



Australian Government

Repatriation Medical Authority

REPATRIATION MEDICAL AUTHORITY

STATEMENT OF REASONS

**REGARDING THE OUTCOME OF THE INVESTIGATION INTO BLAST INDUCED
MILD TRAUMATIC BRAIN INJURY**

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PART I INTRODUCTION

1. The Repatriation Medical Authority (the Authority) has decided not to make Statements of Principles concerning blast induced mild traumatic brain injury pursuant to 196B(6) of the *Veterans' Entitlements Act 1986* (the Act), following notice of an investigation gazetted on 28 April 2025 in the *Commonwealth of Australia Gazette*.
2. On consideration of the sound medical-scientific evidence (SMSE) available to the Authority concerning blast induced mild traumatic brain injury, the Authority formed the view that the SMSE is insufficient to enable the Authority to determine the causation of blast induced mild traumatic brain injury either on the basis of the reasonable hypothesis or balance of probability standard. The SMSE is therefore insufficient in order to determine Statements of Principles for blast induced mild traumatic brain injury.

PART II BACKGROUND TO THE INVESTIGATION

3. On 29 August 2023 the Chair of the Repatriation Medical Authority under section 196C(2)(b) of the *Veterans Entitlements Act 1986*, wrote to the Secretary of the DVA seeking that she *"cause primary research (most usefully cohort or case-control studies) to be undertaken in order to obtain sound medical and scientific evidence concerning a possible and probable relationship between dementia pugilistica and chronic repetitive blast injury in veterans."* In that letter it was stated that *"Currently there is a lack of evidence available in order to determine whether blast exposure has a different association with dementia pugilistica/CTE than other forms of head injury. As a result of this lack of evidence, the SOPs for dementia pugilistica currently exclude blast injury." The Chair pointed out that "As there appears to be a confluence of interest from the veteran community, some evidence of an association and much conjecture as to the mechanism of injury from blast exposure, a detailed study would be most welcome."*
4. To date no research has been forthcoming from the Department of Veterans Affairs.
5. A request for investigation pursuant to subsection 196B(4) of the Act for the purpose of making Statements of Principles for blast induced mild traumatic brain injury was received on 3 January 2025 on behalf of Vigil Australia "an organisation representing veterans, Australian mariners, members of the forces, members of Peacekeeping Forces, members within the meaning of the MRCA, or their dependants" in terms of section 196E of the Act
6. The request stated *"I request the Authority carry out an investigation into Blast-Induced Mild Traumatic Brain Injury (BI-mTBI) with a view to make a Statement of Principles concerning this condition. BI-mTBI is distinct from existing classifications such as traumatic brain injury (TBI) or post-concussion*

syndrome (PCS) and is characterized by cumulative low-level exposures to blast overpressure (BOP)."

7. Accompanying the submission was a list of text references as follows:

Full-Text References for Supporting Studies

Peer-Reviewed Publications

Perl, D. P., et al. (2022).

- *Neuropathologic findings in military personnel exposed to blast overpressure.* New England Journal of Medicine.
- Summary: This study analyzed over 400 military brain specimens and highlighted distinct neuropathological changes caused by blast overpressure, including interface astroglial scarring and neurovascular injury.

Broshek, D. K., et al. (2022).

- *Persisting symptoms after concussion: Time for a paradigm shift.* PM&R Journal.
- Summary: Challenges traditional views of post-concussion syndrome, advocating for reclassification of persistent symptoms due to cumulative low-level exposures.

Edlow, B. L., et al. (2020).

- *The evolving concept of mild traumatic brain injury and its management.* Journal of Neurosurgery.
- Summary: Outlines advancements in understanding mTBI, focusing on distinct mechanisms of blast-induced injuries versus sports-related concussions.

McKee, A. C., et al. (2021).

- *Neuropathology of Chronic Traumatic Encephalopathy in blast and non-blast exposed military personnel.* Journal of Neuropathology and Experimental Neurology.
- Summary: Differentiates CTE pathology in athletes and military personnel, emphasizing the unique vascular and astroglial injury patterns in blast-exposed veterans.

Government and Advocacy Reports

Canadian Veterans Affairs Research Initiative (2022).

- *Neurovascular pathology and cumulative low-level blast exposure: Implications for veterans' brain health.*
- Summary: Government-supported findings on the unique impacts of blast overpressure on the brain and the need for updated diagnostic and therapeutic models.

U.S. Department of Veterans Affairs Research Report (2022).

- *Understanding blast-related traumatic brain injury: A comprehensive review.*
- Summary: Highlights the critical differences in pathology and long-term effects between blast-related injuries and CTE or PCS.

Clinical and Advocacy Perspectives

Nowinski, C. J., & Concussion Legacy Foundation (2022).

- *CTE is a disease: Advocacy for better classification and care pathways.*
- Summary: Defines CTE as a disease rather than an injury, underscoring the importance of avoiding conflation with blast-induced brain injuries.

Hellewell, S., et al. (2021).

- *Blast overpressure and its role in cognitive decline: A review of Australian veteran data.* Curtin University Report.
- Summary: A comprehensive review highlighting gaps in recognition and care for Australian veterans with blast-related injuries.

Rowland, J. A., et al. (2020).

- *Astroglial scarring and its implications for behavioral and cognitive deficits in military personnel.* Defense and Veterans Brain Injury Center (DVBIC).
- Summary: Identifies interface astroglial scarring as a key marker of blast-induced brain injury distinct from other forms of TBI.

Pate, K., & Heroic Hearts Project (2021).

- *Neurophysiology of low-level blast exposure: A need for standardized diagnostic criteria.*
- Summary: Advocates for the development of diagnostic standards for military-specific brain injuries caused by repetitive low-level exposures.

International Advocacy Statements

Speech by Canadian Veterans Affairs Minister (2023).

- "The unique challenges of military brain health: Addressing cumulative trauma through research and policy."

Statement by U.S. Deputy Secretary of Defense (2023).

- "Advancing brain health initiatives in the military: A comprehensive approach to blast-related injuries."

Australian Contributions

Buckland, M., & Australian Veterans Brain Bank (2022).

- *Military-specific brain injury in Australian veterans: Recommendations for research and care.*

Rosen, D., et al. (2023).

- *Recognizing blast-induced brain injury in Australia: A path forward.*

Contributing Experts and Collaborators

- **Dr. Joseph Bonvie** – Home Base, Harvard Medical School
- **Dr. Michael Buckland** – Australian Veterans Brain Bank
- **Dr. Brian Edlow** – Massachusetts General Hospital, Harvard Medical School
- **Chris Frueh, PhD** – University of Hawaii & The Menninger Clinic
- **Dr. Sarah Hellewell** – Curtin University, Australia
- **James Mitchell** – UK Ministry of Defence
- **Dr. Sarah Martindale** – U.S. Department of Veterans Affairs
- **Dr. James Meabon** – U.S. Department of Veterans Affairs

- **Dr. Chris Nowinski** – Concussion Legacy Foundation
- **Dr. Kate Pate** – Neurophysiologist, Heroic Hearts Project & Unlimited Sciences
- **Dr. Daniel Perl** – Uniformed Services University of the Health Sciences, Brain Tissue Repository
- **Dr. David Priemer** – U.S. Veterans Affairs Researcher
- **Dr. David Rosen** – Rosen Neurology, Australia
- **Professor Jeffrey Rosenfeld** – Monash University, Department of Surgery
- **Dr. Jared Rowland** – Defense and Veterans Brain Injury Center (DVBIC)

8. The Repatriation Medical Authority, at its meeting on 1 April 2025 decided to issue a Notice of Investigation to determine whether Statements of Principles might be made in respect of “blast induced mild traumatic brain injury” under section 196G of the Act,
9. The Notice of Investigation was signed by the Chairperson of the Authority on 15 April 2025 and was gazetted in accordance with section 196G of the Act in the *Commonwealth of Australia Gazette* on that same date. Submissions were invited from persons and organisations wishing to make a submission by 15 July 2025.

PART III SUBMISSIONS RECEIVED BY THE AUTHORITY PURSUANT TO SECTION 196F

10. Following notification of its investigation, the Authority received 32 submissions from persons or organisations eligible to make submissions pursuant to s.196F of the Act.
11. Not all of the material in the submissions was within the definition of sound medical or scientific evidence (SMSE) in section 5AB (2) of the Act.

PART IV INFORMATION AVAILABLE TO THE REPATRIATION MEDICAL AUTHORITY

12. The following information was available to the Authority.
 - 12.1. A literature search was conducted using Pubmed for any relevant articles concerning “mild TBI” OR “mild traumatic brain injury” AND “repetitive blast exposure” OR “low level blast exposure” OR “blast overpressure” OR “explosive blast” OR “primary blast” OR “blast induced” OR “blast related” OR “clearance divers” OR “clearance diving” AND restricted to study in humans. No limitations were imposed on year of publication. Relevant articles were obtained from this search and were selected based on relevance, study quality, reliability and journal authority. The above search was supplemented by specific searches for various factors of interest, internet searches, manual searches of reference lists and consideration of relevant sections of textbooks.

- 12.2. Medical or scientific publications as set out in the bibliography attached hereto.
- 12.3. A Briefing paper prepared for presentation to the Authority by a Researcher of the Secretariat.
- 12.4. A discussion paper prepared by a Researcher for the April 2025 Repatriation Medical Authority meeting.
- 12.5. The material from Vigil Australia received on 3 January 2025.
- 12.6. Submissions received in response to the Notice of investigation.

PART V LEGISLATION TO WHICH THE AUTHORITY HAD REGARD

SMSE

Section 5AB of the Act defines SMSE as follows:

*"Information about a particular kind of injury, disease or death is taken to be **sound medical-scientific evidence** if:*

- (a) *the information:*
 - (i) *is consistent with material relating to medical science that has been published in a medical or scientific publication and has been, in the opinion of the Repatriation Medical Authority, subjected to a peer review process; or*
 - (ii) *in accordance with generally accepted medical practice, would serve as the basis for the diagnosis and management of a medical condition; and*
- (b) *in the case of information about how that kind of injury, disease or death may be caused - meets the applicable criteria for assessing causation currently applied in the field of epidemiology."*

Relationship to Service - Section 196B(14) of the Act, states as follows:

(14) A factor causing, or contributing to, an injury, disease or death is **related to service** rendered by a person if:

- (a) it resulted from an occurrence that happened while the person was rendering that service; or
- (b) it arose out of, or was attributable to, that service; or
- (c) it resulted from an accident that occurred while the person was travelling, while rendering that service but otherwise than in the course of duty, on a journey:
 - (i) to a place for the purpose of performing duty; or
 - (ii) away from a place of duty upon having ceased to perform duty; or
- (d) it was contributed to in a material degree by, or was aggravated by, that service; or

(e) in the case of a factor causing, or contributing to, an injury—it resulted from an accident that would not have occurred:

- (i) but for the rendering of that service by the person; or
- (ii) but for changes in the person's environment consequent upon his or her having rendered that service; or

(f) in the case of a factor causing, or contributing to, a disease—it would not have occurred:

- (i) but for the rendering of that service by the person; or
- (ii) but for changes in the person's environment consequent upon his or her having rendered that service; or

(g) in the case of a factor causing, or contributing to, the death of a person—it was due to an accident that would not have occurred, or to a disease that would not have been contracted:

- (i) but for the rendering of that service by the person; or
- (ii) but for changes in the person's environment consequent upon his or her having rendered that service.

Insufficient Evidence upon Investigation - Section 196B (6) of the Act states:

(6) If, after carrying out the investigation, the Authority is of the view:

- (a) that there is no sound medical-scientific evidence on which it can rely to determine a Statement of Principles under subsection (2) or (3) in respect of that kind of injury, disease or death; or
- (b) that the sound medical-scientific evidence on which it can rely is insufficient to allow it to do so;

the Authority must make a declaration in writing:

- (c) stating that it does not propose to make a Statement of Principles; and
- (d) giving the reasons for its decision.

13. The Authority also had regard to sections 196B(2) and 196B(3) of the Act setting out its function to determine Statements of Principles on the basis of Reasonable Hypothesis and/or Balance of Probabilities.

14. The Authority relied upon its expert medical knowledge when considering whether any risk factors were causally associated with blast induced mild traumatic brain injury and if so whether these factors could be related to the service rendered by a person.

PART VI SUMMARY OF THE SMSE

The studies can be grouped into the following broad categories.

Low level blast exposure

15. A total of 31 studies examined low level blast exposure or surrogate indicators of low level exposures (using occupational categories: breachers, mortarmen, snipers), of which 16 were cohort studies and 10 cross-sectional. There were also 5 reviews and 1 systematic review. Whilst the overall evidence suggests a pattern of acute neurocognitive changes following low level blast exposure, the validity of these findings is undermined by major methodological limitations, including small sample sizes, lack of confounder adjustment (such as PTSD, prior head trauma, depression, or substance use, despite their relevance to cognitive and neurological outcomes), and substantial heterogeneity in exposure and outcome assessment.

Cognitive effects

16. A combined total of 44 studies were reviewed in relation to blast induced mild TBI or blast exposure and cognitive effects, including 13 cohort studies, 24 cross-sectional studies, and 7 reviews. Although the overall findings may suggest acute cognitive effects, these results are tempered by considerable methodological limitations. The heterogeneity in exposure definitions, inconsistent cognitive assessments, reliance on self-report data, and lack of robust confounder control undermine the strength and reproducibility of the evidence.

Psychiatric Effects

17. A total of 39 studies were reviewed that examined psychiatric conditions or their symptoms in subjects with a history of blast induced mild Traumatic blast injury (TBI) or blast exposure. These comprised 7 cohort studies, 19 cross-sectional studies, 12 reviews and 1 meta-analysis. The studies explored a range of psychiatric effects from diagnosed conditions like PTSD, depression and anxiety to broader emotional and behavioural symptoms such as irritability, disinhibition, and psychosocial dysfunction.
18. Overall, there was strong evidence of an association between psychiatric conditions such as PTSD, anxiety and depression and blast induced mild TBI.

Biomarkers

19. A total of 14 studies were reviewed that examined various serum and urine biomarkers in subjects with a history of blast induced mild TBI or blast exposure. These comprised 10 cohort studies, 3 cross-sectional studies and a single review. Most studies were conducted among military personnel undergoing breacher or artillery training, with sample sizes ranging from 7 to 136 participants.
20. Considering the methodological limitations, particularly small sample sizes, lack of control groups, short follow-up periods (typically under 2 weeks), and absence of confounder adjustment in the reviewed studies, the long-term implications of blast exposure on biomarker levels remains uncertain.

Brain Health

21. A total of 37 studies were reviewed that examined various brain imaging parameters in subjects with a history of blast induced mild TBI or blast exposure. These comprised 9 cohort studies, 21 cross-sectional studies and 7 reviews.
22. Whilst most of the cross-sectional literature reported a possible link between blast exposure and blast induced mild TBI and changes in brain structure and function, more robust longitudinal studies do not support an association.

Vestibular Effects

23. Three reviews, 4 cohort studies and 6 cross-sectional studies were reviewed that examined vestibular effects in subjects with a history of blast induced mild TBI or blast exposure.
24. The 4 cohort studies (Woodall et al 2023, Kamimori et al 2019, Tate et al 2013 and Kamimori et al 2010) did not observe significant differences in self-reported symptoms including ringing in the ears and loss of balance in breachers and mortarmen compared to unexposed controls.
25. Four out of 6 cross-sectional studies found a significant association between blast induced mild TBI or repeated blast exposure (level of blast exposure was not defined) and vestibular outcomes (balance problems, hearing loss or tinnitus). However, only 2 out of the 6 cross-sectional studies adjusted for potential confounders (Modica et al 2020 adjusted for age and history of concussion whereas Capo-Aponte et al 2012 adjusted for age only).

Visual System effects

26. The reviewed evidence included 2 cohort studies and 2 cross-sectional studies and examined blast exposure in mortarmen, breaching instructors and subjects with blast induced mild TBI (due to improvised explosive devices, rocket propelled grenades and mortars). All found significant associations with visual system effects.

Headaches

27. A total of 14 studies including 3 reviews, 5 cohort and 6 cross-sectional studies examined blast exposure and headaches.
28. Taken together the findings especially from larger adjusted longitudinal models do not support an association between blast exposure and long-term headache symptoms. The associations observed in the 2 cohort studies by Kamimori et al (2018) and Mac Donald et al (2014) and 4 cross-sectional studies are undermined by lack of adjustment for confounding.

Chronic Fatigue

29. One out of 2 cohort studies and 1 out of 2 cross-sectional studies found a significant association between blast exposure and blast induced TBI and chronic fatigue.

Sleep Disturbance

30. The 3 reviewed cohort studies did not observe a significant association between blast exposure and sleep disturbance (Woodall et al 2023, Kamimori et al 2018 and Tate et al 2013), however 3 out of the 4 cross-sectional studies found a significant association with sleeping difficulty and sleep symptoms (Solar et al 2024, Martindale et al 2021 and Carr et al 2015). The reviews by Sachdeva (2024) and Chapman et al (2014) noted that sleep disorders and insomnia have been reported in subjects with blast induced neurotrauma (level of trauma was not described).
31. Considering the lack of adjustment in the primary studies, it is likely that the observed associations in the 2 cross-sectional studies may be better explained by an underlying psychiatric condition. In support of this, Chapman et al (2014) in their review actually noted that a central challenge in the literature base concerning blast induced mild TBI is the diagnostic ambiguity surrounding mild TBI in military contexts, as symptoms often overlap with psychological conditions such as PTSD, depression, and anxiety.

Dementia

32. A PubMed search using dementia OR Alzheimer's AND "repetitive blast exposure" OR "low level blast exposure" OR "blast overpressure" OR "explosive blast" OR "primary blast" OR "blast induced" OR "blast related" AND restricted to study in humans yielded 18 search results of which 10 were considered relevant.
33. Seven reviews indicated that evidence of an association between neurodegenerative diseases and blast induced mild TBI was mostly mixed and inconsistent.
34. Of the remaining, the retrospective cohort study by Barnes et al (2019) of veterans found a history of mild TBI without loss of consciousness was significantly associated with dementia. The study also found a history of mild TBI with loss of consciousness was significantly associated with dementia.
35. The retrospective cohort study by Barnes et al (2014) found, a history of TBI with post-concussion syndrome (compared to veterans without a TBI) was significantly associated with dementia as diagnosed by ICD-9 codes.
36. A cross-sectional study by Priemer et al (2022) stated in relation to the study that, *"The small number of CTE [chronic traumatic encephalopathy] cases makes the study underpowered to conclude that blast exposure was or was not associated with CTE"*

37. A post-mortem case-series by Goldstein et al (2012) of brains from 4 male US military veterans (average age 32.3 years) with known blast exposure and/or concussive history found that 3 of the 4 veterans with known blast exposure and/or concussive history exhibited neuropathological findings consistent with early-stage chronic traumatic encephalopathy. Additional findings included astroglial scarring, axonal injury, and microvascular damage in the frontal lobes and other brain regions. The study noted that all of the veterans with blast exposure had documented neuropsychiatric symptoms such as PTSD, depression, memory loss, and impulsivity. However when reviewed in fact, none of the control brains exhibited chronic traumatic encephalopathy related or blast-specific neuropathologies.

EVIDENCE MENTIONED IN SUBMISSIONS BUT NOT CONSIDERED RELEVANT- HEADING SOCCER

38. A veteran (NM) provided three studies which all fell within the definition of SMSE. All three articles which concerned heading in soccer however were not considered directly relevant to evidence concerning low level blast exposure.

EVIDENCE CONCERNING TBI DETECTION USING EVENT RELATED POTENTIALS– NOT CONSIDERED RELEVANT (ELECTRICAL RESPONSES TO STIMULI)

39. A person with expertise in the field (LS) provided two reviews Cecchie (2018) and Rapp et al (2015) on the use of event related potentials in diagnosing mild TBI which it was stated could be used to understand psychophysiological changes in brains due to blast induced mild TBI. Both reviews however do not examine any health effects in relation to blast induced mild TBI. The RAPP review in particular states that ERP methods are not yet widely adopted in standard clinical practice.

PART VII MATERIAL FINDINGS OF FACT AND REASONS FOR DECISION

40. A limitation in the SMSE is the lack of adjustment for psychiatric confounders.
41. This makes it difficult to ascertain whether low level blast exposure alone is causative of brain injury or merely coincides with other contributors to neurocognitive dysfunction.
42. Another limitation in the SMSE is the high degree of heterogeneity across studies in how blast exposure and blast induced mild TBI are defined and assessed.
43. The intensity, frequency, and context of blast events (i.e training vs. combat, type of explosive, cumulative overpressure) vary widely and are often poorly quantified in the SMSE.

44. This limits comparisons across studies and undermines the ability to draw definite conclusions about dose response relationships or thresholds for injury, which are critical in determining causation.
45. Also limiting the strength of the evidence are small sample sizes across many studies.
46. Most studies also failed to adjust for history of prior head trauma from non-blast mechanisms.
47. Therefore the current SMSE does not yet provide sufficient clarity or consistency to support a causal relationship between low level blast exposure and enduring neurocognitive impairment in the absence of acute symptoms of TBI.

Conclusion

48. At present it remains unclear whether repetitive low level blast exposure in the absence of acute symptoms of concussion or other clinical signs of brain injury, causes neurocognitive impairment over time.
49. The Authority concluded that the SMSE available to it at this time is insufficient to justify the making of Statements of Principles concerning “Blast induced mild traumatic brain injury”.
50. Given the conclusions above, the Authority considers that further research in this general field is urgently required.

PART VIII DECISION

51. In view of the SMSE the Authority decided that Repetitive low-level blast overpressure exposure-induced mild traumatic brain injury (blast induced mild traumatic brain injury) was a clearer term to define the condition described in the applicant’s request for investigation.
52. At its meeting on 5 August 2025 the Authority decided not to make Statement of Principles in respect of Repetitive low-level blast overpressure exposure-induced mild traumatic brain injury (blast induced mild traumatic brain injury) for the purposes of subsection (6) of section 196B of the Act as the Authority concluded, for the reasons set out above, that there was insufficient SMSE in order to make Statements of Principles for Repetitive low-level blast overpressure exposure-induced mild traumatic brain injury (blast induced mild traumatic brain injury) .

Addendum

53. Although not part of these reasons to our knowledge, it is useful to note that there are currently no verified objective tests or universally accepted

diagnostic instruments to inform a definitive diagnosis of blast induced mild TBI without acute symptoms of concussion or other clinical signs of brain injury especially in an operational environment.

A handwritten signature in dark ink, appearing to read 'T. Campbell', with a long, sweeping horizontal stroke extending to the right.

Professor Terence Campbell AM
Chairperson
Repatriation Medical Authority

14 August 2025

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