

# Effects of Psychological Stress and Posttraumatic Stress Disorder Symptoms on Cognition

**Larry G. Knauss, PhD**  
*Chief, Research Section*  
*Department of Psychiatry*  
*Madigan Army Medical Center*

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# Disclaimer

*The views expressed in this presentation are those of the author and do not reflect the official policy of the Department of the Army, Department of Defense, Madigan Army Hospital, or the U.S. Government.*

# Objectives for Presentation

To summarize research concerning the impact of psychological stress on cognition.

To describe two neuropsychological cases via the interweave of current research and clinical knowledge.

To discuss practical implications of research and clinical knowledge on stress and PTSD for the clinical neuropsychologist.

To expose those darn little gremlins and exterminate them!

# Diagnostic Stress

- DSM – (1952) contained a diagnostic category called "**gross stress reactions**"
- DSM-II – (1968) substituted "**transient situational disturbances**"
- DSM-III – (1980) substituted "**Posttraumatic Stress Disorder**" (PTSD)
  - Etiology now a traumatic event
  - No longer an individual weakness
  - Acknowledgement PTSD could be long-lasting

# DSM-IV & (TR) – Diagnostic Traumatic Stressor

- **DSM-IV -> traumatic stressor -**
- When the person "experienced, witnessed, or was confronted with an event or events that involved actual or threatened death or serious injury, or a threat to the physical integrity of self or others"  
(Criterion A1)
- **and**
- The person's response involved "intense fear, helplessness, or horror"

Note: In children, this may be expressed instead by disorganized or agitated behavior  
(Criterion A2)

# Spectrum Anxiety Disorders

## DSM-IV-TR

Panic Disorder Without  
Agoraphobia

Panic Disorder With  
Agoraphobia

Agoraphobia Without History of  
Panic Disorder, Specific  
Phobia, Social Phobia

Obsessive-Compulsive  
Disorder

Posttraumatic Stress Disorder

- Acute Stress Disorder
- Generalized Anxiety Disorder
- Anxiety Disorder Due to a  
General Medical Condition
- Substance-Induced Anxiety  
Disorder
- Anxiety Disorder Not Otherwise  
Specified.

# Anxiety Disorders DSM-IV-TR

- Posttraumatic Stress Disorder (PTSD)
  - Characterized by the reexperiencing of an extremely traumatic event
  - Accompanied by symptoms of increased arousal
  - Avoidance of stimuli associated with the trauma.
- Acute Stress Disorder (ASD)
  - Characterized by symptoms similar to those of PTSD
  - The symptoms occur within 1 month after exposure to an extreme traumatic stressor (Criterion A)

# Stress Disorders

- Adjustment Disorder
- Posttraumatic Stress Disorder
- Acute Stress Disorder
  - All require the presence of a stressor.
  - PTSD and ASD are characterized by
    - an extreme stressor and
    - a specific constellation of symptoms.
  - In contrast, Adjustment Disorder can be triggered by a stressor of any severity and may involve a wide range of possible symptoms.

# Trauma Does Not Equal PTSD

- Trauma does not happen to everyone who experiences potentially traumatic events.
- Despite the high prevalence of exposure to traumatic stressors, relatively few people exposed to traumas subsequently develop PTSD (McNally, 2003; Yule, 2001).
- On average, 25% of individuals experiencing one or more traumas develop PTSD (Green, 1994).
- Reaction to trauma occurs on a continuum.

# Commonly Identified:

## Risk Factors

Male  
Younger  
History of prior  
exposure  
PTSD  
symptomatology

## Personal Characteristics

- Neuroticism
- Childhood conduct disorder
- Pretrauma substance disorder
- Familial psychiatric history

# High Risk Groups

Military personnel are a “high risk group” for experiencing trauma

As are:

- Inner-city children
- Citizens and refugees of postconflict countries
- Victims of:
  - . *Terrorist attacks*
  - . *Crime*
  - . *Disasters*

# Cognitive Deficits

- Attention and memory deficits are seen as core to PTSD and are incorporated as part of the DSM-IV diagnostic criteria (C3, D3, & D4).
- When neuropsychological deficits accompany PTSD, they are likely **MILD** and in the areas of:
  - attention
  - memory impairment
- Deficits typically do not reflect basic language, visual recognition, or fine motor dysfunction

# Emotions

- Emotion has complex effects on memory
  - Emotion can enhance and impair memory
  - Research suggests
    - ❖ Emotion effects memory via neural substrate
    - ❖ Particularly via the interaction between the hippocampal system and the amygdala.

# Brain Regions

Known to be dysregulated in individuals with PTSD:

- Prefrontal cortex
- Amygdala
- Hippocampus
- Dorsal raphe nucleus
- Locus coeruleus

# Structural and Functional Anatomy

Focus on specific structures:

- Amygdala
- Medial prefrontal cortex
- Hippocampus

Structures are presented in the  
neurocircuitry model of PTSD

by Rauch et al. (1998)

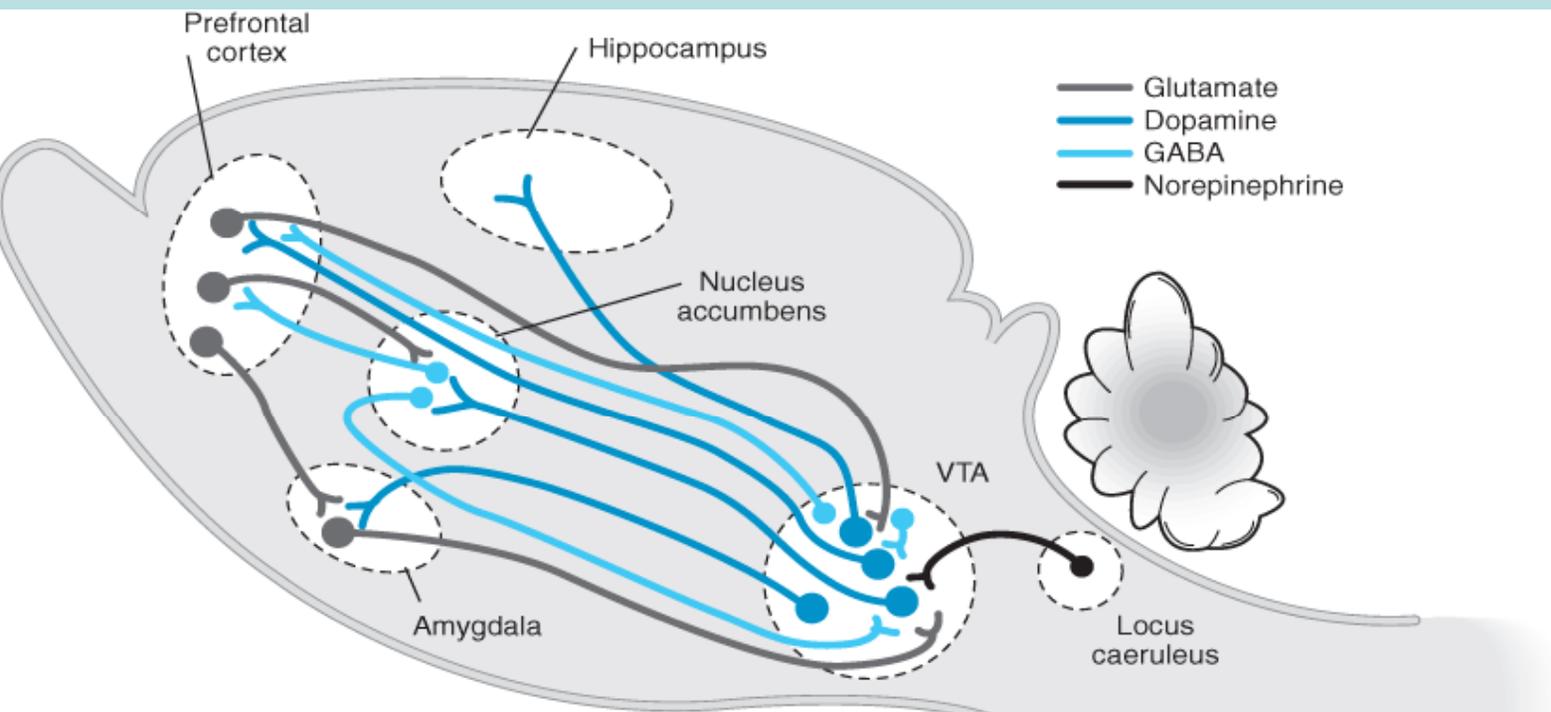
# Amygdala

A medial temporal lobe structure involved in the assessment of threat-related stimuli (Davis & Whalen, 2001)

Plays a crucial role in the process of fear conditioning

In individuals with PTSD, the amygdala is hyperresponsive

# Amygdala



Major connections of the mesolimbic dopamine system in the rat brain. The dopamine projection originates in the ventral tegmental area (VTA). Main targets are the nucleus accumbens (NAc), prefrontal cortex (PFC), and amygdala. Excitatory inputs reach the VTA from the PFC and the amygdala. Inhibitory inputs onto dopamine neurons come from GABA neurons within the VTA (interneurons) or as a feedback loop from the NAc. The locus coeruleus releases norepinephrine onto the VTA. Transmitters used by the neurons are indicated by gray for glutamate, black for norepinephrine, dark color for dopamine

# Amygdala Hyperresponsivity

- Mediates symptoms of hyperarousal
  - Excessive activation of the amygdala by stimuli perceived to be threatening
  - Ambiguous stimuli are more likely to be appraised as threatening
  - Disinhibition of the amygdala produces a vicious spiral of recurrent fear conditioning
- Inadequate influence by medial prefrontal cortex underlies deficits of extinction
  - Mechanisms for extinguishing such responses are nullified
- Explains the indelible quality of the emotional memory for the traumatic event
- Decreased influence of the hippocampal function underlies deficits in identifying safe contexts, as well as explicit memory difficulties

# Amygdala

In PTSD, the normal checks and balances on amygdala activation have been impaired

The restraining influence of the medial prefrontal cortex (PFC) are severely disrupted, especially the:

- anterior cingulate gyrus
- orbitofrontal cortex

(Charney, 2004; Vermetten & Bremner, 2002).

# Hippocampus

- Hippocampus
  - A medial temporal lobe structure
  - Involved in memory processes (Eichenbaum, 2000; Schacter, 1997)
  - Severe stressors and high levels of stress-related hormones associated with
    - Memory impairment
    - Abnormal hippocampal functioning (decreased communication w/ amygdala).

# Severity of PTSD Symptomatology

Two factors reported to influence severity:

- Extent and Gravity
  - . Actual exposure to a stressful event, and Subjective severity of the exposure
- The more an event is perceived to be:
  - . Adverse
  - . Uncontrollable
  - . Unpredictable
- The more likely it is to elicit higher levels of PTSD

# Interim Summary

- Research concerning brain structure, chemistry, and function in PTSD has provided evidence consistent with:
  - An inverse relationship between the amygdala and medial prefrontal cortex.
    - Amygdala - exaggerated responsivity
    - Medial prefrontal cortex - diminished responsivity
  - To a lesser degree, neuroimaging data suggests **diminished** volumes, neuronal integrity, and functional integrity of the hippocampus in PTSD.

# Clinical Neuropsychological Evaluation

Establishing a Diagnosis of PTSD

- Elicitation of the Trauma History
- Assessment of PTSD Symptom Criteria

Comorbid Psychopathology

Associated Medical and Somatic  
Disorders

Medications

# Neuropsychological Testing Issues with the Client w/ PTSD

- Selection of Neurobehavioral Instruments:
  - Tests that provide both confirmatory and disconfirmatory evidence
  - Assess functional domains that have a high probability of impairment if PTSD
  - Assess functional domains that have a low probability of impairment if PTSD

# Which Domains Most Likely Sensitive to PTSD?

Attention

Memory

# Which Domains Are Likely to Be Least Sensitive to PTSD?

## Basic language functions

- ❖ Language comprehension
- ❖ Repetition
- ❖ Spontaneous speech

## Motor speed

- ❖ Finger tapping

## Visuospatial skills

- ❖ Visual construction
- ❖ Visual object recognition
- ❖ Left-right orientation

# PTSD population may show performance deficits:

- When executive control or strategic planning is required
  - Motor
  - Visual-organizational tasks
  - Word-list generation (sensitive to prefrontal integrity)

# Prefrontal Cognitive Functions

Not strong evidence for deficits on common clinical tasks of executive functioning

- ❑ Wisconsin Card Sorting Test

Error analysis (e.g., Vasterling et al., 1998) has provided evidence that PTSD is associated with impaired inhibitory functions on memory and attentional tasks.

# Differentiating Diagnostic Etiologies

Look at both pattern and severity of neuropsychological deficit

Dramatic decline in neuropsychological functioning may indicate a non-PTSD disorder

## **Signs that may indicate a non-PTSD dx**

Primary language dysfunction or aphasia (e.g., impairment of auditory comprehension or speech output)

Visuoperceptual impairment (e.g., visual agnosia)

Significant fine motor impairment

# Do not expect to find

unilateral deficits or sensorimotor impairment, *despite* preliminary findings of more subtle interhemispheric differences on information-processing tasks

(e.g., Metzger et al., 2004; Vasterling, Duke, Tomlin, Lowery, & Kaplan, 2004).

# When neuropsychological deficits accompany PTSD

## Most likely:

- Characterized by mild attentional and memory impairment

## Typically, do not reflect:

- basic language
- visual recognition
- fine motor dysfunction

# Consideration for the Neuropsychologist

□ Extending beyond the widely used clinical executive tasks (WCST) to one of the multifaceted instruments:

□ Behavioral Assessment of the Dysexecutive System

[Wilson, Alderman, Burgess, Emslie, & Evans, 1996]

□ Delis-Kaplan Executive Function System (D-KEFS)

[Delis, Kaplan & Kramer, 2003]

# Case Presentation

31y/o active duty Army male, E5 (Sgt).  
Referred for treatment of his nightmares.  
Presenting problems: nightmares, poor initiation of sleep, 4-hours sleep/night, memory loss, language difficulties, loss of fine motor dexterity, full body aches, extremity numbness, migraine headaches, sudden hair loss, and intention tremors.

In the last 6 months, medically evacuated from Afghanistan for a shrapnel injury.

Memory problems extend to most aspects of his life

- Frequently forgetting names of his children
- Getting lost in his neighborhood
- No recall of ever attending college in Illinois (he reports having a BA in economics and an MBA in electrical engineering).

Able to detail his combat exposure in Iraq, medication regimen, and sleep history.

- Nightmares combat related: discovering piles of severed limbs, witnessing civilians dying in explosions, himself being wounded by explosion, and witnessing burned bodies of fellow soldiers.
- Reports daydreaming these events and deliberately avoids triggers to these memories: driving on the freeway or pungent smells.

Denies memory problems interfere with his work as an electrician, attributes this to his wife writing his reports.

- Wife does most of the driving and sends him text pages to remind him to complete tasks.

Reports difficulties writing with a pen, occasional tremor,

Language difficulties he reported - "making up words," combining words inappropriately.

Currently taking Trazadone, 300mg, for sleep, w/o benefit.

Past Psychiatric Hx: Denied.

Past Medical Hx: extremity numbness, body aches, treated without relief with gabapentin.

Last month reported to PCP he has "Gulf War Syndrome"

Possible perforated ear drum from shrapnel wound from IED explosion

Social – Married to 3<sup>rd</sup> wife; 2-children from her previous relationship, wife pregnant with his child.

Military History: Saudi Arabia - first Gulf War, NYC following 9/11, Iraq in 2003 and 2004, and Afghanistan – led to medical evacuation

Denies ETOH abuse, denies illicit drugs, smokes cigarettes - 1/2 ppd.

Neuro exam – possible Apraxia, unable to complete serial 7s – became tearful.

spells world backwards as "DLRWOW"

He reports mispronounced words and word-finding difficulty. Complains of making spelling errors.

Significant sleep problems, trazodone did not help. Having nightmares 4 or 5 times a week. Started prazosin – at 3 mg/day his nightmares have significantly decreased. Notes worst nightmares when napping and a worsening when he pulled 24 CQ duty.

He also tends to be jumpy. Gets overwhelmed easily. For example, wife reports that once when he was asleep in the same room as the baby, and she had gone to take a shower, he came to her and started yelling at her but could not tell her what was wrong. Finally, he was able to say the baby was hungry. She told him to feed the baby, but he could not figure out how to do it. She gave him some instructions about how to heat up the formula, but he could not follow through on the instructions. She reports and he confirms that now when he feels overwhelmed, he hides in the closet.

The baby makes him very nervous because he cries all the time and it makes him feel “funny inside.”

# Neuropsych Testing Results

What do you predict?

# WAIS-III

VIQ	92	30%
PIQ	98	45%
FSQ	95	37%

Voc	9		PC	14
Sim	9		DSY	4
Art	11		BD	10
DSp	3		MR	9
Info	10		PA	12
Com	11		SS	6

# Weschler Memory Scale

M IM	16	RE	10
M IM	9	RE	7

<b>VRAT 3</b>	ss	%ile	Grade
Reading	71	3	4
Spelling	57	5	2
Math	84	14	6

## Stroop Test

Part 1	227"	Part 2	480"Est	Part 1-2	253"Est
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# Case Summary

Multiple problems noted on the psychological testing.

Speed of processing, very poor, 1st to 10th percentile.

Reading 3rd percentile. Spelling 5<sup>th</sup> percentile. Written arithmetic 14th percentile.

Attention and concentration: immediate attention span was low, significant problems in ability to sustain and shift attention.

Impairments in both the Trail Making and Stroop tests.

Substantial difficulty in focusing on 3-tape tests that required him to differentiate speech and nonspeech sounds.

His recall of ideas and stories presented once was well below average.

On a verbal learning test, he started out slowly, but then showed a learning curve with repetition, recalling 15 of 16 stimulus words. He was vulnerable to interference and delay, and made an excessive number of intrusions.

Reproduction from memory was adequate for simple geometric figures but relatively poor for a complex geometric figure.

Responses to stimulation with tactile and visual modalities were within normal limits. He was functionally deaf in the left ear.

On motor and visual motor functions, he demonstrated a preference to the right hand, which was observed to be slow on a measure of finger tapping speed. Conversely, the strength of grip was relatively weak with the left hand.

On various tests of visual motor tracking/search, he performed extremely slowly.

Block assembly and figure copying were adequate, although he had difficulty initially copying a cross.

On language and auditory functions, he manifested numerous difficulties in spelling, reading, naming and articulating items that are easy for most persons.

Handwriting was dysgraphic. He also had problems with simple math. He made an excessive number of errors in repeating auditory strings of numbers and letters and in differentiating speech and nonspeech sounds.

On executive functioning and complex problem solving, he demonstrated confusion and reduced capacity to plan and monitor his behavior even within the structure of the testing situation.

Nonverbal abstract reasoning was in the mildly impaired range on the category test.

He was slow in the left hand on the tactile performance test and subsequent memory for spatial locations was impaired.

Mental flexibility and information processing speed were low.

# Diagnosis?

Conclusion

Recommendations

# Lesson Learned

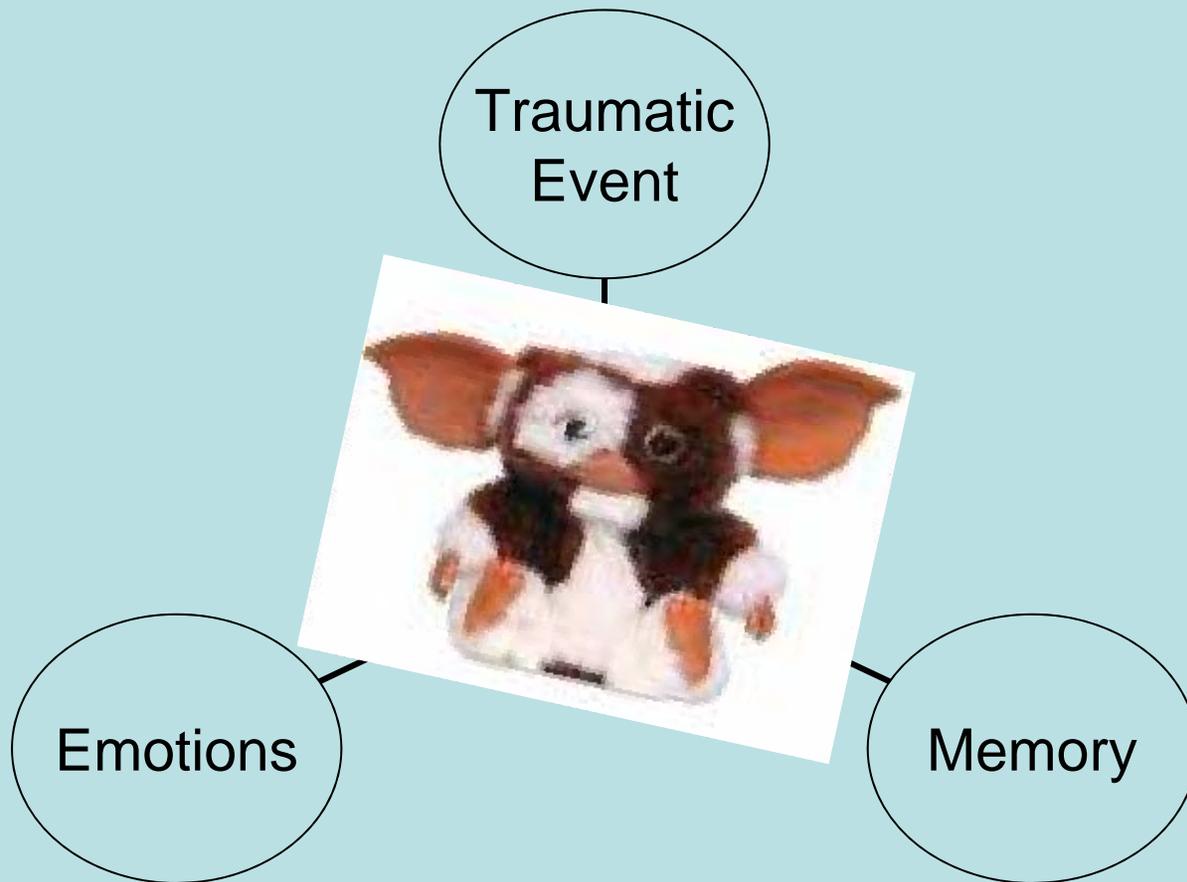
Danckwerts & Leathem (2003) suggest that "PTSD has been linked with impairments in cognitive functioning, but anomalies appear to arise on several levels, masking the true nature of the relationship."

**GREMLINS!**

# Summary: Take Home Message

- The research findings are getting clearer.
  - The role of stress and specifically PTSD on cognition as measured by neuropsychological testing is a mixed bag.
- The path to understanding PTSD may begin by unlocking or getting a better understanding of and ways to measure:
  - Emotional sequelae
  - Memory

# Gremlins!!!



# VA Information - PTSD

Contact Miles McFall, PhD at  
(206-764-2177)

**POSTTRAUMATIC STRESS  
DISORDER VA Puget Sound  
Health Care System  
Specialized Treatment  
Programs**

## ***American lake Division***

- ***Tacoma, WA 98493***
- ***253-583-1609***

## ***Seattle Division***

- ***1660 South Columbian Way***
- ***Seattle, WA 98108***
- ***206-277-4369***

- ***PTSD Treatment Services Available***
- The PTSD Program offers an integrated array of specialized PTSD treatment services at the *American Lake* and *Seattle Divisions* of the Puget Sound Health Care System.
- These services address PTSD resulting from military-related trauma, such as combat, sexual assault, and serious accidents. Programs are available for male and female veterans, and serve veterans from all periods of service. Treatment is provided through the following programs:

# VA PTSD Programs

## PTSD Inpatient Program)-- Seattle Division.

The PTSD Inpatient Program provides an intensive inpatient experience that addresses severe PTSD symptoms that interfere with veterans' safety or ability to function in everyday life. Veterans admitted to the program generally stay 1-2 weeks, and receive medical care, medications for PTSD, group psychotherapy, and help for financial and housing problems.

- PTSD Outpatient Clinic--  
American Lake and Seattle  
Divisions. The PTSD Outpatient Clinic provides treatment on an outpatient basis, usually consisting of weekly group, individual, and/or couples therapy sessions. Medication management and specialized treatment of substance abuse problems are also important treatment offerings. Veterans learn coping skills for reducing and managing symptoms, they engage in wellness programs to improve their physical health, and they have an opportunity to process their traumatic experiences so that distress about these events is

# VA - PTSD Programs

## PTSD Domiciliary--American Lake Division

The PTSD Domiciliary is a residential facility for veterans with PTSD whose symptoms are worsened by homelessness or substandard community residence.

Veterans who need residential care in a protected environment, even if they have stable housing, are also served.

Veterans usually stay about 1 month and receive up to 10 treatment groups each week, in addition to assistance with housing and finances and other community re-entry activities available in the PTSD Domiciliary and PTSD Outpatient Clinic.

- [How to Enroll in the PTSD Program](#)
- If you are interested in enrolling in any of the PTSD programs, you should phone the PTSD Program Triage Coordinator at either the American Lake Division (253-583-1609) or
- Seattle Division (206-277-4369) of the Puget Sound Health Care System.
- You may also report to the Psychiatric Emergency Services located at the Seattle Division or American Lake Division for brief evaluation and timely referral to one of the PTSD treatment programs that is most suitable for your individual needs.