Effect of Elective Surgery on Subjective Health in Veterans With Chronic Posttraumatic Stress Disorder

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Posttraumatic stress disorder (PTSD) is common, is often chronic, and has been associated with greater risk of postoperative mortality in veterans. The purpose of this study was to determine if elective outpatient surgery had a persistent effect on the physical or mental health of veterans with chronic PTSD. A longitudinal, quasi-experimental study was conducted that followed up 60 veterans with chronic PTSD over 12 weeks. Self-reported physical and mental health, depressive symptom severity, and posttraumatic symptom severity were measured in 29 veterans undergoing outpatient elective surgery and 31 veterans not having elective surgery (controls). Data collection was performed at baseline and repeated 1, 4, and 12 weeks after surgery or enrollment. At base-

line, both surgical and control subjects reported poor physical and mental subjective health status. After surgery, surgical group subjects reported mean age- and gender-adjusted reductions of 3.9 points on the Physical Component Summary score and 2.9 points on the Mental Component Summary score of the Veterans Rand 36-item Health Survey, which resolved by 4 weeks after surgery. These findings suggest that veterans with PTSD were at greater risk of mortality because of poor baseline health, but did not demonstrate persistent decline in health following common elective surgical procedures.

Keywords: Elective surgery, mental health, posttraumatic stress disorder, PTSD, veterans.

Posttraumatic stress disorder (PTSD) is common,[1-6] can be chronic,[7] and has been associated with greater risk of postoperative mortality.[8] Posttraumatic stress disorder is an anxiety disorder characterized by avoidant behavior, physiological reactivity, emotional numbing, intrusive thoughts, and unwanted recurrent memories that develop after exposure to a traumatic event and persists for at least 1 month.[9] Approximately 6.8% of Americans[1] and 9% to 43% of veterans will develop PTSD at some point in their lives,[2-6] and as many as half of these patients may never be free from symptoms despite receiving treatment.[10] Despite the prevalence of PTSD, few published studies have examined the effects of noncardiac surgery on patients with preexisting PTSD. In a sample of veterans undergoing gastric bypass surgery, PTSD did not affect length of hospital stay, the incidence of postoperative complications, or the mean amount of weight lost after 1 year.[11] However, a retrospective study of veterans with PTSD reported that they were at least 3 times more likely than veterans without PTSD to die within 1 or 5 years of surgery.[8] Therefore, the causal process that links PTSD to mortality in this population was not captured by the traditional postoperative outcome measures such as hospital length of stay, complication

rates, or surgical diagnosis-related hospital readmission.

The long-term effects of PTSD may confound comparisons of health and mortality between patients with and without PTSD. Outpatients with PTSD report greater than national average prevalence of diabetes, asthma, stroke, myocardial infarction, cancer, and liver cirrhosis.[12,13] The relationship between PTSD and the accumulation of these chronic conditions is likely mediated by health risk behaviors. Patients with PTSD report little physical exercise and a greater than national average prevalence of tobacco use, drinking, and drug use.[13,14] Patients with PTSD also demonstrate greater prevalence of depression, likely because the disorders have overlapping symptoms and may share a common genetic liability.[15] Studies have reported a prevalence of comorbid depression in 36% to 61% of patients with PTSD, compared with 3.5% to 26% of patients without PTSD, and depression is an independent predictor of mortality in older adults.[16] The presence of these comorbidities and health risk behaviors would likely result in functional disability and place any patient at greater risk for poor outcomes after surgery regardless of PTSD status.[17]

The comorbidities and health risk behaviors associated with PTSD are risk factors for mortality regardless of exposure to surgery. Studies of Vietnam-era veterans

have demonstrated that those with PTSD were more likely to die from cardiovascular and external causes, including suicide, homicide, and accidents, than those without PTSD.[18-21] Therefore, studies that estimate the risk of postoperative mortality in patients with PTSD through comparison with patients without PTSD may suggest that surgery is harmful to patients with PTSD, when actually their health is worse than that of their peers without PTSD but unchanged or improved by surgery. This is an important distinction, because some surgeries are elective and may be deferred indefinitely. That knowledge gap may be addressed by comparing patients with PTSD who undergo elective surgery with patients with PTSD who do not undergo surgery.

However, nonsurgical patients do not generate postoperative outcomes such as hospital length of stay, surgical complication rates, or surgery-related hospital readmission rates. Patient age and PTSD symptom duration were intercorrelated (r = .91; P <.001), so PTSD symptom duration was excluded as a covariate in further analyses because of the risk of multicollinearity. Mortality would be one such criterion; however, approximately 900 subjects evenly divided between those with and without PTSD would need to be followed up for a year to detect a doubling in annual mortality due to PTSD.[22,23] An alternative is to measure a patient attribute that has predictive validity for mortality, such as subjective health status.[24] Subjective health is the patient's assessment of his or her own health status, including physical, mental, and social well-being. Studies have demonstrated that outpatients with worse or declining subjective health demonstrate greater risk of mortality.[24-26]

Subjective health status provides a means to quantify the effect of surgery on the patient with PTSD. Any patient undergoing elective surgery should experience an initial decline in subjective health status, followed by a return to baseline after a few weeks or months.[27-29] If patients with PTSD are harmed by elective surgery or do not recover from elective surgery, they should display postoperative subjective health declines from which they do not recover. Therefore, a longitudinal, quasi-experimental, nonequivalent control group study was conducted to test whether a group of patients with chronic PTSD would demonstrate a sustained decline in physical or mental health status and greater increases in posttraumatic or depressive symptom severity after surgery compared with a group of patients with chronic PTSD who did not undergo elective surgery. Patients in both groups were recruited and followed for 12 weeks after surgery or enrollment.

Materials and Methods

• *Setting and Sample.* Following institutional review board approval, subjects were recruited at a large Veterans Affairs Medical Center (VAMC) in the south-

east. The sample consisted of patients who met the following inclusion criteria: (1) were aged at least 18 years with military service-connected lifetime or current PTSD status documented in the Veterans Affairs Computerized Patient Record System; (2) were eligible for care at the VAMC; (3) were noninstitutionalized; (4) could read and understand the English language as evidenced by an ability to verbalize understanding of the consent form to the investigator and; (5) were ASA Physical Status Classification 1 to 3. Exclusion criteria included surgery within the prior year; history of dementia, organic mental disorder, or schizophrenia; current manic syndrome; or current abuse or dependence on substances other than alcohol or tobacco. All surgical subjects were scheduled for outpatient elective surgery under general anesthesia. Control group subjects could not be scheduled for surgery at the time of study enrollment.

The target enrollment was 60 subjects. A sample size of 30 subjects per group was required to achieve at least 80% power to detect a medium effect of elective surgery relative to the control group on scores for the Veterans Rand 36-Item Health Survey (VR-36) Physical Component Summary (PCS), when employing a mixed-effects model for longitudinal data with a Type I error probability of .05. Assuming 80% within-person correlations across time, a group-by-time interaction effect in the medium range (for *f*, Cohen defines a medium effect size as .25) represented a clinically meaningful effect.

• *Recruitment and Baseline Assessment.* The electronic medical records of patients scheduled for preoperative or PTSD clinic appointments were reviewed to identify potential subjects for the surgical and control groups, respectively. All potentially eligible patients identified during the study period were mailed an informational letter describing the study. On the day of their preoperative or PTSD clinic appointment, patients who desired to participate and met inclusion and exclusion criteria gave informed consent and were enrolled in the study. Subjects for the control group were also recruited by self-referral. Flyers were placed in the PTSD, mental health, and primary care clinics, and potential subjects were asked to contact the investigators directly to determine eligibility and initiate enrollment.

After informed consent was obtained, information about subjects' demographic status and their medical and psychiatric history was collected. The season in which the data collection occurred was captured as a 4-level categorical variable (winter, spring, summer, or fall) to allow for evaluation of the effect of seasonality on mood, posttraumatic symptoms, and depressive symptoms.[30,31] Subjects then completed a series of self-report instruments and structured clinical interviews to assess their mental and physical health. The measures were administered in the order in which they are presented here,

• *Veterans Rand 36-Item Health Survey.*[32,33] The

VR-36 measures the subjective health concepts of physical functioning, role limitations due to physical problems, bodily pain, general health perception, vitality, social functioning, role limitations due to emotional problems, and emotional well-being using Likert-type responses. Factor-based composite T scores were calculated to measure the aggregate health concepts of overall physical subjective health (PCS score) and mental subjective health (Mental Component Summary, or MCS score) status. The T scores range from 0 to 100 (mean ± SD = 50 ± 10), with higher scores indicating better subjective health status.[33-35] The VR-36 PCS score was considered the primary outcome of the study.

• *Geriatric Depression Scale (GDS)*.[36] Severity of depressive symptoms was measured with the GDS. This 30-item yes/no format questionnaire has total scores ranging from 0 to 30, with higher scores indicating greater depressive symptom severity. Although developed to measure depressive symptom severity in older adults, the GDS demonstrates validity across the adult lifespan.[37]

• *Clinician-Administered PTSD Scale (CAPS)*.[38] Posttraumatic symptom severity was measured with the CAPS, a 30-item, semistructured interview that uses directed questions with scoring criteria to measure PTSD severity. The CAPS severity score is determined by summing the ratings of 17 symptom criteria for frequency and severity on 5-point Likert scales. Possible scores range from 0 to 136, with higher scores indicating greater PTSD severity.

• *Follow-Up Assessments*. Follow-up data were collected from surgical and control group subjects at 1 week, 4 weeks, and 12 weeks after surgery or enrollment, respectively. As part of each data collection the number of days since surgery or enrollment was recorded, as was the season in which the assessment took place. At the baseline assessment, all subjects were provided with a copy of the VR-36 and a stamped envelope. Surgical group subjects were asked to complete and return the VR-36 by mail 1 week after surgery, and control group subjects were asked to complete and return the VR-36 by mail 1 week after enrollment. Subjects from both groups were asked to return to the VAMC at 4 and 12 weeks after surgery or enrollment to complete the VR-36, GDS, and CAPS. Therefore, data collection was timed to provide parallel data from both groups from baseline to 12 weeks after enrollment to coincide with previous research on subjective health status after outpatient elective surgery.[27-29] All assessments were completed by the principal investigator (K.W.) in a quiet, private room.

• *Statistical Analysis*. Nondirectional statistical tests were conducted, and the level of significance was .05 for all statistical tests. The results were not adjusted for multiple outcomes because of the exploratory nature of the study. Quantitative data were examined for normality and transformed as necessary before the investigators performed between-group analyses. Specifically, GDS scores were reflected and the square root was transformed because of negative skewness. Student *t* tests for continuous measures and χ^2 tests (alternatively, Fisher exact tests) for categorical measures were conducted to test whether the surgical and control groups differed on baseline demographic and clinical characteristics. If the groups differed significantly on a key measure, the baseline measure was considered for inclusion as a covariate in the efficacy analyses. The assumption of data missing at random was evaluated using Fisher exact tests to compare between-group attrition at each follow-up assessment.

Random coefficients regression models (RRM) adjusting for age and gender were used to test for between-group differences in trajectories of change in the primary outcome of VR-36 PCS scores and the secondary outcomes of VR-36, MCS, GDS, or CAPS scores. The RRM approach, a type of hierarchical mixed-effects model for longitudinal data, was applied because the method allows the intercept and slope of change for each patient to vary at random across time.[39] The models for the VR-36 PCS or MCS outcomes included assessments at baseline, 1 week, 4 weeks, and 12 weeks, whereas the models for GDS and CAPS scores collected at baseline, 4 weeks, and 12 weeks.

For determination of the appropriate RRM models, the unadjusted means for the PCS, MCS, GDS, or CAPS scores were initially graphed over time to visually examine the temporal pattern of change in surgical and control groups over the course of data collection. These preliminary figures suggested a nonlinear pattern of change over time. Quadratic, cubic, and square root trajectory models were evaluated, but none of these models were significant predictors of change in outcome scores over time in either group. Methods described by Singer and Willett[40] were used to account for the observed discontinuous change. Specifically, surgical intervention was coded as an individual (ie, level 1) predictor that occurred between baseline and 1 week only to subjects in the surgical group to account for observed changes in both level and slope of outcome scores over time.

Each RRM model included the fixed effects of surgical intervention (exposed to surgery or not), time, the intervention-by-time interaction, and the fixed effects of 2 covariates (age and gender). Models of MCS, GDS, and CAPS severity scores were tested for the fixed effects of season; if significant, season was included as in the final RRM. Random effects in each model were subject and subject-by-time with random intercepts and slopes. If the group-by-time interaction was significant at the .05 level, then a posteriori contrasts were conducted on the trajectory of change between the 2 groups at each time point.

Results
Sixty subjects were enrolled in the study between September 2011 and October 2012. The surgical group

A)

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┌─────────────────────────────┐
│ 91 Patients Approached for  │
│       Participation         │
└─────────────────────────────┘
            │ ──────────────────► ┌──────────────┐
            │                     │ 62 Declined  │
            ▼                     └──────────────┘
┌─────────────────────────────┐
│ 29 Consented for Participation│
│  and Underwent Baseline     │
│       Assessment            │
└─────────────────────────────┘
            │
            ▼
┌─────────────────────────────┐
│   29 Completed 1 Week       │
│       Assessment            │
└─────────────────────────────┘
            │ ──────────────────► ┌──────────────────┐
            │                     │ 1 Withdrew Due to│
            │                     │ Lack of          │
            │                     │ Transportation   │
            ▼                     └──────────────────┘
┌─────────────────────────────┐
│   28 Completed 4 Week       │
│       Assessment            │
└─────────────────────────────┘
            │ ──────────────────► ┌──────────────────┐
            │                     │ 1 Withdrew Due to│
            │                     │ Lack of          │
            │                     │ Transportation   │
            ▼                     └──────────────────┘
┌─────────────────────────────┐
│   27 Completed 12-Week      │
│       Assessment            │
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B)

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┌──────────────────────────────┐
│ 83[a]/10[b] Patients Approached/│
│ Self-Referred for Participation│
└──────────────────────────────┘
            │ ──────────────────► ┌──────────────────────┐
            │                     │ 60[a]/1[b] Declined   │
            ▼                     └──────────────────────┘
┌──────────────────────────────┐
│ 23[a]/9[b] Consented for      │
│       Participation          │
└──────────────────────────────┘
            │ ──────────────────► ┌──────────────────────┐
            │                     │ 1[b] Withdrawn for    │
            │                     │ Undisclosed SUD       │
            ▼                     └──────────────────────┘
┌──────────────────────────────┐
│ 23[a]/8[b] Completed Baseline │
│       Assessment             │
└──────────────────────────────┘
            │ ──────────────────► ┌──────────────────────┐
            │                     │ 1[a]/1[b] Lost to     │
            │                     │ Follow Up             │
            ▼                     └──────────────────────┘
┌──────────────────────────────┐
│ 22[a]/7[b] Completed 1 Week   │
│       Assessment             │
└──────────────────────────────┘
            │ ──────────────────► ┌──────────────────────┐
            │                     │ 2[a] Lost to Follow Up│
            ▼                     └──────────────────────┘
┌──────────────────────────────┐
│ 20[a]/7[b] Completed 4 Week   │
│       Assessment             │
└──────────────────────────────┘
            │ ──────────────────► ┌──────────────────────┐
            │                     │ 1[a] Lost to Follow Up│
            ▼                     └──────────────────────┘
┌──────────────────────────────┐
│ 19[a]/7[b] Completed 12-Week  │
│       Assessment             │
└──────────────────────────────┘
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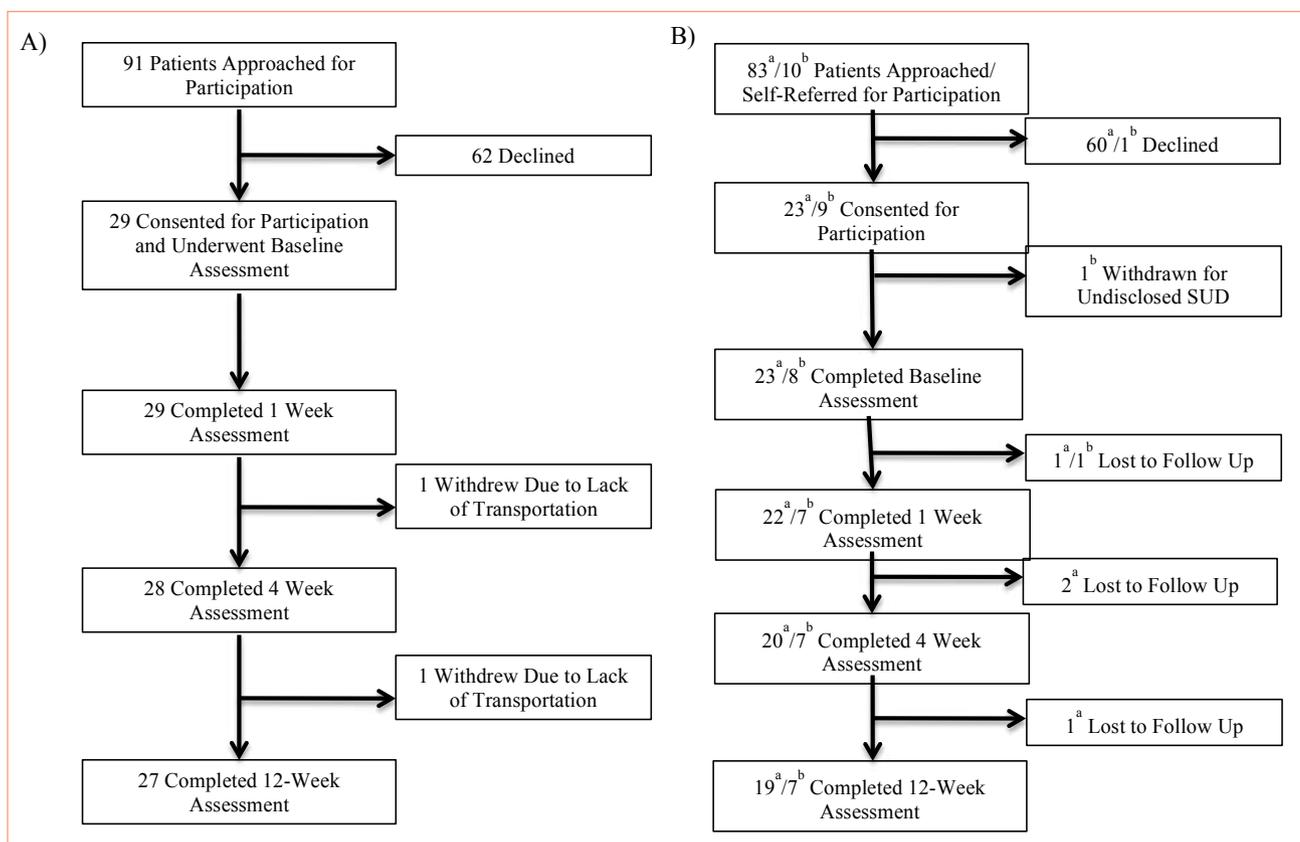
Figure 1. Subject Enrollment and Retention

Note: Panel A depicts enrollment and retention of surgical group subjects recruited from the anesthesia preoperative clinic. Panel B depicts enrollment and retention of control group subjects.

Abbreviation: SUD, substance use disorder.

[a] Number of subjects recruited from the PTSD clinics; [b]Subjects recruited through self-referral.

included 29 patients who completed the baseline assessment and proceeded to have surgical procedures as scheduled. The most common surgical procedure was orthopedic (n = 9), with the remainder evenly divided between general (n = 4), gynecology and urology (n = 4), plastic (n = 4), neurosurgery (n = 4), and oral-maxillofacial/otolaryngology (n = 4). The control group initially included 32 subjects who underwent no surgical intervention during the 3 months of study participation. However, 1 control group subject disclosed misrepresenting exclusion criteria immediately after providing consent and was therefore withdrawn from the study before completing the baseline assessment. Therefore, 31 control group subjects completed baseline assessment, 8 (25.8%) of whom self-referred for participation.

Of the 60 analyzable subjects, 58 (96.6%) provided data at 1 week, 55 (91.6%) provided data at 4 weeks, and 53 (88.3%) provided data at 12 weeks. Seven (11.7%) of the participants withdrew or were lost to follow-up before completing the 12-week assessment. The frequency of attrition was not significantly different between the surgical and control groups at 1 week (P = .49), 4 weeks (P = .35), or 12 weeks of study participa-

tion (P = .43). Subjects who were lost to follow up were not significantly different from subjects who remained in the study with respect to age (P = .71), gender (P = .99), years of education (P = .31), or baseline PCS, (P = .74), MCS (P = .93), GDS (P = .35), or CAPS severity scores (P = .15). Thus, there was no evidence of a systematic bias in missing baseline or outcomes data in the 2 groups. Screening, enrollment, and retention in the surgical and control groups are depicted in Figure 1A and Figure 1B, respectively.

Control patients were older and had experienced PTSD symptoms for longer times (Table) but were otherwise similar to surgical patients with respect to demographics and comorbidities. Patient age and PTSD symptom duration were intercorrelated (r = 0.91; P < .001), so PTSD symptom duration was excluded as a covariate in further analyses because of the risk of multicollinearity. At baseline, there were no differences between surgical and control subjects with regard to mean MCS, PCS, GDS, or CAPS severity scores (Table).

• *Effect of Elective Surgery on Physical Health*. The RRM analysis on longitudinal PCS scores demonstrated a significant effect of age ($F_{1, 60.6}$ = 5.20; P = .03), interven-

Variable	Surgical (n = 29)	Control (n = 31)	P
Age, y	51.8 ± 2.3	59.4 ± 1.5	< .01[b]
Education, y	13.2 ± 0.3	13.8 ± 0.4	.24
Duration of PTSD symptoms, y	24.8 ± 3.1	36.4 ± 1.9	< .01[b]
Male gender	25 (86)	27 (87)	.91
Depression	18 (62)	25 (81)	.11
Hypertension	18 (62)	24 (81)	.11
Myocardial infarction	2 (7)	2 (7)	.95
Chronic obstructive pulmonary disease	3 (10)	2 (6)	.61
Chronic bronchitis	4 (14)	3 (10)	.62
Obstructive sleep apnea	9 (31)	7 (23)	.46
Tobacco use (current)	10 (34)	9 (29)	.65
Ethanol dependence (history)	15 (52)	19 (61)	.45
Obesity	14 (48)	18 (58)	.45
Illicit substance use (history)	5 (17)	11 (35)	.11
Diabetes (type 2)	6 (20)	8 (26)	.19
Chronic pain	21 (72)	23 (74)	.88
Baseline VR-36 Physical Component Summary (PCS) score	37.2 ± 1.5	37.7 ± 1.7	.81
Baseline VR-36 Mental Component Summary (MCS) score	37.6 ± 2.1	34.3 ± 1.9	.24
Baseline Geriatric Depression Scale (GDS) score	18.3 ± 1.7	19.6 ± 1.4	.53
Baseline Clinician-Administered PTSD Scale (CAPS) severity score	69.6 ± 5.0	74.3 ± 4.0	.46

Table. Baseline Sociodemographics, Comorbidities, and Baseline Scores[a]

Abbreviations: PTSD, Posttraumatic stress disorder; VR-36, Veterans Rand 36-Item Health Survey.
[a] Data are described as mean ± standard error of the mean or as number (percent).
[b] Significant at $P < .05$.

tion ($F_{1,141} = 14.01$; $P < .0003$), and the intervention-by-time interaction ($F_{1, 58.8} = 5.45$; $P = .02$), but not time ($F_{1, 55.8} = 3.30$; $P = .07$) or gender ($F_{1, 56.9} = 0.94$; $P = .34$). Mean adjusted PCS scores for the surgical group were significantly lower than those of the control group at 1 week ($F_{1, 142} = 14.01$; $P = .0005$), but not 4 weeks ($F_{1, 132} = 3.41$; $P = .07$) or 12 weeks ($F_{1, 50.8} = 0.13$; $P = .72$) after surgery or enrollment. The mean adjusted PCS scores over time are depicted in Figure 2A.

• *Effect of Elective Surgery on Mental Health.* The RRM analysis on longitudinal MCS scores demonstrated a significant effect of age ($F_{1, 57.6} = 20.64$; $P \leq .0001$), season ($F_{3, 136} = 2.82$; $P = .04$), intervention ($F_{1, 138} = 6.42$; $P = .01$), and the intervention-by-time interaction ($F_{1, 62.7} = 7.07$; $P = .0099$), but not time ($F_{1, 48.5} = 0$; $P = .96$) or gender ($F_{1,53.9} = 0.35$; $P = .56$). Mean adjusted MCS scores of the surgical group were significantly lower than those of the control group at 1 week ($F_{1, 138} = 5.06$; $P = .03$), but not 4 weeks ($F_{1, 134} = 0.15$; $P = .70$) or 12 weeks ($F_{1, 50.3} = 2.12$; $P = .15$) after surgery or enrollment. The mean adjusted MCS scores over time are depicted in Figure 2B.

The RRM analysis on longitudinal GDS scores demonstrated a significant effect of age ($F_{1, 60.7} = 25.27$; $P < .0001$), but not time ($F_{1, 67.5} = 0.17$; $P = .68$), intervention ($F_{1, 69.5} = 0.96$; $P = .33$), or the intervention-by-time

interaction ($F_{1, 70.4} = 0.13$; $P = .72$). Because the omnibus test of the intervention-by-time interaction was not significant, no cross-sectional analyses were performed at each assessment point. Similarly, RRM analysis on longitudinal CAPS severity scores demonstrated a significant effect of age ($F_{1, 59.7} = 19.18$; $P < .0001$), but not time ($F_{1, 73.7} = 0.57$; $P = .45$), intervention ($F_{1, 69.1} = 0.16$; $P = .69$), or intervention-by-time interaction ($F_{1, 77.2} = 0.09$; $P = .76$). The mean adjusted GDS and CAPS severity scores over time are depicted in Figure 2C and Figure 2D, respectively.

• *Adverse Events.* Two surgical group subjects experienced significant adverse events during study participation. One subject was unexpectedly admitted to the hospital for overnight observation after surgery because of concerns about sleep apnea, and another subject made a suicidal gesture 6 weeks after having surgery. Neither subject was permanently harmed by these events. No subject in the control group experienced any adverse events.

Discussion
The findings of this study suggest that surgery has a significant but short-lived adverse impact on the physical and mental subjective health status of veterans with PTSD. This effect peaked shortly after surgery, but re-
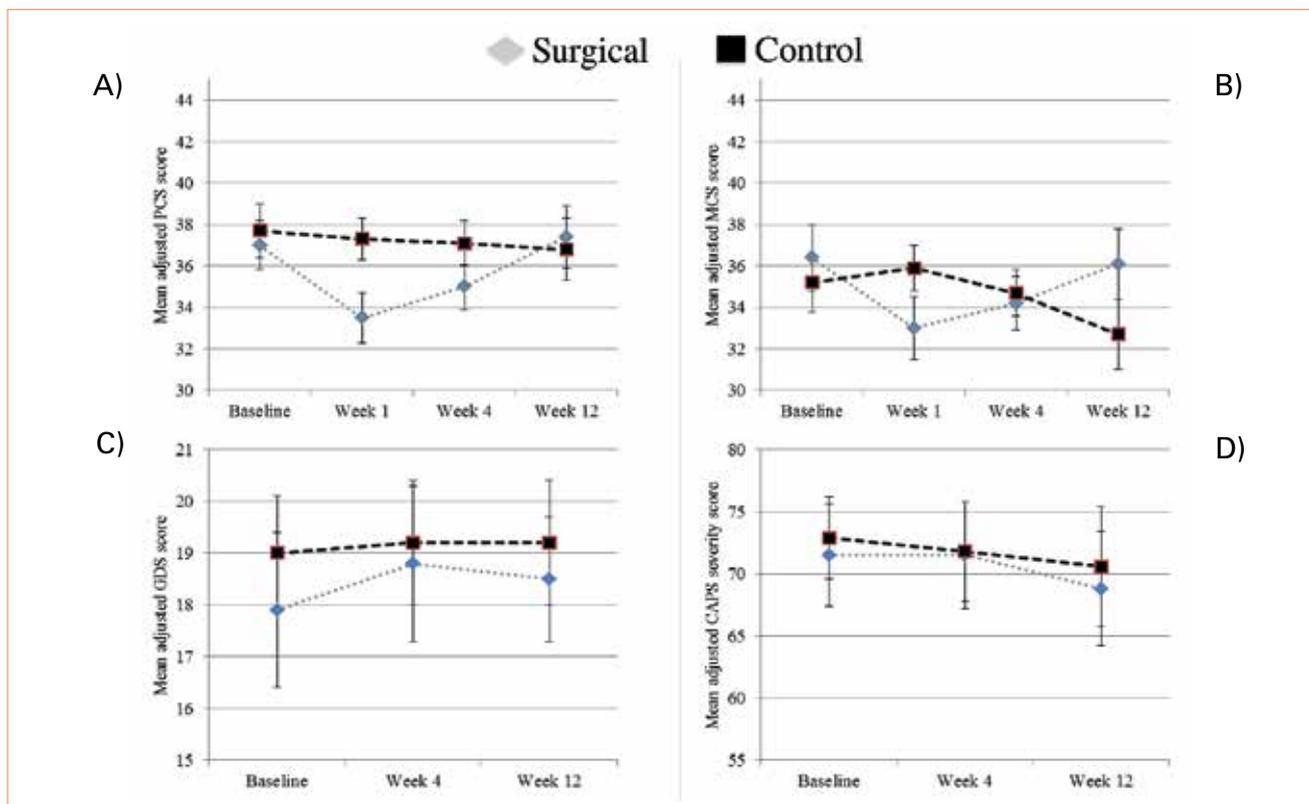
Figure 2. Mean (SE) Longitudinal Adjusted Scores Over Time
Note: X-axis represents time in weeks from baseline to 12 weeks after surgery (surgical group) or enrollment (control group). Y-axis represents mean score after adjustment for the fixed and random effects described in the analysis.
Abbreviations: CAPS, Clinician-Administered PTSD (Posttraumatic Stress Disorder) Scale; GDS, Geriatric Depression Scale; MCS, Mental Component Summary; PCS, Physical Component Summary.

solved for most patients within 1 month. We were unable to detect an effect on posttraumatic symptom severity or depressive symptom severity 1 month after surgery, possibly because the adverse effects had abated before these symptoms were reassessed. However, the most significant finding may be that the mean age- and gender-adjusted subjective mental and physical health scores of veterans with PTSD were in the lowest 10% of the US population.[41] This finding suggests a significant burden of physical and mental comorbidity regardless of surgical status, and that physical and mental comorbidity may be the source of greater risk of postoperative mortality in veterans with PTSD.

The subjective health status of the subjects presenting for elective surgery was poor. At baseline, the age- and gender-adjusted mean preoperative PCS score was an average of 1.3 SD below population norms. This is concerning, because a study of outpatient veterans reported that each 0.5-SD increment below a PCS score of 50 increased the odds ratio for risk of 1-year mortality by 1.27 compared with veterans whose PCS score was within 0.5 SD of the population mean.[26] Similar findings were observed for subjective mental health status. The age- and gender-adjusted mean preoperative MCS score was

1.4 SD below population norms. Fortunately, subjective mental health status was less influential on risk of mortality. In outpatient veterans, each 0.5-SD increment below an MCS score of 50 increased the odds ratio for risk of 1-year mortality by 1.08 compared with veterans whose MCS score was within 0.5 SD of the population mean.[26] Therefore, the veterans in this study were at greater risk of mortality before they entered the operating room.

Participants in the surgical group also presented with clinically significant depressive and posttraumatic symptoms. The mean GDS score of veterans with chronic PTSD was 17.9 before surgery, indicating mild to moderate depression,[36] and the mean CAPS severity score was 71.5 before surgery, indicating moderate to severe PTSD symptoms.[42] Therefore, patients with chronic PTSD continue to experience psychiatric sequelae of their experiences, even decades after being exposed to a traumatic event.

Surgery transiently affected both the physical and mental health of patients with chronic PTSD. Surgical group subjects experienced a mean age- and gender-adjusted decline of 3.9 points in PCS scores and 2.9 points in MCS scores, which resolved by 1 month after surgery. For comparison, chronic lung disease has been estimated to result in a difference of 3.6 points in PCS score and depres-

sion to result in a difference of 8 points in MCS score.[41] However, the lack of a significant effect of outpatient elective surgery on depressive and posttraumatic symptoms may have been due to the selected measurement points. In the present study we were unable to collect in-person data on posttraumatic and depressive symptom severity 1 week after surgery because of concerns about excessive subject burden. Given that subjects reported significant decreases in subjective mental health status 1 week after surgery, a study that collects data about posttraumatic and depressive symptoms within a week after surgery may detect a significant effect of surgery on the severity of these more specific psychiatric symptoms.

The primary limitation of the present study was the difference between the surgical and control groups. The differences between surgical and control subjects' mean age and PTSD symptom duration highlight the nonequivalent nature of the control group. Outcomes were not significantly different between groups at baseline, but the differing age of the surgical and control groups indicates that they were members of 2 different populations and may have been exposed to different influences other than the effect of surgery over the course of data collection. Although less than one-third of control subjects self-referred (Figure 1), the ability of control group subjects to self-refer may also have created a selection bias that was not present in the surgical group. These design limitations highlight the hazards of attempting to draw causal inferences from a nonequivalent control group, quasi-experimental study.

Additional limitations include the duration of data collection, the need to assess surgical group subjects approximately 1 week before surgery, the reliance on self-report measures, and the small sample size. Limiting data collection to 12 weeks after surgery meant that we could not rule out an adverse effect of surgery on long-term mortality in this population. Assessing surgical group subjects 1 week before surgery was pragmatic but also a source of random error, because events may have occurred to surgical group subjects between baseline assessment and their day of surgery that were not accounted for. The reliance on self-report measures could be addressed by incorporating clinician assessments of functional status; however, clinician assessments of functional status were not practicable for this study because of the range of surgical diagnoses included in this sample. Finally, the small sample size precluded assessing the effect of differing types of surgery, because adequate degrees of freedom were not available to analyze the multiple-level categorical variable of type of surgery.

Strengths of the present study include the use of previously validated measures, the inclusion of an appropriate comparison group to assess the effect of elective outpatient surgery on the mental and physical health of veterans with chronic PTSD, and the use of data analysis

methods that allowed us to estimate the effects of both surgery (surgical intervention) and the healing process (surgical intervention-by-time interaction) while controlling for covariates.

We do not consider these results applicable to veterans undergoing surgeries requiring hospitalization or veterans experiencing more acute exposure to traumatic events. Future studies should assess the impact of surgery and hospitalization on veterans with chronic PTSD, include a surgical group of veterans without PTSD, and attempt to replicate these findings in a sample of patients undergoing a single type of surgery. Future studies should also explore the effect of surgery on younger veterans with more recent exposure to traumatic experiences.

Veterans with PTSD appear to be at greater risk of mortality at presentation for surgery because of poor physical and mental health. On average, veterans with chronic PTSD can expect a significant but transient decline in their physical and mental subjective health after elective outpatient surgery, but should recover within 1 month. The present study found no evidence for a detrimental effect of outpatient elective surgery on physical or mental subjective health after 3 months, and did not support a detrimental or beneficial effect of common outpatient elective surgeries on posttraumatic or depressive symptom severity in veterans with chronic PTSD. Therefore, there was no evidence to suggest that veterans with chronic PTSD should avoid common outpatient elective procedures if the risk-to-benefit ratios are otherwise favorable.

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