Reduced heart rate variability during sleep: a candidate PTSD biomarker with implications for health risk: Commentary on Ulmer et al., “Posttraumatic stress disorder diagnosis is associated with reduced parasympathetic activity during sleep in US veterans and military service members of the Iraq and Afghanistan wars”

Thomas Alan Mellman*

Department of Psychiatry and Behavioral Medicine, Howard University College of Medicine, Washington, DC

*Corresponding author. Thomas Alan Mellman, 520 W st NW, Washington, DC 20059. Email: tmellman@howard.edu.

Since the initial designation of posttraumatic stress disorder (PTSD) in the DSM-III, heightened arousal has been a core construct operationalized by symptom cluster criteria that have included insomnia symptoms, vigilant behaviors, poor concentration (perhaps as a consequence of the prior two symptoms), irritability, and startle reactivity [1]. The conceptualization underlying this cluster criterion has invoked that increasing arousal is an adaptive response to threat that can persist maladaptively after a period of trauma exposure, manifesting in the aforementioned symptoms. The most consistent validation of this construct has come from numerous demonstrations of conditioned reactivity to trauma-related stimuli (including stimuli with more generalized threatening content) with effects on psychological, physiological, and functional neuroimaging measures [2]. Establishing objective validation and biomarkers of heightened arousal absent a symptom provocation paradigm has been elusive. This uncertainty may have influenced the relabeling of the symptom cluster to “alterations in arousal and reactivity” in the DSM-5 PTSD definition which controversially now includes “self-destructive and reckless behavior.” [3] Evaluations of arousal in PTSD typically measure functions regulated by the autonomic nervous system and its involvement in regulating arousal, reactivity to stress, and altered activity with PTSD are well established [4, 5]. The PTSD symptom criterion in the DSM-5 for sleep has been subtly changed from difficulty initiating and maintaining sleep to disturbed sleep, which is defined as difficulty initiating and maintaining, and/or restless sleep [3]. This change may reflect the near ubiquity of reports of disturbed sleep with variability in finding abnormal sleep initiation and maintenance with PTSD in studies where sleep was objectively monitored [6]. This variability may in part be accounted for by differences in population (age, gender, and chronicity) and setting (home versus lab). Sleep disruption can be strongly conditioned by trauma, particularly when one is deployed to a threatening environment. Impairment in sleep is distinct in the arousal cluster in that it involves attainment of a restorative state of diminished arousal in contrast with reacting to provocative stimuli with increased arousal. Sleep also has critical benefits to health and well-being.
The report by Ulmer and colleagues [7] provides a major contribution to emerging evidence that abnormal autonomic activity during sleep, specifically reduction in the normal rise in parasympathetic activity (indexed by high-frequency [HF] spectral heart rate variability [HRV] activity), may be an objectively measured arousal-related sleep abnormality of PTSD. Strengths of their study include the focus on Veterans of the more recent Iraq and Afghanistan wars, state of the art laboratory assessment of sleep and HRV, and a moderate to large sample size from three cohorts studied at two sites. The authors review three prior relevant studies and it is noted that the one study that was not consistent with their findings reported on respiratory sinus arrhythmia rather than HF frequency spectra. Ulmer et al. cite our publication reporting reduced normalized HF (nHF) measured in participant’s home settings with PTSD compared with a resilient trauma-exposed group [8]. A subsequent analysis that we published suggested that the aforementioned difference depended on the use of a control group who had been resilient to high-impact trauma [9]. Of note, there was a robust correlation of nHF during sleep and sleep duration within the resilient group that was not present in the PTSD group [8]. As noted by Ulmer et al., our cumulative findings further suggest that abnormalities of HRV during sleep are more evident from home-based recordings, suggesting that the differences with PTSD they reported could be more robust if measured in participant’s habitual, home environment. That differences achieved significance in nonrapid eye movement (NREM) sleep is consistent with research demonstrating that the normal rise in parasympathetic activity during sleep is more prominent during its NREM stages [10].

The findings reported by Ulmer et al. along with prior findings suggest that autonomic activity indexed by spectral HRV-derived indices from the sleep period be considered as a candidate for inclusion in the elusive quest for PTSD biomarker panels. An additional important implication, which is also noted by the authors, is identification of a pathway between PTSD and health, particularly cardiovascular, risk. Autonomic activity has long been invoked as a critical link between psychological stress and adverse physical health outcomes [11]. Short sleep duration which appears to influence nocturnal autonomic balance [8] is well established to increase health risk including mortality [12]. Although studies are limited, there is documentation of conditions where PNS dominance during sleep is compromised being associated with adverse cardiovascular consequences. These include association with the absence of nocturnal blood pressure reduction which is an established risk factor for hypertension and other cardiovascular events [13], apneic events during sleep [14], and among patients with histories of myocardial infarction [15].

With regard to mental health, a cholinergically innervated brain state (which may parallel peripheral parasympathetic activity) has been postulated to facilitate adaptive emotional processing of trauma memories [16]. I look forward to replication and extension of the important findings of Ulmer et al. [7] and future studies evaluating the potential mediation of nocturnal autonomic health risk in the progression of PTSD and its associated health risk, and its utilization as a target in treatment and preventive interventions.

Conflict of interest statement. None declared.

References