Blast Incident Chronology
Thomas M Fox MAS,MS,CHT

The invisible injury of war veterans from this country's involvement in the war on terror is a silent epidemic. Estimates place the number of veterans at over 1.2 million. Their care is no doubt is the responsibility of the people whom they defend. Despite an exhaustive search and numerous clinical trials to determine an adequate therapeutic approach for comprehensive care, no approach has successfully addressed the wounds of veterans from the combat zone.

Observations seen-

Pressure changes in the combat zone can subject service members to a threshold sufficient to form de novo bubbles and micro-bubbles without lung tissue damage. Formation is a matter of magnitude of pressure/time of exposure. If the magnitude of pressure is great enough, time is no longer a consideration.

Mechanism of emboli formation-

- Overpressurization and over distention
- Evolved gas
- Compressible turbulence
- Nanocavitation

The discharge of the individual combat weapon creates a pressure envelop which moves outward in all directions. The fielding of the M4A1 with 10.5in barrel increased the pressure at the point of discharge by 50% and brought it closer to the soldier. The heat from the firing and the associated pressure change is further noted in failures of the weapon during rapid fire.

The Navy sets 140 dB as the maximum level of safe exposure to humans. The sound recorded in the firing of the M4A1 is 165 dB, exceeding the maximum level of safe human exposure.

The full impact of the effects of blast or pressure changes in the combat theatre is something that is not fully appreciated. The detrimental effects of pressure changes on the human body is something that has been acknowledged for over 100 years.

Studies of the effects blasts on humans were undertaken following the First World War, the Second World War and every war since. Details of these studies appearing in the Textbook of Military Medicine published by the Walter Reed Institute of Research describe the role and presence emboli secondary to explosions.

Infrasound is especially dangerous, due to its strong vibrations, or oscillations. Infrasound waves hug the ground, travel for long distances without losing strength, and are unstoppable. Not much amplitude is needed to produce negative effects in the human body, and even mild infrasound exposure requires several hours, or even days, to reverse symptoms

IED detonations create subtle wounds that virtually undetectable unless you look at a biomarker, a protein S100B which is elevated when the casualty is exposed to the pressure changes of explosive detonation.

In 2001 at the annual UHMS meeting, the elevation of the S100B protein associated with decompression sickness.

Since at least 1992, the formation of emboli at a result of exposure to explosive detonation has been documented in the UHMS Committee Report.

Charles Hoge in a 2004 NEJM article showed a direct relationship between the incidence of PTSD and involvement in firefights

A common constellation of signs and symptoms is seen in PTSD/ mTBI is consistent with neurological decompression sickness following exposure to the pressure changes.

Mechanism of Action-Invisible Injury

Is best explained by the exposure to the pressure changes seen in explosive detonation (regardless of the magnitude) and the associated infrasound.

The pressure associated with blasts is amplified by:

1. Reflective surfaces ie helmets, personal protective body armor, enclosed spaces
2. Blast amplification of the battle dress uniform has been verified by ARL Natick.

The insult to the individual following blast is more like a micro-emboli shower delivered in waves depending on the area of origination. Due to the supersonic nature of the forces generated by blasts, the events are near simultaneous.

The emboli and micro-emboli create ischemic reperfusion injuries depending upon the gas loading.

Reoccurrence of symptoms is often seen blast victims two-three weeks following the blast event. This can be explained as a post hypoxic leukoencephalopathy.

The impact of explosions and blasts continues impact the health of veterans. Yet recognizing the complex mechanism of injury provides insight to the appropriate therapeutic approach.