

NATIONAL SECURITY FELLOWS PROGRAM

# Modern Warfare Destroys Brains

Creating Awareness and Educating  
the Force on the Effects of Blast  
Traumatic Brain Injury

Warren Stewart

Kevin M. Trujillo



HARVARD Kennedy School

**BELFER CENTER**

for Science and International Affairs

PAPER

JULY 2020



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Both authors pledged to donate their brains to the Center for Neuroscience and Regenerative Medicine Brain Donation Awareness Program. For information how to donate your brain for research: <https://www.research-braininjury.org/registry/>

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# Table of Contents

Executive Summary .....	1
1. Introduction .....	2
2. “Operator Syndrome” .....	7
Post-Traumatic Stress Disorder.....	10
Traumatic Brain Injury and the Scope of the Problem.....	14
Interrelated Conditions of “Operator Syndrome” .....	19
Endocrine Dysfunction .....	19
Sleep Disturbance and Sleep Apnea .....	20
Depression and Suicide .....	21
Remaining Components of the “Operator Syndrome” .....	22
National Security Implications.....	23
3. Blast Related Traumatic Brain Injury.....	25
Effects of Repeated Blast Exposures.....	28
Differences Between CTE and IAS .....	30

<b>4. Humanizing the Impacts.....</b>	<b>32</b>
The Costs.....	35
<b>5. Current USSOCOM and DOD Efforts to Address Warfighter Brain Health .....</b>	<b>37</b>
Department of Defense Efforts—USD for Personnel and Readiness.....	38
<b>6. Policy Recommendations .....</b>	<b>41</b>
Technology .....	41
Research .....	42
Policy.....	44
Education.....	46
<b>7. Conclusion.....</b>	<b>48</b>
<b>Bibliography.....</b>	<b>50</b>





# Glossary

bTBI	Blast related traumatic brain injury/Blast wave traumatic brain injury
CTE	Chronic traumatic encephalopathy
DOD	Department of Defense
IAS	Interface Astroglial Scarring
mTBI	mild traumatic brain injury
PTSD	Post-Traumatic Stress Disorder
SO	Special Operator
SOF	Special Operations Forces
TBI	Traumatic Brain Injury
USSOCOM	United States Special Operations Command

**blast related traumatic brain injury:** traumatic brain injury caused by an explosion or blast that can be more complex compared with a TBI from other causes

**blast wave:** complex pressure wave generated by an explosion, an instantaneous rise in atmospheric pressure that is much higher than normal for humans to withstand.

**comorbidities:** the simultaneous presence of 2+ morbid conditions or diseases in the same Pt, which may complicate a Pt's overall health or treatment plan

**chronic traumatic encephalopathy:** a neurodegenerative disease caused by repeated head injuries

**interface astroglial scarring:** distinct and previously undescribed pattern of scarring at boundaries between brain parenchyma and fluids, and at junctions between grey and white matter.

**posttraumatic stress disorder:** a psychological reaction occurring after experiencing a highly stressing event (such as wartime combat, physical violence, or a natural disaster) that is usually characterized by depression, anxiety, flashbacks, recurrent nightmares, and avoidance of reminders of the event.

**traumatic brain injury:** A traumatically induced structural injury or physiological disruption of brain function, as the result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs immediately following the event: Any alteration in mental status (e.g., confusion, disorientation, slowed thinking, etc.). Any loss of memory for events immediately before or after the injury. Any period of loss of or a decreased level of consciousness, observed or self-reported.



Rangers from 75th Ranger Regiment train on the 120mm Mortar System.

US Army Photo / Spc. Garrett Shreffler



# Executive Summary

“Operator Syndrome,” especially blast TBI (bTBI) and PTSD, are destroying the lives of special operators at an alarming rate. For the purposes of this paper, operators are Green Berets, SEALs, MARSOC Raiders, Combat Controllers, Pararescue, Explosive Ordnance Disposal Technicians, Special Mission Units or those that may accompany special operations forces regularly in training or on missions. The USSOCOM must continue to aggressively address bTBI. The authors acknowledge that the Nation and the command have invested heavily in developing strategies to address this issue; however, thus far, the efforts seem disjointed and have failed to mitigate the impact on special operators. These well-intentioned programs, policies, and research efforts are not making it to the team rooms or the ready rooms of our Ranger Platoons, Green Beret “A-Teams,” SEAL Platoons, Marine Special Operations Teams or other special mission units. There is no time to waste—senior leaders, policy makers and researchers must translate the current knowledge into actionable programs. There is no doubt that if provided the right tools, equipment and education, the senior non-commissioned officers will undoubtedly alter training protocols, inform their teammates and force positive change.

This paper has two primary objectives. First, it will support the argument that blast related TBI is uniquely different from the more recognized brain injury known as chronic traumatic encephalopathy (CTE) injury associated with impact trauma and therefore requires a different approach to both diagnosis and treatment. Second, it will provide recommendations for mitigating the effects of bTBI on the readiness and long-term health of special operators.

Key recommendations will include identifying blast pressure thresholds, developing imaging technology, and blood markers to diagnose bTBI. It calls for the DoD to institute and sustain “baseline” health surveillance to detect patterns of injury and health distress early, promote awareness for the Center for Neuroscience and Regenerative Medicine Brain Donation Awareness Program, and to establish an active Cross-Functional Brain Consortium. An additional recommendation will include changes to training plans that continue to prepare operators for combat but reduce their exposure to blast trauma.

# 1. Introduction

*SOF Truth #1:*

*“Humans are More Important Than Hardware”<sup>1</sup>*

Due to the nature of the current global counter-terrorism and partnership efforts, the men and women of the United States Special Operations Command (USSOCOM) have been disproportionately exposed to direct combat and high-risk training compared to their conventional force counterparts.<sup>2</sup> As a clear example of the high operational tempo, the number of countries where special operations forces (SOF) deployed increased from “60 countries in 2009 to over 147 in 2015.”<sup>3</sup> These forces continue to conduct a wide range of SOF missions to include foreign internal defense and direct action raids in support of the counterterror fight. Owing to their relatively small footprint and ability to operate within “ungoverned spaces,”<sup>4</sup> SOF will continue to be employed across the globe, all while retooling for the near-peer competitor fight. The recent USSOCOM cultural and ethics review revealed a “mission accomplishment” culture that sacrificed leader development and created significant stress on the force.<sup>5</sup> The study uncovered an ethos unwilling to say “no” to employment, regardless of its impact on the force, which created a high demand for SOF, exposing a large number of special operators to both physical and psychological injuries.<sup>6</sup>

Suicide rates continue to rise among Special Operations Service members. New, emerging scientific evidence is increasingly illuminating the connection between traumatic brain injury and the increased risk for suicide.<sup>7</sup> The Department of Defense, the Veterans Affairs Administration and several

1 “SOF Truths,” accessed January 27, 2020, <https://www.socom.mil/about/sof-truths>.

2 Daniel Byman and Ian A. Merritt, “The New American Way of War: Special Operations Forces in the War on Terrorism,” *The Washington Quarterly* 41, no. 2 (April 3, 2018): 79–93, <https://doi.org/10.1080/0163660X.2018.1484226>.

3 Byman and Merritt.

4 Byman and Merritt.

5 John Friberg, “USSOCOM Comprehensive Review of Culture and Ethics,” *SOF News* (blog), January 29, 2020, <https://sof.news/ussocom/ussocom-sof-culture-ethics-report-2020/>.

6 Friberg.

7 Lisa A. Brenner et al., “Suicidality and Veterans with a History of Traumatic Brain Injury: Precipitants Events, Protective Factors, and Prevention Strategies,” *Rehabilitation Psychology* 54, no. 4 (November 2009): 390–97, <https://doi.org/10.1037/a0017802>.

private foundations are expending tremendous resources to research and develop means to combat this growing epidemic. Despite the multitude of efforts, we continue to lose many Service members to suicide, which is having significant, strategic impacts on our national security.

This high stress, physically demanding profession has created a “cascade of medical, emotional, and social problems...” that have proven difficult to manage.<sup>8</sup> Christopher Frueh et al. utilizes the term “Operator Syndrome” to describe the “constellation of medical and behavioral healthcare issues that include traumatic brain injury (TBI), endocrine dysfunction, sleep disturbance, obstructive sleep apnea, chronic joint/back pain, orthopedic problems and headaches. Additional problems included in the syndrome involve substance abuse, depression and suicide, posttraumatic stress disorder (PTSD), anger and stress reactivity. Finally, operators suffer from high rates of marital, family, and community dysfunction, experience problems with sexual health and intimacy, suffer from memory, concentration and cognitive impairments, and have diminished vestibular function and vision problems.”<sup>9</sup>

The first SOF truth states that “Humans are More Important than Hardware,”<sup>10</sup> and General James McConville, the Army’s 40th Chief of Staff, has been clear that his number one priority is people. He argues that for the Army to win in war, it must ensure that Soldiers receive the best possible leadership, training and equipment.<sup>11</sup> Providing for the safety and health of special operators and their Families is fundamental to any “people-centric” philosophy. Additionally, the cornerstone of mission command is trust between the Commander and his/her subordinates.<sup>12</sup> To maintain that trust, leaders must make every effort to protect the health of their charges and, if injured, ensure they receive the most exceptional care

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8 B. Christopher Frueh et al., “‘Operator Syndrome’: A Unique Constellation of Medical and Behavioral Health-Care Needs of Military Special Operation Forces,” *International Journal of Psychiatry in Medicine*, February 13, 2020, 91217420906659, <https://doi.org/10.1177/0091217420906659>.

9 Frueh et al.

10 “SOF Truths.”

11 “New Chief of Staff: Taking Care of People Key to Winning the Fight,” [www.army.mil](http://www.army.mil), accessed October 26, 2019, [https://www.army.mil/article/225377/new\\_chief\\_of\\_staff\\_taking\\_care\\_of\\_people\\_key\\_to\\_winning\\_the\\_fight](https://www.army.mil/article/225377/new_chief_of_staff_taking_care_of_people_key_to_winning_the_fight).

12 “Adrp6\_0.Pdf,” accessed October 26, 2019, [https://fas.org/irp/doddir/army/adrp6\\_0.pdf](https://fas.org/irp/doddir/army/adrp6_0.pdf).

possible. If people are genuinely the “most important weapon system,”<sup>13</sup> then military medicine and other vital stakeholders must first acknowledge and be willing to address the constellation of issues associated with “Operator Syndrome.”

Due to the limited scope and length of this paper, the authors will focus on blast-related traumatic brain injury due to the high number of operators impacted, because TBI is central to “Operator Syndrome,” and finally because TBI is widely considered the “signature injury” of the current war on terror.<sup>14</sup> Traumatic brain injury is defined by the Center for Disease Control as a “disruption in the normal function of the brain that can be caused by a bump, blow, or jolt to the head or a penetrating head injury.”<sup>15</sup> TBI has significant long-term effects on the patient that include impaired cognition, chronic pain, and increased risk for suicide.<sup>16</sup> Fortunately, most TBI (i.e. mTBI) patients recover in a reasonable amount of time. However, there are many with protracted recoveries for various reasons and risk factors.<sup>17</sup>

Because of the scope and complexity of diagnosing and treating TBI, there must be a coordinated effort across multiple government departments and agencies, civilian medical and research institutions, and non-profit organizations. A failure to address this emerging crisis in a timely manner threatens national security for various reasons outlined herein are three of the most important. First, service members are willing to put themselves in harm’s way because they have faith that they will receive the highest quality of care if wounded — military medicine’s inability to provide solutions to this issue jeopardizes that commitment. Second, if TBI remains in the

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13 “40th Chief of Staff of the Army Initial Message to the Army Team,” [www.army.mil](http://www.army.mil), accessed October 23, 2019, [https://www.army.mil/article/225605/40th\\_chief\\_of\\_staff\\_of\\_the\\_army\\_initial\\_message\\_to\\_the\\_army\\_team](https://www.army.mil/article/225605/40th_chief_of_staff_of_the_army_initial_message_to_the_army_team).

14 Christine L. Mac Donald et al., “Prospectively Assessed Clinical Outcomes in Concussive Blast vs Nonblast Traumatic Brain Injury among Evacuated US Military Personnel,” *JAMA Neurology* 71, no. 8 (August 2014): 994–1002, <https://doi.org/10.1001/jamaneurol.2014.1114>.

15 “Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel,” n.d.

16 Maya Troyanskaya et al., “Combat Exposure, PTSD Symptoms, and Cognition Following Blast-Related Traumatic Brain Injury in OEF/OIF/OND Service Members and Veterans,” *Military Medicine* 180, no. 3 (March 2015): 285–89, <https://doi.org/10.7205/MILMED-D-14-00256>.

17 Amanda R. Rabinowitz et al., “Prevalence and Predictors of Poor Recovery from Mild Traumatic Brain Injury,” *Journal of Neurotrauma* 32, no. 19 (October 1, 2015): 1488–96, <https://doi.org/10.1089/neu.2014.3555>.

public consciousness, it will continue to impact the ability of the services, and in return, the USSOCOM to recruit and retain the best quality force.

Most importantly, the inability to correctly prevent, diagnose, and treat TBI will leave the thousands affected to suffer without optimized care. To humanize this issue, according to the *New York Times*, 100% of the Special Operators that committed suicide in 2014 had previously sought treatment for TBI.<sup>18</sup>

“Operator Syndrome,” especially bTBI and PTSD, are destroying the lives of special operators.<sup>19</sup> The USSOCOM must continue to aggressively address blast TBI as well as mental health. The authors acknowledge that the Nation and the command have invested heavily in developing strategies to address this issue; however, thus far, the efforts seem disjointed and have failed to mitigate the impact on special operators. These well-intentioned programs, policies, and research efforts are not making it to the team rooms or the ready rooms of our Green Beret “A-Teams,” SEAL Platoons, Ranger Platoons, Marine Special Operations Teams or other special mission units. There is no time to waste -- senior leaders, policy makers and researchers must translate the current knowledge into actionable programs. There is no doubt that if provided the right tools, equipment and education, the senior non-commissioned officers will undoubtedly alter training protocols, inform their teammates and force positive change.

This paper has two primary objectives. First, it will argue that blast related TBI is uniquely different from the more recognized brain injury known as chronic traumatic encephalopathy (CTE) injury associated with impact trauma and therefore requires a different approach to both diagnosis and treatment. Second, it will provide recommendations for mitigating the effects of bTBI on the readiness and long-term health of special operators. Key recommendations will include identifying blast pressure thresholds, developing imaging technology, and blood markers to diagnose bTBI. It calls for the DoD to institute and sustain “baseline” health surveillance to

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18 Thom Shanker and Richard A. Opperl Jr, “War’s Elite Tough Guys, Hesitant to Seek Healing,” *The New York Times*, June 5, 2014, sec. U.S., <https://www.nytimes.com/2014/06/06/us/politics/wars-elite-tough-guys-hesitant-to-seek-healing.html>.

19 Robert F. Worth, “What If PTSD Is More Physical than Psychological?,” *The New York Times Magazine*, June 10, 2016, <https://nytimes.ms/1TYyp6U>.

detect patterns of injury and health distress early, promote the Center for Neuroscience and Regenerative Medicine Brain Repository, and to establish a Cross-Functional Brain Consortium. An additional recommendation will include changes to training plans that continue to prepare operators for combat but reduce their exposure to blast trauma. This potentially controversial recommendation is in response to reports that as high as 85% of operators experience TBI from training alone.<sup>20</sup>

The authors will focus on special operations forces because they are disproportionately exposed to multiple risk factors during training and combat deployments, and due to its service-like authorities, USSOCOM is uniquely postured to tackle this problem aggressively. The recommendations will be relevant to joint and conventional force commanders - particularly those exposed to repeated concussive blast events such as AC-130 Gunship aerial gunners, US Navy Gunner's mates, armor crewman, artillerymen, explosive ordnance disposal technicians, and engineers as exposure to repeated concussive blasts permeate all services.

This paper will explore the constellation of conditions identified in the "Operator Syndrome" framework, focusing on blast TBI, PTSD and suicide. Next, the authors will describe the difference between CTE and blast wave TBI and explore the current evidence on the prevention and treatment of blast-related traumatic brain injury. Additionally, the paper will describe ongoing efforts within the USSOCOM, the DoD and other public and private organizations that promote awareness of care to operators impacted by these difficult to treat conditions. Finally, the authors will provide clear, concise recommendations for policymakers and commanders within the special operations community that will improve operator health and unit readiness.

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20 Frueh et al., "Operator Syndrome."



## 2. “Operator Syndrome”

*“I have seen boys like these, younger than these, their arms torn out, their legs ripped off. But there is nothin’ like the sight of an **amputated spirit**. There is... no prosthetic for that.”*

*Lt. Col Frank Slade, portrayed by Al Pacino in the movie *Scent of a Woman**

To best understand the complexity of the problem facing SOF, it is essential to spend some time discussing the “Operator Syndrome,” and the physical and psychological injuries that can mask the diagnosis of TBI and complicate its treatment. While the link between the injuries is still not fully understood, medical providers and commanders should maintain a high degree of humility and circumspection when caring for special operators with bTBI.

The landmark 2008 RAND publication *Invisible Wounds of War*<sup>21</sup> described three medical conditions that often go undiagnosed and, therefore, untreated in many veterans of the wars in Iraq and Afghanistan: post-traumatic stress disorder, major depressive disorder, and traumatic brain injury.<sup>22</sup> This critical work served as a call to action for the United States Congress,<sup>23</sup> the Department of Defense, medical professionals, and other vital stakeholders that resulted in improvements in awareness, diagnosis, and treatment of these insidious conditions.<sup>24</sup> Unfortunately, these

21 Terri Tanielian, Lisa H. Jaycox, David M. Adamson, et al., “Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery,” Product Page, 2008, <https://www.rand.org/pubs/monographs/MG720.html>.

22 Tanielian, Jaycox, Adamson, et al.; Rachel P. Chase and Remington L. Nevin, “Population Estimates of Undocumented Incident Traumatic Brain Injuries among Combat-Deployed US Military Personnel,” *The Journal of Head Trauma Rehabilitation* 30, no. 1 (February 2015): E57-64, <https://doi.org/10.1097/HTR.000000000000061>.

23 “Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel.”

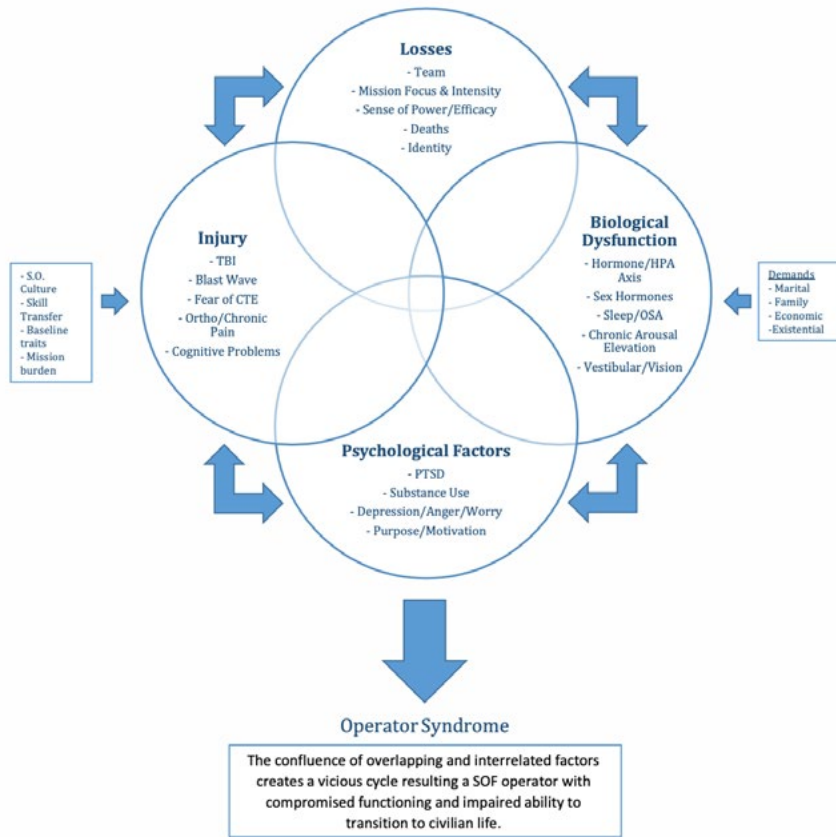
24 Ralph G. DePalma and Stuart W. Hoffman, “Combat Blast Related Traumatic Brain Injury (TBI): Decade of Recognition; Promise of Progress,” *Behavioural Brain Research* 340 (15 2018): 102–5, <https://doi.org/10.1016/j.bbr.2016.08.036>; Committee on the Assessment of Ongoing Efforts in the Treatment of Posttraumatic Stress Disorder, Board on the Health of Select Populations, and Institute of Medicine, *Treatment for Posttraumatic Stress Disorder in Military and Veteran Populations: Final Assessment* (Washington (DC): National Academies Press (US), 2014), <http://www.ncbi.nlm.nih.gov/books/NBK224878/>.

efforts failed to produce significant progress in either the number of troops impacted by TBI or its morbidity.<sup>25</sup>

The impacts of these injuries are far-reaching and affect not only the individual but their social support system<sup>26</sup> and the readiness of their unit. The negative consequences include impaired cognition, suicidal ideation, alcohol and opiate dependence, family dysfunction, chronic pain, and decreased quality of life.<sup>27</sup> The degradation of unit readiness can be attributed to the loss of person-hours, disruption of close-knit teams and a strain on resources to include funding, medical support, training time and commanders' priorities.<sup>28</sup>

As described earlier, Frueh et al. recently published an article describing a cluster of definitive signs and symptoms within the SOF community, using the term "Operator Syndrome." Frueh and his colleagues developed a schematic model to illustrate the interrelated factors that lead to diminished functioning.<sup>29</sup> (See Figure 1)

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- 25 Kimberly A. Hepner et al., "Delivering Clinical Practice Guideline-Concordant Care for PTSD and Major Depression in Military Treatment Facilities," *Rand Health Quarterly* 7, no. 3 (April 2018): 3; Daniel K. Schneider et al., "Current State of Concussion Prevention Strategies: A Systematic Review and Meta-Analysis of Prospective, Controlled Studies," *British Journal of Sports Medicine* 51, no. 20 (October 2017): 1473–82, <https://doi.org/10.1136/bjsports-2015-095645>; Terri Tanielian et al., "Barriers to Engaging Service Members in Mental Health Care Within the U.S. Military Health System," *Psychiatric Services (Washington, D.C.)* 67, no. 7 (01 2016): 718–27, <https://doi.org/10.1176/appi.ps.201500237>.
- 26 Terri Tanielian et al., "Military Caregivers: Cornerstones of Support for Our Nation's Wounded, Ill, and Injured Veterans," *Rand Health Quarterly* 3, no. 1 (2013): 3; Joan M. Griffin et al., "The Invisible Side of War: Families Caring for US Service Members with Traumatic Brain Injuries and Polytrauma," *The Journal of Head Trauma Rehabilitation* 27, no. 1 (February 2012): 3–13, <https://doi.org/10.1097/HTR.0b013e3182274260>.
- 27 Kevin J. Heltemes et al., "Blast-Related Mild Traumatic Brain Injury Is Associated with a Decline in Self-Rated Health amongst US Military Personnel," *Injury* 43, no. 12 (December 2012): 1990–95, <https://doi.org/10.1016/j.injury.2011.07.021>; Yelena Bogdanova and Mieke Verfaellie, "Cognitive Sequelae of Blast-Induced Traumatic Brain Injury: Recovery and Rehabilitation," *Neuropsychology Review* 22, no. 1 (March 2012): 4–20, <https://doi.org/10.1007/s11065-012-9192-3>; Maya Troyanskaya et al., "Combat Exposure, PTSD Symptoms, and Cognition Following Blast-Related Traumatic Brain Injury in OEF/OIF/OND Service Members and Veterans," *Military Medicine* 180, no. 3 (March 2015): 285–89, <https://doi.org/10.7205/MILMED-D-14-00256>; Sara Dolan et al., "Neuropsychological Sequelae of PTSD and TBI Following War Deployment Among OEF/OIF Veterans," *Neuropsychology Review* 22, no. 1 (March 2012): 21–34, <https://doi.org/10.1007/s11065-012-9190-5>.
- 28 Tanielian, Jaycox, Adamson, et al., "Invisible Wounds of War," 2008; Suzanne McGarity et al., "Community Reintegration Problems Among Veterans and Active Duty Service Members With Traumatic Brain Injury," *The Journal of Head Trauma Rehabilitation* 32, no. 1 (February 2017): 34, <https://doi.org/10.1097/HTR.0000000000000242>.
- 29 Frueh et al., "Operator Syndrome."



**Figure 1:** Schematic of the “Operator Syndrome” and its Impact on the Operator.<sup>30</sup>

30 Frueh et al.

# Post-Traumatic Stress Disorder

Understanding PTSD and its impact on special operations forces and their support systems, is vital for a few reasons. First, the risk for PTSD increases with the severity, duration, and recurring exposure to combat<sup>31</sup>, all of which place SOF in a higher risk group than their conventional counterparts. Second, PTSD has a significant impact on the individual, including interpersonal problems, physical health comorbidities and, most concerning, is strongly associated with suicide.<sup>32</sup> The physical comorbidities include alcohol dependence, major depressive disorder, and illicit drug use.

Interestingly, PTSD is linked to “...joint disease, cardiological conditions, and metabolic disease.”<sup>33</sup> Importantly for this paper, PTSD is closely associated with mTBI. According to Carlson et al., up to 39% of TBI patients also have PTSD.<sup>34</sup> Awareness of the TBI/PTSD relationship is key to understanding those suffering from this dual diagnosis.

Post-Traumatic Stress Disorder entered the Nations’ consciousness following the Vietnam War, but has been described throughout the history of warfare. Literature from prior wars applied terms like “soldier’s heart,” “shell shock,” and “battle fatigue,”<sup>35</sup> to describe a psychiatric disorder caused by exposure to a traumatic event such as combat. For the diagnosis of PTSD, the patient must be exposed either directly or indirectly to a traumatic experience, then exhibit symptoms for a minimum of 30 days. The symptoms can present immediately or, in many cases, weeks to months

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31 Rajeev Ramchand et al., “Prevalence Of, Risk Factors For, and Consequences of Posttraumatic Stress Disorder and Other Mental Health Problems in Military Populations Deployed to Iraq and Afghanistan:,” Product Page, 2015, [https://www.rand.org/pubs/external\\_publications/EP50677.html](https://www.rand.org/pubs/external_publications/EP50677.html).

32 Ramchand et al.

33 Rajeev Ramchand et al., “Prevalence Of, Risk Factors For, and Consequences of Posttraumatic Stress Disorder and Other Mental Health Problems in Military Populations Deployed to Iraq and Afghanistan:,” Product Page, 2015, [https://www.rand.org/pubs/external\\_publications/EP50677.html](https://www.rand.org/pubs/external_publications/EP50677.html).

34 Jitender Sareen, “Posttraumatic Stress Disorder in Adults: Impact, Comorbidity, Risk Factors, and Treatment,” *Canadian Journal of Psychiatry. Revue Canadienne de Psychiatrie* 59, no. 9 (September 2014): 460–67, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4168808/>.

35 “What Is PTSD?,” accessed February 8, 2020, <https://www.psychiatry.org/patients-families/ptsd/what-is-ptsd>.

following the event. The symptoms fall into four different categories and can vary in severity.<sup>36</sup>

1. “**Intrusive thoughts** such as repeated, involuntary memories; distressing dreams; or flashbacks of the traumatic event. Flashbacks may be so vivid that people feel they are re-living the traumatic experience or seeing it before their eyes.”<sup>37</sup>
2. “**Avoiding reminders** of the traumatic event may include avoiding people, places, activities, objects and situations that bring on distressing memories. People may try to avoid remembering or thinking about the traumatic event. They may resist talking about what happened or how they feel about it.”<sup>38</sup>
3. “**Negative thoughts and feelings** may include ongoing and distorted beliefs about oneself or others (e.g., “I am bad,” “No one can be trusted”); ongoing fear, horror, anger, guilt or shame; much less interest in activities previously enjoyed; or feeling detached or estranged from others.”<sup>39</sup>
4. “**Arousal and reactive symptoms** may include being irritable and having angry outbursts; behaving recklessly or in a self-destructive way; being easily startled; or having problems concentrating or sleeping.”<sup>40</sup>

Recent studies estimate rates as high as 15-20% of combat veterans from the wars in Iraq and Afghanistan screen positive for PTSD.<sup>41</sup> Identifying prevention, screening and treatment options for PTSD has been a significant focus of the VA/DoD and their civilian behavioral health counterparts since it was officially recognized in the 1970s by the American Psychiatric

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36 Wei Qi, Martin Gevonden, and Arieh Shalev, “Prevention of Post-Traumatic Stress Disorder After Trauma: Current Evidence and Future Directions,” *Current Psychiatry Reports* 18 (2016), <https://doi.org/10.1007/s11920-015-0655-0>.

37 “What Is PTSD?”

38 “What Is PTSD?”

39 “What Is PTSD?”

40 “What Is PTSD?”

41 Ramchand et al., “Prevalence Of, Risk Factors For, and Consequences of Posttraumatic Stress Disorder and Other Mental Health Problems in Military Populations Deployed to Iraq and Afghanistan,” 2015; Terri Tanielian, Lisa H. Jaycox, David M. Adamson, et al., “Invisible Wounds of War: Psychological and Cognitive Injuries, Their Consequences, and Services to Assist Recovery,” Product Page, 2008, <https://www.rand.org/pubs/monographs/MG720.html>.

Association.<sup>42</sup> A brief discussion of those efforts can assist with providing context to the authors' recommendations later in the paper.

While many risk factors for PTSD have been described, there is currently no individualized risk prediction available. Risk factors include gender, age, genetics, type of traumatic exposure and intensity. Other factors include past psychiatric history, family history and education level. Special operators are exposed to some risk factors to include intense and repeated combat, potential genetic factors, and previously undiagnosed behavioral health issues. They have an inherent advantage pre-exposure due to their age, physical fitness, higher problem-solving ability and lower emotional reactivity related to most demographic groups studied.<sup>43</sup>

Because all operators have some level of risk in the development of PTSD, systematic screening should occur post-exposure, or at a minimum post-deployment and then months later due to the frequent late onset of PTSD. Screening within the DoD is accomplished through the Post Deployment Health Assessment (PDHA), the Post Deployment Health Reassessment (PDHRA) and the annual Physical Health Assessment (PHA). The PDHA and PDHRA utilize a shortened PTSD screening tool that appears to identify those with potential PTSD accurately; however, RAND researchers warn that the screening tools are not entirely validated for this specific population and more research is required.<sup>44</sup>

There is evidence that prevention strategies can be helpful in particular patient populations, but generalizable treatment options have proven difficult. According to a literature review by Qi et al., there are “two primary goals for early interventions: to mitigate the development of early symptoms, and to increase the likelihood of remission in those who develop symptoms.”<sup>45</sup> Mitigation is accomplished through “...attempts to reduce the stressfulness of the traumatic event (e.g., ‘stress management’

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42 Miriam Reisman, “PTSD Treatment for Veterans: What’s Working, What’s New, and What’s Next,” *Pharmacy and Therapeutics* 41, no. 10 (October 2016): 623–34, <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5047000/>.

43 Qi, Gevonden, and Shalev, “Prevention of Post-Traumatic Stress Disorder After Trauma.”

44 Terri Tanielian, Lisa H. Jaycox, Terry L. Schell, et al., “Invisible Wounds of War: Summary and Recommendations for Addressing Psychological and Cognitive Injuries,” Product Page, 2008, <https://www.rand.org/pubs/monographs/MG720z1.html>.

45 Qi, Gevonden, and Shalev, “Prevention of Post-Traumatic Stress Disorder After Trauma.”

‘need-based assistance’), and interventions meant to reduce participants’ initial responses to the event or its encoding in memory...”<sup>46</sup>

Behavioral health providers commonly utilize psychological debriefing and cognitive behavioral therapy to target psychosocial factors. Psychological debriefing has fallen out of favor, but when used attempts to reduce the impact of PTSD through the processing of the emotional impact of trauma immediately following a traumatic experience.<sup>47</sup> Cognitive Behavioral Therapy “challenges the patient’s beliefs about the meaning and current implication of the trauma and is offered individually or in a small group.<sup>48</sup> Patients that respond to this therapy seldom relapse but continue to be at risk if exposed to new trauma.<sup>49</sup>

The methods utilized to address the neurobiological mechanisms include the use of medications and the use of fear conditioning and neurobehavioral training. According to a 2014 Cochrane review, hydrocortisone is moderately supported by evidence to provide benefit to trauma survivors that were not previously being treated for psychiatric conditions. Unfortunately, the analysis failed to confirm the efficacy of other promising drugs that include morphine, propranolol, oxytocin and gabapentin. Additionally, benzodiazepines were found to increase the effects of PTSD and are currently discouraged in the treatment of PTSD.<sup>50</sup>

PTSD with TBI is challenging to treat; however, the USSOCOM is moving in the right direction by employing individualized treatment plans. The use of multidisciplinary teams provides the best chance for success in treatment. Future efforts must include the reduction of the stigma associated with seeking behavioral health care, further exploration of pharmacological options, and the continued emphasis on screening for PTSD with any diagnosis of TBI.

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46 Qi, Gevonden, and Shalev.

47 Qi, Gevonden, and Shalev.

48 Qi, Gevonden, and Shalev.

49 Qi, Gevonden, and Shalev.

50 Qi, Gevonden, and Shalev.

# Traumatic Brain Injury and the Scope of the Problem

The Assistant Secretary of Defense defines traumatic Brain Injury (TBI) as:

*A traumatically induced structural injury or physiological disruption of brain function, as the result of an external force that is indicated by new onset or worsening of at least one of the following clinical signs immediately following the event: Any alteration in mental status (e.g., confusion, disorientation, slowed thinking, etc.). Any loss of memory for events immediately before or after the injury. Any period of loss of or a decreased level of consciousness, observed or self-reported.*<sup>51</sup>

Traumatic brain injury has three categories: mild, moderate and severe. All three have specific diagnostic criteria that are outside of the scope of this paper. Because mTBI is the most common and most likely to go undiagnosed or undertreated, it is worth noting its characteristics and common signs and symptoms. The term mild TBI is interchangeable with a concussion and received increased attention due to its impact on athletes, especially professional football players. Because this type of brain injury does not present in radiographic studies, and there is not currently a reliable laboratory test to confirm, diagnosis requires a detailed physical examination and a comprehensive patient history that includes a traumatic event involving the head that results in a loss of consciousness for less than 30 minutes, and return to baseline cognition in under 24 hours.<sup>52</sup> Mild TBI can occur from exposure to blunt trauma (car accident, fall), or blast trauma (Improvised Explosive Device (IED), breaching charges),

51 "Assistant Secretary of Defense. Traumatic Brain Injury: Updated Definition and Reporting. Washington, DC: Department of Defense; 2015. - Google Search," accessed October 26, 2019, <https://www.google.com/search?q=Assistant+Secretary+of+Defense.+Traumatic+brain+injury%3A+Updated+definition+and+reporting.+Washington%2CDC%3A+Department+of+Defense%3B+2015.&aq=Assistant+Secretary+of+Defense.+Traumatic+brain+injury%3A+Updated+definition+and+reporting.+Washington%2CDC%3A+Department+of+Defense%3B+2015.&aq=chrome..69i57.2316j0j8>.

52 Ralph G. DePalma, "Combat TBI: History, Epidemiology, and Injury Modes," in *Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects*, ed. Firas H. Kobeissy, Frontiers in Neuroengineering (Boca Raton (FL): CRC Press/Taylor & Francis, 2015), <http://www.ncbi.nlm.nih.gov/books/NBK299230/>.



or a combination of the two.<sup>53</sup> Due to its insidious nature, mTBI often is undiagnosed and untreated. Even when discovered, treating the associated symptoms is often a challenge.

It is important to note that mTBI related to blast wave exposure can occur without loss of consciousness and can occur in common military tasks to include demolition training, firing large caliber weapons, and being in proximity to other explosive events. Furthermore, bTBI creates Interface Astroglial Scarring (IAS) which is a “distinct and previously undescribed pattern of scarring at boundaries between brain parenchyma and fluids, and at junctions between grey and white matter.”<sup>54</sup> This will be discussed in more detail shortly.

The most troubling chronic symptoms of mTBI include headache, sleep disorder, decreased cognition, depression, suicidal ideation, post-traumatic stress disorder, dizziness and tinnitus.<sup>55</sup> These symptoms can exacerbate or cause even more problematic issues that include alcohol and opiate abuse, behavioral problems that impact work performance, family dysfunction and, in extreme cases, actual suicide.<sup>56</sup>

According to the RAND Corporation, 20% of veterans from the wars in Iraq and Afghanistan suffer from traumatic brain injury.<sup>57</sup> A review of the Defense and Veterans Brain Injury Center Clinical Tracking Form by Licona et al. found that over 80% of combat zone TBI was related to blast trauma.<sup>58</sup> Although traumatic brain injury has been a focus of significant

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53 Nathaniel W. Nelson et al., “Blast-Related Mild Traumatic Brain Injury: Neuropsychological Evaluation and Findings,” in *Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects*, ed. Firas H. Kobeissy, Frontiers in Neuroengineering (Boca Raton (FL): CRC Press/Taylor & Francis, 2015), <http://www.ncbi.nlm.nih.gov/books/NBK299235/>.

54 Sharon Baughman Shively et al., “Characterisation of Interface Astroglial Scarring in the Human Brain after Blast Exposure: A Post-Mortem Case Series,” *The Lancet. Neurology* 15, no. 9 (2016): 944–53, [https://doi.org/10.1016/S1474-4422\(16\)30057-6](https://doi.org/10.1016/S1474-4422(16)30057-6).

55 Jennifer J. Vasterling et al., “Neuropsychological Outcomes of Mild Traumatic Brain Injury, Post-Traumatic Stress Disorder and Depression in Iraq-Deployed US Army Soldiers,” *The British Journal of Psychiatry: The Journal of Mental Science* 201, no. 3 (September 2012): 186–92, <https://doi.org/10.1192/bjp.bp.111.096461>.

56 Terri Tanielian, Lisa H. Jaycox, Terry L. Schell, et al., “Invisible Wounds of War: Summary and Recommendations for Addressing Psychological and Cognitive Injuries,” Product Page, 2008, <https://www.rand.org/pubs/monographs/MG720z1.html>.

57 Tanielian, Jaycox, Schell, et al.

58 Nytzia E. Licona et al., “Prospective Tracking and Analysis of Traumatic Brain Injury in Veterans and Military Personnel,” *Archives of Physical Medicine and Rehabilitation* 98, no. 2 (February 2017): 391–94, <https://doi.org/10.1016/j.apmr.2016.09.131>.

research and effort, solutions for prevention, diagnosis, and treatment remain elusive. Despite changes in protective equipment (ballistic helmets, armored vehicles), mandated use of TBI screening tools, and mandatory rest periods following TBI exposure, the number of those affected remains alarmingly high. According to the Center for Disease Control, from 2000 through 2011, 235,046 service members (or 4.2% of the 5,603,720 who served in the Army, Air Force, Navy, and Marine Corps) were diagnosed with a TBI.<sup>59</sup> Incredibly, 33,149 U.S. military personnel were diagnosed with a TBI in 2011 alone.<sup>60</sup> Most recently, the Senior Enlisted Leader to the Joint Chiefs of Staff stated that 413,858 service members had sustained a TBI since 2000.<sup>61</sup>

There are several contributing factors to the increased prevalence of TBI during the current war on terror. First, the improvements in body armor, combat casualty care, and armored vehicle design resulted in casualties surviving traumatic events that would have otherwise killed them in prior conflicts.<sup>62</sup> Second, the nature of the threat, especially the use of improvised explosive devices have increased the exposure to brain injury.<sup>63</sup> Finally, repeated deployments for many service members, particularly those in combat arms specialties, added to the accumulative effects of blast exposure, both in training and in actual combat.

The DoD mandated screening for all personnel exposed to a potentially concussive event. Department of Defense Instruction 6490.11 defines those that require testing to be any member that is involved in a vehicle blast event, collision or rollover, present within 50 meters of a blast (inside or outside), suffers a direct blow to the head or witnessed a loss of consciousness, and finally, exposed to more than one blast event. The DOD

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59 "Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel."

60 "Report to Congress on Traumatic Brain Injury in the United States: Understanding the Public Health Problem among Current and Former Military Personnel."

61 Ramon Colon, "Senior Enlisted Advisor to the Chairman," FaceBook, March 20, 2020, <https://www.facebook.com/SEAC.JCS/>.

62 DePalma and Hoffman, "Combat Blast Related Traumatic Brain Injury (TBI)."

63 Christine L. Mac Donald et al., "Detection of Blast-Related Traumatic Brain Injury in U.S. Military Personnel," *The New England Journal of Medicine* 364, no. 22 (June 2, 2011): 2091–2100, <https://doi.org/10.1056/NEJMoa1008069>.

instruction includes mandatory rest periods following any event and reporting of screening results.<sup>64</sup>

The DoD developed a TBI screening tool to help medical providers treat patients that have been exposed to a potentially concussive event. The Military Acute Concussion Evaluation 2 is an evidence-based instrument that provides an easy to administer, standardized tool that augments the provider's clinical judgment and the use of the Concussion Management Tool (CMT) to best manage mTBI.<sup>65</sup> The CMT provides treatment recommendations from the initial presentation up to seven days post-injury. The tool includes recommendations on follow-on screening, rest, sleep hygiene, headache management, referral criteria, return-to-duty criteria and other management options.<sup>66</sup> The DoD/Veterans Administration Clinical Guidelines provides clinicians with an evidence-based recommendation for the acute and long-term care of mTBI patients. Current treatment options for mTBI focus on symptom management and do not address the structural changes that occur with brain injury, especially blast-related changes.

Thus far, developing a cure for the sequela of mTBI has proven elusive. Still, research continues in a wide range of areas that include preventative equipment, therapeutic and treatment options, and biomarkers for the detection of mTBI. Devices like jugular vein compression collars have shown the potential to reduce the impact of the blast wave on the brain. The collar has been tested in civilian Special Weapons and Tactics (SWAT) teams during explosive breaching training and showed promise in reducing injury.<sup>67</sup> Additionally, Magnetic Resonance Therapy is already being tested within the USSOCOM and is a non-invasive brain stimulation process that utilizes Magnetic Resonance Imaging machines. The therapy has shown

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64 "Fact Sheets," DVBC, September 14, 2015, <https://dvbic.dcoe.mil/fact-sheets>.

65 "Military Acute Concussion Evaluation 2 (MACE 2)," DVBC, August 27, 2018, <https://dvbic.dcoe.mil/material/military-acute-concussion-evaluation-2-mace-2>.

66 "Concussion Management Tool," DVBC, October 31, 2017, <https://dvbic.dcoe.mil/material/concussion-management-tool>.

67 Scott Bonnette et al., "A Jugular Vein Compression Collar Prevents Alterations of Endogenous Electrocardiac Dynamics Following Blast Exposure during Special Weapons and Tactical (SWAT) Breacher Training," *Experimental Brain Research* 236, no. 10 (October 2018): 2691–2701, <https://doi.org/10.1007/s00221-018-5328-x>; Ming Gu et al., "Protection against Blast-Induced Traumatic Brain Injury by Increase in Brain Volume," *BioMed Research International* 2017 (2017): 2075463, <https://doi.org/10.1155/2017/2075463>.

potential in improving cognitive function in TBI patients.<sup>68</sup> Most importantly, USSOCOM must continue to research point of injury and acute treatment options that can mitigate the impact of mTBI. One potential therapeutic tool is the use of Magnesium (Mg<sup>2+</sup>) in some combination to protect brain function. Adenosine, lidocaine and Mg<sup>2+</sup> resuscitation has great potential in both hemorrhagic trauma and TBI but requires further investigation.<sup>69</sup> While a recent study<sup>70</sup> failed to show that the administration of Mg<sup>2+</sup> alone improves outcomes, this neuroprotective agent still holds possibilities and should be investigated further. Finally, the diagnosis of mTBI relies on clinical exam, but there is hope that someday biomarkers could confirm the presence of TBI or serve to screen those that have sub-clinical signs and symptoms that are missed during physical exams.<sup>71</sup>

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68 Si A. Lee and Myoung-Kwon Kim, "Effect of Low Frequency Repetitive Transcranial Magnetic Stimulation on Depression and Cognition of Patients with Traumatic Brain Injury: A Randomized Controlled Trial," *Medical Science Monitor : International Medical Journal of Experimental and Clinical Research* 24 (December 4, 2018): 8789–94, <https://doi.org/10.12659/MSM.911385>; Iuri Santana Neville et al., "Repetitive Transcranial Magnetic Stimulation (RTMS) for the Cognitive Rehabilitation of Traumatic Brain Injury (TBI) Victims: Study Protocol for a Randomized Controlled Trial," *Trials* 16 (October 5, 2015), <https://doi.org/10.1186/s13063-015-0944-2>; Arnold Toth, "Magnetic Resonance Imaging Application in the Area of Mild and Acute Traumatic Brain Injury: Implications for Diagnostic Markers?," in *Brain Neurotrauma: Molecular, Neuropsychological, and Rehabilitation Aspects*, ed. Firas H. Kobeissy, *Frontiers in Neuroengineering* (Boca Raton (FL): CRC Press/Taylor & Francis, 2015), <http://www.ncbi.nlm.nih.gov/books/NBK299202/>.

69 Hayley L. Letson and Geoffrey P. Dobson, "Adenosine, Lidocaine, and Mg<sup>2+</sup> (ALM) Resuscitation Fluid Protects against Experimental Traumatic Brain Injury," *The Journal of Trauma and Acute Care Surgery* 84, no. 6 (2018): 908–16, <https://doi.org/10.1097/TA.0000000000001874>.

70 Nancy R. Temkin et al., "Magnesium Sulfate for Neuroprotection after Traumatic Brain Injury: A Randomised Controlled Trial," *The Lancet. Neurology* 6, no. 1 (January 2007): 29–38, [https://doi.org/10.1016/S1474-4422\(06\)70630-5](https://doi.org/10.1016/S1474-4422(06)70630-5).

71 Tor Ingebrigtsen and Bertil Romner, "Biochemical Serum Markers for Brain Damage: A Short Review with Emphasis on Clinical Utility in Mild Head Injury," *Restorative Neurology and Neuroscience* 21, no. 3.4 (January 1, 2003): 171–76, [https://content.iospress.com/articles/restorative-neurology-and-neuroscience/rnn00236?utm\\_source=TrendMD&utm\\_medium=cpc&utm\\_campaign=Restorative\\_Neurology\\_and\\_Neuroscience\\_TrendMD\\_1&origin=32511c9b9969d834c3d35830fea57b29](https://content.iospress.com/articles/restorative-neurology-and-neuroscience/rnn00236?utm_source=TrendMD&utm_medium=cpc&utm_campaign=Restorative_Neurology_and_Neuroscience_TrendMD_1&origin=32511c9b9969d834c3d35830fea57b29).

# Interrelated Conditions of “Operator Syndrome”

Understanding the interlinked conditions associated with the “Operator Syndrome” will help to formulate potential treatment plans. Traumatic brain injury appears to be central to the syndrome and any holistic care plan must address the entire syndrome.<sup>72</sup> A brief description of the remaining conditions will illustrate the complexity of the problem facing the operator, their caregivers, and medical providers.

## Endocrine Dysfunction

Traumatic brain injury, and especially bTBI, is known to cause endocrine dysfunction. Over 33% of bTBI patients will suffer from neuroendocrine alterations that can lead to psychiatric disorders.<sup>73</sup> Brain trauma disrupts the hypothalamic-pituitary-adrenal axis, which is responsible for homeostasis, stress responses, energy metabolism, and neuropsychiatric function.<sup>74</sup> The impact on the special operator is multifaceted and can compound PTSD, anxiety, and depression. Because the axis plays a significant role in the stress response, disruption can alter the release of cortisol and norepinephrine that leads to insomnia and sleep disruption, while lowering the body’s immune response.

Additionally, TBI can create hypogonadism, which can lower testosterone levels, resulting in chronic fatigue and can mimic depression.<sup>75</sup> Studies have found that special operators, regardless of TBI, have lower than

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72 Frueh et al., “Operator Syndrome.”

73 Ashley L. Russell et al., “Differential Responses of the HPA Axis to Mild Blast Traumatic Brain Injury in Male and Female Mice,” *Endocrinology* 159, no. 6 (01 2018): 2363–75, <https://doi.org/10.1210/en.2018-00203>.

74 Sharon DeMorrow, “Role of the Hypothalamic–Pituitary–Adrenal Axis in Health and Disease,” *International Journal of Molecular Sciences* 19, no. 4 (March 26, 2018), <https://doi.org/10.3390/ijms19040986>; Walter L. Miller, “The Hypothalamic-Pituitary-Adrenal Axis: A Brief History,” *Hormone Research in Paediatrics* 89, no. 4 (2018): 212–23, <https://doi.org/10.1159/000487755>.

75 Züleyha Karaca et al., “GH and Pituitary Hormone Alterations After Traumatic Brain Injury,” *Progress in Molecular Biology and Translational Science* 138 (2016): 167–91, <https://doi.org/10.1016/bs.pmbts.2015.10.010>; Andrew E. Jensen et al., “Hormonal Balance and Nutritional Intake in Elite Tactical Athletes,” *Steroids* 152 (2019): 108504, <https://doi.org/10.1016/j.steroids.2019.108504>.

normal testosterone levels.<sup>76</sup> The only way to diagnose hormonal imbalances is through lab testing. It is recommended that all operators receive lab tests on a routine basis.<sup>77</sup>

## Sleep Disturbance and Sleep Apnea

As mentioned above, bTBI is implicated in the disruption of endocrine function, which can cause sleep disturbances. As many of 30%-70% of TBI patients suffer from disruptions in sleep cycles,<sup>78</sup> and 24% of TBI patients are diagnosed with sleep apnea.<sup>79</sup> Regardless of TBI, special operators are high-risk for sleep disruptions, especially when coupled with other co-occurring conditions. The frequent use of “reverse cycle” work schedules while deployed, emotional stress, chronic pain, and high levels of substance abuse all contribute to suboptimal sleep patterns. According to Frueh et al., “sleep disturbance is nearly universal in special operators which can lead to irritability, cognitive impairment, memory loss, impulsivity, poor concentration, depression and even paranoia.”<sup>80</sup> In addition to the above issues, insufficient sleep can contribute to heart disease, Type-2 diabetes and obesity.<sup>81</sup> Obstructive sleep apnea alone can cause significant medical problems that include high blood pressure, stroke, heart failure, headaches and reduces cognitive function in TBI patients.<sup>82</sup>

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76 Jon K. Linderman, Reginald O'Hara, and Jason Ordway, “Effect of Special Operations Training on Testosterone, Lean Body Mass, and Strength and the Potential for Therapeutic Testosterone Replacement: A Review of the Literature,” *Journal of Special Operations Medicine: A Peer Reviewed Journal for SOF Medical Professionals* 20, no. 1 (2020): 94–100.

77 Frueh et al., “Operator Syndrome.”

78 Christian R. Baumann et al., “Sleep-Wake Disturbances 6 Months after Traumatic Brain Injury: A Prospective Study,” *Brain: A Journal of Neurology* 130, no. Pt 7 (July 2007): 1873–83, <https://doi.org/10.1093/brain/awm109>.

79 Richard J. Castriotta and Jayasimha N. Murthy, “Sleep Disorders in Patients with Traumatic Brain Injury: A Review,” *CNS Drugs* 25, no. 3 (March 2011): 175–85, <https://doi.org/10.2165/11584870-000000000-00000>.

80 Frueh et al., “Operator Syndrome.”

81 Sang Jun Yoon et al., “Systemic and Local Metabolic Alterations in Sleep-Deprivation-Induced Stress: A Multiplatform Mass-Spectrometry-Based Lipidomics and Metabolomics Approach,” *Journal of Proteome Research* 18, no. 9 (September 6, 2019): 3295–3304, <https://doi.org/10.1021/acs.jproteome.9b00234>; Nadir M. Balba et al., “Increased Sleep Disturbances and Pain in Veterans With Comorbid Traumatic Brain Injury and Posttraumatic Stress Disorder,” *Journal of Clinical Sleep Medicine: JCSM: Official Publication of the American Academy of Sleep Medicine* 14, no. 11 (15 2018): 1865–78, <https://doi.org/10.5664/jcsm.7482>.

82 Mieke Verfaellie et al., “Self-Reported Sleep Disturbance Mediates the Relationship Between PTSD and Cognitive Outcome in Blast-Exposed OEF/OIF Veterans,” *The Journal of Head Trauma Rehabilitation* 31, no. 5 (October 2016): 309–19, <https://doi.org/10.1097/HTR.0000000000000197>.

Medical providers must remain vigilant for any sleep disorder when caring for special operators and care plans should include screening for these disorders, especially in any operator diagnosed with bTBI. Insomnia is the most common disorder and can respond to non-pharmacological treatments (e.g., stimulus control, environmental modifications, cognitive behavioral therapies, and sleep hygiene).<sup>83</sup>

## Depression and Suicide

A detailed discussion regarding depression and suicide is beyond the scope of this paper, but there is no doubt that both are of significant concern within the special operations community. Depression and self-directed violence, which includes suicidal ideation, suicidal attempt, and completed suicide, take a toll on the operator and their families. A review of literature describes numerous risk factors for suicide; however, there is no clear pattern of which factors will cause an individual to attempt suicide. One largely held theory suggests that a sense of isolation, feelings of being a burden to others, and access to lethal means play a major role in suicide.<sup>84</sup> Other studies indicate that a history of substance abuse and a mental health diagnosis increase suicide risk.<sup>85</sup>

It is unclear on the direct role that TBI plays on suicide, but there seems to be a strong connection between the two. Several studies in the civilian population found a significant increase in suicide risk for patients that suffered from TBI,<sup>86</sup> and Brenner et al. found that military members and veterans with TBI were 1.5 times more likely to die from suicide than veterans without TBI.<sup>87</sup> One study suggests that patients with multiple TBIs are at

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83 "DOD Clinical Recommendation | June 2014," 2014, 16.

84 Kimberly A. Van Orden et al., "The Interpersonal Theory of Suicide," *Psychological Review* 117, no. 2 (2010): 575–600, <https://doi.org/10.1037/a0018697>.

85 Terri Tanielian, "Reducing Suicide Among U.S. Veterans: Implications from RAND Research," Product Page, 2019, <https://www.rand.org/pubs/testimonies/CT510.html>.

86 Seena Fazel et al., "Suicide, Fatal Injuries, and Other Causes of Premature Mortality in Patients with Traumatic Brain Injury: A 41-Year Swedish Population Study," *JAMA Psychiatry* 71, no. 3 (March 2014): 326–33, <https://doi.org/10.1001/jamapsychiatry.2013.3935>; Michael Fralick et al., "Association of Concussion With the Risk of Suicide: A Systematic Review and Meta-Analysis," *JAMA Neurology* 76, no. 2 (01 2019): 144–51, <https://doi.org/10.1001/jamaneurol.2018.3487>.

87 Brenner et al., "Suicidality and Veterans with a History of Traumatic Brain Injury."

higher risk than those without or with just one prior TBI.<sup>88</sup> In addition to the direct connection to suicide, TBI is associated with other potential risk factors that include chronic pain, depression, substance abuse, and PTSD.

Strategies that can reduce the impact of suicide include building strong teams and ensuring that the USSOCOM provides resources and policies that strengthen families. Based on the author's personal experience, Servicemembers must be encouraged to seek help, and leaders must role model that behavior and reduce stigma for those seeking care. Leaders must pay close attention to any operator that has been isolated from his/her support system to include family due to separation or divorce, and their unit-level team due to injury or other reasons. Removal from a close-knit team due to injury or disciplinary reasons can create a sense of isolation and worthlessness in operators that are already at risk due to TBI and other associated injuries. Additionally, providers must screen all operators diagnosed with TBI and/or PTSD for substance abuse, depression and suicide risk. Medical units must ensure that operators maintain the same primary care provider to improve continuity of care and to build trust between the provider and patient.

## Remaining Components of the “Operator Syndrome”

The remaining components of the syndrome include acute and chronic muscular-skeletal injuries, family dysfunction, sexual and intimacy problems, substance abuse, decreased cognition, and vestibular and vision impairment. Operators also suffer from hypervigilance, anxiety disorders, anger, survivors' guilt, and a mindset that discounts the future.<sup>89</sup>

Because the operators' support system is crucial to their emotional and physical health, it is important to discuss the impact of family dysfunction and problems with sexual intimacy within the special operations community. It is impossible to separate the issues occurring at home from those

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88 Craig J. Bryan and Tracy A. Clemans, “Repetitive Traumatic Brain Injury, Psychological Symptoms, and Suicide Risk in a Clinical Sample of Deployed Military Personnel,” *JAMA Psychiatry* 70, no. 7 (July 2013): 686–91, <https://doi.org/10.1001/jamapsychiatry.2013.1093>.

89 Frueh et al., “Operator Syndrome.”



at work. The stress is especially true when the spouse is also serving as a caregiver to their injured operator. One spouse described her home life as a duck on water: “For those wives outside of our community, it looks like we have it all together, but if they could see under the water, they would see we are kicking hard just to stay afloat.” The ever-present stress due to the operational tempo, high-risk deployments, frequent field training exercises when not deployed, high rates of PTSD, TBI, and other syndrome conditions creates an enormous strain on the family. The result is high rates of divorce, increases in domestic violence and reduced work performance.<sup>90</sup>

## National Security Implications

Ensuring that patients receive quality care, grounded in the best evidence, is the charge of any healthcare provider. The Department of Defense and the Nation have a sacred duty to safeguard the health of those willing to serve, especially those wounded in combat or injured in training. The failure to act would tear at the very fabric of the department’s and the Nation’s values and would result in the continued suffering of thousands of active-duty members and veterans.

While the duty to act and the complexity of the problem alone requires a strategic effort, there are less apparent reasons that “Operator Syndrome” and TBI are a risk to national security. The hazards include the potential loss of confidence in military medicine, the breaking of trust between leaders and their subordinates, and finally, creating challenges to special operations recruitment and retention efforts.

The credibility of military medicine, including the Veterans Administration, is critical to the quality of life of service members and their families and is considered a significant influencer on the decision to remain in military service.<sup>91</sup> While there is a paucity of literature that

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90 Frueh et al.

91 Lawrence Kapp, “Recruiting and Retention: An Overview of FY2011 and FY2012 Results for Active and Reserve Component Enlisted Personnel,” n.d., 21.

directly links the issue of TBI to a lack of patient trust, it is a significant contributor.<sup>92</sup>

This lack of confidence in military medicine from those within the military has crept into popular culture. Recent examples include a popular CBS series that portrayed a Navy SEAL with TBI committing suicide due to a lack of competent care and uncaring leadership.<sup>93</sup> There is evidence that public perception of TBI, suicide, and post-traumatic stress has impacted recruitment.<sup>94</sup> Anecdotally, one of the authors recently served as the commander of a recruiting battalion, and a frequent question asked by prospective recruits and their influencers regarded the risk of TBI and PTSD. The inability of the United States Army Recruiting Command in 2018 to meet its recruiting mission constrained the U.S. Army's increase in end-strength and impacted its ability to win a conflict with a near-peer competitor. Additionally, the failure of service-specific recruiting effort directly impacts the talent pool from which USSOCOM draws its force.

There is no doubt that "Operator Syndrome" is a threat to the health and wellbeing of operators and their families. The failure to address the key components of the syndrome, especially TBI, places the Nation's security at risk. The next chapter will focus on blast related traumatic brain injury because it is the central contributor to the syndrome and requires a different approach than the better understood impact TBI.

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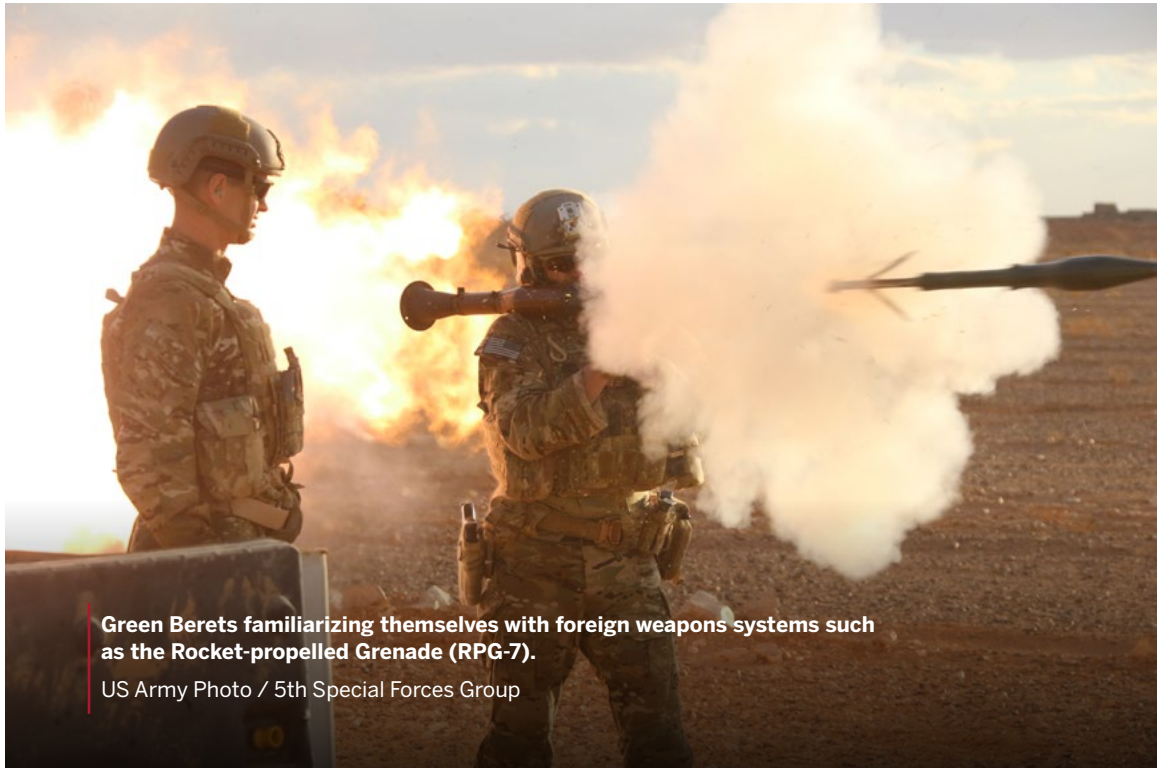
92 Lawrence Kapp, "Recruiting and Retention: An Overview of FY2011 and FY2012 Results for Active and Reserve Component Enlisted Personnel," n.d., 21; Marcus VanSickle et al., "Perceived Barriers to Seeking Mental Health Care among United States Marine Corps Noncommissioned Officers Serving as Gatekeepers for Suicide Prevention.," *Psychological Assessment* 28, no. 8 (August 2016): 1020–25, <https://doi.org/10.1037/pas0000212>; "U.S. Army Soldiers' Trust and Confidence in Mental Health Professionals," accessed October 27, 2019, <http://tpcjjournal.nbcc.org/u-s-army-soldiers-trust-and-confidence-in-mental-health-professionals/>.

93 "We Have to Talk about This Week's 'SEAL Team' Death," *We Are The Mighty - Americas Tactical Military Entertainment Brand*, April 26, 2019, <https://www.wearthemighty.com/entertainment/seal-team-episode-medicare-isolate>.

94 Kapp, "Recruiting and Retention: An Overview of FY2011 and FY2012 Results for Active and Reserve Component Enlisted Personnel," n.d.

### 3. Blast Related Traumatic Brain Injury

*“This changes the earlier paradigm of ‘battle injury’ and demonstrates unique and specific biological changes in brains due to these injuries.” Dr. Daniel Perl*



**Green Berets familiarizing themselves with foreign weapons systems such as the Rocket-propelled Grenade (RPG-7).**

US Army Photo / 5th Special Forces Group

Despite the reduction of conventional formations in Iraq, Afghanistan and Syria, Special Operations Forces (SOF) have repeatedly been called to deploy, return, train-up and redeploy. The persistent, intensive training prior to the deployments is taking a toll on SOF; specifically, the repeated use of heavy machine guns, calling in close air support with live ordnance, extensive employment of recoilless rifles (Carl Gustav), 60 and 81mm mortar fires, explosive charges used for breaching, and demolition ranges. Moreover, while in combat, along with their organic weapon systems, the operator is exposed to incoming rockets, mortars and improvised explosive devices that can wreak havoc on the mind, brain and body as a whole. The training is real, and it has to be, but it comes at a cost. This cost lies not only with the

family, friends and teammates, but also has a strategic impact on national security. How can our Nation continue to send our operators to execute the most sensitive of mission sets in the most dangerous and austere environments globally, if they are not operating at their optimal level?

It is important to have a general understanding of a blast wave and the types of injuries associated. The purpose of this section is to show that blast TBI is a very different brain injury than concussive TBI, commonly associated with contact sports and car wrecks. Each type of blast injury uniquely impacts the brain and undoubtedly causes damage.

US Department of Defense Blast Injury Research Coordinating Office (BIRCO) defines a blast wave as:

*An area of pressure expanding supersonically outward from an explosive core. It has a leading shock front of compressed gases. The blast wave is followed by a blast wind of negative pressure, which sucks items back in towards the center. The extent of damage caused by the blast wave mainly depends on five factors:*

- *Peak of the initial positive pressure wave*
- *Duration of overpressure*
- *Medium of explosion*
- *Distance from the incident blast wave*
- *Degree of focusing because of a confined area or walls<sup>95</sup>*

Despite wearing personal protective equipment (such as helmets, body armor, or being inside armored vehicles), which primarily provide protection from shrapnel or direct fire weapon systems, blast effects can actually be exacerbated if an individual is inside a vehicle during the initiation of an improvised explosive device, indirect fire, or rocket propelled grenade.

<sup>95</sup> "Blast Injury Research Coordinating Office (BIRCO) - The Science of Blast," accessed February 14, 2020, [https://blastinjuryresearch.amedd.army.mil/index.cfm/blast\\_injury\\_101/science\\_of\\_blast](https://blastinjuryresearch.amedd.army.mil/index.cfm/blast_injury_101/science_of_blast).

BIRCO further indicates that: “Blast waves from explosions that occur near or within hard solid surfaces can be amplified **two to nine times** because of shock wave reflection, causing an increase in their destructive potential.”<sup>96</sup>

For example, people located between a blast and a building will often suffer more extensive injuries than when the blast occurs in an open space. Because blast waves reflect, people exposed to an explosion rarely experience an idealized blast waveform as depicted above. Even in open field conditions, the primary blast wave reflects from the ground, generating reflective waves that interact with the primary wave and change its characteristics. In more closed environments, such as a building, an urban setting, or the inside of a vehicle, the blast wave interacts with the surrounding structures creating multiple complex waves.<sup>97</sup>

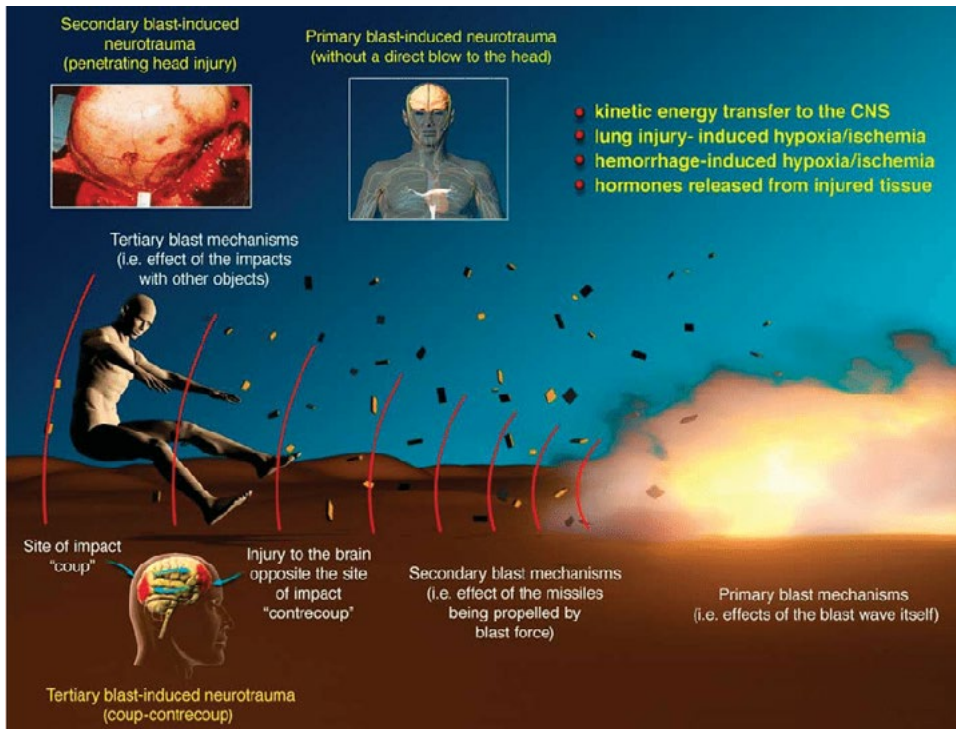
Special Operators spend a great deal of time in “shoot houses,” firing multiple weapons (individual and crew-served weapons) in tight, enclosed urban areas, reducing improvised explosive devices, firing mortars, employing air to ground munitions, or shooting weapon systems from multiple vehicle platforms or other static and dynamic fighting positions.

Figure 2 provides a visual depiction of a blast wave and shows the primary, secondary and tertiary blast induced neurotrauma.

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96 “Blast Injury Research Coordinating Office (BIRCO) - The Science of Blast.”

97 “Blast Injury Research Coordinating Office (BIRCO) - The Science of Blast.”



**Figure 2:** Mechanisms of injury to the brain related to blast wave exposure.<sup>98</sup>

## Effects of Repeated Blast Exposures

Recent research conducted by Dr. Daniel Perl, MD and his team at the Center for Neuroscience and Regenerative Medicine discovered a new phenomenon in their analysis of post-mortem brain specimens of SOF operators.

Through careful dissection and viewing under high powered microscopes, researchers at CNRM uncovered unique scarring directly connected with repeated military blast exposures. This unique pattern of injury is called Interface Astroglial Scarring (IAS). “This distinctive pattern of scarring may indicate specific areas of damage from blast exposure consistent with the general principles of blast biophysics...”<sup>99</sup> After analysis of five specimens, “All five cases with chronic blast exposure showed prominent

98 Ibolja Cernak and Linda Noble-Haeusslein, “Traumatic Brain Injury: An Overview of Pathobiology with Emphasis on Military Populations. 10.1038/Jcbfm.2009.203.,” *Journal of Cerebral Blood Flow and Metabolism* 30 (2009): 255–66.

99 Shively et al., “Characterisation of Interface Astroglial Scarring in the Human Brain after Blast Exposure.”

astroglial scarring that involved the subpial glial plate, penetrating cortical blood vessels, grey–white matter junctions, and structures lining the ventricles; all cases of acute blast exposure showed early astroglial scarring in the same brain regions.”<sup>100</sup> Essentially, grey and white matter of the brain are shearing, thereby causing the scarring. One of the major complications for preventing, identifying and treating IAS is that current medical imaging technologies cannot detect this particular scarring because it resides at the microscopic level—and is only visible through high powered microscopes, postmortem.<sup>101</sup> Additionally, PTSD and TBI have similar symptoms, thereby making it difficult to discern for treatment.



**Figure 3:** Overlapping Symptoms of PTSD/TBI<sup>102</sup>

<sup>100</sup> Shively et al.

<sup>101</sup> Shively et al.

<sup>102</sup> “Concussion Signs and Symptoms Fact Sheet,” DVBC, December 31, 2014, <https://dvbic.dcoe.mil/material/concussion-signs-and-symptoms-fact-sheet>.

## Differences Between CTE and IAS

It is important to note that IAS is unique, as it differs from Chronic Traumatic Encephalopathy (CTE) which results from repeated blunt trauma (i.e. physical impact) to the head. Whereas IAS is caused from blast waves that pass through the skull and brain tissue and does not involve impact trauma directly to the head. The movie *Concussion* highlights the research efforts by Dr. Bennet Omalu. He “was the first to identify and name Chronic Traumatic Encephalopathy as a disease entity in football and wrestlers.”<sup>103</sup> CTE is a degenerative disease and, like IAS, is only identified postmortem. Unlike IAS, CTE takes years to develop and progressively worsens over time. The signs and symptoms of both are similar. The Mayo Clinic identifies symptoms: “patients exhibit poor sleep, difficulty thinking (cognitive impairment), impulsive behavior, depression or apathy, short-term memory loss, difficulty planning and carrying out tasks (executive function), emotional instability, substance misuse and suicidal thoughts or behavior.”<sup>104</sup> The signs and symptoms experienced by Servicemembers with blast TBI are quite similar. More challenging, the signs and symptoms are like those associated with Post Traumatic Stress Disorder—a psychological diagnosis. Thus, it is easy to understand the enormous difficulty in successfully differentiating between the three pathologies.

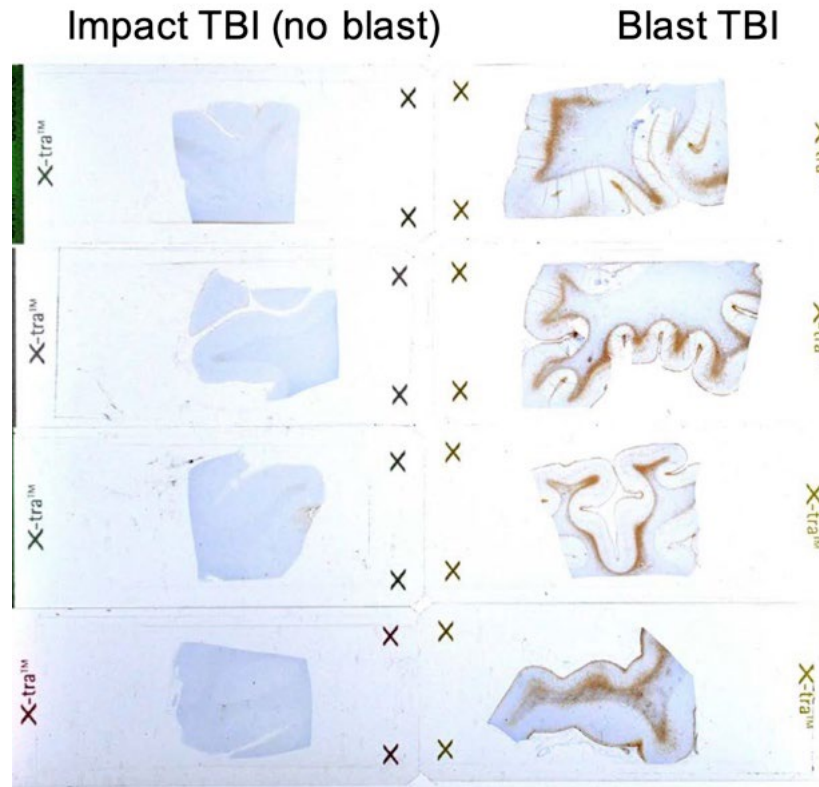
The below picture provides a visual depiction of the differences between post-mortem brain tissue stemming from impact trauma and blast trauma. The brown portion is the scarring incurred from repeated blast exposures.

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103 “What Is CTE? | Brain Injury Research Institute,” accessed February 12, 2020, <http://www.protect-thebrain.org/Brain-Injury-Research/What-is-CTE-.aspx>.

104 “Chronic Traumatic Encephalopathy - Symptoms and Causes,” Mayo Clinic, accessed November 3, 2019, <https://www.mayoclinic.org/diseases-conditions/chronic-traumatic-encephalopathy/symptoms-causes/syc-20370921>.





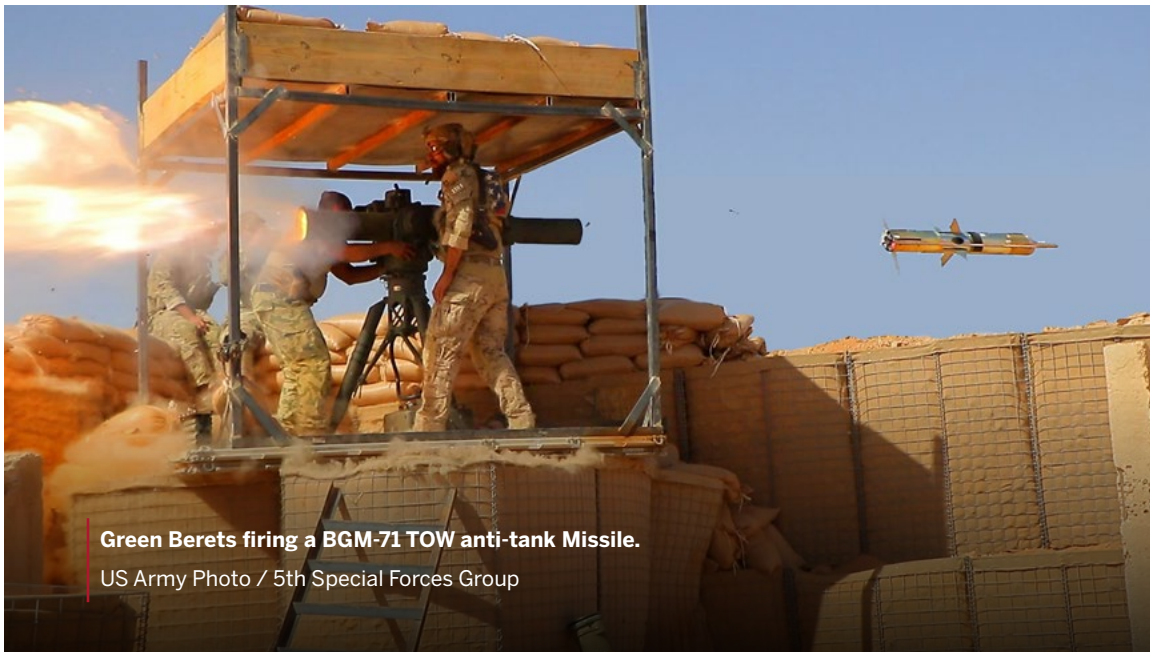
Picture courtesy of the DoD/USU Brain Tissue Repository

Too often, policy makers and key stakeholders can get disoriented in the data associated with complex problems. Well-meaning people can get lost in statistics or become so stove-piped while working within their ‘lane’ that they become dissociated from the human impact. Chapter 4 will attempt to provide the reader with a better understanding of the terrible toll that “operator syndrome” and, especially, TBI is taking on the special operator, their family and the unit.

## 4. Humanizing the Impacts

*“It’s the priority of every commander to get their soldiers back in the fight,” she said. “But (a TBI) is invisible; it’s a blast-pressure wave coming at your brain, which is essentially a bowl of jello inside a skull. If you shake the jello hard enough, it’s going to sever connections that we can’t see. So you’ve got this enlisted medic trying to tell a bunch of officers, ‘I cannot send this guy back into the fight, he needs to rest.’ And it’s even harder to get that soldier to stay down and rest when no one can see the injury.” “It really is the invisible wound of war. These are not just headaches.”*

*Dr. Kate Kemplin, Spouse of SFC Michael Froede who committed suicide after suffering from TBI.*



**Green Berets firing a BGM-71 TOW anti-tank Missile.**

US Army Photo / 5th Special Forces Group

Special Warfare Operator 1st Class Ryan Larkin was a model SEAL, as was his father, and served as a sniper, SOF Medic, and a trained explosive demolition breacher. Ryan served in both Iraq and Afghanistan with a total of four combat deployments. After each deployment, his father noticed

changes in his behavior and disposition. He was withdrawn, irritable, anxious, depressed, disorganized, couldn't sleep and rapidly became emotionally detached.<sup>105</sup> Ryan complained that something was wrong with his head and often told his father that if something happened to him, to donate his brain for research. Doctors diagnosed Ryan with PTSD. Nearly a year after Ryan was discharged from the Navy - and after over 40 different medications prescribed to treat him - his parents found him dead in the basement of their home at the young age of 29. Ryan's parents followed his wishes and donated his brain to the Center for Neuroscience and Regenerative Medicine. Dr. Perl discovered that he had the "brown dust; a distinctive pattern of tiny scars," in his brain.<sup>106</sup>

The scarring was in the same places as other specimens who were exposed to blast injuries previously examined and "correspond to the brain's center for sleep, cognition, and other classic brain-injury trouble spots."<sup>107</sup> This scarring was not present in other specimens examined with CTE or in the brains of people with drug addictions. Knowing this, provided the family some degree of closure to a painful chapter in their lives. His brain donation allowed Ryan to continue serving his teammates. More importantly, this discovery by the family instigated his father to serve as an advocate for further research on this epidemic, and highlighted the question, "What if PTSD is More Physical Than Psychological?"<sup>108</sup>

Staff Sergeant Michael Mantenuto, known for his acting role, playing Jack O'Callahan in the Disney movie *Miracle* (highlighting the U.S. Men's Hockey victory over the Soviet Union in the 1980 Olympic Games), was a college hockey player turned Green Beret. Michael suffered from substance addiction, and later committed suicide at the age of 35 years old. What is not known is whether repeated impact injuries endured while playing college hockey and (briefly) professional hockey combined with the blast-related injuries endured during his time as a Green Beret, contributed to his suicide. "During his final year in the military, he reportedly fought

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105 adminsofx, "RYAN'S STORY," SOFX, May 14, 2018, <https://www.sofx.com/2018/05/14/ryans-story/>.

106 Worth, "What If PTSD Is More Physical than Psychological?," June 10, 2016.

107 Robert F. Worth, "What If PTSD Is More Physical than Psychological?," *The New York Times Magazine*, June 10, 2016, <https://nytimes.ms/1TYyp6U>.

108 Worth.

ISIS in Iraq and Syria as part of Operation Inherent Resolve and ‘something happened over there’ that led him to commit suicide”, his father told TMZ.<sup>109</sup>

Sgt. 1st Class Michael Froede, deployed six times. On his initial deployment his vehicle struck an explosively formed penetrator. Although, no visible wounds existed, Michael undoubtedly suffered from the blast waves associated with such an event. When he returned, his symptoms progressively worsened. He became irritable, exhibited poor sleep patterns, and his wife noticed he became more anxious. His wife, Dr. Kate Kemplin, a PhD, studied TBI prior to Michael’s initial deployment and she watched all of these signs unravel before her eyes. After a divorce, Michael took his own life.

Sgt. First Class Michael B. Lube, a decorated Green Beret, deployed four times to combat.

He ended his life and left a note, “I’m so goddamn tired of holding it together.”<sup>110</sup> His wife Susan said, “he would put this mask on, but behind it was a shattered version of the man I knew.” With each deployment came changes and families who are often the first line of defense in seeing these changes in their family members.

Immediately after retiring with over 20 years of service, former Navy SEAL, Chief Petty Officer Dave Collins, signed on with a defense contracting company. As with most operators, they are able to hide their symptoms and carry out most tasks associated with work. Generally, they are able to compartmentalize, are self-reliant, and don’t like to admit when they aren’t fully functioning 100%. However, families are the ones who notice the changes and, more commonly, the “unraveling” that begins to occur. His wife, Jennifer said, “It was like the light in him had gone out.”<sup>111</sup> Dave’s cognitive function declined, and he began forgetting how to do simple tasks or where

109 Nicole Bitette, “‘Miracle’ Actor Michael Mantenuto Fought ISIS in Army and before His Suicide His Father Says ‘Something Happened over There’ - New York Daily News,” April 29, 2017, <https://www.nydailynews.com/entertainment/miracle-star-michael-mantenuto-army-article-1.3116735>.

110 Shanker and Jr, “War’s Elite Tough Guys, Hesitant to Seek Healing.”

111 Corinne Reilly, “‘It Was like the Light in Him Had Gone out’: Wife of Navy SEAL Diagnosed with Brain Disease Watches Him Unravel,” [pilotonline.com](https://www.pilotonline.com/news/health/article_2e4b3910-72b8-55da-ab2e-e398934d1238.html), accessed February 15, 2020, [https://www.pilotonline.com/news/health/article\\_2e4b3910-72b8-55da-ab2e-e398934d1238.html](https://www.pilotonline.com/news/health/article_2e4b3910-72b8-55da-ab2e-e398934d1238.html).

he placed things. He suffered from severe insomnia, anxiety, forgetfulness, and the simple tasks became arduous. In his final text to Jennifer, Dave told her he couldn't pick up their son from school. "So sorry baby," he wrote. "I love you all."<sup>112</sup> Suffering for many years, Dave ended his life. After donating his brain to research, his wife received news that Dave had damage to his brain and irrefutable evidence that he died as a result of combat or training for combat.

It's imperative to note that the operators above were high-performing individuals, with strong support systems, yet experienced changes as a result of blast traumatic brain injuries associated with multiple combat deployments, ultimately leading to suicide. It is important to read these stories, to humanize the issue, as they are not just statistics. These are not only anecdotes, they are husbands, fathers, brothers, sons and teammates.

## The Costs

The human costs are tragic, and the financial costs are unsustainable. The amount of money spent, and the resources expended are incalculable. It's important to examine the overall impacts to the Servicemembers and the Department of Veterans Affairs's health care system. The Defense and Veterans Brain Injury Center, the office responsible for collecting TBI data for the Department of Defense, reports that from 2000-2019 Q1-3, 413,858 Servicemembers were diagnosed with TBI.<sup>113</sup> The 2019 National Veteran Suicide Prevention Annual Report indicates that the number of Veterans committing suicide averaged 17 a day, this staggering number does not include those currently serving. This number is profound as it equates to roughly 6,205 a year.<sup>114</sup> The "invisible wounds of war" are impacting our active ranks, Veterans seeking treatment at VA facilities, families and the unit readiness. Aside from the personal costs to the individual Servicemember, the financial costs associated with life-long healthcare are

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112 "Profile in Courage: Jennifer M. Collins," Old Dominion University, accessed April 8, 2020, <http://www.odu.edu/about/odu-publications/insideodu/2017/07/06/morenews1>.

113 "DoD Worldwide Numbers for TBI," DVVIC, June 9, 2016, <https://dvbic.dcoe.mil/dod-worldwide-numbers-tbi>.

114 "Frequently Asked Questions—2019 National Veteran Suicide Prevention Annual Report," *Suicide Prevention*, n.d., 11.

staggering. The Congressional Budget Office Report titled, Possible Higher Spending Paths for Veterans' Benefits, "VA's spending (adjusted to remove the effects of inflation) has grown rapidly—from \$64 billion, or 2.6 percent of all federal spending, in 2000 to \$180 billion, or 4.4 percent of spending, in 2017."<sup>115</sup>

The USSOCOM is not alone in trying to reduce the impact of allostatic loads on their operators. There are a wide range of public and private partners that are working to provide solutions to this complex problem. These efforts include research, treatment, policy development, equipment, and educational programs that look to decrease the effect of bTBI on service members. As previously discussed, this problem requires a national level response that includes the USSOCOM, DoD/VA, as well as academic and public policy institutions and private organizations. The next chapter will discuss some of the efforts being made by the USSOCOM, DoD, and other organizations in the struggle to understand, detect and promote awareness of TBI, IAS and CTE.

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115 "Possible Higher Spending Paths for Veterans' Benefits," n.d., 29.

## 5. Current USSOCOM and DOD Efforts to Address Warfighter Brain Health

*The overall goal is to improve warrior readiness and mission effectiveness. Specifically, it is to ensure we “reduce unnecessary exposure and harm” in training without diluting training through understanding, education and leadership.*

*Email from VADM Szymanski to SOCOM Component Commanders, 9 January 2019*

USSOCOM is the organization that can aggressively drive change due to its service-like authorities, thereby allowing it to promulgate change throughout the Service Branches and the Defense Department.

*USSOCOM is a unique organization with authorities under the United States Code (U.S.C.) Title 10 §164 and 167 with the principal function to prepare SOF to carry out assigned missions. The commander has combatant command authority pursuant to U.S.C. Title 10 §164 and is “responsible for, and has the authority to conduct, all affairs of such command relating to special operations activities.” Additionally, under U.S.C. Title 10 §167, the commander has service-like functions that include developing strategy, doctrine, and tactics; preparing and submitting budget proposals; exercising authority, direction, and control over the expenditure of funds; training assigned forces; conducting specialized courses of instruction for commissioned and noncommissioned officers; validating requirements; establishing priorities for requirements; ensuring the interoperability of equipment and forces; monitoring the promotions of SOF and coordinating with the Services on personnel matters.*

Early 2019, USSOCOM initiated a Comprehensive Strategy for SOF Warfighter Brain Health. This comprehensive initiative will survey exposures, cognitive performance, document symptoms, and provide data on cumulative blast exposure. The often called, “Signature Injury” from

operations in Iraq, Syria, and Afghanistan is traumatic brain injury. A preponderance of the TBIs are mild, 82.3%.<sup>116</sup> As previously discussed, SOF operators have a greater propensity for exposures to TBI due to their extensive training and employment. Below are the salient points outlined by USSOCOM Policy Memorandum 19-01:

**Goal:** Longitudinal surveillance to enhance/extend readiness of the operator

**Key Tenants:**

1. Neurocognitive Assessment (NCAT) baseline and periodic evaluation
2. Comprehensive Assessment and Symptom History (CASH)
3. Blast exposure monitoring (BEM)
4. Working group formation (SPARTAN WG)

This initiative is long overdue and a positive way to begin to address this problem. The programs are set and now it's vital to educate the force and the SOF medical personnel so that they can accurately adjust their respective training and medical protocols. Collaboration and sharing of treatments and information can better educate the force, enabling USSOCOM to enhance and optimize their readiness and lethality. While this effort by USSOCOM is vitally important, it is not enough. There are still a number of actions that USSOCOM can and should take the lead into the mitigation and prevention of bTBI.

## **Department of Defense Efforts— USD for Personnel and Readiness**

In an October 1, 2018, in a memorandum the DEPSECDEF wrote, “I direct the USD P&R to develop a comprehensive strategy and plan of action focused on promoting warfighter brain health and countering TBI.” The

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116 {Citation}



strategy is called the “Comprehensive Strategy for Warfighter Brain Health”. It develops Department-wide prioritized solutions to:

- Optimize Warfighter brain health, including brain exposures from blast
- Detect traumatic brain injury immediately when it occurs
- Counter TBI effects on Warfighters, their families, line leaders/ commanders, and their communities at large.
- Goal to keep Servicemember in; not take offline and RTD if injured.

The overarching goals of the strategy:

1. **Optimize Brain Health with focus on physical and cognitive performance**
2. **Identify, Monitor and Mitigate Brain Exposures**
3. **Prevent, Reduce and Treat Traumatic Brain Injury**
4. **Reduce or Eliminate Long-term / Late effects**

In addition, the National Defense Authorization Act for FY 2018 Section 734 stated, “The Secretary of Defense to conduct a longitudinal medical study on the blast pressure exposures of the Armed Forces during combat and training, including members who train with any high overpressure weapons system, such as anti-tank recoilless rifles or heavy-caliber sniper rifles.” The interim report was released one year after initiation of the study in 2019. The overall program structure is established, the Program Coordinators assigned, the Offices of Primary Responsibility appointed, and the five lines of designation solidified: Surveillance, Weapon Systems, Exposure Environment, Blast Characterization, and Health and Performance.<sup>117</sup> The working group continues to refine their action plans and gather data and the strategy has not yet been implemented throughout

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117 “REPORT TO ARMED SERVICES COMMITTEES Section 734 of the National Defense Authorization Act for Fiscal Year 2018 (Public Law 115-91) Longitudinal Medical Study on Blast Pressure Exposure of Members of the Armed Forces Initial Report,” Interim Report (Under Secretary of Defense for Personnel and Readiness, April 11, 2019).

operational units. Despite the excessive turnover of several key positions within the Pentagon, the study continues with forward progress. The final report is expected four years from initiation of the study—sometime around the year 2022.

In a memorandum written by James M. Stewart, the Assistant Secretary of Defense for Manpower and Reserve Affairs, performing duties of the Undersecretary Secretary of Defense for Personnel and Readiness, “During FYs 2013-2017, total expenditures for CTE-relevant research were \$90,937,066.53. This research consisted of 47 projects within the National Research Action Plan Portfolio.”<sup>118</sup> Overall, the Defense Department is expending large sums of money, resources and time to combat this issue, but minimal action has taken place directly impacting the Servicemembers who continue exposing themselves to repeated blast exposures.

There are a number of private, non-profit organizations like the Concussion Legacy Foundation who are doing some exceptional work and primarily focused on CTE related to athletes but are also highlighting and promoting awareness of CTE in Veterans. In 2009, the Concussion Legacy Foundation teamed up with Veterans Affairs, Boston University established a Brain Bank with a focus of understanding the potential relationship between brain trauma and CTE. CLF’s aggressive social media marketing and humanization of impacts using personal vignettes, is a powerful tool to promote awareness and educate regarding the impacts.

The authors of this paper are moved by the efforts being made to combat bTBI, but strongly believe that the time to make an impact at the operator level is now. The toll on operators and their families is already too high, and USSOCOM must provide tactical-level leaders, individual operators, and their families with actionable solutions to combat bTBI. The following chapter will provide several recommendations the authors believe are operationally relevant and can be used to improve the lives of the operators that sacrifice every day to protect our Nation.

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<sup>118</sup> “Report to Congressional Armed Services Committees Chronic Traumatic Encephalopathy Research in the Military” (Under Secretary of Defense for Personnel and Readiness, June 2019).

## 6. Policy Recommendations

*The commander of USSOCOM is responsible for the **combat readiness of SOF; monitoring preparedness to carry out assigned missions; and development and acquisition of SOF peculiar equipment, material, supplies, and services.***

### Technology

5. Develop imaging technology and blood markers to diagnose bTBI and mTBI early in the injury evolution.<sup>119</sup>
  - a. Immediately embrace the cutting-edge imaging research and development being conducted by both government and civilian centers of excellence (COE).
  - b. Consult with and integrate manufacturers of current imaging technology to ensure their capture of imaging requirements associated with diagnosing bTBI and mTBI.
  - c. Identify a cohort of symptomatic operators and a parallel control group to be radiologically studied for patterns of TBI, with the goal of designing more comprehensive peer reviewed studies.
  - d. Rally the expertise of leading imaging COE's and imaging equipment manufacturers to baseline current diagnostic capabilities and gaps, and to define new engineering requirements that result in our ability to image these injury patterns in a living person.
  - e. Invest in research efforts working to develop blood markers capable of detecting inflammatory processes and neuro-chemical changes associated with brain injury. We've already seen pervasive patterns of low testosterone and high cortisol levels following combat deployments in

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119 Larkin.

combination with other abnormal bio-chemical findings. What role does inflammation play in brain health with regard to vulnerability for brain injury, injury detection, neuro-regeneration and recovery?

6. Explore the Utilization Magnetic Resonance Therapy
  - a. Magnetic Resonance Therapy is a non-FDA approved therapy that uses a combination of EEG reading, neuro stimulation from transcranial magnetic stimulation therapy and an algorithm developed by the Brain Treatment Center © to treat bTBI
  - b. MRT is not currently FDA approved, but the components utilized to perform MRT are approved and at least one research study to being conducted to measure the efficacy and safety of this method.
  - c. MRT is a non-invasive treatment that has shown promise in improving cognition in TBI patients.

## Research

7. Identify the blast pressure thresholds that cause the microscopic tears associated with interface astroglial scarring.<sup>120</sup>
  - a. This threshold value can immediately be cross-referenced to blast sensor data already collected to identify weapons systems and tactics that carry risk for bTBI. This correlation will be central to DoD's response to Congress pursuant to section 734 of the 2018 NDAA (Public Law 115-91).
  - b. Adjust training protocols at the unit level or develop new training processes to reduce bTBI exposure without reducing training and or combat effectiveness.

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<sup>120</sup> Frank Larkin, "Brain Health Priorities," October 22, 2019.

- c. Publish blast tables from data that already exists in collaboration with breaching and weapons experts to guide the use of breaching and other explosive weapons systems.

## 8. Research Jugular Vein Compression Collars

- a. A jugular vein compression collar may be an alternative technology for protecting the brain, and it does so from within the brain.
- b. The collar applies gentle pressure to the internal jugular vein, which slows venous outflow and thus increases intracranial blood volume. The increased blood volume is hypothesized to surround the brain and provide cushioning which minimizes the intracranial space for rapid changes in brain positioning (i.e., “slosh”).
- c. Studies involving youth sports and law enforcement SWAT breaching training have shown promise in reducing the effects of bTBI.<sup>121</sup>

## 9. Put More Effort into Animal Studies, VA Research Efforts

- a. Continue to fund the Veterans Affairs the [Translational Research Center for TBI and Stress Disorders \(TRACTS\)](#), based at the VA Boston Healthcare System, with a site at the Michael E. DeBakey VA Medical Center in Houston; and the [Chronic Effects of Neurotrauma Consortium \(CENC\)](#), a joint project of VA and the Department of Defense (DOD).
- b. Promote and expand animal bTBI studies and research efforts in collaboration with other academic and research entities.

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<sup>121</sup> Bonnette et al., “A Jugular Vein Compression Collar Prevents Alterations of Endogenous Electrocortical Dynamics Following Blast Exposure during Special Weapons and Tactical (SWAT) Breacher Training.”

# Policy

10. Institutionalize the Defense Brain Bank (CNRM) and amplify visibility of the brain donation program throughout DoD.<sup>122</sup>
  - a. Brain donations enable the critical research that is needed to characterize disease progression for both bTBI and mTBI.
  - b. Provides evidence of invisible injury suffered in service to our nation.
  - c. Informs on other brain disease challenges.
  - d. A way for those donating to continue serving their teammates
  - e. Institute Brain donation program for new recruits, include on ID card along with other organ donor programs.
  
11. Institutionalize and sustain “baseline” health surveillance with the goal of detecting patterns of injury and health distress early in the evolution of injury/disease progression.<sup>123</sup>
  - a. Continue to perfect base line measurements and follow-on assessments for physical, medical and mental health that will assist with profiling changes over time or following critical exposure incidents.
  - b. Identify high risk individuals for increased health surveillance; such as breachers, EOD technicians, AC-130 aerial gunners, combat engineers, snipers, artillerymen, IED victims, and individuals with prior TBI’s.
  - c. Incorporate and utilize “Blast Logs” to capture exposures during both training and combat.

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<sup>122</sup> Larkin.

<sup>123</sup> Larkin.

- d. Create a confidential user-controlled password protected reporting mechanism for blast exposures, impact injuries, hazardous materials exposures (burn pits), and other health threat exposures that is an adjunct to a warfighter's medical record.
- e. Develop a standardized national assessment survey to capture the history of health and critical incident exposures associated with military service, combat deployments, off-duty experiences, pre and post-enlistment periods that transcends military, VA and civilian medical and mental health domains.
- f. Connect medical records to operational reports to further qualify exposure incidents, inform on baseline health changes, and identify patterns of behaviors that can be incorporated in diagnostic surveillance algorithms and prevention protocols.
- g. Anonymize and integrate data for continued TBI research. Collected data, both past and present, is currently scattered and disconnected. This self-imposed condition is the key impediment to doing the high-end analysis that could hold key revelations about the cause, effect and potential solutions for TBI, PTSD, substance disorder, and moral injury challenges. The emphasis should be on prevention, with training being the close in target to buy down exposure risk. Increased knowledge of both the biological and psychological root causes will enable individual specific care plans customized for effective health recovery and rehabilitation.
- h. Research integrated and embedded sensors in vehicles and PPE that can help classify and measure the types of blast trauma.

## 12. Continuity of Care: Maintain a Primary Care Manager for Servicemembers

- a. Regardless of Duty Station, Servicemembers should be allowed to maintain their providers.

- b. This continuity of care ensures the Servicemember timely, effective and equitable care.
- c. Operators suffering from the conditions associated with the “operator syndrome” require consistent and potentially resource intensive care coordination, so that the entire complex can be addressed, and so the operator and provider can develop trust and a shared understanding of the treatment plan and patient goals.
- d. The use of telemedicine should be considered for operators separated from their primary care manager due to deployment or permanent change of station.

## Education

### 13. Train and Educate the Force on Brain Injuries.<sup>124</sup>

- a. Ensure all operational units at the tactical level are armed with the education of repeated blast wave exposures.
- b. Reduce barriers to care and remove stigmas associated with seeking help for invisible wounds. Manifestations exhibited or reported by a warrior in need cannot be weaponized against them.
- c. Reduce the communications and information gaps/disconnects between medical providers and leadership at all operational levels that directly risk poor decisions and outcomes when deciding the fate of a distressed warrior.
- d. Increased knowledge founded on good science and data collection will set conditions for effective solutions with a focus on prevention.
- e. Any Providers diagnosing any operator with PTSD that has exposure to blast waves, must rule out blast TBI.

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<sup>124</sup> Larkin.



14. Initiate an Aggressive Public Health Awareness Campaign focused on bTBI.

- a. Use of DoD and USG Public Affairs assets
- b. Armed Forces Network (Radio/TV)
- c. Information dissemination via major military treatment hospitals
- d. Collaborate with non-profit organizations dedicated to the study of CTE/IAS
- e. Distribute Information Sheets highlighting ways for mitigation.
- f. Maintain close ties with Veteran's Affairs and the various SOF specific service organizations.

15. Establish a Cross Functional Brain Consortium.

- a. USSOCOM sponsor a yearly Brain Consortium derived from academia, industry and DoD to examine, collaborate and disseminate bTBI related information.
- b. Much like USSOCOM's TALOS program, rely heavily on industry experts to come up with creative solutions to a problem affecting our force.

16. Educate SOF Families on Support Programs

- a. Educate spouses regarding recognition of relevant signs/symptoms and actions appropriate to obtain Servicemember assistance.
- b. Provide information resources to family members.
- c. USSOCOM continues to provide updates through JSOFSEA, Commander's / Senior Enlisted Pre-command Course(s), Surgeon General Office

## 7. Conclusion

*“I heard that they had headaches. And a couple of other things, but I would say, and I can report, it is not very serious.”<sup>125</sup>*

*President Donald Trump in response to Iran’s strike on a US base in Iraq*

The National Defense Strategy number one line of effort is, “First, rebuilding military readiness as we build a more lethal Joint Force.”<sup>126</sup> The health and wellness of our Special Operators is a strategic concern to the force readiness. We cannot sacrifice the combat effectiveness and operational lethality of our Special Operations Forces. The impacts to our forces of relentless and realistic training events and repeated deployments are undoubtedly impacting their optimization. Commanders are obligated to take aggressive action to care for their teammates and those they lead. And these obligations are lifelong. The Department of Defense must call on research institutions, academia, non-profit organizations and medical technology firms to collaborate and seek timely solutions to minimize blast traumatic brain injury to our Servicemembers.

Undoubtedly, solving the “operator syndrome” is a complex problem to undertake. However, there are several actions to take in the short term. The key is in preventing and/or minimizing the impacts of blast exposures. It may be prudent to aggressively challenge current methods of treatment for individuals with repeated blast exposures.<sup>127</sup> Second, U.S. Special Operations Command needs to initiate a public health campaign within the SOF community for brain health. The USSOCOM Brain Health Initiative is a positive start, but the impacts of repeated blast exposure need to get to the operators in the team rooms, mandatory baselining with

<sup>125</sup> “109 U.S. Troops Suffered Brain Injuries In Iran Strike, Pentagon Says,” NPR.org, accessed April 17, 2020, <https://www.npr.org/2020/02/11/804785515/109-u-s-troops-suffered-brain-injuries-in-iran-strike-pentagon-says>.

<sup>126</sup> Jim Mattis, “Summary of the 2018 National Defense Strategy,” n.d., 14.

<sup>127</sup> Barbara Starr, “US Special Operations Suicides Triple in 2018, as Military Confronts the Issue - CNNPolitics,” February 2, 2019, <https://www.cnn.com/2019/02/02/politics/socom-military-suicide-spike-2018/index.html>.

new SOF Operators needs episodic monitoring to detect changes, and SOF Operators should strongly consider donating their brains to CNRM for research. Third, we need to understand and have clear baseline measurements of blast pressure thresholds that cause the astroglial scarring. Fourth, training protocols require adjustment to minimize exposures. And finally, the DoD and USSOCOM should begin work to developing imaging technologies and biomarkers for early detection.

There are a number of initiatives at very senior levels of the Department of Defense however, many of these initiatives and policies are not making it to the team rooms or the ready rooms of our Green Beret “A-Teams,” SEAL Platoons, Ranger Platoons, Marine Special Operations Teams or other special mission units. If knowledge of the impacts of repeated concussive events or bTBI is understood by the community, senior non-commissioned officers will undoubtedly alter training protocols and force positive change.

Most importantly, senior governmental leaders, policy makers, and members of Congress need to understand the true nature of traumatic brain injuries and their impacts to our most precious asset—our Servicemen and women. Though not visible externally, traumatic brain injuries are serious, physical injuries and should be treated as such. We owe it to our Special Operators to make them aware and educate them on the impacts of blast TBI. Armed with this knowledge, they’ll be a more lethal and optimal force.

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