Evaluating Remote Blast Exposure: The Salisbury Blast Interview

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CENC Chronic Effects of Neurotrauma Consortium

VA U.S. Department of Veterans Affairs

Disclaimer

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Background

Experience of blast events is common among service members

Training Exposures

- Grenades
- Breachers
- Artillery

Exposure Types

- Incoming
- Outgoing

Current Blast Research

- Elevated symptom burden
- Deficits in verbal memory
- Effects on white matter integrity
- Effects on functional connectivity

Blast and TBI

Frequent cause of TBI

Blast and TBI

Frequent cause of TBI

-BUT-

Does not always result in a TBI

Blast Exposure

No accepted definition of the term *blast exposure*

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No accepted definition of the term *blast exposure*

Limited evaluation outside the context of TBI

Blast Exposure

Blast events are highly complex

- Munitions
- Environment (e.g., reflective forces)
- Protective factors

Blast Exposure

Blast events are highly complex

- Munitions
- Environment (e.g., reflective forces)
- Protective factors

Inconsistent evaluation methods across studies

Characterization of Blast Injury

PRIMARY

What is it?
Impact of over-pressurization wave

Associated Injuries

- **Pulmonary barotrauma**
- **Eardrum rupture**
- **Abdominal hemorrhage/perforation**
- **Ocular globe rupture**
- **Concussion (TBI without physical signs of injury)**

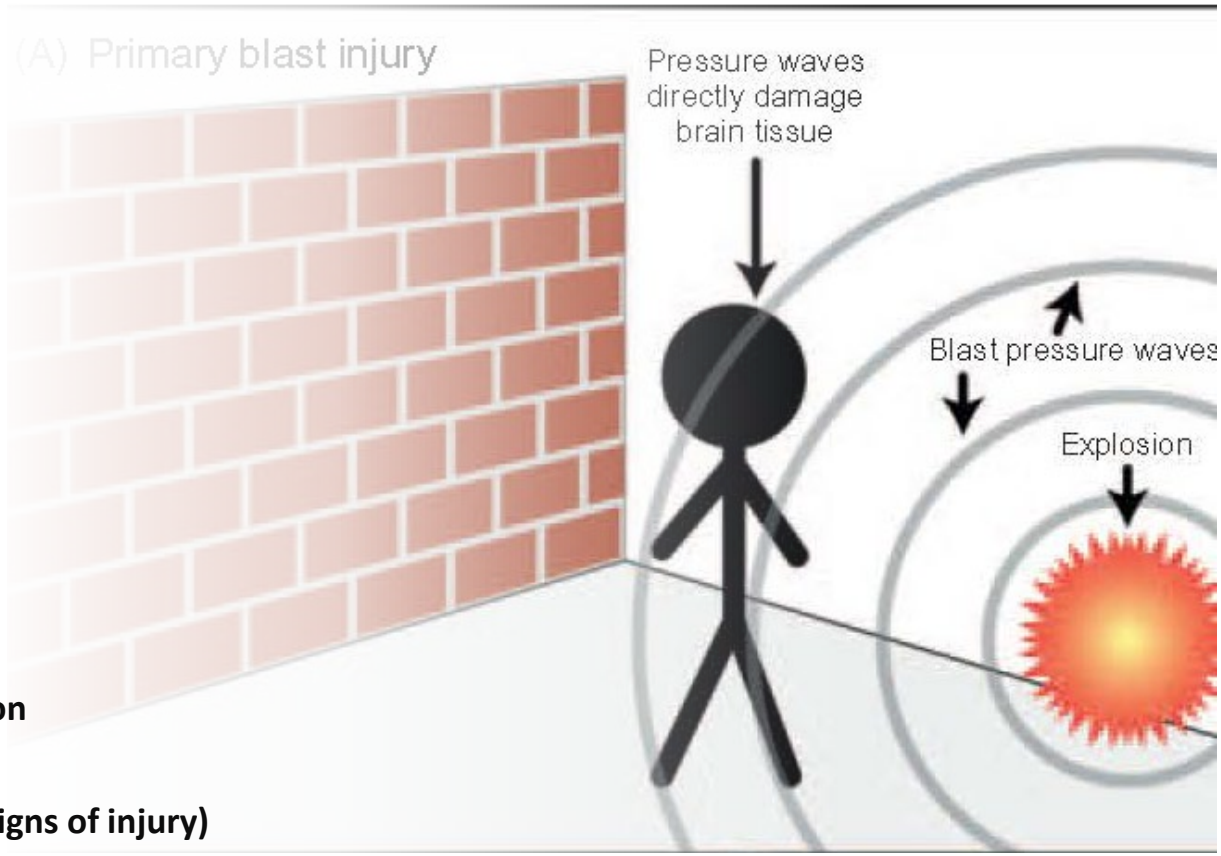

Image Credit: Pitt, 2020

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Characterization of Blast Injury

SECONDARY

What is it?
Impact from flying debris and fragments

Associated Injuries
- **Penetrating**
- **Blunt**

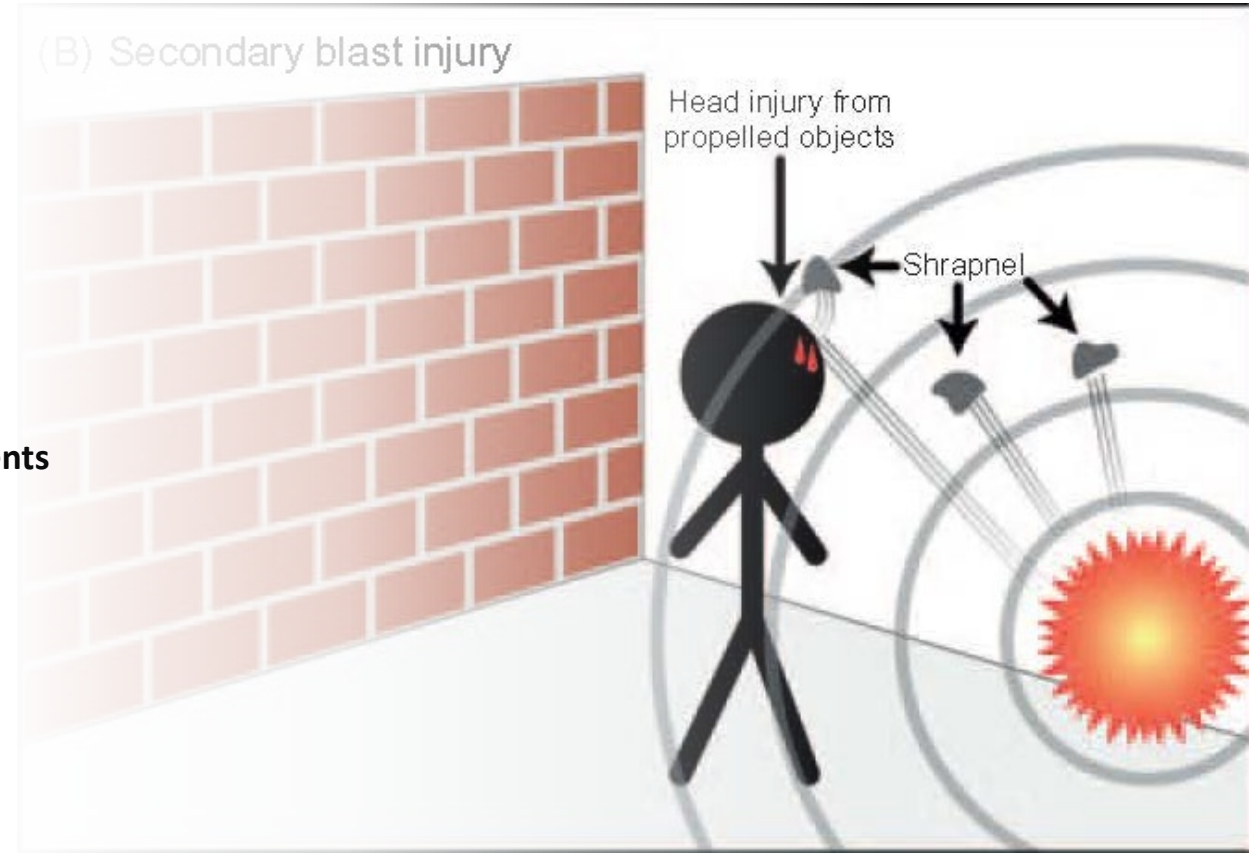

Image Credit: Pitt, 2020

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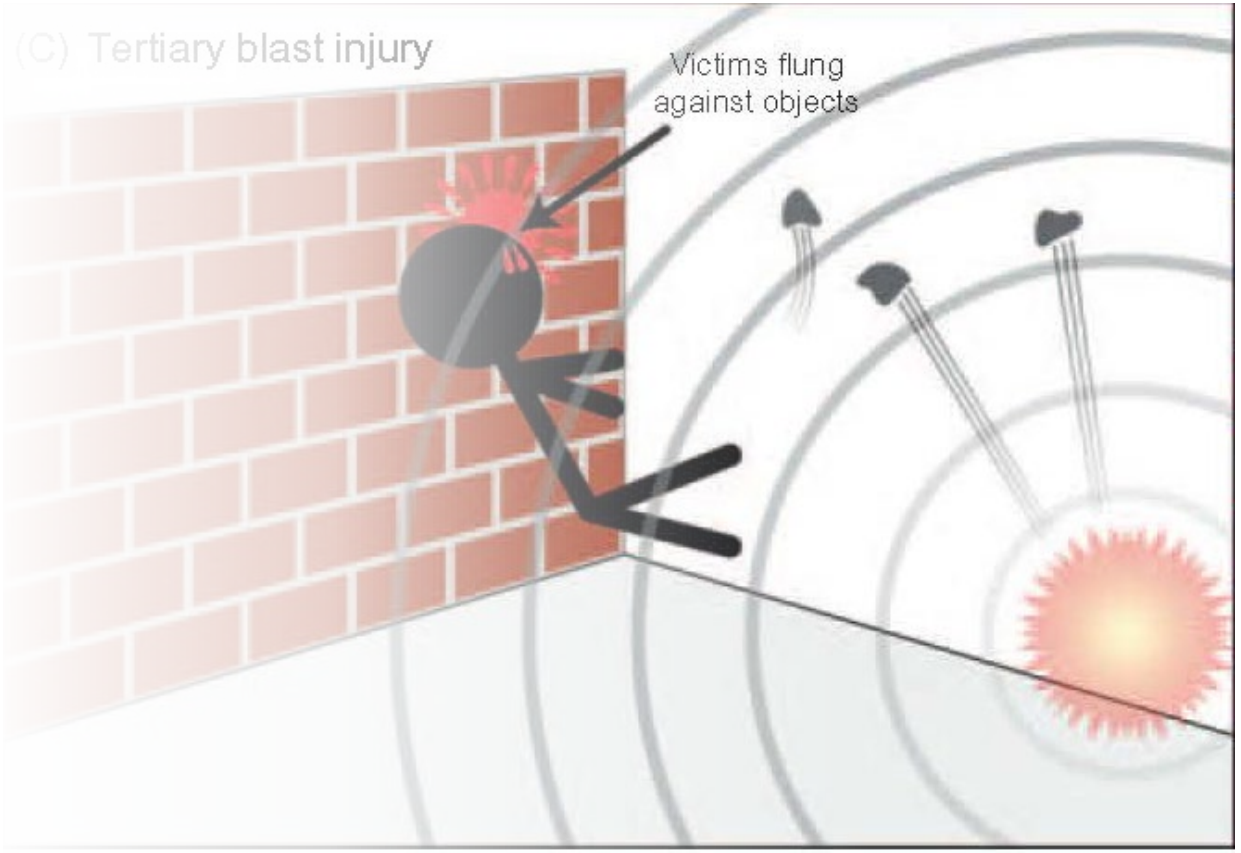
Characterization of Blast Injury

TERTIARY

What is it?
Thrown by wind from blast

Associated Injuries
- **Fracture**
- **Traumatic amputation**
- **Concussion/TBI**



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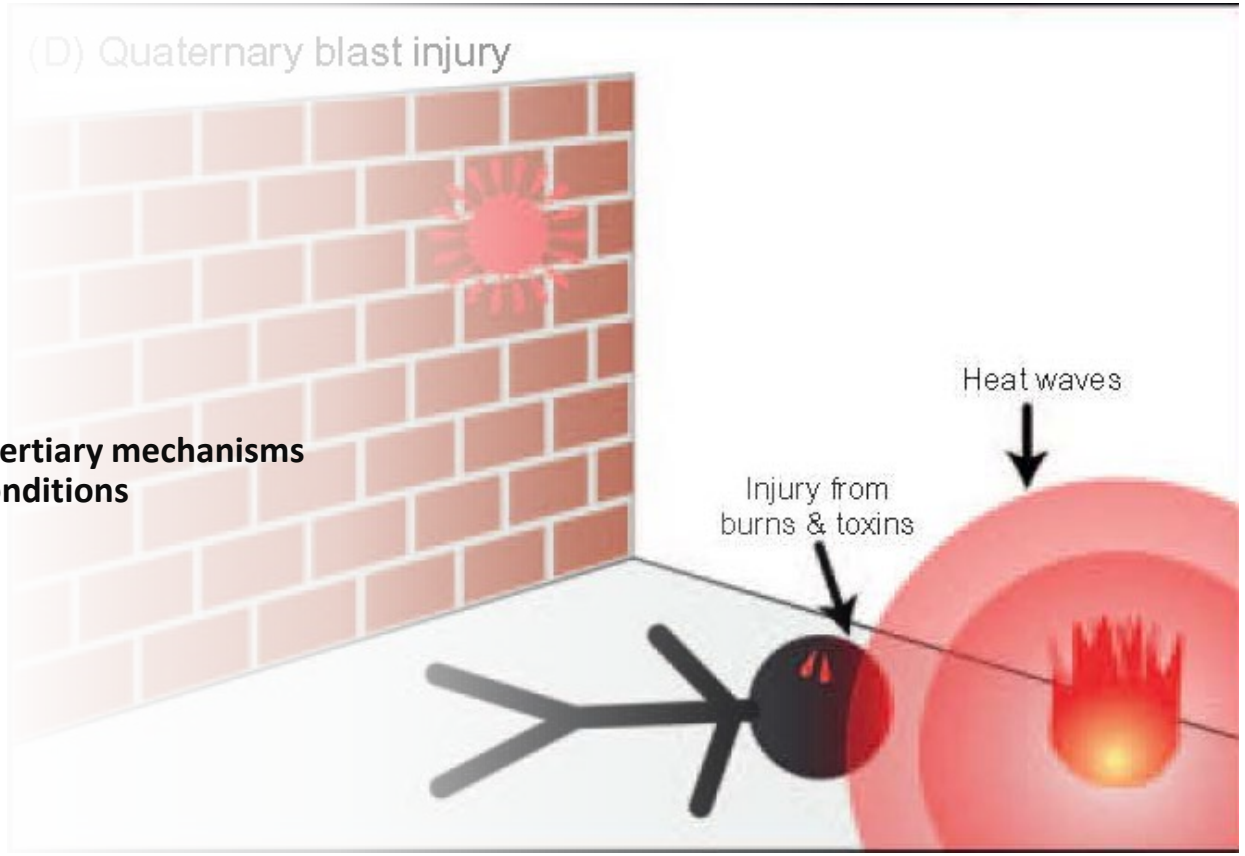
Characterization of Blast Injury

QUATERNARY

What is it?
All other non-primary, secondary, or tertiary mechanisms
Exacerbating/complicating existing conditions

Associated Injuries

- **Burns**
- **Crush**
- **TBI**
- **Asthma/COPD**
- **Hyperglycemia**
- **Hypertension**



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BRAIN INJURY
https://doi.org/10.1080/02699052.2020.1729418

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Sequelae of Blast Events in Iraq and Afghanistan War Veterans using the Salisbury Blast Interview: A CENC Study

Jared A. Rowland [a,b,c], Sarah L. Martindale [a,b,d], Kayla M. Spengler[a], Robert D. Shura [a,b,e], and Katherine H. Taber[a,b,f,g]

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ABSTRACT

Objective: To comprehensively characterize blast exposure across the lifespan and relationship to TBI.
Participants: Post-deployment veterans and service members (N = 287).
Design: Prospective cohort recruitment.
Main Measures: Salisbury Blast Interview (SBI).
Results: 94.4% of participants reported at least one blast event, 75% reported a pressure gradient during a blast event. Participants reported an average of 337.7 (SD = 984.0) blast events (range 0–4857), 64.8% occurring during combat. Across participants, 19.7% reported experiencing a traumatic brain injury (TBI) during a blast event. Subjective ratings of blast characteristics (wind, debris, ground shaking, pressure, temperature, sound) were significantly higher when TBI was experienced and significantly lower when behind cover. Pressure had the strongest association with resulting TBI (AUC = 0.751). Pressure rating of 3 had the best sensitivity (.54)/specificity (.87) with TBI. Logistic regression demonstrated pressure, temperature and distance were the best predictors of TBI, and pressure was the best predictor of primary blast TBI.
Conclusion: Results demonstrate the ubiquitous nature of blast events and provide insight into blast characteristics most associated with resulting TBI (pressure, temperature, distance). The SBI provides comprehensive characterization of blast events across the lifespan including the environment, protective factors, blast characteristics and estimates of distance and munition.

ARTICLE HISTORY
Received 6 September 2019
Revised 4 February 2020
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KEYWORDS
Explosion; traumatic brain injury; military; assessment

Introduction

Military service often results in exposure to a multitude of different blast forces throughout training, deployment and combat (1,2). Many service members deployed to combat zones in support of Operations Enduring Freedom (OEF), Iraqi Freedom (OIF) and New Dawn (OND) have been exposed to blasts or explosions, often without symptoms of traumatic brain injury (TBI) at the time of exposure (3). In the instance of TBI, exposure to blasts accounts for roughly 78% of wounded-in-action cases in OEF/OIF/OND service members and veterans (4). Given the high prevalence of exposure to blasts and explosions, it is important to understand the potential sequelae of such exposures and the circumstances that most likely lead to negative outcomes.

Currently, no well-accepted, standardized criteria exist to identify and characterize an individual's experience of blasts or explosive events such as those that exist for TBI (5,6). The myriad variables present during a blast event make characterization and standardization difficult (3). These include the source (e.g., rocket, mortar, improvised explosive device, heavy weapons), magnitude and distance of the blast, as well as the presence of environmental factors (e.g., protective gear, reflective surfaces) that can alter the generated forces. Despite this limitation, several studies have assessed sequelae of blast exposure using a variety of methods.

A few longitudinal studies have reported detrimental acute effects of blast exposure in a portion of military personnel undergoing breacher training (7,8), heavy weapons training (9), and with subconcussive blast exposures during deployment (10). Cross-sectional studies have reported higher levels of self-reported symptoms associated with blast exposures during deployment (3) and in personnel with repeated exposures to low-level blasts (e.g., breachers, operators of heavy weapons) (11). These results have been observed in individuals without history of TBI. For example, Mac Donald et al. (2017) found elevated symptom burden in blast-exposed combat veterans without TBI compared to those without a history of either TBI or blast exposure (12). Close-range (<10 m) blast exposure has been demonstrated to alter functional connectivity within the default mode network (13,14). Effects of blast exposure on white matter integrity have repeatedly been demonstrated in the absence of TBI (15–18). Grande et al. (2018) demonstrated deficits in verbal memory associated with close-range blast exposure and with greater number of exposures at any distance (19).

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Appendix A

Salisbury Blast Interview

"I want to go over any time you were exposed to a blast or explosion. This includes blasts and explosions th not so close. If you could see it, hear it, feel it, or had some other indication that there was a blast or explos

Has the participant been exposed to blasts of any kind? **YES/NO**

1. When did this happen? Date: ___/___/___
2. During combat? **YES/NO** During deployment? **YES/NO** During military service? **YES/NO**
3. Were you:
   - in a vehicle? **YES/NO**
     - (if yes) was it flipped or thrown into anything by the blast? **YES/NO**
   - behind cover? **YES/NO**
   - Was anything between you and the blast? **YES/NO**
   - wearing a helmet? **YES/NO**
   - wearing ear protection? **YES/NO**
   - wearing eye protection? **YES/NO**
   - wearing body armor? **YES/NO**
   - injured from the blast (burns, lacerations, etc.)? **YES/NO**
   - thrown to the ground by the blast? **YES/NO**
   - thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
   - hit by anything from the blast? **YES/NO**
4. What caused the blast? mortar/rocket/IED/grenade/RPG/missile/bomb/landmine/other
5. Use the following scale to rate how much you experienced the following due to the blast:
   - a) Wind : 0 1 2 3 4 5
   - b) Debris: 0 1 2 3 4 5
   - c) Ground shaking: 0 1 2 3 4 5
   - d) Pressure change/gradient: 0 1 2 3 4 5
   - e) Temperature change/gradient: 0 1 2 3 4 5
   - f) Sound: 0 1 2 3 4 5
6. How far were you from the blast? quantity: _____ units:_____
7. Is this a multiple exposure rating? **YES/NO**

Notes:_____

a) Start date: ___/___/___ End date: ___/___/___
b) "How many events do you estimate occurred during this time period?" _____
c) for any event were you:
   - i. thrown to the ground by the blast? **YES/NO**
   - ii. thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
   - iii. hit by anything from the blast? **YES/NO**
   - iv. If yes to any, did ppt strike their head as a result? **YES/NO**

Appendix B

a) Wind:
- **0 = none,**
- **1 = slightly**, leaves blowing, but not flags,
- **2** = flags waving,
- **3 = moderately**, light objects blowing away
- **4** = difficult to stand or walk
- **5 = strongly**, not possible to stand or walk

b) Debris:
- **0 = none**
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- **2** = small amounts of debris blowing through air
- **3 = moderately**, moderate amount of debris in the air including small pebbles or similar objects,
- **4** = significant amount of debris in air including small rocks
- **5 = strongly**, significant amount of debris including medium to large objects.

c) Ground shaking:
- **0 = none**
- **1 = slightly**, minimal vibration in ground
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- **3 = moderately**, strong ground vibration, feel rattled, small objects moved, minimal effects on balan
- **4** = small earthquake, noticeable ground movement, balance/stability affected
- **5 = strongly**, strong earthquake, thrown about even if lying prone.

d) Pressure change/gradient:

Salisbury Blast Interview

Rowland et al., 2020a

BRAIN INJURY
https://doi.org/10.1080/02699052.2020.1729418

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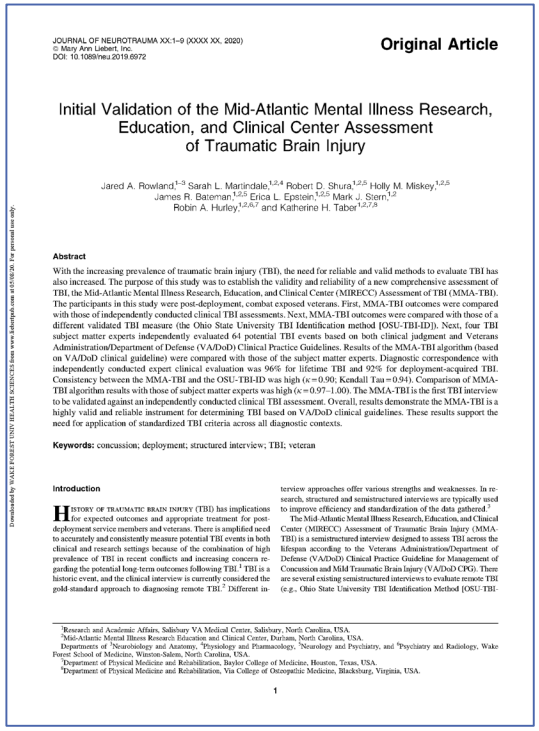

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Original Article

Initial Validation of the Mid-Atlantic Mental Illness Research, Education, and Clinical Center Assessment of Traumatic Brain Injury

Jared A. Rowland,[1–3] Sarah L. Martindale,[1,2,4] Robert D. Shura,[1,2,5] Holly M. Miskey,[1,2,5] James R. Bateman,[1,2,3] Erica L. Epstein,[1,2,3] Mark J. Stern,[1,2] Robin A. Hurley,[1,2,6,7] and Katherine H. Taber[1,2,7,8]

Abstract

With the increasing prevalence of traumatic brain injury (TBI), the need for reliable and valid methods to evaluate TBI has also increased. The purpose of this study was to establish the validity and reliability of a new comprehensive assessment of TBI, the Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MIRECC) Assessment of TBI (MMA-TBI). The participants in this study were post-deployment, combat exposed veterans. First, MMA-TBI outcomes were compared with those of independently conducted clinical TBI assessments. Next, MMA-TBI outcomes were compared with those of a different validated TBI measure (the Ohio State University TBI Identification method [OSU-TBI-ID]). Next, four TBI subject matter experts independently evaluated 64 potential TBI events based on both clinical judgment and Veterans Administration/Department of Defense (VA/DoD) Clinical Practice Guidelines. Results of the MMA-TBI algorithm (based on VA/DoD clinical guideline) were compared with those of the subject matter experts. Diagnostic correspondence with independently conducted expert clinical evaluation was 96% for lifetime TBI and 92% for deployment-acquired TBI. Consistency between the MMA-TBI and the OSU-TBI-ID was high ($\kappa = 0.90$; Kendall Tau = 0.94). Comparison of MMA-TBI algorithm results with those of subject matter experts was high ($\kappa = 0.97–1.00$). The MMA-TBI is the first TBI interview to be validated against an independently conducted clinical TBI assessment. Overall, results demonstrate the MMA-TBI is a highly valid and reliable instrument for determining TBI based on VA/DoD clinical guidelines. These results support the need for application of standardized TBI criteria across all diagnostic contexts.

Keywords: concussion; deployment; structured interview; TBI; veteran

Introduction

History of traumatic brain injury (TBI) has implications for expected outcomes and appropriate treatment for post-deployment service members and veterans. There is amplified need to accurately and consistently measure potential TBI events in both clinical and research settings because of the combination of high prevalence of TBI in recent conflicts and increasing concern regarding the potential long-term outcomes following TBI.[1] TBI is a historic event, and the clinical interview is currently considered the gold-standard approach to diagnosing remote TBI.[2] Different interview approaches offer various strengths and weaknesses. In research, structured and semistructured interviews are typically used to improve efficiency and standardization of the data gathered.[3]

The Mid-Atlantic Mental Illness Research, Education, and Clinical Center (MIRECC) Assessment of Traumatic Brain Injury (MMA-TBI) is a semistructured interview designed to assess TBI across the lifespan according to the Veterans Administration/Department of Defense (VA/DoD) Clinical Practice Guideline for Management of Concussion and Mild Traumatic Brain Injury (VA/DoD CPG). There are several existing semistructured interviews to evaluate remote TBI (e.g., Ohio State University TBI Identification Method [OSU-TBI-

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Departments of [3]Neurobiology and Anatomy, [4]Physiology and Pharmacology, [5]Neurology and Psychiatry, and [6]Psychiatry and Radiology, Wake Forest School of Medicine, Winston-Salem, North Carolina, USA.
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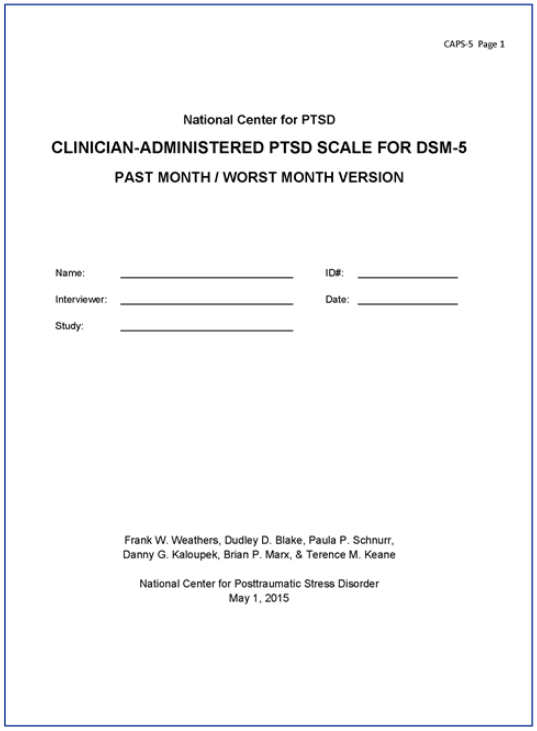

National Center for PTSD

CLINICIAN-ADMINISTERED PTSD SCALE FOR DSM-5

PAST MONTH / WORST MONTH VERSION

Name: _____ ID#: _____

Interviewer: _____ Date: _____

Study: _____

Frank W. Weathers, Dudley D. Blake, Paula P. Schnurr, Danny G. Kaloupek, Brian P. Marx, & Terence M. Keane

National Center for Posttraumatic Stress Disorder
May 1, 2015

Interview Utility

- Evaluates <u>lifetime</u> blast exposure
- Designed to be used with other measures
  - Mid-Atlantic MIRECC Assessment of TBI (MMA-TBI)
  - Clinician-Administered PTSD Scale (CAPS-5)
- Dates/Events can be cross-referenced
  - Comprehensive picture of circumstances

Rowland et al., 2020a; Rowland et al., 2020b; Weathers et al., 2015

Appendix A

Salisbury Blast Interview

"I want to go over any time you were exposed to a blast or explosion. This includes blasts and explosions that were close, as well as those that were not so close. If you could see it, hear it, feel it, or had some other indication that there was a blast or explosion we want to talk about it.

Has the participant been exposed to blasts of any kind? **YES/NO**

1. When did this happen? Date: ___/___/___
2. During combat? **YES/NO** During deployment? **YES/NO** During military service? **YES/NO**
3. Were you:
   - in a vehicle? **YES/NO**
     - (if yes) was it flipped or thrown into anything by the blast? **YES/NO**
   - behind cover? **YES/NO**
   - Was anything between you and the blast? **YES/NO**
   - wearing a helmet? **YES/NO**
   - wearing ear protection? **YES/NO**
   - wearing eye protection? **YES/NO**
   - wearing body armor? **YES/NO**
   - injured from the blast (burns, lacerations, etc.)? **YES/NO**
   - thrown to the ground by the blast? **YES/NO**
   - thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
   - hit by anything from the blast? **YES/NO**
4. What caused the blast? mortar/rocket/IED/grenade/RPG/missile/bomb/landmine/other
5. Use the following scale to rate how much you experienced the following due to the blast:
   - a) Wind : 0 1 2 3 4 5
   - b) Debris: 0 1 2 3 4 5
   - c) Ground shaking: 0 1 2 3 4 5
   - d) Pressure change/gradient: 0 1 2 3 4 5
   - e) Temperature change/gradient: 0 1 2 3 4 5
   - f) Sound: 0 1 2 3 4 5
6. How far were you from the blast? quantity: _____ units:_____
7. Is this a multiple exposure rating? **YES/NO**

   Notes:_____

   _____

   _____

   _____

   _____

   a) Start date: ___/___/___ End date: ___/___/___

   b) "How many events do you estimate occurred during this time period?" _____

   c) for any event were you:
      - i. thrown to the ground by the blast? **YES/NO**
      - ii. thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
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      - iv. If yes to any, did ppt strike their head as a result? **YES/NO**

Appendix B

a) Wind:
- **0 = none,**
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c) Ground shaking:
- **0 = none**
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- **2 =** moderate ground vibration, easily seen in a glass of water, no movement of objects
- **3 = moderately**, strong ground vibration, feel rattled, small objects moved, minimal effects on balance/stability
- **4 =** small earthquake, noticeable ground movement, balance/stability affected
- **5 = strongly**, strong earthquake, thrown about even if lying prone.

d) Pressure change/gradient:

Procedure

Rowland et al., 2020a

Procedure

Appendix A

Salisbury Blast Interview

"I want to go over any time you were exposed to a blast or explosion. This includes blasts and explosions that were close, as well as those that were not so close. If you could see it, hear it, feel it, or had some other indication that there was a blast or explosion we want to talk about it.

Has the participant been exposed to blasts of any kind? **YES/NO**

1. When did this happen? Date: ___/___/___
2. During combat? **YES/NO** During deployment? **YES/NO** During military service? **YES/NO**
3. Were you:
   - in a vehicle? **YES/NO**
     - (if yes) was it flipped or thrown into anything by the blast? **YES/NO**
   - behind cover? **YES/NO**
   - Was anything between you and the blast? **YES/NO**
   - wearing a helmet? **YES/NO**
   - wearing ear protection? **YES/NO**
   - wearing eye protection? **YES/NO**
   - wearing body armor? **YES/NO**
   - injured from the blast (burns, lacerations, etc.)? **YES/NO**
   - thrown to the ground by the blast? **YES/NO**
   - thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
   - hit by anything from the blast? **YES/NO**
4. What caused the blast? mortar/rocket/IED/grenade/RPG/missile/bomb/landmine/other
5. Use the following scale to rate how much you experienced the following due to the blast:
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   - d) Pressure change/gradient: 0 1 2 3 4 5
   - e) Temperature change/gradient: 0 1 2 3 4 5
   - f) Sound: 0 1 2 3 4 5
6. How far were you from the blast? quantity: _____ units:_____
7. Is this a multiple exposure rating? **YES/NO**

   Notes:_____

   a) Start date: ___/___/___ End date: ___/___/___
   b) "How many events do you estimate occurred during this time period?" _____
   c) for any event were you:
      - i. thrown to the ground by the blast? **YES/NO**
      - ii. thrown into anything by the blast (wall, vehicle, or other object)? **YES/NO**
      - iii. hit by anything from the blast? **YES/NO**
      - iv. If yes to any, did ppt strike their head as a result? **YES/NO**

Appe

a) Win

b) I

c) C

d) P

Blast Interview

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Has the participant been exposed to blasts of any kind? YES NO

Rowland et al., 2020a

Blast Circumstances and Protective Factors

1. When did this happen? Date: ___/___/___

2.

Criterion A Event	Yes	No
Traumatic Event	Yes	No
TBI Event	Yes	No
During Deployment	Yes	No
During Military Service	Yes	No

3. Were you…

In a vehicle	Yes	No
(if yes) was it flipped or thrown into anything by the blast?	Yes	No
Behind cover	Yes	No
Was anything between you and the blast	Yes	No
Wearing a helmet	Yes	No
Wearing ear protection	Yes	No
Wearing eye protection	Yes	No
Wearing body armor	Yes	No
Injured by the blast (burns, lacerations, etc)	Yes	No
Thrown to the ground by the blast?	Yes	No
Throw into anything by the blast (wall, vehicle, or other object)	Yes	No
Hit by anything from the blast	Yes	No

4. What caused the blast?

Mortar	___	RPG	___
Rocket	___	Missile	___
IED	___	Bomb	___
Grenade	___	Landmine	___
Other	_____		

Rowland et al., 2020a

5. Use the scale below to rate how much you experienced the following due to the blast:

a) Wind	0	1	2	3	4	5
b) Debris	0	1	2	3	4	5
c) Ground Shaking	0	1	2	3	4	5
d) Pressure Change/Gradient	0	1	2	3	4	5
e) Temperature Change/Gradient	0	1	2	3	4	5
f) Sound	0	1	2	3	4	5

6. How far were you from the blast? quantity: _____ units:_____

Blast Event Characteristics

Rowland et al., 2020a

Blast Event Characteristics

a) Wind

0 **none**
1 **slightly,** leaves blowing, but not flags
2 flags waving
3 **moderately**, light objects blowing away
4 difficult to stand or walk
5 **strongly** not possible to stand or walk

b) Debris

0 **none**
1 **slightly**, dirt, sand, or paper blowing along ground
2 small amounts of debris blowing through air
3 **moderately,** moderate amount of debris in the air including small pebbles or similar objects
4 significant amount of debris in air including small rocks
5 **strongly,** significant amount of debris including medium to large objects

d) Pressure Change/Gradient

0 **none**
1 **slightly**, noticeable but not uncomfortable
2 noticeable and uncomfortable
3 **moderately**, results in minor pain or alteration in function
4 resulted in minor injury
5 **strongly**, resulted in greater than minor injury

Rowland et al., 2020a

7. Multiple exposure rating? Yes No

Notes: _____

_____

_____

_____

_____

_____

_____

a) Start date: ___/___/___ End date: ___/___/___

b) How many events do you estimate occurred during this time period? _____

c) For any event were you…

Thrown to the ground by the blast	Yes	No
Thrown into anything by the blast (wall, vehicle, or other object)	Yes	No
Hit by anything from the blast?	Yes	No
If yes to any, did individual strike their head as a result?	Yes	No

Multiple Exposure Ratings

Rowland et al., 2020a

Evaluation of the SBI

Study 34, Chronic Effects of Neurotrauma Consortium (CENC)

- **Inclusion:** deployed after 9/11/2001, combat exposure
- **Exclusion:** moderate to severe TBI, major neurologic disorder, serious mental illness, dementia, current substance use disorder, psychosis

Measures

- Salisbury Blast Interview (SBI)
- Mid-Atlantic MIRECC Assessment of TBI (MMA-TBI)
- Structured Clinical Interview for DSM-IV (SCID)
- Clinician Administered PTSD Scale (CAPS-5)

Sample Characteristics

Table 1. Descriptive statistics of demographic and characteristic variables.

Variable	Total sample
n = 287	
Age (years)	41.7 (9.8)
Education (years)	15.0 (2.2)
Number of Deployments	2.7 (3.4)
Minority (%)	45.6
Sex (% male)	86.2
Veteran (%)	92.9
Number blast events	337.7 (984.0)
Time since most recent	3697.7 (1311.55)
Blast event (days)	
TBI history (%)	80.0
Deployment TBI history (%)	50.5
Number TBI	2.4 (3.4)
Time since most	4694.5 (3964.4)
Recent TBI (days)[a]	
Current PTSD (%)	37.3
Service branch (%)	
Army	42.6
Army national guard	17.7
Army reserves	13.1
Marine corps	9.2
Air force	5.9
Navy	3.3
Other	11.2

Rowland et al., 2020a

Blast Characteristics

Table 2. Frequency of the presence of protective factors during blast events.

Protective factor	Present	Absent
In a vehicle	271 (31.3%)	595 (68.7%)
Behind cover[a]	465 (53.7%)	401 (46.3%)
Object between	560 (64.6%)	307 (35.4%)
Helmet	569 (65.6%)	298 (34.4%)
Ear protection	309 (35.6%)	558 (64.4%)
Eye protection	427 (49.3%)	440 (50.7%)
Body armor	534 (61.6%)	333 (38.4%)

Data presented from 867 individually rated blast events across the entire sample. [a]n = 866 due to a missing data point.

Table 3. Descriptive statistics of blast event characteristic ratings.

Variable	Minimum	Maximum	Median	Mean	Standard Deviation
Wind	0	5	1.00	1.30	1.5
Debris	0	5	1.00	1.64	1.6
Ground shaking	0	5	3.00	2.54	1.5
Pressure	0	5	1.00	1.39	1.4
Temperature	0	5	0.00	0.67	1.2
Sound	0	5	3.00	3.31	1.3

Rowland et al., 2020a

Blast and TBI

Table 4. Blast event characteristic ratings of all events compared across events involving TBI and not involving TBI, as well as for events involving individuals with primary blast TBI only and those without TBI history.

	All Events[a]		Primary Blast TBI[b]	
	TBI Event (n = 169)	Non-TBI Event (n = 698)	Primary Blast TBI Event (n = 52)	Non-TBI Event (n = 133)
Wind[c,e]	2.01 (1.7)	1.13 (1.4)	1.94 (1.8)	1.01 (1.3)
Debris[c,e]	2.64 (1.7)	1.40 (1.5)	2.77 (1.7)	1.44 (1.6)
Ground Shaking[c,e]	3.40 (1.4)	2.33 (1.4)	3.65 (1.3)	2.44 (1.4)
Pressure[c,e]	2.52 (1.5)	1.12 (1.3)	2.75 (1.4)	1.00 (1.2)
Temperature[c,e]	1.41 (1.5)	0.49 (1.0)	1.71 (1.5)	0.32 (0.7)
Sound[c,e]	4.04 (1.2)	3.13 (1.2)	4.00 (1.1)	3.07 (1.2)
Distance (feet)[c,d]	81.34 (176.1)	953.72 (2418.4)	67.07 (195.3)	766.31 (1970.8)

Rowland et al., 2020a

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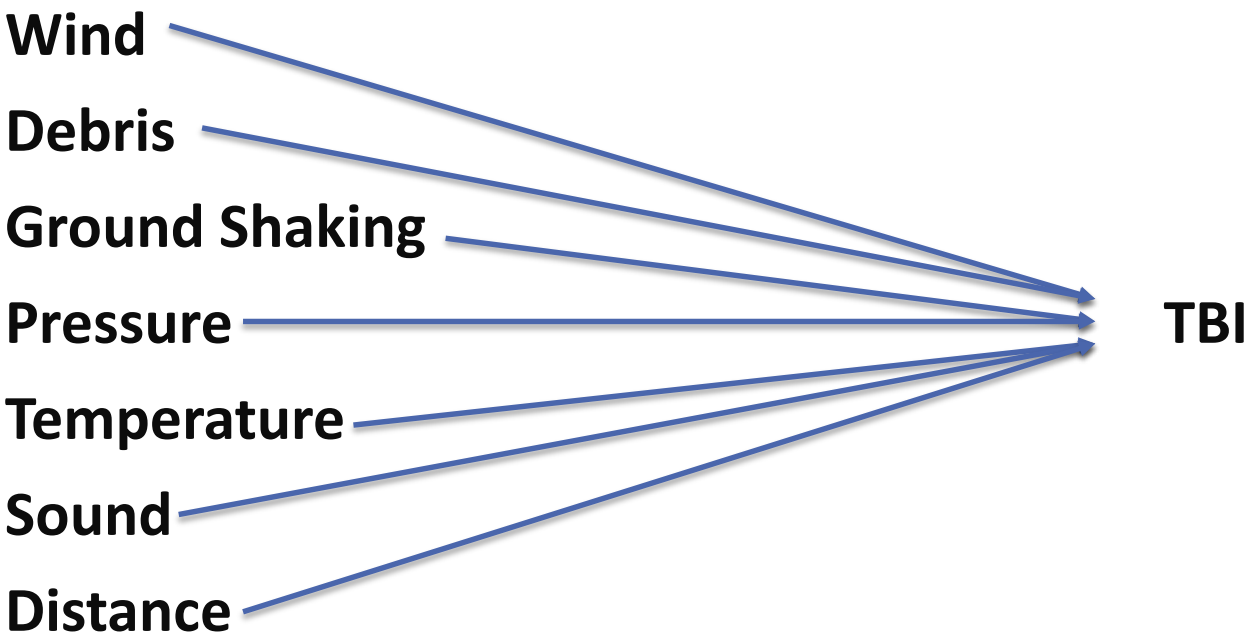
Blast and TBI

Rowland et al., 2020a

Blast and TBI



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Blast and TBI

Wind

Debris

Ground Shaking

Pressure → **TBI**

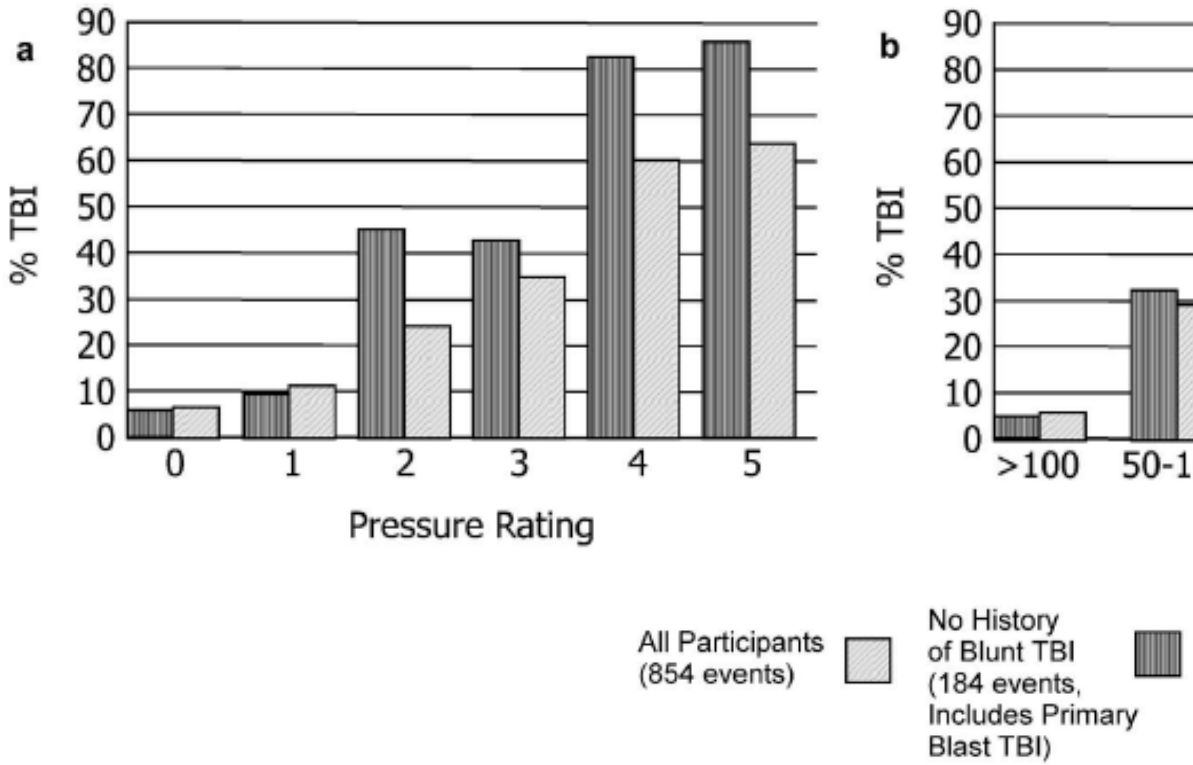
Temperature

Sound

Distance → **TBI**

Rowland et al., 2020a

Blast and TBI



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Blast and TBI

Table 5. Sensitivity, specificity, and AUC of blast event characteristic ratings to the occurrence of TBI during the blast event.

		Characteristic rating					
		1	2	3	4	5	AUC
Wind	Sensitivity	0.702	0.554	0.423	0.214	0.113	0.645
	Specificity	0.478	0.678	0.808	0.936	0.977	
Debris	Sensitivity	0.895	0.425	0.342	0.218	0.116	0.698
	Specificity	0.492	0.527	0.688	0.855	0.959	
Ground	Sensitivity	0.952	0.893	0.792	0.506	0.250	0.655
	Specificity	0.117	0.318	0.510	0.780	0.943	
Pressure	Sensitivity	0.857	0.762	0.512	0.250	0.125	0.752
	Specificity	0.452	0.646	0.843	0.962	0.983	
Temperature	Sensitivity	0.554	0.429	0.286	0.071	0.054	0.668
	Specificity	0.733	0.860	0.934	0.981	0.994	
Sound	Sensitivity	0.976	0.970	0.917	0.702	0.470	0.711
	Specificity	0.010	0.063	0.341	0.662	0.797	

Rowland et al., 2020a

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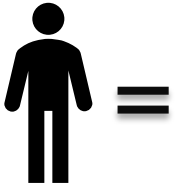
Rowland et al., 2020a

Blast and Symptoms

W=2	W=1	W=3	W=1	W=3
D=3	D=2	D=2	D=0	D=1
G=3	G=1	G=1	G=2	G=3
P=2	P=1	P=2	P=0	P=3
T=1	T=0	T=1	T=0	T=1
S=2	S=2	S=4	S=1	S=2

Rowland et al., 2020a

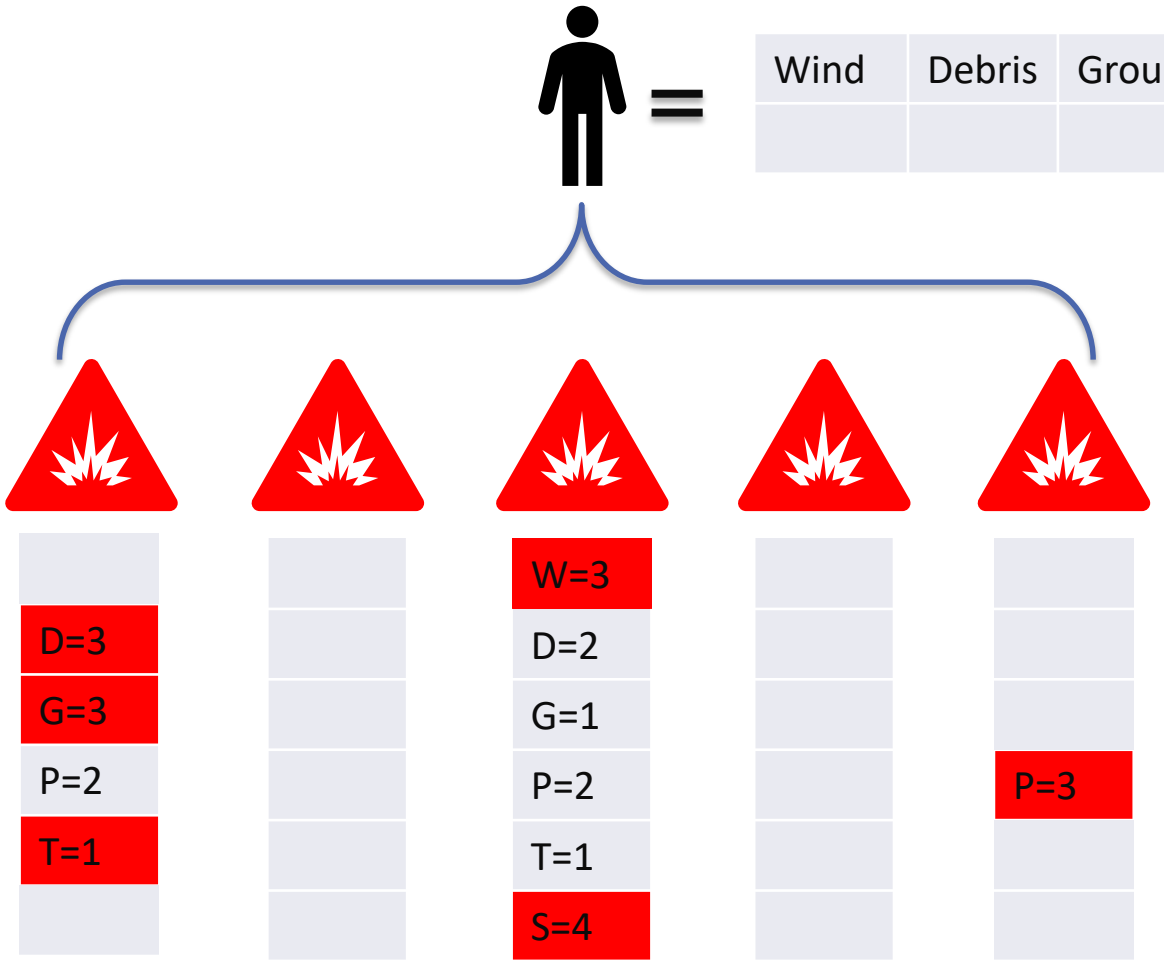


Wind	Debris	Ground	Pressure	Temp	Sound

W=2	W=1	W=3	W=1	W=3
D=3	D=2	D=2	D=0	D=1
G=3	G=1	G=1	G=2	G=3
P=2	P=1	P=2	P=0	P=3
T=1	T=0	T=1	T=0	T=1
S=2	S=2	S=4	S=1	S=2

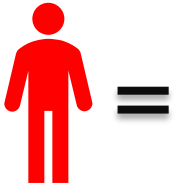
Blast and Symptoms

Rowland et al., 2020a



Blast and Symptoms

Rowland et al., 2020a



Wind	Debris	Ground	Pressure	Temp	Sound
3	3	3	3	1	4

W=2	W=1	W=3	W=1	W=3
D=3	D=2	D=2	D=0	D=1
G=3	G=1	G=1	G=0	G=3
P=2	P=1	P=2	P=0	P=3
T=1	T=0	T=1	T=0	T=1
S=2	S=2	S=4	S=1	S=2

Blast and Symptoms

Rowland et al., 2020a

		DRRI-2-C	PCL Total	NSI Total
Maximum wind	All[a]	.406***	.245***	.230***
	Non-Blunt TBI[b]	.464***	.284*	.292**
	No TBI[c]	.435***	.271*	.269*
Maximum debris	All[a]	.474***	.269***	.221**
	Non-Blunt TBI[b]	.518***	.413***	.390***
	No TBI[c]	.507***	.429**	.419**
Maximum ground shake	All[a]	.479***	.327***	.289***
	Non-Blunt TBI[b]	.549***	.438***	.447***
	No TBI[c]	.505***	.402**	.401**
Maximum pressure	All[a]	.527***	.346***	.325***
	Non-Blunt TBI[b]	.622***	.497***	.478***
	No TBI[c]	.659***	.392**	.365**
Maximum temperature	All[a]	.468***	.304***	.274***
	Non-Blunt TBI[b]	.635***	.500***	.492***
	No TBI[c]	.556***	.442***	.343*
Maximum sound	All[a]	.414***	.353**	.317**
	Non-Blunt TBI[b]	.481***	.454***	.422***
	No TBI[c]	.588***	.434***	.413**
Minimum distance	All[a]	−.148*	−.025	−.004
	Non-Blunt TBI[b]	-.332**	-.234*	-.276*
	No TBI[c]	-.195	-.200	-.246
Number of events	All[a]	.074	.086	.037
	Non-Blunt TBI[b]	.133	.121	.105
	No TBI[c]	.188	.180	.183

Blast and Symptoms

Rowland et al., 2020a

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Rowland et al., 2020a

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Rowland et al., 2020a

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	Non-Blunt TBI[b]	.549***	.438***	.447***
	No TBI[c]	.505***	.402**	.401**
Maximum pressure	All[a]	.527***	.346***	.325***
	Non-Blunt TBI[b]	.622***	.497***	.478***
	No TBI[c]	.659***	.392**	.365**
Maximum temperature	All[a]	.468***	.304***	.274***
	Non-Blunt TBI[b]	.635***	.500***	.492***
	No TBI[c]	.556***	.442***	.343*
Maximum sound	All[a]	.414***	.353**	.317**
	Non-Blunt TBI[b]	.481***	.454***	.422***
	No TBI[c]	.588***	.434***	.413**
Minimum distance	All[a]	−.148*	−.025	−.004
	Non-Blunt TBI[b]	-.332**	-.234*	-.276*
	No TBI[c]	-.195	-.200	-.246
Number of events	All[a]	.074	.086	.037
	Non-Blunt TBI[b]	.133	.121	.105
	No TBI[c]	.188	.180	.183

Blast and Symptoms

Rowland et al., 2020a

Blast Ratings

		Number of events	Time since event
Maximum wind	All[a]	.117*	−.014
	Non-Blunt TBI[b]	.054	.066
	No TBI[c]	.046	.014
Maximum debris	All[a]	.081	−.094
	Non-Blunt TBI[b]	.110	-.048
	No TBI[c]	.143	-.101
Maximum ground shake	All[a]	.052	−.110
	Non-Blunt TBI[b]	.193	-.143
	No TBI[c]	.223	-.130
Maximum pressure	All[a]	.134*	−.066
	Non-Blunt TBI[b]	.100	-.098
	No TBI[c]	.195	-.079
Maximum temperature	All[a]	.141*	.029
	Non-Blunt TBI[b]	.173	.022
	No TBI[c]	.263	-.031
Maximum sound	All[a]	.075	−.035
	Non-Blunt TBI[b]	.189	-.009
	No TBI[c]	.160	-.001
Minimum distance	All[a]	−.027	.139*
	Non-Blunt TBI[b]	-.057	-.008
	No TBI[c]	-.126	-.028
Number of events	All[a]	1.00	−.054
	Non-Blunt TBI[b]	1.00	-.078
	No TBI[c]	1.00	-.126

Rowland et al., 2020a

Summary and Future Directions

Interview Summary

- First published interview specifically focused on exposure to blasts and explosions

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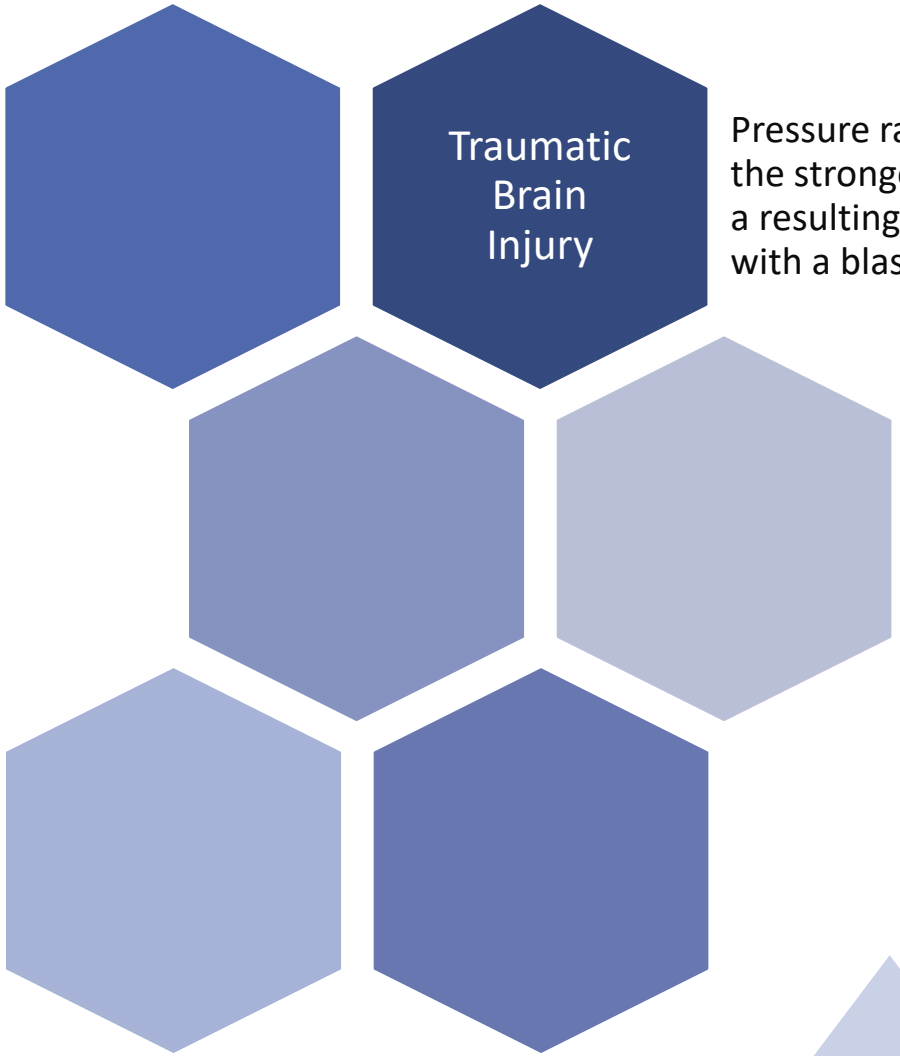
- Addresses limitations of instruments currently used to evaluate blast exposure

Interview Summary

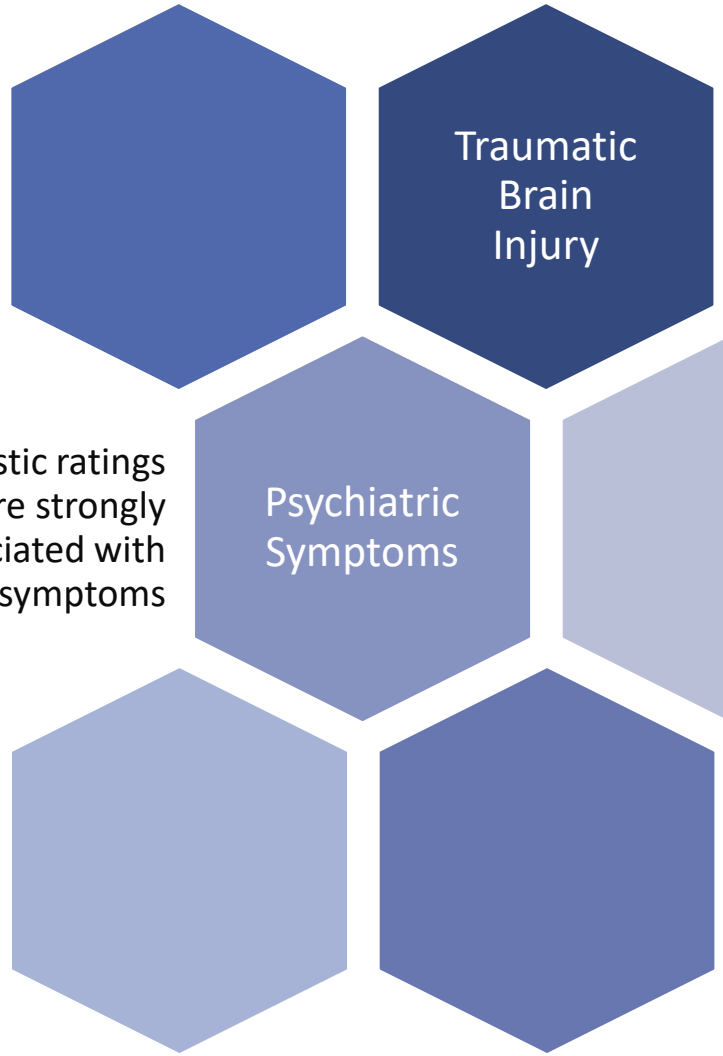
- First published interview specifically focused on exposure to blasts and explosions
- Addresses limitations of instruments currently used to evaluate blast exposure
- Outcomes were consistent with expectations and followed logical patterns

Performance Summary



Pressure ratings provide the strongest predictor of a resulting TBI associated with a blast event

Performance Summary



Pressure ratings provide the strongest predictor of a resulting TBI associated with a blast event

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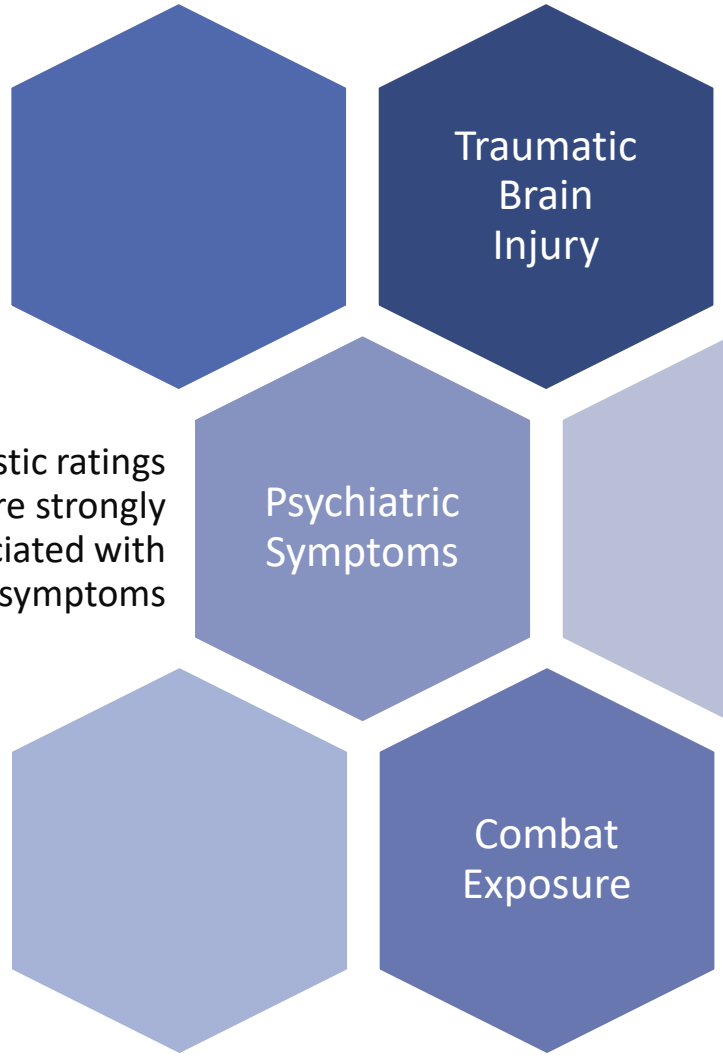

Pressure ratings provide the strongest predictor of a resulting TBI associated with a blast event

Characteristic ratings were strongly associated with psychiatric symptoms

Characteristic ratings had a strong relationship with combat exposure

Future Directions

- Development of interview metrics that take advantage of nested, event level data.
  - Cumulative, lifetime “blast exposure score”

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- Occupational Exposure
  - New section
  - Additional prompts

Future Directions

- Effects of remote blast exposure
  - Blast and Cognition
  - Blast and Hippocampal Volume
  - Blast and Mental Health Symptoms

Martindale et al., 2020; Martindale et al., in press

Future Directions

- Effects of remote blast exposure
  - Blast and Cognition
  - Blast and Hippocampal Volume
  - Blast and Mental Health Symptoms
- Consensus/definition of blast exposure
  - Similar to TBI/concussion

Martindale et al., 2020; Martindale et al., in press

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