

Routine Exposures Associated with Military Deployment Are Associated With Debilitating Chronic Disease

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INTRODUCTION

Military service is a noble endeavor in many regards. Men and women of our armed services put their bodies on the line in service to their country and the people within it. However military service is not without its risks. Health risk is self-evident in the line of enemy fire, but many risks may not be immediately apparent. The purpose of this review is to:

- 1) Highlight some of the known environmental exposures associated with military deployment,
- 2) Promote policy change to meet the needs of our armed services and
- 3) Encourage healthcare providers to develop cultural competence when treating military patients.

MATERIALS AND METHODS

This review was compiled from pre-existing contemporary research, government data and news reports. Pre-existing studies utilized in this review have been featured previously in predominant medical journals and nationally circulated news publications. This review is based on studies and reports published on the trends in military exposure medicine over the past 20 years from about 2002 to 2023.

Compliance with Ethical Standards

The author wishes to declare that he has no conflict of interest while reporting this piece. This is not a research study, therefore no experiments involving human participants and/or animals was conducted. No informed consent was required due to lack of human participants.

RESULTS

Blast exposure

One of the known environmental exposures associated with military deployment is traumatic brain injury (TBI). Some Military roles are at higher risk for TBI than others. “Breachers” are a subset of military personnel who force entry into enclosed areas using tactical techniques which repeatedly expose them to “overpressure.” Overpressure can be defined as a shock wave that exceeds normal atmospheric pressure. As a result, breachers often develop sequelae of TBI (termed “breacher’s brain”) (Boutté et al., n.d.).

Not all head injuries cause overt penetration. For this reason, objective measures must be in place to quantify risk of underlying damage. The Center for Disease Control (CDC) defines traumatic brain injury as a Glasgow Coma Scale (GCS) score of at least 13 to 15 measured thirty minutes after head injury. Mild TBI is defined as a GCS score ranging from 13 to 15. Moderate TBI is considered with a GCS score between 9 to 12. Severe TBI is considered w/ a GCS score less than 8. Lower GCS scores imply greater levels of structural neurological damage (Centers for Disease Control and Prevention, n.d.).

Structural white matter brain changes have been demonstrated in those with blast exposure. It has also been demonstrated that these structural brain changes occur independently of overt clinical symptoms. Trotter et al. demonstrated this by using Diffusion Tensor Imaging (DTI). DTI determines the integrity of brain tissue by measuring the diffusion of water in a 3D space within the tissue. A dose-response relationship was demonstrated between the number of blast exposures and decline in white matter integrity (Trotter et al., n.d.). Trotter et al. also showed a negative association between time since blast exposure and white matter integrity suggesting that an element of scarring and structural reorganization occurs.

Boutte et al. demonstrated the presence of TBI-related biomarkers in serum within one hour of blast-exposure. These biomarkers were associated with TBI symptomology and slowed reaction time. Decreases in Nf-L (neurofilament light chain) and GFAP (glial fibrillary protein) were associated with increases in Tau protein and amyloid protein (A β -40 and A β -42) (Boutté et al., n.d.) In 2016, a consensus panel convened by the National Institute of Neurological Disorders and Stroke/National Institute of Biomedical Imaging and Bioengineering (NINDS/NIBIB) identified the pathognomonic lesion of chronic traumatic encephalopathy as an accumulation of abnormal hyperphosphorylated Tau protein(p-tau) in neurons and astroglia distributed around the small blood vessels in the cortical sulci (McKee et al., n.d.). This finding implies a relationship between military blast exposure and development of chronic neurodegenerative disease.

Ambient exposure

Ambient exposure is largely categorized by the personnel's theater of deployment because a causal relationship to health outcomes must be demonstrated before Veteran's Affairs services are reimbursed.

Post-WWII, a number of experiments were conducted on troops (knowingly and unknowingly) to determine the effect of chemical, biological and radiological exposure. These included the Aberdeen/Edgewood, Shipboard Hazard and Defense (SHAD) and Smokey experiments to name a few. Documentation was limited to acute effects with little to no long-term follow-up. Because of poor follow-up, determination of health effects was limited to the Smokey experiments which determined a statistically significant correlation between leukemia diagnosis and radiation exposure. This poor follow-up has limited compensation benefits for effected Veterans.

The Vietnam era has become synonymous to exposure to the herbicide, Agent Orange. Despite a number of chronic illnesses being attributed to deployment in Vietnam, causal relationship could not be demonstrated. Despite this, Congress passed the "Agent Orange Act of 1991" which created a means for VA services to be rendered for Vietnam era associated conditions.

Deployment during the First Gulf War has been associated with a constellation of symptoms which included fatigue, headaches, neurological problems, memory loss, musculoskeletal pain, gastrointestinal problems, skin rashes, cancers and birth defects. This constellation of symptoms was termed the "Gulf War syndrome." Despite many possible exposures being implicated (ie: sarin gas, oil well fires, depleted uranium, battlefield stress), again no causal relationship was able to be demonstrated (Richards, n.d.).

Concerning exposure during more recent conflicts (ie: Operation Enduring Freedom, Operation Iraqi Freedom) has centered around burn pit exposure. Burn pits have been used to dispose solid waste materials such as plastics, metals, rubber, paints, solvents, munitions and wood. However these burn pits have been a significant source of compounds which are carcinogenic. Mallon et al. have summarized Department of Defense research on the relationship between ambient exposure and biomarker serological levels. At Joint Base Balad in Iraq (2007), measured sources for polycyclic aromatic hydrocarbons (PAH), polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzofurans (PCDFs) were isolated to burn pits, diesel vehicles, generators and aircraft emissions. PCDD/PACDF compounds were focused around the burn pits while PAH were more widely distributed across the base. In addition to this, there was determined to be statistically significant correlation between differential expression of miRNA levels and the presence of serum PAH and PCDD/PCDF (Mallon et al., n.d.).

The link between troop ambient exposure to inhaled particulate matter and respiratory illness is one that few would dispute. Prior to passage of the PACT Act of 2022, the VA policy, under secretary Denis McDonough, deemed a diagnosis of rhinitis, sinusitis or asthma to be a presumed service-related condition related to burn pit exposure whose care the VA compensated for (Titus, 2021)

However, PAH and PCDD/PCDF are known carcinogens. PAH is known to be absorbed through the respiratory epithelium to enter systemic circulation and subsequently initiate and propagate carcinogenesis. PAH is stored in systemic tissues as DNA adducts (Boström et al., n.d.). They alkylate DNA by covalent binding to guanine and less frequently to adenine and cytosine. This causes mispairing of bases during DNA replication resulting in mutations that eventually lead to activation of oncogenes, inactivation of tumor suppressor genes and overexpression of anti-apoptotic genes (Błaszczuk & Mielżyńska-Švach, n.d.). PAH is classified by the American Cancer Society as “reasonably anticipated to be human carcinogens” (American Cancer Society, n.d.). PCDD and PCDF are primarily absorbed through dietary intake of fat and stored in adipose tissue where they are not readily metabolized or excreted (Milbrath et al., 2009). PCDD and other dioxin-like compounds are thought to induce changes to chromatin structure via aryl hydrocarbon receptor mediated changes, which increase access to gene promoter regions (Wu & Whitlock, 1992). PCDF and other furan class compounds are thought to illicit a toxic response via alkylation of proteins by reactive intermediates (Peterson, 2000). Both PCDD and PCDF are classified by the American Cancer Society as group 1 carcinogens to humans (American Cancer Society, n.d.).

PAH, PCDD and PCDF have been linked to increased cardiovascular mortality through action on aryl hydrocarbon receptors differentially expressed on cardiovascular endothelium and activation of xenobiotic metabolizing enzymes which generate reactive oxygen species (El-Kadi & Korashy, n.d.). PCDD and other dioxin compounds have been linked to CNS/PNS pathology, chloracne, porphyria, diabetes (Pelclová et al., 2006) and thyroid disorders as well (Pavuk et al., 2003).

On August 10th 2022, the Biden Administration signed into law the PACT Act of 2022. Prior to this, in order to determine service-related connectivity to any condition caused by burn pits (other than rhinitis, sinusitis or asthma), veterans need to file a claim with Veteran’s Affairs. After the claim was processed, the patient was eligible for disability based on his assigned disability rating. Veterans were also encouraged to sign their name on The Airborne Hazards and Open Pit Registry in order to create a record of exposure-associated illness (however doing so does not initiate a disability claim) (CCK Law, 2023).

The PACT Act shifts the onus of proving causality between symptomology and toxic exposure from the patients onto the Veterans Health Administration (VHA). The PACT Act creates new

responsibilities within the VHA to establish causality through screening processes, provide outreach to service members with known toxic exposures, determine service need by patients with known toxic exposures who've developed symptoms and to appraise the cost of those services.

These new responsibilities obviously require new infrastructure and added layers of bureaucracy within the VHA. Retaining staff has been a problem within the VHA system due to competitiveness of outside salaries as well as the length of the employment onboarding process. This legislation removes previously established salary caps as well as the cap on those eligible for expedited onboarding. Also, in order to fund this expansion, the law allocates extra funding for these purposes to the "Cost of War Toxic Exposures Fund." However, additional funding can only be allocated through an act of Congress and funds can only be released with permission of the appropriate Congressional Committee (117th Congress, n.d.).

Post-Traumatic Stress Disorder

Military personnel run the risk of combat exposure with deployment. Another link that few would dispute is the link between combat stress and post-traumatic stress disorder. Though PTSD remains a clinical diagnosis (Brainline, 2023), there do exist objective biomarkers which can be used to predict onset of PTSD. Steudte-Schmiedgen et al. determined that lower hair cortisol concentrations and lower salivary cortisol stress reactivity were predictive of PTSD symptomology amongst military personnel with traumatic exposure (Steudte-Schmiedgen et al., n.d.).

Another source of stress amongst military personnel is that their voices are not heard within the military chain of command. Military personnel are instilled with an ethos which guides their morality. For example, they hold the welfare of others in higher regard than their own. They also have a commitment to finish to mission and protect their brothers-in-arms (OJIN, n.d.). However, quite often this military ethos conflicts with the realities of being a member of the armed forces. Recently one Marine Lt Colonel Stuart Scheller voiced his discontent with the American troop and civilian withdrawal from Afghanistan on social media. He regarded the withdrawal to be hasty, disorganized and the cause for the loss of lives among his fellow military brothers. Instead of sitting down with him to glean his point of view, military brass court-marshalled him (Calder, 2021). In addition to this, many in the media took the side of military brass and labeled him a "radical wanting to overthrow civilian control" (Hohmann, 2021). Not only do combat and ambient exposures serve as a source of stress to military personnel. A lack of shared-decision making capability and a lack of an outlet to voice concerns are additional stressors.

DISCUSSION AND CONCLUDING REMARKS

With the passage of the PACT Act of 2022, the breadth of presumed health conditions related to routine deployment exposures is now sufficient. The VA previously did reimburse healthcare services related to neurodegenerative disease such as Alzheimer's dementia, Parkinson's dementia and ALS with the presumption that it was linked to TBI/blast exposure (U.S. Department of Veterans Health Affairs, 2013). With the passage of the PACT Act, a litany of respiratory conditions and cancers are now presumed to be linked to toxic exposures while deployed. However, the new requirements put upon the VHA require additional layers of bureaucracy whose additional funding can only happen through an act of Congress. The need for Congressional approval for funding is a potential limitation to the services patients are now eligible for.

The aforementioned information also highlights a need to provide care to troops within the context of their military services. The term cultural competence within healthcare has been defined as the ability to provide care to patients within the context of the sum of their lived experiences (Centers for Disease Control and Prevention, n.d.). People have different cultural backgrounds. As a result, a need arises to address cultural differences within delivered care. This may involve hiring a translation service to address language barriers. It may also involve hiring staff from a background similar to the target patient population and holding workshops with current staff to convey the needs of the clientele.

When dealing with military personnel, a need for military cultural competence arises. And military cultural competence should be regarded as the ability to provide care to the patient within the context of his military service. Being aware of the patient's combat/ post-traumatic stress and ambient exposures during deployment is of utmost importance to provide quality care to the patient. In addition, they shouldn't feel as though they are passive members in healthcare delivery. Providers should actively convey to troops that healthcare delivery is a shared decision-making process and that they have the right to have their concerns heard. If they disagree with the care they are receiving, they have the right to voice that concern.

Finally, all healthcare complications associated with military service should be disclosed to military applicants prior to enrollment. To many, the decision to enlist in the military serves as a way to access higher education and a stepping stone to stand out in a competitive jobs market. All information about that decision, including the potential health risks, should be disclosed to applicants in order for them to weigh all the pros and cons of military service before making a commitment.

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