

## Unconventionally Acquired Brain Injury

### Guidance and Instruction About an Emerging Challenge to Warfighter Brain Health

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#### ABSTRACT

Special Operations Forces have made brain health a medical priority in recent years, and new guidance identified a new challenge—unconventionally acquired brain injury (UBI). Although this emerging condition is described as a cluster of neurosensory and cognitive symptoms with unknown etiology/origin, there remain critical questions about how this diagnosis differs from other brain injuries. More importantly, there are limited recommendations about how medical personnel should approach the problem. The current discussion will provide context and information about UBI based on higher guidance and will also review the scant literature to provide context. Foremost, UBI can be distinguished from traumatic brain injury (TBI) largely due to an unknown point of injury. The described symptoms otherwise appear to be largely the same as TBI. Likewise, the recommended course of treatment is to follow the Clinical Practice Guidelines for mild TBI/TBI even if the injury is an actual or suspected UBI. Personnel must be careful to avoid entering sensitive information into the medical record, which may be particularly challenging if identifying the cause involves classified information about an unconventional weapon. Finally, we briefly discuss the literature about several suspected incidents fitting UBI diagnostic criteria, and we conclude with five primary takeaways for medical personnel to follow.

**KEYWORDS:** *unconventional, acquired brain injury; traumatic brain injury; Havana syndrome; Special Operations; Frey effect*

#### Introduction

Brain health is a documented priority in Special Operations medicine.<sup>1</sup> Most often, this focus involves medical issues related to TBI or mild TBI (mTBI). These extensive injuries repeatedly arise as the result of severe concussive events or as a consequence of repeated low-level overpressurization events to which Special Operations Forces (SOF) are exposed over the course of a career.<sup>2</sup> Either variant can cause long-term physiological and psychological health issues that can be challenging to overcome, if not outright disqualifying for military service. Recent guidance has identified another challenge to preserving brain health for our forces—UBI.<sup>3</sup> This potential injury outlines a unique, albeit complementary medical challenge to concussive events. Unfortunately, medical

providers might not understand some of the nuances between TBI and UBI. Both issues describe an acquired brain injury, yet this categorization merely denotes an injury to the brain that occurs after birth rather than due to congenital or degenerative causes. Presuming that blunt traumatic or concussive events are the conventionally acquired TBI, what makes something “unconventional”? Do the symptoms differ in TBI from concussive events? What issues arise in treatment and reporting for this separate source of injury, or do they differ at all?

The current discussion will provide additional context and recommendations for medical providers following the release of United States Special Operations Command (USSOCOM) formal guidance on UBI.<sup>3</sup> We will begin by reviewing definitions and symptoms as outlined by this health instruction. Next, we will discuss complications in the treatment and reporting procedures for UBI given the uncertain and potentially sensitive nature of some possible causes. Finally, having discussed official USSOCOM policy on the matter, we will address controversies from prior incidents and disagreements in the academic literature regarding a similar class of symptoms. These combined talking points should help Special Operations medical providers remain informed and identify emerging threats to the health of our operators—and most importantly, understand how they should respond if they encounter such an injury.

#### Definitions: What Is a “UBI”?

Although there is controversy about the source and nature of this injury, USSOCOM has provided a concrete definition around which we can build a larger discussion. Foremost, and most critical to our ongoing examination, the following is how USSOCOM describes UBI:

“A cluster of neurosensory and cognitive symptoms of unknown etiology/origin with at least one of the following symptoms: vestibular deficits/disturbances, oculomotor deficits, headaches/head pressure, anxiety, sleep impairment, light sensitivity, nose bleeds, ear pain, disrupted executive function, disorientation, auditory symptoms, vision changes, and nausea. A secondary phase of symptoms related to vestibular disturbances or cognitive deficits may potentially present after the initial phase.”<sup>3</sup>

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Meanwhile, the same instruction refers to TBI as “structural injury or physiological disruption to brain function as a result of an external force,” that includes at least one symptom of memory loss, any period of loss of consciousness (LOC), or any vestibular disturbance.<sup>3</sup> Both definitions differ slightly in their descriptions, to include an explicit list of symptoms rather than the more all-encompassing term involving an alteration of mental status.<sup>1</sup> However, they effectively include the same suite of potential indicators. As such, when diagnosing UBI versus TBI, there are few differences in symptomology. The only notable variation involves whether the cause is unknown versus a known traumatic event involving blunt or concussive force. By definition then, UBI would appear to present similarly to TBI, except that the point of injury would be unknown or ambiguous at the time of injury.

Identifying a UBI could be comparable to other psychological diagnoses in families of disorders, known as “not otherwise specified” or “not elsewhere classified,” as popular in the *Diagnostic and Statistical Manual of Mental Disorders* (DSM).<sup>4,5</sup> The comparison is not ideal as the DSM uses “not otherwise specified” when the symptom cluster is similar to the diagnosis but does not meet the criteria. A related problem exists when documenting severity. For example, the term “mild” can be misleading in brain injuries given that mTBI can produce serious cognitive impairments.<sup>6</sup> Such ambiguity is neither the purpose nor intent of having UBI as an identifiable condition. However, it creates the potential of an otherwise undiagnosed, catch-all category for brain injuries—which should be avoided to prevent needless diagnoses. For now, UBI is primarily differentiated from TBI by the cause. Medical information and diagnostic criteria will need to be accumulated to differentiate the symptomology and severity as new cases arise.

The provided definition does appear to align UBI closely to TBI, yet it must also be considered alongside non-TBI.<sup>7-9</sup> The latter refers to brain injury caused by internal factors such as lack of oxygen, toxins, or damage due to infectious disease. Even though these injuries are serious and could be permanently debilitating, they do not receive the same focus within defense circles as TBI. The difference could be attributable to the relative prevalence of blast exposure or other concussive events in military service, as compared to infectious diseases which cause brain damage. Moreover, there is a distinction between TBI versus non-TBI in that TBI is more likely to occur from hostile action than its alternative. Blast exposure can induce TBI, whereas non-TBI could include a contracted disease or mechanical failure that causes prolonged hypoxia in addition to chemical, biological, radiological, or nuclear (CBRN) attack. Still, this issue creates a somewhat academic point. Because the description refers to a cluster of symptoms rather than a causal source, both interpretations are possible. However, the intent of UBI appears to align with an interpretation that the cause is hostile in nature, rather than accidental or natural.

The other instruction-specific definition would be “worried well,” which describes healthy individuals with concerns about undiagnosed illness or nonspecific symptoms that could indicate some disease.<sup>10</sup> This concern is relevant simply because it can be difficult to distinguish between someone with diagnosable UBI compared to hypochondriac-like fears, especially given the importance of self-reported symptoms in the definition. Another possibility is that seemingly “worried well” may have been exposed to sources inflicting a non-TBI.<sup>11</sup> Either

possibility demonstrates how ambiguity in self-reports further emphasizes the importance of objective diagnostic assessments that include validity measures. From the instruction, the intent of “worried well” persons would appear to be a categorical description of an individual suspected to have been subject to an event that could have caused UBI. It would be similar to describing a person under investigation for an illness, but not yet confirmed to have the illness.

### Treatment and Reporting

There are no current Clinical Practice Guidelines for UBI. Instead, USSOCOM guidance<sup>3</sup> recommends using the Clinical Practice Guidelines as recommended for TBI treatment.<sup>3,12-14</sup> Any individual who needs treatment should undergo additional neurocognitive testing per instruction.<sup>1</sup> It is also important for health care providers to be cognizant of the potential psychologic effects associated with UBI. The lack of a defining event at the time of initial symptoms could result in accidental or inadvertent environmental associations. These can be problematic in future scenarios in which the same environmental exposure (e.g., sound, odor, sensation) is present, thereby resulting in associated symptomatology regardless of the presence or absence of a causative etiology. Despite providing an approach to treatment, the primary course of action involves symptom management, such as alleviating headaches with medication until symptoms begin to resolve.

As such, education is the most important element of care management to expedite return to full duty and reduce the likelihood of persistent symptoms. This issue applies as much to UBI for now as it does TBI. For patient care in the context of a UBI/TBI event, the next steps involve conducting a thorough evaluation and assessing the number of similar events within the past 12-month period. If the patient has only endured one suspected event in the past 12 months: (1) initiate a mandatory 24-hour rest period; (2) reassess the patient after 24 hours; (3) initiate progressive return to activity (PRA) protocol if symptoms persist; (4) conduct exertional testing once no symptoms exist; and (5) conduct neurocognitive testing to support a return-to-duty assessment as long as there is a continued absence of symptoms. This process would be largely similar if the patient had prior episodes in the previous 12-month period. The two primary differences would be a required PRA protocol with or without symptoms, and symptom resolution must last for 7 days before the patient can progress to later stages of the PRA. If the incident is at least the third event in the last 12 months, then specialty care would be warranted for all cases. It should also be noted that there are other treatment regimens with more aggressive return to activity guidelines. However, these steps better align with the military health system return-to-duty protocols. In these protocols, the system is designed for larger volumes of concussed individuals and, therefore, potentially less direct time with care providers, than what would be expected in an athletic program. More importantly, a slower and less aggressive return to activity regimen is highly recommended for UBI given the myriad of short-term and long-term unknowns regarding the condition.

Persistent symptoms following concussive events often present in overlapping clusters. Five different symptoms clusters suggest different treatment recommendations. Each emphasizes a particular subspecialty during subsequent visits (Table 1). The “Cognitive” cluster includes symptoms such as mental foginess, short-term memory difficulty, and word-finding

**TABLE 1** Symptom Clusters for Persistent Issues Following a Concussive Event

Cluster	Symptoms	Referral
Cognitive	Mental foggiess, short-term memory difficulty, and word-finding difficulties	Cognitive rehabilitation
Vestibular	Vertigo, balance issues, and postural disturbance	Vestibular or vision therapy
Oculomotor	Photosensitivity, blurred vision, double vision, and impaired eye movements	Neuro-ophthalmology and/or neurology
Headache/migraine	Persistent difficulty with headaches	Neurology
Anxiety/mood	Anxiety, irritability, emotional lability, depression, and apathy	Mental health

difficulties. Cognitive rehabilitation would be the referral for the cognitive cluster. The “Vestibular” cluster includes symptoms such as vertigo, balance issues, and postural disturbance. Persistent vertigo and balance disturbance warrant a referral to vestibular or vision therapy. The “Oculomotor” cluster includes symptoms such as photosensitivity, blurred vision, double vision, and impaired eye movements. Persistent difficulty with these symptoms warrants a referral to neuro-ophthalmology and/or neurology. The “Headache/Migraine” cluster involves persistent difficulty with headaches and warrants a referral to neurology. The fifth and final symptoms cluster is the “Anxiety/Mood” cluster, which presents with symptoms of anxiety, irritability, emotional lability, depression, and apathy. Consider referral to mental health in service members reporting such symptoms and/or a complex psychiatric history. For the Anxiety/Mood cluster, it should be noted that the current SOCOM guidance does not address mood, although it is likely these factors will cluster similar to TBI symptoms. Mood-related factors thus represent an important area of future attention concerning UBIs. Although each of these clusters describes TBI symptoms, in lieu of other evidence for UBI, they provide a starting point for anyone seeking UBI treatment.

With an unconfirmed source of injury and emerging technologies, there are additional considerations for treatment. For example, a directed energy weapon could conceivably cause injury, but medical research into this potential damage is a burgeoning area of study—not a definitive source of information.<sup>15</sup> Directed energy weapons could be in violation of the Geneva Conventions if the weapons explicitly target central nervous system functioning.<sup>16</sup> This should limit their use and may explain the limited research available about corresponding medical treatments. Should international law not stop a hostile force from using directed energy weapons on humans, it will be especially important to understand how these different weapons could manifest an injury on an individual. More importantly, brain injury of unknown origin may need to change how medical professionals approach the injury. Consider the contrast in how a directed energy injury might alter course of treatment. If a concussive injury that induces TBI is akin to an egg falling onto the ground, a directed energy weapon inducing UBI could be more akin to putting an egg into the microwave. Both damaging effects may produce physiological disruption, albeit in substantially different ways. The scientific community is continuing to study a variety of proposed mechanisms of injury and mechanisms of action by which directed energy may cause symptoms and cellular pathology. Without

knowing the origin of the injury, medical personnel will need to keep an open mind when pursuing a course of treatment.

Conversely, it is possible that there is a known source of injury—which happens to involve classified information. This issue complicates reporting and documentation due to security concerns. Initial reporting should remain through operational and secure channels given the event that it could involve classified information. For the medical record, personnel are recommended to enter UBI in accordance with comparable TBI documentation for a deployed setting.<sup>12</sup> The potentially sensitive nature requires a sanitized medical record to ensure operational security, and while the UBI incident can be documented, only nonsensitive information about the event can be recorded. These details should pertain largely to the physical injuries and symptoms, along with any psychological issues observed following the injury. Medical information cannot include sensitive information that might be divulged to civilian medical or academic institutions for the purposes of research and development, despite what will likely be a growing interest in these future events. There is a path for the release of information through USSOCOM, but it requires higher approval—and again, the medical record should be free of sensitive details.

An important consideration is also how the incident becomes recorded. USSOCOM instruction provides a pathway for diagnosing UBI, but the diagnosis is not widely recognized among the medical community. From a medical systems perspective, you might be entering something into the record for which there are no codes, insurance coverage, or otherwise available information. This consideration raises the larger, longer-term issue of how health insurance organizations would view the incident after service, or even how the incident would be factored into consideration for disability pay upon separation or retirement. It is conceivable that an insurance provider or civilian medical organization will not provide the same weight in evaluating UBI compared to TBI, as the former has no clear medical definition. As such, health care providers should be careful how the incident is entered into the medical record, and it might be advisable to diagnose the incident as a TBI-UBI for documentation purposes. An alternative would be to diagnose the resultant condition or symptom(s), such as vertigo-possible UBI. These alternatives would provide a consensus medical understanding in definition, while UBI would be a meaningful variant for Special Operations medical personnel who might need to review the record.

### Literature and Controversy

Two examples are cited as similar incidents that could have involved UBI diagnoses: Havana, Cuba, and Guangzhou, China.<sup>17–19</sup> In these cases, individuals reported heterogeneous combinations of possible symptoms involving oculomotor, vestibular, and cognitive dysfunction. Neuroimaging research indicated differences in white matter volume and functional connectivity among auditory and visuospatial networks when compared against healthy controls.<sup>17</sup> The authors referred to the cause as a potential directional phenomena exposure without citing a specific source, as well as noting the clinical uncertainty given symptomatic differences between individuals. A State Department official independently testified that descriptions were given involving “baffling sensation” and “a high-pitched beam of sound.”<sup>20</sup> Without concrete causal

mechanisms or identifiable weapons, media outlets jumped on the uncertainty and reported a variety of potential causes. Meanwhile, scientific investigations presented multiple possible explanations for the source of injuries.

Potential explanations are provided here for situational awareness should medical personnel be engaged in discussions about incidents in Havana or Guangzhou. We are making no claims and offering no suggestions about the source of these incidents. Still, it benefits medical personnel to be aware of the potential arguments they might face about what individuals heard about, what might have happened or what might have caused their injury, fully noting the nested and multifaceted nature of that conditional statement.

Broadly speaking, the potential sources could be divided into hostile attacks and nonhostile coincidences. Hostile attacks presume intentional assault upon an intended target, whereas nonhostile coincidences presume an accidental source of injury that unintentionally harmed the personnel. Hostile intent stands as the primary difference between the explanations, although adversarial intent has no impact on diagnosis and treatment. The original neuroimaging study cited some directional phenomena as the primary cause of the injury.<sup>17</sup> Its authors never actually use the word “weapon,” although one of the co-authors named microwave weapons as a possible source during a subsequent interview.<sup>21</sup> Pulsed radiofrequency or microwave radiation has been proposed as an explanation for their symptoms.<sup>22</sup> Specifically, this presumption would argue that the Frey effect, which describes auditory effects caused by pulsed or modulated radio frequencies, was being used for hostile purposes.<sup>23</sup> Frey’s original experiments were conducted in the 1960s and used electromagnetic energy to induce the perception of sounds in both normal hearing and deaf humans. These proposed explanations inherently imply that the experiences of American and Canadian diplomats in Cuba were the direct result of hostile action intended to do harm with some experimental weapon.

The alternative category of explanations suggests nonhostile coincidences as the source of injury. One explanation suggests the auditory effects were due to a particular cricket, although the authors note that this explanation would only address the sound and not the health issues.<sup>24</sup> Others have suggested the coincidental auditory effects aligned with a mass psychogenic illness, in which many people begin to feel ill or experience the same symptoms despite no underlying biological cause.<sup>25,26</sup> This claim would indicate a psychosomatic source rather than hostile intervention. However, testimony from the State Department firmly identified that the observed injuries were most likely due to trauma from some nonnatural source.<sup>20</sup> It is also conceivable that the incident in Havana occurred due to accident rather than intent. For example, exposure to ultrasound could have produced some of the auditory effects due to acoustic interference from malfunctioning equipment.<sup>27</sup> This explanation could suggest adversarial involvement, albeit there was no intent to harm as the exposure would be attributable to equipment malfunction.

Each explanation has relative merit, but their presentation here serves a secondary purpose. Namely, when classified materials could be involved and the point of injury is unknown, conspiracy theories will abound. People from reputable and disreputable organizations alike may find the potential explanations

more tantalizing than benign or logical options. Additionally, the lack of confirmation from federal officials will only further the intrigue. None of this speculation matters for the medical personnel intending to treat the patient, except to note the high degree of scrutiny that could arise might be better posed to James Bond than a Special Operations medic.

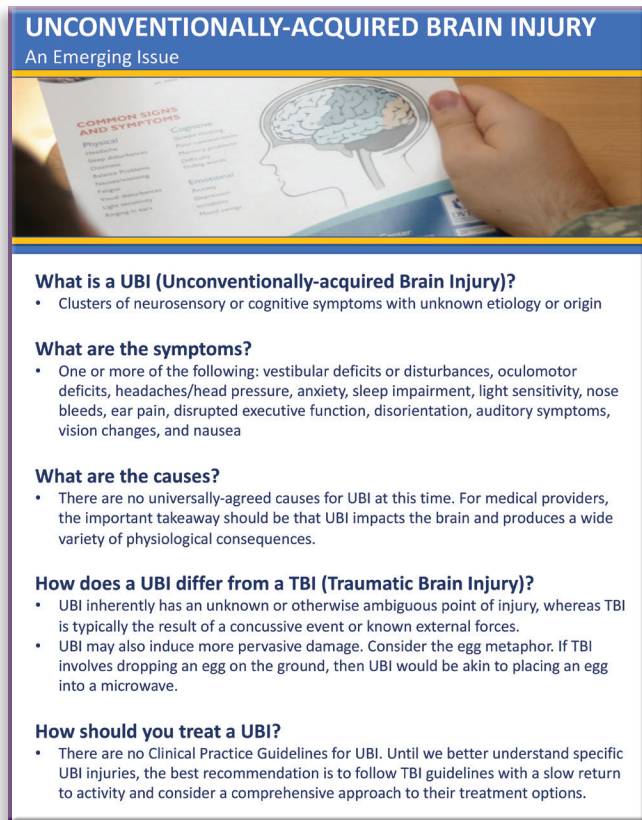
Controversy also undermines the very legitimate emerging threat of directed energy weapons. New weapons bring the potential for new injuries that medical personnel will have to treat, which will be complicated by an unknown point of injury. The UBI instruction serves as a bridge to this future challenge by directing medical staff to begin thinking along these lines and preparing for how to treat an individual presenting with UBI symptoms, rather than trying to decide in the moment. Whatever the specific cause of injury, it should be documented that personnel were treated for UBI in accordance with the guidelines for TBI or mTBI while deployed (Figure 1).

## Summary

Special Operations medicine will always need to contend with emerging threats from across the world. UBI may introduce some new terminology into our medical lexicon, but it is a necessary addition to benefit our operations in the future battlespace. To aid medical providers who might need to diagnose and treat a UBI, here are the main questions and answers we hope that the reader takes away from this discussion:

1. *What does “unconventional” mean in UBI?*
  - Acquired brain injury describes damage inflicted that is not congenital or degenerative in nature. Whereas other acquired brain injuries could be divided into traumatic and nontraumatic categories, unconventional aligns these injuries as traumatic incidents with an ambiguous or unknown point of injury. In this way, the point of injury cannot be linked to a concussive event, single or repeated in nature, although the injury could be linked to hostile actions using unconventional weapons that might emerge in the future battlespace. This definition further differentiates UBI from brain damage caused by toxins or disease.
2. *What causes UBI?*
  - There are no universally agreed causes for UBI at this time. Controversy surrounding incidents in Havana and Guangzhou demonstrate the confusion and conspiracy-minded nature of incidents that might involve unconventional weapons, especially if portions of the incident are classified. For medical providers, the important takeaway should be that UBI will impact the brain and produce a wide array of possible symptoms.
3. *How does a UBI differ from a TBI?*
  - At present, the UBI definition matches TBI quite closely. Both include a collection of possible symptoms with substantial overlap, but UBI and TBI have two main differences. First, there is an unknown or otherwise ambiguous point of injury with UBI. There are no concussive events to which the injury could be linked, and it is possible hostile action with an unconventional weapon could go undetected while inflicting the injury. Second, UBI may have more pervasive damage. Consider the egg metaphor as a potential contrast between the two—if TBI involves dropping an egg onto the ground, then UBI could involve placing the egg into a microwave. Each approach could induce extensive damage in very different ways.

FIGURE 1 Some basic information about UBI for providers.



Source: <https://www.dvidshub.net/image/969320/traumatic-brain-injury-clinic>

#### 4. How should you treat a UBI?

- There are no current clinical guidelines for UBI. Until we better understand specific UBI injuries, the recommendation is to treat the symptoms and to follow the Clinical Practice Guidelines for TBI as the closest proxy. However, medical providers should consider a more comprehensive approach to their treatment options.
- It is important to consider nontraditional TBI associations, including physiological or hormonal disruptions, such as those that could occur with hypothalamic-pituitary-adrenal (HPA) axis dysfunction. The UBI diagnosis should include a rigorous review of systems (ROS). In the ROS, be sure to interrogate the full scope of organ systems to include cardiac, gastrointestinal, and musculoskeletal signs and symptoms. When faced with this potential UBI diagnosis, this is a time to consider the “zebras” in the differential diagnosis. Appropriate data collection at the time of initial evaluation could be of significant value to the research communities and future healthcare providers.

#### 5. What reporting issues might arise with a UBI?

- There is the potential for operationally sensitive information to be involved during an incident that causes UBI. One important issue will be ensuring that sensitive information is not entered into the medical record without the proper precautions. Additionally, although a medical record could document UBI rather than TBI, medical providers must consider the complications of reporting something in the medical record that lacks universal definition or formal recognition in TRICARE and other medical or insurance reporting.

- Ensure the appropriate reporting procedures are followed and that the patient and treating providers maintain strict operational security until otherwise cleared to release information.

Ultimately, UBIs are another example of the medical complications faced by modern warfare. The National Academies of Sciences, Engineering, and Medicine convened a panel of national experts to discuss the UBI emerging threat and recently released a 2020 document with several recommendations and considerations—it is indeed an enigmatic challenge.<sup>28</sup> Although our military providers may regularly struggle with the challenges of novel technologies, such as those arising from telemedicine and unique treatment modalities, similar novel technologies in the form of threats and weapons are also introducing new problems to medical treatment paradigms. UBI introduces new terminology that may eventually enable the precision management of brain injuries arising from hostile actions without necessarily knowing: the weapon involved, when the service member was attacked, or for how long the attack lasted. It is important that UBI not be used as a catch-all term or otherwise function as a TBI “not elsewhere classified.” The diagnosis should be carefully applied by medical personnel who understand the emerging threats faced by SOF and the ever-evolving reactions needed from the medical department.

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