

Despite the difficulties inherent in research examining trauma due to disaster, we were able to recruit all of those 22 crew members involved in this disaster who remained assigned to the ship. Their responses were anonymous, a critical factor when assessing those assigned to submarine duty where PTSD and depression could be grounds for reassignment. As a result of the small sample size and the low rate of PTSD discovered, potential analysis and subsequent conclusions are necessarily limited to those 22 remaining crew members and should not be interpreted as a prevalence rate for the entire crew. Unfortunately time and resources did not permit tracking of the crew who transferred to request their participation in the study, although the authors acknowledge such information would have been valuable.

Despite the small number of those acknowledging symptoms of PTSD in this sample (9.1%), this rate is similar to those who report PTSD following other single episode disasters of short duration.[17] Given the high threat of death or serious injury, a higher rate of PTSD and peritraumatic distress would be expected in a civilian population.[18]

The relatively low degree of peritraumatic dissociation is consistent with previous studies which showed that more highly screened, better trained, and experienced military members have lower levels of dissociative symptoms than age-matched peers with less experience and training when exposed to the same high stress environment.[19] Those studies also demonstrated a consistent finding of an altered perception of the passing of time. The fact that no subjects endorsed a sense of disorientation despite the flooding, fires, toxic fumes, and fear of potential death indicates the value of extensive, platform-specific disaster training.

PTSD and PTSD symptoms were found to be unrelated to sensory exposures during the incident. This may be the result of the small sample size and the extremely high levels of exposure experienced by all in the sample. Higher rates of PTSD are commonly associated with the degree of exposure to trauma in populations with greater variance of exposure. The association among current PTSD symptoms, peritraumatic dissociation, initial emotional response, and current depressive symptoms is consistent with previous studies. This suggests that within groups with high exposure during a short-lived traumatic event,

the emotional impact of the event and possible difficulty in cognitive processing of the event may have a stronger effect than the specific number of exposures. These findings are consistent with a recent study of the survivors of the terrorist attack on the Pentagon in September 2001.[12]

Current depressive symptoms were associated with previous and subsequent life events rather than with exposures or emotional reactions at the time of the accident. This finding suggests the need to evaluate for both previous events and subsequent life events when studying the psychological symptoms in individuals exposed to traumatic events.

Current perceived safety aboard the ship was rated as high, and few had considered transfer or leaving naval service. Lower perceived safety was associated with less time and less familiarity with the ship rather than exposures and emotional responses at the time of the accident. This is consistent with the concept of training and experience as mitigating factors in reducing the psychological impact of an isolated event. The association between consideration of possible transfer and time spent in the water suggests that some exposures did have a significant impact on some individuals. It is also significant that this aspect of the accident was an area in which there had been less training and less preparation for that potential threat. Consideration of leaving naval service was associated with previous and subsequent life events rather than the events at the time of the accident. This suggests that career choices may be related more to events outside the scope of service than specific threatening events encountered during naval service.

This study confirms the findings of previous studies. Individuals who volunteer for work in high-risk situations are carefully screened, receive training to respond to specific disasters, and are less likely to experience traumatic sequelae following a disaster than those who lack such training. Subsequent research must therefore consider these factors when exploring trauma as a result of life-threatening disasters.

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