Cumulative blast exposure estimate model for Special Operations Forces combat Soldiers

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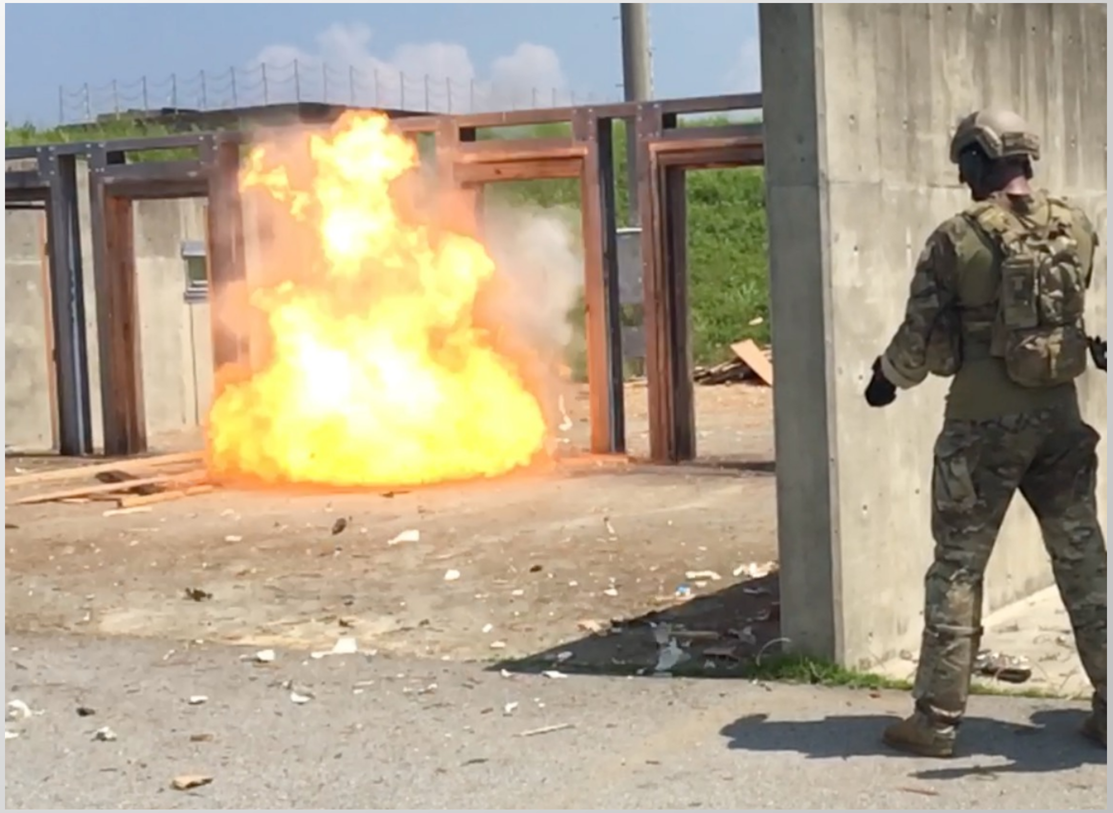
- The opinions and assertions contained herein are the private views of the authors and are not to be construed as official or as reflecting the views of the U.S. Army Medical Department or the U.S. Army Service at large

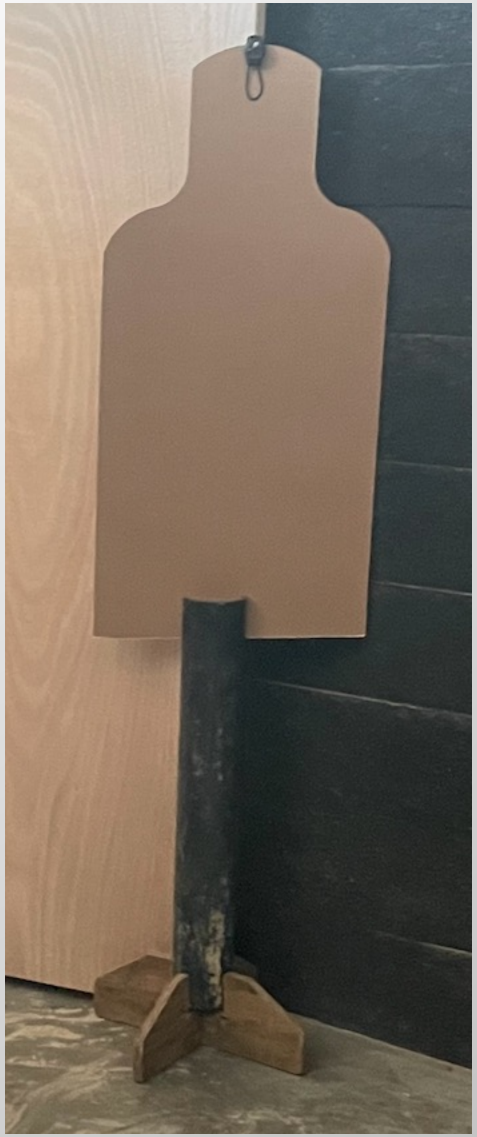
Introduction

- Working in Special Operations for 9+ years, our team recognized a gap in blast research, specifically repetitive low level blast (LLB)
- Special Operations Forces (SOF) service members are exposed to a high number of occupational blast exposures over the duration of their career
- The effect of cumulative LLB is unknown, but chronic exposure is postulated to contribute to neurodegenerative diseases consistent with singular large blast exposure
- Being able to calculate total occupational exposure may better inform providers on future care and research



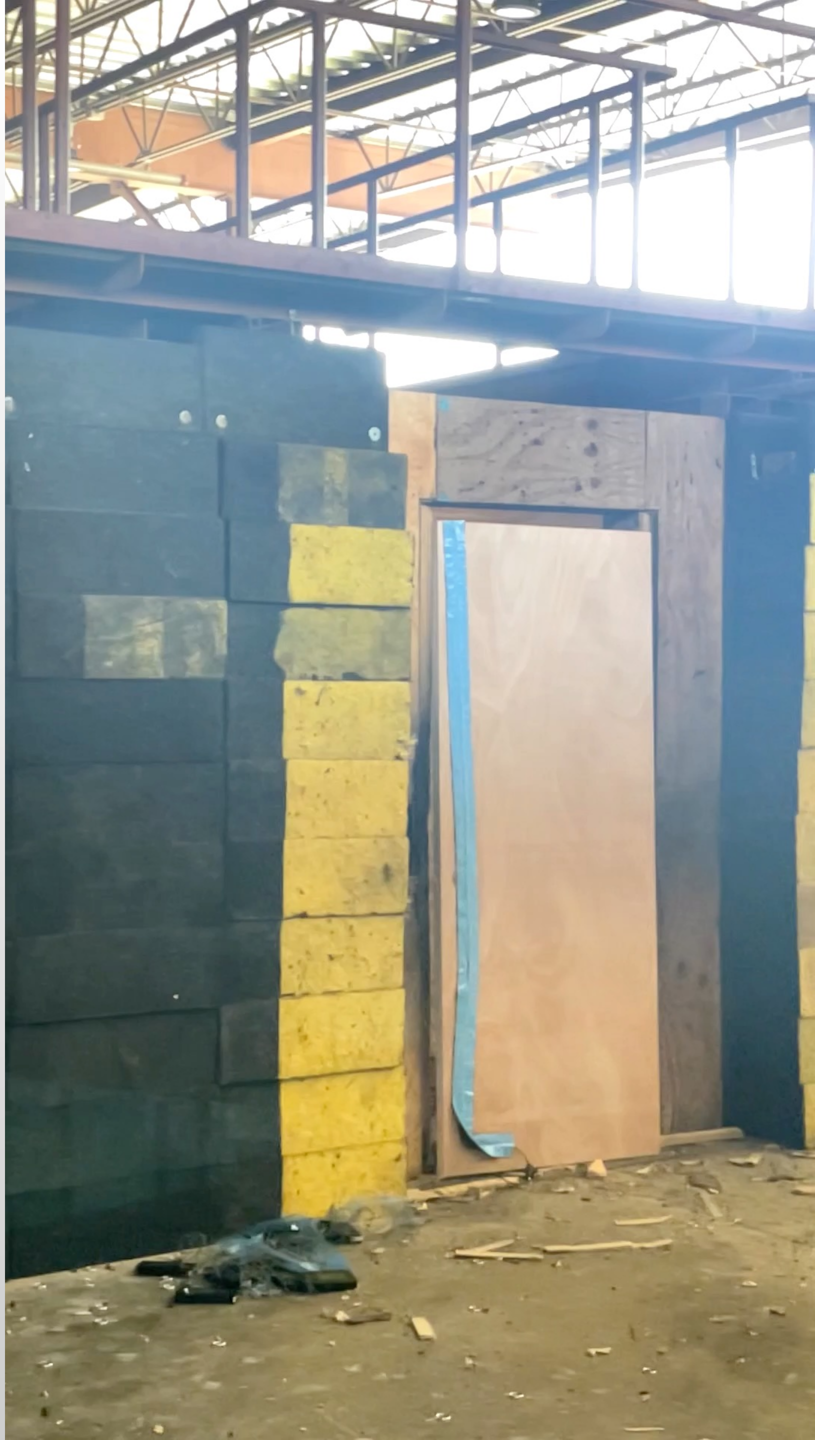
Methods

- Observational study to determine mean peak pressure during standard SOF training
- Utilizing mannequins (standard NATO E-Type silhouettes) with blast gauges secured to them
- Four mannequins were placed at a standard training distance from the explosive
- Mean peak pressure of all four mannequins were calculated for each explosive charge



Methods

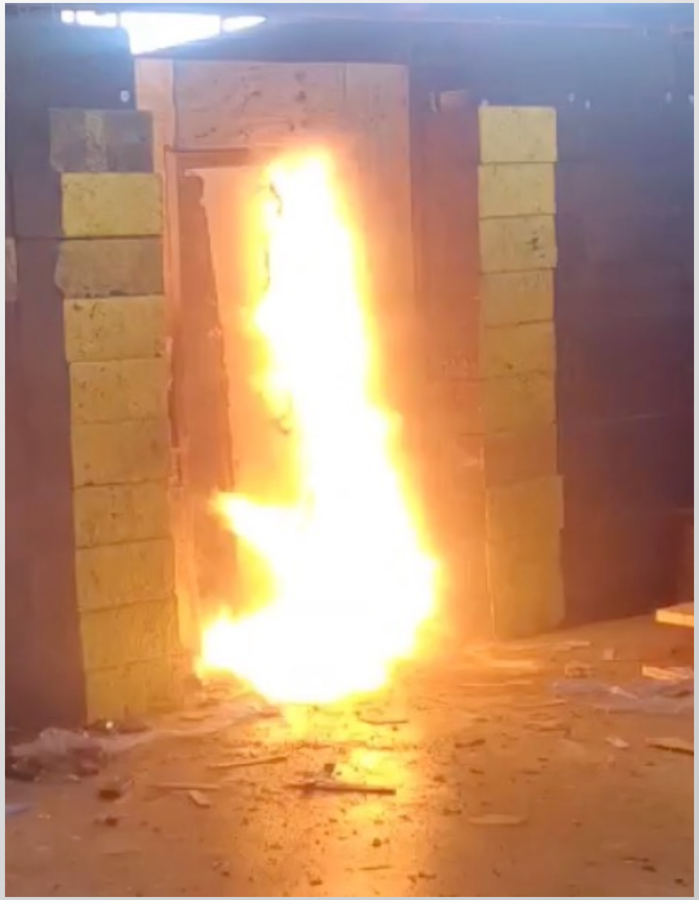
Explosive charge	Description
Flashbang	Commonly used device in both military and law enforcement. Non-lethal grenade style device emitting a loud noise, bright flash, and significant blast wave meant to stun and disorient adversaries prior to SOF personnel entering a room during close quarter battle (CQB). Different styles exist. Our study exclusively employed a flashbang with two distinct flashes and explosions (known within SOF as a ‘two-bang’). A single typical CQB ‘run’ may employ upwards of 20 flashbangs.
Single strand roll up	A standard interior breaching charge used for explosive entrance into interior rooms during CQB. The explosive is a 96-inch (2.44m) strip of detonation cord with an adhesive backing. The charge is built with a net explosive weight (NEW) of 0.92 lbs (0.42kg)
300 gr ECT	A 14-inch (0.36m) linear shape charge with a V-shaped metal hull designed to cut the entry door. The charge has an adhesive backing. The 300gr internal charge is one of the most commonly utilized internal breaching charges for explosive entry into interior rooms during CQB. The NEW of the 300gr ECT is 0.96lbs (0.44kg).
Jelly charge	A smaller charge made up of 2 strips of 12-inch detonation cord with one 16-inch piece in the middle, the detonation cord in this charge is backed by a 0.5-inch rubber piece and an adhesive backing. The jelly charge is built with a NEW of 0.48 lbs (0.22kg).



Results

- Mean peak pressures, standard deviation, and 95% CI were calculated based on Blast Gauge data

Charge Name	Net Explosive Weight (NEW)	Mean Peak psi	SD (psi)	95% CI of Mean (psi)	Mean msec >0.02 psi
Flash bang (n=93)	N/A	1.97	0.50	(1.86, 2.07)	1.54 msec
Single Strand Roll Up (n=80)	0.92	3.88	1.15	(3.63, 4.14)	4.10 msec
300 grain explosive cutting tape (n=28)	0.96	2.78	0.62	(2.54, 3.03)	5.40 msec
Jelly Charge (n=71)	0.48	1.89	0.69	(1.73, 2.06)	2.67 msec



Cumulative Blast Equation

- Pragmatic estimate for occupational exposure of SOF service members
- Example
  - Service member in one day blows up:
    - 10 Flashbangs
    - 2 Single Strand Roll Up
    - 2 300gr ECT
    - 2 Jelly Charges

$$CBE = \sum[(\bar{x}_{fb})(n_{fb}) + (\bar{x}_{ss})(n_{ss}) + (\bar{x}_{300})(n_{300}) + (\bar{x}_{jc})(n_{jc})]$$

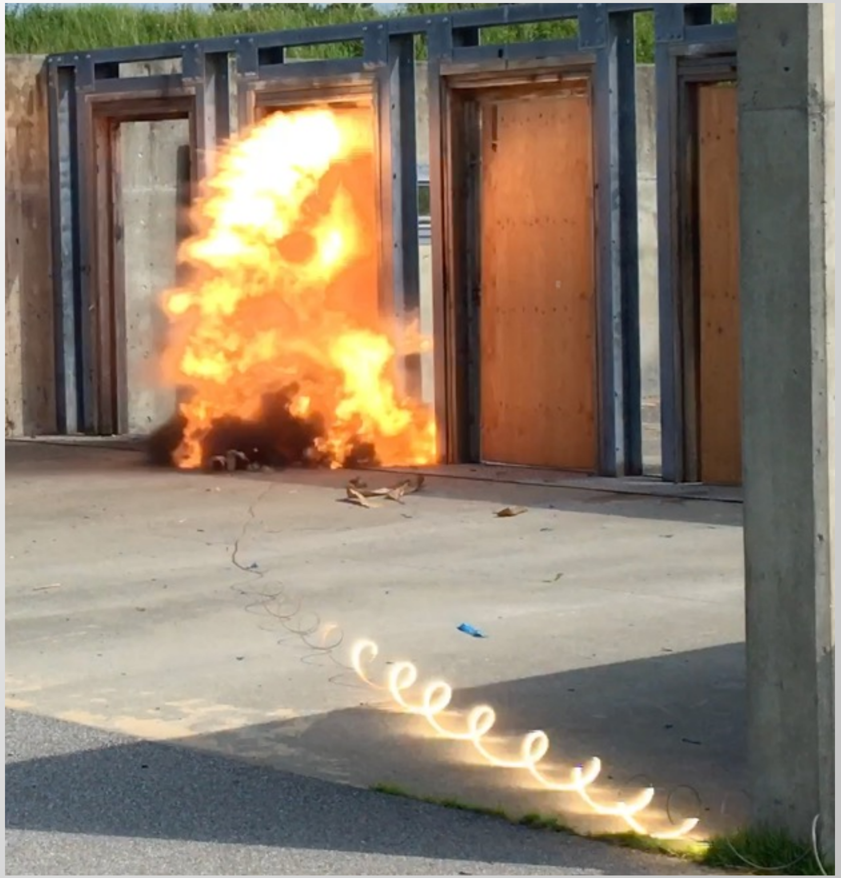
$$CBE = \sum[(1.97\ psi)(10) + (3.88\ psi)(2) + (2.78\ psi)(2) + (1.89\ psi)(2)]$$

$$CBE = \sum[(19.7\ psi) + (7.76\ psi) + (5.56\ psi) + (3.78\ psi)]$$

$$CBE = 36.8\ psi$$

Conclusion/Ways Ahead

- Our teams goal is to utilize the CBE as a pragmatic approach to accurately quantify exposure to clinical findings in SOF service members
- Current validation of CBE in SOF students and cadre in CQB course. After emplacing blast sensors on students/cadre, we are in the early stages of analysis comparing real-time exposure to the overpressure exposure calculated by the CBE to validate our findings
- Additionally we have drawn blood samples from these students/cadre and are in the early stages of identifying novel blood biomarkers indicative of low-level repetitive blast injury in hopes of determining safe vs. unsafe training thresholds. Our hope is to be able to apply the CBE model based off thresholds of physiological injury identified with these novel biomarkers
- We believe the DoD and VA need to better document repetitive LLB in order to have a more robust picture of a service members exposure history
- If chronic exposure can be documented by our proposed CBE alongside longitudinal studies of pathology it may reveal a defined level in which chronic low-level blast becomes injurious



Questions