TBI Policies of NATO Countries

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FROM THE HFM-193 REPORT AUTHORED BY KATHY HELMICK, KIT MALIA, DAVID TARANTINO, BRYAN GARBER AND ERIC VERMETTEN

ABSTRACT

There are documented effective treatments for those who sustain severe and penetrating brain injuries, but there are fewer empirically validated and effective interventions for concussion/MTBI. The current effective treatments for concussion/MTBI supported by scientific evidence include rest and education, including the positive expectation of recovery. This document discusses the acute evaluation and treatment for combat-related MTBI of some of the NATO nations, the similarities and differences between these and any new evidence that has come to light since the NATO report were written.

It also concluded that careful reporting during a sustained blast exposure and targeted screening is essential to evaluate immediate impact and evaluate long-term effects. Implementation of a screening instrument such as the MACE for traumatic brain injury, as well as post-traumatic cognitive symptoms, can provide an opportunity for structured assessment of the effects of blast and other combat-related MTBI on the health and operational fitness of the individual soldier.

1.0 INTRODUCTION

The aim of the various policies regarding Traumatic Brain Injury (TBI) is to detect concussion / Mild Traumatic Brain Injury (MTBI) as early as possible, in order to provide early treatment. Although most service personnel will recover spontaneously within the first few weeks post injury, a minority may require ongoing treatment. For both of these groups of personnel it is essential to provide appropriate targeted treatment once identification has taken place. For the former group, this treatment will help to prevent the development of psychological

reactions to the injury symptoms and will thereby improve speed of recovery, and for the latter group, treatment will help them learn how best to manage any remaining symptoms and how to deal with their developed psychological reactions to the symptoms.

There are documented effective treatments for those who sustain severe and penetrating brain injuries, but there are fewer empirically validated and effective interventions for concussion/MTBI. The current effective treatments for concussion/MTBI supported by scientific evidence include rest and education, including the positive expectation of recovery. The treatments provided to personnel who do not recover within the first few months draw from the scientific evidence base for various psychological therapies, but these have not been studied specifically in the context of concussion/MTBI.

Treatment can vary depending on the Role/Echelon. (A description of NATO's Role/Echelon care delivery is provided in Annex B). Early identification, support and treatment of concussion/MTBI are important. Current evidence points to success from early educational intervention, which should be focused on an expectation of rapid recovery [41], [43]. This will reduce the likelihood of persistent symptoms developing in the majority of cases and allow management to take place predominantly in the Role 1 / primary care setting.

Persisting symptoms may or may not be associated with a reported concussion/MTBI, but where it becomes apparent that the condition is not resolving in the expected timeframe, early onward referral to the next Role/Echelon should take place.

For many NATO Nations, service personnel may appear in the health system of care for complaints that may be related to MTBI (post-concussion symptoms), but there is no systematic process of MTBI care. At the time of this report, Canada, the UK and the US, have promulgated Clinical Practice Guidelines (CPGs) for the treatment/management of MTBI in the deployed setting. What follows is a description of the common elements of these three approaches, followed by a detailed description of the guidelines by country. In 2009, the Netherlands instituted a study protocol to evaluate personnel within 25 meters of a blast. While not a clinical practice guideline, this is described separately later in this chapter. Where appropriate, this topic has been broken down into a presentation of what takes place at each Role/Echelon by Nation.

2.0 COMMON ELEMENTS OF CURRENT CLINICAL PRACTICE GUIDELINES

2.1 Concussion MTBI Definition

All three CPG's provide a definition of concussion/MTBI which are largely similar (see Table 1).

Table 1: Definition of MTBI in UK, US and Canadian Guidelines.

UK	US	Canada
LOC-for 30 min or less; and/or AOC from a moment (e.g. confused, dazed) up to 24 hours; and/or PTA-less than 24 hrs; and/or Transient neurological abnormality +GCS no lower than 13 (after 30 min)	LOC 0 – 30 min and/or AOC from a moment up to 24 hours; and/or PTA from 0 to 1 day. Normal structural imaging.	Concussion may be diagnosed if the following criteria or met: a) **Head injury event** (blast, fall motor vehicle accident, head impact). b) **Alteration of consciousness** (dazed, confused, PTA or LOC).

2.2 Treatment Initiation

Both the UK and Canada employ a symptom-based approach for medical evaluation, whereby individuals who have concerns about MTBI self-report, or line Commanders refer individuals for evaluation. Since 2010, the US has implemented an event-based approach, in which all military personnel who are within 50 meters of a blast event or other potentially concussive events are required to undergo medical evaluation.

2.3 Evaluation for Acute Neurosurgical Conditions

All three algorithms incorporate a series of "Red Flag" symptoms and signs which may be indicative of an acute neurosurgical condition and warrant evaluation with neuroimaging and specialist consultation.

2.4 Neurocognitive Evaluation

Both the US and Canada utilize the Military Acute Concussion Evaluation (MACE) tool to evaluate both symptoms and neurocognitive performance as part of their in-theatre algorithms. The UK utilizes a concussion/MTBI Score Chart to monitor progression/resolution of symptoms and signs. The US will routinely perform more detailed neurocognitive testing in theatre, while both Canada and the UK leave this to the discretion of the clinician.

2.5 Exertional Testing

Exertional testing may be performed on individuals who are asymptomatic and show normal neurocognitive performance in a stress test. Exertional testing is done before making return to duty determinations. This is part of the US and Canadian algorithms, but not included by the UK.

2.6 Mandatory Minimum Rest Period

All three guidelines require a mandatory minimum 24-hour rest period in all suspected cases of concussion, as the operational situation allows.

2.7 Explicit Return to Duty Criteria

The UK requires the individual to show resolution of symptoms and signs based on concussion/MTBI Score Chart. The US and Canada require that the individual be asymptomatic with a MACE Score > 25, following exertional testing.

2.8 History of Multiple Concussions

In the US guidelines, 3 concussions in the past 12 months warrants a comprehensive in-theatre evaluation that includes a neurological examination, a functional evaluation, a neuroimaging study and a thorough neuropsychological assessment (see Clinical Management Algorithm #4). The Canadian guideline recommends specialist evaluation, and there is no specific guidance regarding this in the UK algorithm.

2.9 Repatriation from Theatre

In the Canadian guideline, individuals who are symptomatic for more than 7 days are evacuated to Role 3 for specialist assessment. These individuals are likely to be evacuated from theatre. In the US guideline, individuals who remain symptomatic after primary care evaluation and treatment are transferred to an in-theatre Concussion Care Center for more advanced and further treatment. In the UK guideline, individuals who remain symptomatic during ongoing monitoring over a period of 14 days should be considered for evacuation to Role 2/3 and possibly removed from theatre.

2.10 Role 4 Management

There is considerable variation between the US, the UK and Canada in where care is delivered. In the UK, care is centralized at a specialty facility. In the US, care is delivered at the primary care level and then at more specialized centres for more complicated cases. In Canada, most of the care is delivered by primary care physicians, with specialist consultation as required. Guidelines are in place for the US, the UK and Canada, and are summarized below. In all 3 cases, emphasis is on a symptom-based approach to management.

3.0 DETAILED DESCRIPTION OF EXISTING GUIDELINES IN NATO NATIONS AND PARTNERS

3.1 United Kingdom

An overview of the UK system is provided in Annex C. The algorithm in Figure 1 guides medical staff in the management of concussion/MTBI in the deployed setting both for the Role 1 primary care provider and at Role 2/3.

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ANNEX A – CONCUSSION / MTBI CLINICAL MANAGEMENT ALGORITHM

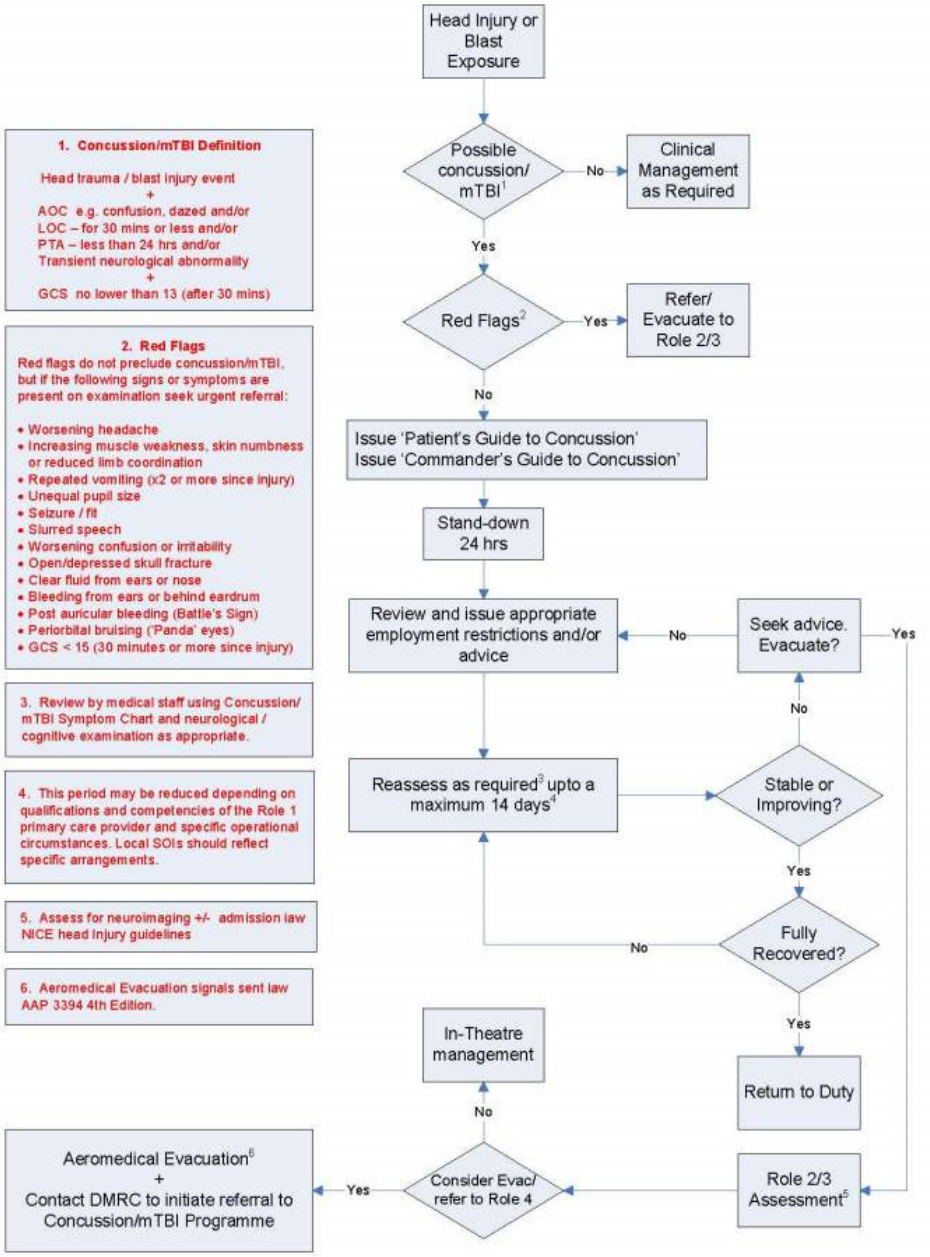

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Figure 1: UK Concussion/MTBI Clinical Management Algorithm.

The UK guidelines aim to reduce the impact of concussion/MTBI on the patient by ensuring early education and information through use of a patient information leaflet (Figure 2) and timely symptom-based intervention, whilst at the same time minimizing the operational impact of unnecessary evacuation.

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ANNEX B – PATIENT'S GUIDE TO CONCUSSION

What happened to me? Your assessment indicates that you have had a concussion. This is also sometimes referred to as a "mild traumatic brain injury" (mTBI).

What is a concussion? A concussion is a head injury from a hit, blow, or jolt to the head (either from a direct blow or from being close to a blast) that briefly knocks you out (loss of consciousness), or makes you feel confused or "see stars" (alteration or change in consciousness).

What are the symptoms? Immediately or soon after the concussion, you may feel disorientated and may experience headaches, dizziness, balance difficulties, ringing in the ears, blurred vision, nausea, vomiting, irritability, temporary gaps in your memory, sleep problems, or attention and concentration problems.

How long does it last? Most people recover completely from concussion. Symptoms usually begin to improve within hours and typically resolve completely within days to weeks.

Recovery. Recovery is different for each person and depends on the nature of the injury. The most important thing you can do is to allow time for your brain to recover and this is best done by a combination of rest and a graduated return to full duties.

Why does a concussion affect return to duty? Concussion can reduce your effectiveness which could impair your performance and endanger you or your colleagues. If you get another concussion before healing from the first one, you are at greater risk of a more serious injury.

What happens now that I have been diagnosed with a concussion?

- You may have been given a period of stand down or light duties. You will be advised when you need any medical review. Be honest about your symptoms when you see your medical provider - they are protecting you and your unit.
- Your military line manager will be informed of any work restrictions. With your consent they will receive a separate leaflet providing guidance on concussion and advice on how to promote your quick recovery.
- Rest - Avoid exerting yourself physically (heavy lifting, exercising, etc). Avoid mental exertion (e.g. writing reports and activities requiring you to concentrate hard).
- Return to Duty - Expect to recover fully and RTD. Your medical provider will continue to evaluate you and will determine (in conjunction with you and your military Line Manager) when it's safe for you to RTD.

Do's & Don'ts

Things That Speed Recovery	Things That Slow Recovery
• Maximise downtime/rest during the day • Get plenty of sleep • Protect yourself from another concussion: avoid contact sports • Let others know that you've had a concussion so they can watch out for you • Return immediately to your medical staff if you're feeling worse or experience any warning signs*	• Another concussion before healing of the first one • Alcohol • Inadequate sleep (made worse by caffeine or 'energy-enhancing' products) • Aspirin, ibuprofen, and other over-the-counter pain medications unless instructed by your doctor • Sleeping aids and sedatives unless instructed by your doctor

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Coping measures. The following table lists some practical coping measures that you are advised to use:

Symptom	Action
Slower Thinking, Confusion and Difficulty Concentrating	•Establish a daily routine and structure your time. •Ask others to slow down and to repeat things if needed. •Allow extra time to complete tasks. •Break activities down into smaller periods and take more rests. •Do only one thing at a time. •Avoid distractions e.g. turn off the TV/radio when working. •Consult with friends/colleagues when making important decisions.
Memory problems	•Put important items in the same place all the time. •Use a pen and notebook to keep track of things that need to be done or are hard to remember. Keep to hand at all times. •Ask friends and colleagues to remind you.
Irritability	•Walk away from situations if they cause annoyance. •Actively use relaxation techniques. • Working out in the gym can help if it does not over-tire. •More rest can reduce irritability.
Fatigue	Rest whenever possible.
Anxiety, sleep problems, and low mood	These tend to be reactions to the other problems and tend to improve as other symptoms reduce. If you are worried about them see your medical staff.

* **Warning Signs.** If you begin to experience any of the following, seek immediate medical attention:

• Worsening headache • Worsening balance • Double or disturbed vision	• Decreasing level of alertness • Increased disorientation • Repeated vomiting	• Seizures or fits • Unusual behaviour • Amnesia/memory problems

Figure 2: UK Patient's Guide to Concussion.

The role of the patient's line manager is considered crucial in the management of concussion/MTBI during the early post-injury phase, and advice for Commanders is therefore included in Figure 3. 'Red Flag' indicators are highlighted to assist medical staff in identifying when early onward referral is appropriate or when further advice should be sought.

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ANNEX C – COMMANDER'S GUIDE TO CONCUSSION

Why have I received this? Medical staff have determined that one of your personnel has sustained a concussion - sometimes also referred to as a "mild traumatic brain injury" (mTBI). The patient has consented to sharing this information with you. As the patient's military line manager you have an important role in promoting their recovery.

What is a concussion? A concussion is a head injury from a hit, blow, or jolt to the head (either from a direct blow or from being close to a blast) that briefly knocks the person out (loss of consciousness), or makes them feel confused or "see stars" (alteration or change in consciousness).

What are the symptoms? Immediately or soon after the concussion, the affected individual may feel disorientated and may experience headaches, dizziness, balance difficulties, ringing in the ears, blurred vision, nausea, vomiting, irritability, temporary gaps in memory, sleep problems, or attention and concentration problems.

How long does it last? Most people recover completely from a concussion. Individuals should be reassured that symptoms usually begin to improve within hours and typically resolve completely within days to weeks.

Recovery. Recovery is different for each person and depends on the nature of the injury. The most important thing is to allow time for the brain to recover and this is best done by a combination of rest and a graduated return to full duties.

Why does a concussion affect return to duty? Concussion can reduce effectiveness which could impair an individual's performance. In the operational environment this may endanger them or their colleagues. If the individual sustains another concussion before healing from the first one, they are at greater risk of a more serious injury.

How can I help? Medical staff will already have reassured the patient and encouraged them to expect a full recovery - you should reinforce this message. Evidence shows that you can assist the speed of recovery by reducing the demands placed upon the individual to a level that does not worsen their symptoms. Medical staff will advise on any 'stand down' or period of light duties/restricted activity but you are better placed to tailor this to the individual's role. Match duties to the individual's ability and level of symptoms. Encourage them to talk regularly with you about this. If symptoms get worse this may indicate they are pushing themselves too hard. Routine and familiar tasks will be easier than new and unfamiliar ones. Encourage personnel to take extra breaks if needed. Once symptoms have stabilised increase the amount of work gradually.

Do's & Don'ts. Patients are advised to do the following:

Things That Aid Recovery	Things That Impair Recovery
• Maximise downtime/rest during the day • Get plenty of sleep • Protect from further concussion; no contact sports • Let colleagues know that they've had a concussion so they can look out for them – use 'buddy' system • Return immediately to medical staff if they are feeling worse or experience any warning signs*	• A further concussion before healing of the first one • Alcohol • Inadequate sleep (made worse by caffeine or 'energy-enhancing' products) • Aspirin, ibuprofen, and other over-the-counter pain medications unless instructed by medical staff • Sleeping medication unless instructed by MO

Coping Measures. The following table lists some practical coping measures that patients are advised to use:

Symptom	Action
Slower Thinking, Confusion and Difficulty Concentrating	•Establish a daily routine and structure their time. •Ask others to slow down and to repeat things if needed. •Allow extra time to complete tasks. •Break activities down into smaller periods and take more rests. •Do only one thing at a time. •Avoid distractions e.g. turn off the TV/radio when working. •Consult with friends/colleagues when making important decisions.
Memory problems	•Put important items in the same place all the time. •Use a pen and notebook to keep track of things that need to be done or are hard to remember. Keep to hand at all times. •Ask friends and colleagues to remind them.
Irritability	•Walk away from situations if they cause annoyance. •Actively use relaxation techniques. • Working out in the gym can help if it does not over-tire. •More rest can reduce irritability.
Fatigue	Rest whenever possible.
Anxiety, sleep problems, and low mood	These tend to be reactions to the other problems and tend to improve as other symptoms reduce. If affected personnel are worried about them see medical staff.

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Figure 3: UK Commander's Guide to Concussion.

Defence Medical Rehabilitation (DMRC) Headley Court is the DMS centre of expertise on the treatment of symptoms associated with concussion/MTBI. Where diagnostic confusion exists, advice may also be sought from the DCMH teams (for mental health symptoms), or from a military neurologist.

3.1.1 Pre-Role 1: The First Responder

The UK's current symptom-based approach does not require mandatory medical assessment (screening) following exposure to head injury / blast incident. However, medical staff should adopt a proactive approach following any high risk incident and be alert to the possibility of concussion/MTBI in those involved.

3.1.2 Role 1

Personnel who are medically stable can be held at Role 1 for a maximum of 14 days, after which referral or advice must be sought from Role 2/3. The policy does not differentiate between those Role 1 locations with a Medical Officer (MO) or Nursing Officer (NO) and those remote locations where other Role 1 medical personnel (RN Medical Assistants (MA), Combat Medical Technicians (CMT and RCMT) and RAF Medics) may be operating without immediate supervision.

These guidelines are deliberately generic, and detailed Standing Operating Instructions (SOIs) may need to be developed for specific operating environments, taking into account the experience and qualifications of medical staff at Role 1 locations. In such cases, it may be appropriate for local SOIs to reduce the period for which concussion/MTBI patients may be held under review before referral to a MO/NO.

The principle of treatment is to foster natural recovery by reassurance, education and monitoring. Periodic medical review will be required, tailored to each individual, until symptom free and returned to duty.

The majority of patients will present to Role 1 medical staff soon after a head injury/blast incident. Assuming no other injuries take precedence, medical staff should take a careful history to determine the details of the suspected concussion/MTBI event. Any physical, cognitive and emotional symptoms should be determined and a basic neurological examination[1] conducted to exclude any 'red flags' that may require evacuation or referral. It should be noted that 'red flags' do not necessarily preclude a diagnosis of concussion/MTBI but merely provide an indicator to seek further medical opinion.

Where a diagnosis of concussion/MTBI is made, the following action is to be taken:

- Reassure and advise patient. Issue 'Patient's Guide to Concussion' (Figure 2).
- Issue 'Commander's Guide to Concussion' (Figure 3) for patient's military line manager with appropriate verbal consent recorded in the medical record. Where consent to release information is not given, this must also be recorded.
- Stand-down patient for 24 hours and consider subsequent employment restrictions (see below).
- Review patient at 24 hours; as required thereafter; and prior to return to duty.

Figure 4 provides the document that should be used by medical staff to chart progress of concussion/MTBI symptoms. The ability to demonstrate an improving trend in symptoms will be reassuring to the patient and may assist the recovery process. Conversely, a deteriorating trend in symptoms may highlight to medical staff

[1] As a minimum this should include standard head injury observations as per F Med 290 'Head Injury Observation Chart', i.e., GCS score, pupil reaction and symmetry, limb power, pulse and blood pressure.

the need for onward referral. Once completed, the record will become part of the patient's medical record and should be managed accordingly.

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ANNEX D - CONCUSSION/mTBI SYMPTOM SCORE CHART FOR USE BY MEDICAL STAFF

Patient's Name:

Service No:

Unit:

Ask the patient to score signs and symptoms using the following scale:

0 = Not experienced 1 = Not a problem 2 = Mild 3 = Moderate 4 = Severe

	Date & Time							
Signs & Symptoms								
Physical								
Feeling Dazed								
Headache								
Dizziness or Balance problems								
Nausea and/or vomiting								
Feeling fatigued								
Sleep difficulties								
Blurred or Double vision								
Sensitivity to bright light or loud noise								
Hearing difficulty								
Numbness or tingling								
Cognitive								
Confusion								
Disorientation								
Difficulty remembering things								
Slowed thinking skills								
Difficulty concentrating								
Problems with multi-tasking								
Behavioural & Emotional								
Anxiety								
Feeling agitated								
Being irritable, easily angered								
Feeling depressed or tearful								
Mood swings								
*Store in medical record when complete	**Signature**							

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Figure 4: UK Concussion/MTBI Symptom Score Chart for Use by Medical Staff.

There is no specific drug treatment for the management of concussion/MTBI, but simple analgesics (e.g., paracetamol) may be used for headache symptoms.

All patients diagnosed with concussion/MTBI are to be given a minimum 24-hour rest period whenever the operational situation allows. Assuming the individual can be adequately rested and attend for any necessary medical reviews, this stand-down should take place in the individual's normal place of duty.

Following this period of stand-down, appropriate employment restrictions should be tailored to individual circumstances and managed in collaboration with the patient's local chain of command. This will be important in protecting the patient from stressors which may delay recovery, and should include steps to minimize the risk of exposure to any further concussion/event before full recovery has taken place.

If all symptoms resolve within 24 hours of the injury, the individual may return to full duties following local medical review but should be advised to seek further medical assistance if symptoms return. Those individuals not fully recovered after this period should be reviewed and considered for further stand-down or a limited return to work. This graduated return to full duties must be tailored to their rate of recovery as measured by the presence or absence of concussion/MTBI symptoms, and based on a local risk assessment.

Examples of common restrictions that should be considered after a concussion/MTBI event are below:

- Unfit weapon handling and/or guard duties.
- Unfit to operate unguarded machinery.
- Unfit to operate vehicles (e.g., MT, aircraft, marine craft, as required).
- Unfit extended working hours / shift work; or fit limited working hours only.
- Unfit strenuous physical exertion including physical training.

Individuals who have not recovered adequately by 14 days post-incident are to be referred to Role 2/3 for further assessment.

Particular care should be taken where there is a history of previously diagnosed concussion/MTBI incidents. Any stand-down period may need to be extended and medical staff should seek advice and/or consider early referral to a higher level of care where there is a history of multiple concussion/MTBI incidents.

3.1.3 Role 2 or 3

Suspected concussion/MTBI cases referred to Role 2 or 3 will undergo more detailed neurological and cognitive examinations that may include neuroimaging and specialist advice, in accordance with national best practice in secondary care:

a) JDP 4-03.1 Clinical Guidelines for Operations (CGOs) – Section 3, Treatment Guideline 9a, 'Head Injury'; and

b) NICE Clinical Guideline 56–Head Injury dated 28 Nov 1997 (www.nice.org.uk/CG56).

Where the diagnosis remains unchanged, subsequent management will be determined by the local situation and any theatre medical holding policy in force. It may be appropriate to return the patient to their forward location to continue under Role 1 management or to retain the patient in a rear echelon area.

Where evacuation from theatre is recommended for a primary diagnosis of concussion/MTBI, the referring clinician is to ensure that appropriate arrangements are made for review of the patient in the Defence Medical Rehabilitation Centre (DMRC) Headley Court and that any aeromedical evacuation signals are addressed accordingly.

3.1.4 Role 4

Provision of concussion/MTBI care in the UK Home Base is focused on DMRC Headley Court where a multi-disciplinary team delivers the 'Concussion/MTBI Programme'. The detailed management of each patient referred to DMRC is tailored to the individual case, but in summary, Role 4 management is based on a three-tiered approach (see Annex C for a fuller description):

- **Tier 1** – Assessment by interview followed by specific therapeutic goal-driven phone and web-based therapy for those who have persistent symptoms.
- **Tier 2** – Enrolment in a two-week intensive in-patient treatment group.
- **Tier 3** – Tailored follow-up programme to ensure symptoms remain managed following return to full-time work.

In addition to referrals from operational theatres, DMRC assesses all in-patients and out-patients who may be at risk of concussion/MTBI. Similar routine assessment also takes place on all casualties evacuated to RCDM Birmingham from any operational theatre.

Recognising that in some cases patients may not report their MTBI/concussion symptoms until after leaving an operational theatre, the MTBI team at DMRC will also accept medical referrals from elsewhere within the DMS in the normal manner.

3.2 United States

As MTBI has emerged as a leading combat injury, the management of concussion in the deployed setting has been codified in a Defense Department level policy (Department of Defense Instruction 6490.11), signed 18 September 2012, that directs both the reporting requirements as well as clinical care (Annex D). There are 4 potentially concussive events that trigger a mandatory medical evaluation for concussion. These events are:

- Involvement in a vehicle blast event, collision or rollover;
- Presence within 50 meters of a blast (inside or outside);
- A direct blow to the head or witnessed loss of consciousness; and
- Exposure to more than one blast event (the service member's Commander shall direct a medical evaluation).

The clinical care rendered is organize by Roles and is outlined in the following sections. The complete clinical management algorithms, revised in July 2012, are attached as Annex E.

3.2.1 Pre-Role 1: First Responder

First Responder care (pre-Role 1) is a central component of modern battlefield trauma care. First responder care includes self-care, buddy care, and medical first responder (medic/corpsman) care.

It is essential that first responder care adapt to the challenge of MTBI on the battlefield through appropriate tactics, techniques, and procedures, as well as education and training. It is increasingly recognized that repeat exposures to concussive events, without adequate treatment and resolution of symptoms, can have significant adverse consequences [98].

The central imperatives for first responder MTBI care are to triage for severity of injury by identifying red flags that may necessitate a neurosurgical intervention, to recognize a potentially concussive event exposure, to remove from combat to avoid potential repeat exposure, as well as to not degrade operational effectiveness of themselves and possible injury, and to evacuation to appropriate level of care.

It is essential to maintain an index of suspicion for concussion/MTBI in a trauma setting, where more obvious injuries (amputation, etc.) might distract attention from an 'invisible' concussion/MTBI.

Standard trauma assessments (primary and secondary surveys) must include assessment of neurological function to identify potential presence and severity of MTBI/concussion. If a concussion/MTBI is suspected, then proper triage is essential to determine transport and treatment decisions. A useful tool for MTBI triage is the presence/ absence of red flags – such as witnessed loss of consciousness, persistent altered mental status, or abnormal neurological examination. The presence of one or more red flags should prompt immediate medical evacuation to an appropriate/higher level of care.

Service personnel exposed to potentially concussive events should be removed from combat for further evaluation. The purpose of removing the service member from combat is three-fold:

1) Prevent potential repeat exposure;
2) Ensure proper evaluation and subsequent treatment for concussion, if warranted; and
3) Maintain operational readiness of the force by removing a patient who may be impaired to function optimally.

All patients with potentially concussive event exposures should be referred to a medical provider (Role 1 or higher) for thorough evaluation, treatment, and disposition.

The above principles and practices necessitate specific skills and actions by the various categories of first responders in the setting of MTBI on the battlefield. Individual personnel are responsible for self-care, so in the setting of potential MTBI, they must be prepared to identify and report any potentially concussive event exposure to a buddy, medical first responder, or medical provider. Personnel are also responsible for providing buddy care on the battlefield, so in the setting of potential MTBI, they must be prepared to identify and report any potentially concussive event exposure, remove the victim from combat, and conduct basic triage. Medical first responders have the most critical role in identification and triage of battlefield MTBI, and must be prepared to recognize potentially concussive exposures, remove the patient from combat, conduct detailed trauma assessment – to include MTBI triage using 'red flags', make a determination regarding medical evacuation and appropriate level of care, and refer the patient for evaluation, treatment, and disposition by a medical provider. Of note, in remote/dispersed operations, immediate transport to a Role 1 facility/medical provider may not be feasible. This may require initiation of concussion evaluation and treatment by the medical first responder (discussed in more detail below).

It is essential that militaries include the above principles and practices in first responder Tactics, Techniques and Procedures (TTPs) and education/training – such as Combat Lifesaver Course and Tactical Combat Casualty Course (CLS/TCCC).

3.2.2 Role 1

An example of a Role 1 capability is a Battalion Aid Station. Role 1 capabilities have a central role in the management of MTBI/concussion in the deployed setting.

As described above, first responders should conduct initial triage of suspected MTBI and evacuate cases with identified red flags to higher levels of care (Role 2 or 3). Patients with potentially concussive event exposures (and no red flags) should be sent to the nearest Role 1 facility for thorough evaluation, treatment, and disposition or referral. Of note, in settings of dispersed/remote operations, even Role 1 facilities may not be proximate enough for immediate transport. In these cases, up to 24 hours, medical first responders (medics/corpsmen) may initiate some of the evaluation and treatment measures described below, preferably with at least verbal coordination with a medical provider.

Evaluation, treatment and disposition of concussion in the deployed setting should be standardized to the greatest extent possible through the use of evidence-based clinical practice guidelines. Evaluation of potential concussion requires a detailed history and physical examination – with particular emphasis on exposure history, loss or alteration of consciousness, amnesia; symptoms of concussion; and neurological examination. A test of cognitive function is another important evaluation tool. The US military uses the MACE, which includes history, symptoms, neurological examination, and cognitive function components (MACE July 2012, version 4.0 – Annex F).

Treatment of concussion should focus on expectancy of recovery, patient education, rest, and management of symptoms [138]. The US military has developed clinical practice guidelines for the management of concussion in the deployed setting which emphasize these approaches (US Clinical management algorithms – Annex E). Role 1 facilities are well-suited to provide these initial, basic interventions, for uncomplicated concussions, with the added benefit of proximity to units. Disposition, or return-to-duty decisions, in the setting of concussion, requires a standardized approach (see Chapter 2, Section 2.4). Minimal considerations for return-to-duty decision include resolution of symptoms, normalization of neurological examination, as well as some form of exertional testing. Management of concussion with basic interventions such as education, rest, and symptom management is generally appropriate at Role 1 facilities for the initial 3 – 7 days. If operational realities make such management impossible, or the patient worsens or fails to improve within 3 – 7 days, then consideration must be given to referral to a higher level of care (Role 2 or 3).

3.2.3 Role 2/3

Typically a Role 2/3 facility, whether surgically equipped or not, would not have significant increased capability over a Role 1 facility (other than increased holding capacity) to manage concussion in the deployed setting. However, in light of experiences with concussion care centres (augmented Role 2/3 facilities) in Afghanistan has demonstrated efficacy for management of concussion in the deployed setting.

The function of Role 2/concussion care centres in deployed settings should be to provide comprehensive concussion care for uncomplicated or refractory concussions.

Role 2/3 concussion care centres could receive patients via ‘step-down’ from a Role 3 after ruling out moderate or severe TBI and addressing other trauma, via direct referral/transport, or via referral from Role 1 facilities.

Desired capabilities at Role 2/concussion care centres include medical evaluation/treatment, physical therapy, occupational therapy, behavioural health evaluation/treatment for co-morbidities, complementary/alternative therapy (acupuncture), and neurocognitive testing. Of note, this level of capability – which does not require

specialist care or advanced imaging found at Role 3 facilities − has been demonstrated to be effective in the management of the vast majority of concussions.

Certainly, the above capabilities could be positioned or co-located at a Role 3 facility, but placement at a Role 2 facility has the advantage of unit proximity.

Evaluation, treatment, and disposition principles described for Role 1 facilities remain the same at Role 2 facilities; however, with enhanced capability to conduct more thorough and comprehensive evaluation, treatment, and disposition, ideally through enhanced clinical practice guidelines. A board-certified primary care physician, such as a Family Medicine/Sports Medicine physician (versus the General Medical Officer often found at Role 1 facilities) can provide enhanced medical evaluation and management of concussion. Physical and occupational therapists can provide enhanced rehabilitation modalities. A behavioural health provider can address potential co-morbid conditions, such as acute stress reactions, which can complicate recovery from concussion. Alternate therapies such as acupuncture have shown promise in managing the symptoms of concussion in the deployed settings. Neurocognitive testing, such as the Automated Neuropsychological Assessment Metric (ANAM), can be used to evaluate treatment progress and enhance informed return-to-duty determinations.

Patients who demonstrate worsening or refractory symptoms beyond 14 – 21 days, or those with multiple concussions, should be considered for referral to a Role 3 facility with specialist (neurologist) capability and advanced neuroimaging.

3.2.4 Roles 4 and 5

Treatment for concussion/MTBI in the non-deployed setting is based on the Departments of Veteran Affairs and Defense (VA/DoD) Evidence-Based Clinical Practice Guideline for the Management of Concussion/Mild TBI, which was released in April 2009 (Table 2). This guideline addresses assessment and treatment after 7 days from the initial injury. It is the primary clinical tool used in Role 4 and 5 settings. The evidence was evaluated and rated based on the US Preventative Task Force Grade definitions (Table 2).

Table 2: US Evidence Rating of Interventions.

A	A strong recommendation that the clinicians provide the intervention to eligible patients. *Good evidence was found that the intervention improves important health outcomes and concludes that benefits substantially outweigh harm.*
B	A recommendation that clinicians provide (the service) to eligible patients. *At least fair evidence was found that the intervention improves health outcomes and concludes that benefits outweigh harm.*
C	No recommendation for or against the routine provision of the intervention is made. *At least fair evidence was found that the intervention can improve health outcomes, but concludes that the balance of benefits and harms is too close to justify a general recommendation.*
D	Recommendation is made against routinely providing the intervention to patients. *At least fair evidence was found that the intervention is ineffective or that harms outweigh benefits.*
I	The conclusion is that the evidence is insufficient to recommend for or against routinely providing the intervention. *Evidence that the intervention is effective is lacking, or poor quality, or conflicting, and the balance of benefits and harms cannot be determined.*

There are 26 evidence-based recommendations in this document that address early education, patient perception of symptoms, cognitive symptoms, behavioural symptoms, dizziness and disequilibrium, persistent cognitive and behavioural difficulties greater than 4 weeks, physical rehabilitation, laboratory tests and multiple concussions. Please see the Defense Centers of Excellence (DCoE) fact sheet found at (www.dcoe.health.mil) for specifics related to these areas.

The MTBI treatment plan is based on the following:

- Symptom management;
- Education of patient and family;
- Emphasize recovery, gradual resumption of work and social responsibilities;
- Compensatory strategies and environmental modifications;
- Early intervention maximizing use of non-pharmacological therapies;
- Sleep hygiene and relaxation techniques; and
- Minimize consumption of alcohol, caffeine and other stimulants.

3.2.5 Symptom Management

3.2.5.1 Treatment of Tension-Type Headaches

Non-pharmacological treatment can include relaxation training and biofeedback, in combination with medication, physical therapy and increased physical activity. Pharmacological treatment can include Non-Steroidal Anti-Inflammatory Drugs (NSAIDS), such as Ibuprofen, Naproxen or Acetaminophen.

Medications to be used as prophylactic therapy for 3 or more headaches per week may include Divalproex sodium ER, Topiramate or Metoprolol.

3.2.5.2 Treatment of Migraine Headaches

Non-pharmacological treatment can include awareness and avoidance of migraine triggers, relaxation, biofeedback, visualization extra-cranial pressure, cold compress, regular exercise, maintaining regular exercise, sleep and meal schedules, recognize warning signs (aura), and a headache diary. Pharmacological treatment can include Zolmitriptan oral or nasal spray or Sumatriptan oral, nasal spray or injectable. In addition, an analgesic wash-out period may help.

3.2.5.3 Treatment of Dizziness or Disequilibrium

Vestibular and balance rehabilitation can offer a non-pharmacologic approach. Pharmacological approaches are not shown to be effective in chronic dizziness after concussion. Consider medications only if symptoms are severe enough to significantly limit functional activities. The following have been used for this purpose: Meclizine, Scopolamine, Dimenhydrinate, Lorazepam, Clonazepam, Diazepam.

3.2.5.4 Treatment of Fatigue

Non-pharmacological approaches include well-balanced meals, sleep hygiene, regular exercise and cognitive behavioural therapy. In addition, identifying and treating underlying medical and psychological disorders should

be explored prior to initiation of pharmacological measures. For persistent symptoms (greater than 4 weeks) without improvement of management of sleep, pain, depression, lifestyle, then consider neuro stimulants, including Methylphenidate, Modafanil or Amantadine. The medication trial should be for at least 3 months.

3.2.5.5 Treatment of Sleep Dysfunction

Non-pharmacological approaches include sleep hygiene, which is defined as relaxation training, avoiding alcohol, restricting night-time sleep period to about 8 hours, avoiding going to bed too early in the evening, avoiding stimulants during the evening period, waking and rising from bed at regular times in the morning, reducing or eliminating daytime naps, engaging in daytime physical and mental activities, and avoiding stimulating activities before bedtime. Pharmacological approaches can include Zolpidem or Prazosin.

3.2.6 Education of Patient and Family

It is strongly recommended that patients who sustain a concussion/MTBI be provided with information and education about symptoms and recovery patterns as soon as possible after the injury. Education should be provided in print with verbal review of symptoms and expected outcome, education that the current symptoms are common and expected after the injury event, and reassurance about the expected positive recovery. It is also recommended that techniques to manage stress (sleep hygiene, relaxation, minimize consumption of alcohol, caffeine or other stimulants) be discussed. Finally, patients should be given written contact information and advised to contact their healthcare provider should symptoms get worse or persist for greater than 4 – 6 weeks.

3.2.6.1 Cognitive Symptoms

Early patient and family education may help with managing cognitive complaints. If a pre-injury cognitive evaluation was obtained, a post-injury comparison may be of value. Finally, comprehensive neuropsychological evaluation is not recommended in the first 30 days after injury. Consider cognitive rehabilitation if symptoms persist.

3.2.6.2 Behavioural Symptoms

It is strongly recommended that treatment of psychiatric/behavioural symptoms following MTBI/concussion be based upon individual factors, nature and severity of symptom presentation and include psychotherapeutic treatment. In addition, co-morbid psychiatric conditions, whether or not related to the MTBI, should be treated aggressively.

3.2.6.3 Physical Rehabilitation

There is no contraindication for return to aerobic, fitness and therapeutic activities following MTBI/concussion. Non-contact, aerobic and therapeutic recreational activities should be encouraged within the limits of the patient's individual symptoms to improve physical, cognitive and behavioural complaints after mild TBI. However if symptoms return after exercise, then a more graded approach to activity should be considered.

There are other treatment recommendations based on management of other symptoms, that include pain, vision and hearing difficulties, olfactory deficits, changes in appetite, numbness and nausea. These can be found in the VA/DoD MTBI Clinical Practice Guideline [5].

3.2.7 Clinical Recommendations (CR)

There has been further clinical guidance developed to include the following:

- Guidelines for the Field Management of Combat Related Head Trauma (2006) [140];
- Neurobehavioral Evidence-Based Guidelines for the Treatment in TBI (2006);
- Acute Management of Concussion in the Deployed Setting (2007, 2008, 2010, 2012);
- Cognitive Rehabilitation for Mild TBI (2009);
- Driving Assessments after TBI (2009);
- MTBI and Co-occurring Psychological Health Disorders Tool Kit (2011);
- Neurocognitive Assessment Tool (NCAT) Clinical Recommendation (2011);
- Neuroendocrine dysfunction after mild TBI (2012);
- Clinical Recommendation (CR) for the Detection and Treatment of Dizziness Following TBI (2012);
- CR for the Detection and Referral of Visual Dysfunction Following MTBI (2013);
- CR for progressive return to activity following acute mild TBI in the deployed and non-deployed setting; and
- CR for standardization of neuroimaging in MTBI in the non-deployed setting.

In addition, the following clinical guidance packages are in development and anticipated to be disseminated to the US military health system:

- CR for progressive and graded activity after mild TBI;
- CR to inform the evaluation and treatment approach to sleep disturbances associated with TBI; and
- CR to address post-traumatic headaches following MTBI.

DoD is also focused on identifying effective treatments for MTBI, which may include assessing several potential therapies that are currently Food and Drug Administration (FDA)-approved for other indications as well as investigations into the role and effectiveness of complementary and alternative medicines as part of an integrative health approach model for MTBI. Developing and validating more effective, technology-enhanced cognitive and behavioural rehabilitation tools are also being explored.

3.2.8 MTBI and Co-Morbidities

The issue of co-morbidities appears more pronounced in populations with an existing diagnosis of a traumatic brain injury. For example, among service members with a history of MTBI, two large studies found PTSD prevalence at 33% to 39% of service members. Lew [141] found that in a treatment-seeking sample of 340 VA eligible service members, 81.5% reported chronic pain symptoms, 68.2% reported PTSD symptoms, 66.8% reported TBI symptoms and 42.1% reported symptoms of all three. These are now known as the triad of co-occurring conditions with MTBI. Additional symptoms included sleep disorders, substance abuse, psychiatric illness, vestibular disorders, visual disorders, and cognitive disorders. The co-morbidity of PTSD with a history of MTBI, chronic pain and substance abuse is common in the military and complicates recovery from any single condition.

3.3 Canada

In 2008, based on an expert advisory panel recommendation, the Canadian Forces Health Services implemented clinical practice guidelines for MTBI sustained in the military operational setting. The over-arching philosophy behind these guidelines is that, for the most part, MTBI is an acute injury which largely recovers over a short time period in the majority of individuals, and is optimally managed by rest and education [142], [143]. Those who present with symptoms months after an injury often represent a complex clinical picture, where multiple factors are at play and it cannot be immediately assumed that symptoms are attributable to MTBI without thorough and thoughtful evaluation [17], [22], [144].

Promulgation of a more systematic approach to the identification and management of suspected cases of MTBI has different goals depending on the deployment phase. During deployment, the immediate goal in all cases of head injury is to identify those who may require neurosurgical consultation. Following this, the primary objective is to identify those with symptoms and/or impairments that may be attributable to MTBI in order to evaluate fitness for duty. Identification and management of MTBI in those who have sustained other injuries is an important consideration, as this may have an impact on the clinical course of their recovery. Modification of post-deployment screening provides surveillance data on MTBI in those who have returned from deployment and also allows for a more systematic approach in identifications and management of persistent symptoms regardless of whether they are attributable to MTBI or other causes.

3.3.1 Canadian In-Theatre Guidelines

Although Canada adheres to NATO doctrine in the provision of health-care in deployed settings, MTBI guidelines were not developed by the specific Role/Echelon of health-care.

Two guidelines are in use: the first is intended to be used by medics in more forward areas (see Figure 5), while the second is targeted towards primary care providers (see Figure 6).

Medical Technician Management of Concussion (mTBI) in a Deployed Setting

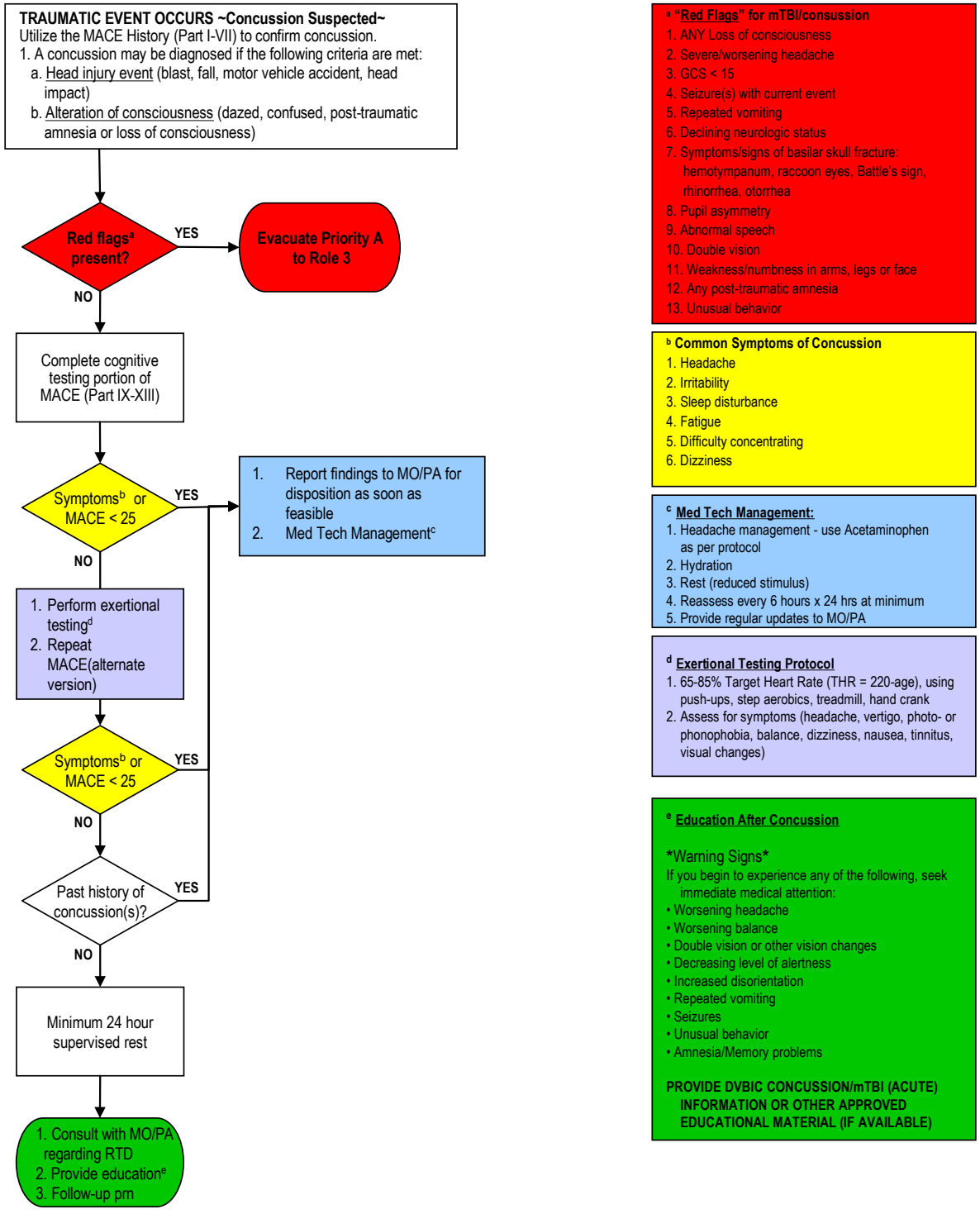

Figure 5: Canadian In-Theatre Guidelines for Medical Technicians.

Primary Care Management of Concussion (mTBI) in a Deployed Setting

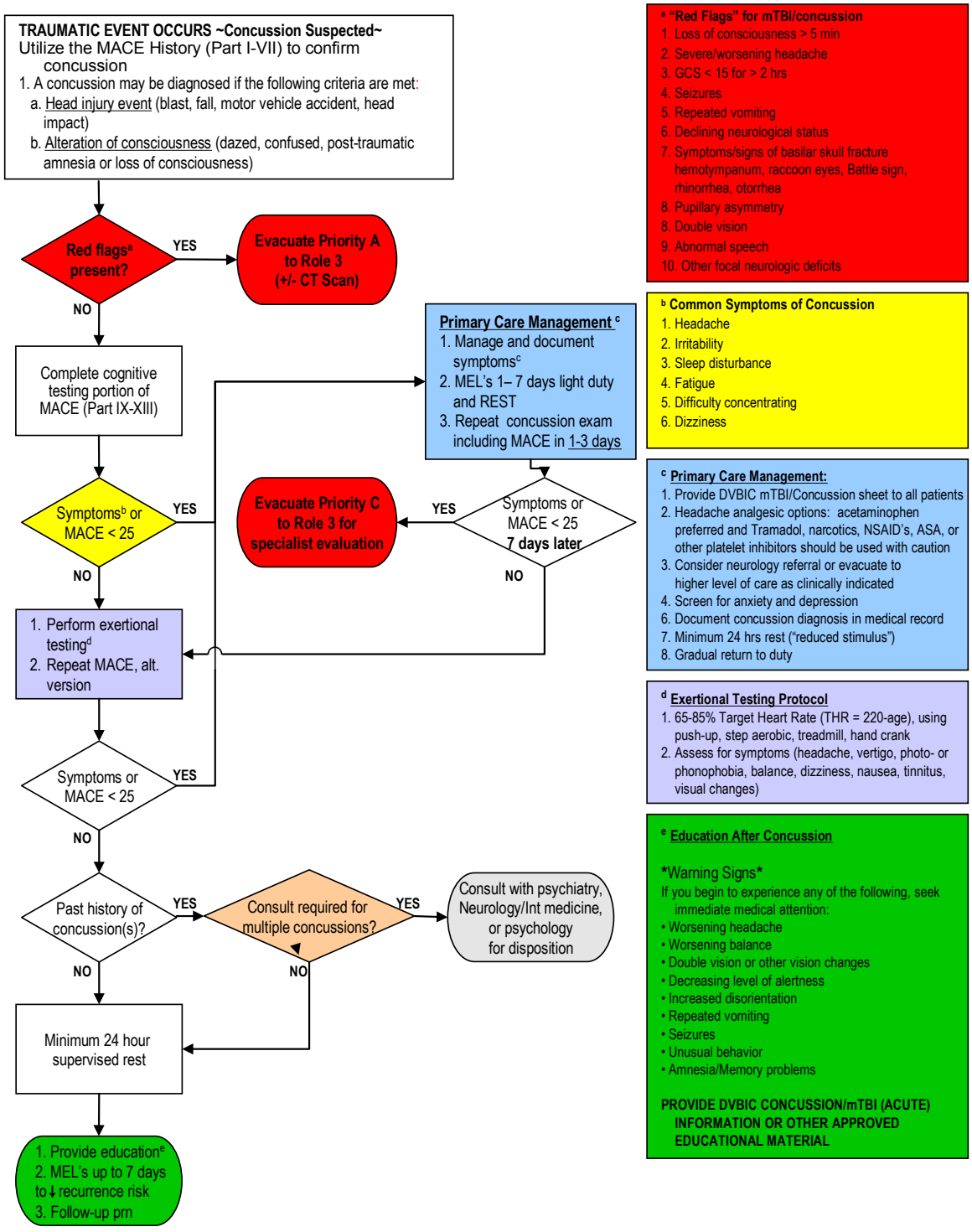

Figure 6: Canadian In-Theatre Guidelines for Primary Care Providers.

The US MACE screening tool is the cornerstone of in-theatre evaluation [145]. A version was translated into French. Medical personnel are trained in the use of the MACE prior to deployment (Annex F). The MACE is a two-staged test. The first stage is oriented towards describing the injury event and current symptoms, while the second stage is oriented towards pragmatic bedside testing of attention, concentration and memory. While it is acknowledged that there is limited validation data on the MACE, it is derived from a well-validated assessment of concussion in the sports population, the Standardized Assessment of Concussion (SAC) [146], and use of it by the Canadian Armed Forces allows for comparison to research findings from the US, where it is currently used.

A crucial first step in evaluating anyone suspected of having sustained a head injury is to identify more serious intracranial lesions that require urgent referral for neuroimaging and/or neurosurgical consultation. Consequently, the initial evaluation of those who have a history suspicious of MTBI is focussed on determining whether there are symptoms or signs suggestive of such pathology. To that end, a number of 'red flag' predictors have been incorporated which emanate from both the Ottawa Head CT Rule and New Orleans Rule [147], [148] as advocated in the American College of Emergency Physicians 2008 Guidelines [149]. Although both of these rules have been well validated in a civilian setting, there has never been validation in a combat setting, where predictors such as advanced age or dangerous mechanism of injury are of little use. Moreover, the deployed setting poses special logistical constraints that need to be factored into clinical decision-making, such as the risk of re-injury when transporting from more forward areas for consultation, Until a set of predictive rules are developed and tested in this context, the use of such civilian guidelines is supported by expert opinion, while cognizant of the special circumstances of the deployed environment.

Cognitive testing in assessing fitness for duty is an element of the MACE, but the use of more detailed neuropsychological testing is left to the discretion of the clinician. The use of such testing is widely supported by expert opinion in the sports literature [150]. However, it must be recognized that the incremental value of such tests on clinical decision-making has not been conclusively demonstrated. To date, the use of such tests in determining fitness for duty in a military operational context has not been scientifically validated. Moreover, even though a number of clinician-administered neuropsychological tests have been employed in research, there is no consensus on what clinician-administered tests alone or in combination are best suited for diagnostic and return to play assessments [143]. Noting many important differences between the playing field and the battlefield when it comes to administering, interpreting, and reacting to such tests, the Canadian Armed Forces Expert Panel has adopted an individualized approach to the use of such testing by clinicians.

There has been increasing attention on the possible impact of multiple concussions, and a consideration of this is important in any return-to-duty decisions. Unfortunately, while the effect of a single concussion on cognitive measures has been relatively well studied, data on the impact of multiple concussions presents conflicting results [150]. In consideration of this, management of multiple concussions is not based on a predefined number of prior concussions. Instead, it is based on an individualized approach that takes into account a number of modifying factors, including:

1) Repeated concussions over time;
2) Injuries close together in time;
3) Recent concussions and repeated concussions occurring with progressively less impact or force;
4) Slower recovery after each successive concussion; and
5) The absolute risk of subsequent concussions [150].

A minimum 24-hour rest period is mandated for individuals who likely had a concussion by history but are asymptomatic and have a normal MACE before and after exertional testing. This recommendation was based on

Canadian Armed Forces medical expert opinion in light of current guidelines for return to play in sports concussion. The goals of this minimum rest period are:

1) To facilitate attentive observation for manifestations of delayed intracranial haemorrhage during the period of greatest risk;
2) To permit a period of physical and cognitive rest, which may hasten resolution of post-concussive symptoms and hence promote an earlier return to full duties; and
3) To decrease the risk of a second concussion (and a potentially more complicated post-concussive course) during the period of greatest risk.

In the sports concussion context, current guidelines emphasize rest until symptoms resolve, followed by a graded program of exertion over a period of 5 to 7 days prior to medical clearance and return to play [10], [150]. Same-day return to play is supported in sports concussion in ideal circumstances [9], [151], [152]. In both instances, neither approach is strongly evidence-based. There are important differences between military concussions sustained in the operational setting and sports concussions sustained on the playing field.

Education on the guidelines for medical staff emphasizes that the 24-hour rest period is just a minimum: many concussed individuals will end up being provided significantly longer periods of rest until they are free of symptoms on exertion and have a normal neurocognitive exam results, using the MACE.

3.3.2 Post-Deployment Guidelines

Provision of MTBI care in a Role 4 setting is contained in the post-deployment guidelines. The underlying philosophy of these guidelines is provided below, and the guidelines are contained in Figure 7.

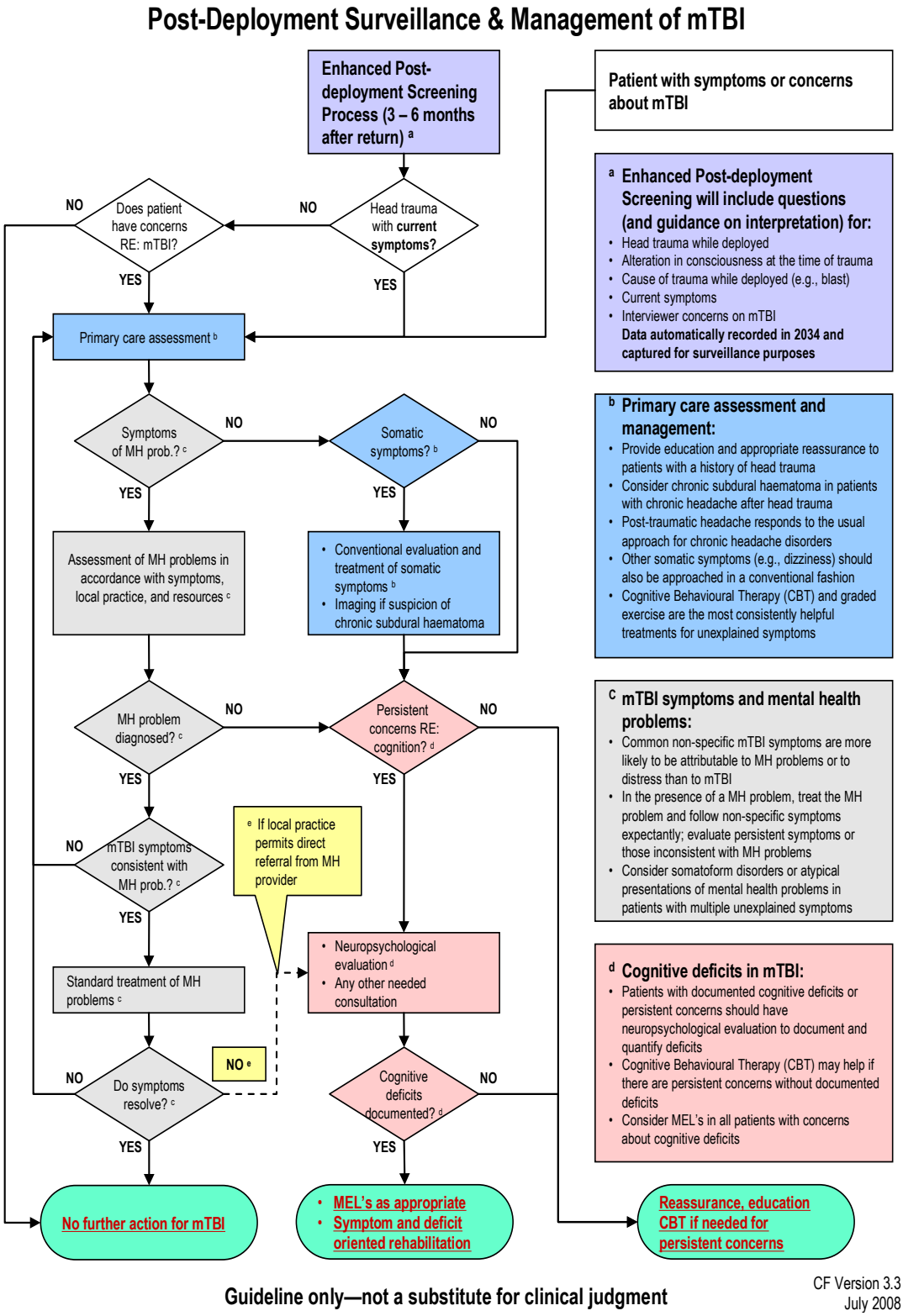

Figure 7: Canadian Post-Deployment Guidelines.

Those who experience a multitude of symptoms many months following a history of deployment-related MTBI present a complex clinical picture. Soldiers who have returned from deployment to a combat zone frequently experience ill health from a variety of causes, many of which are not well understood. There is abundant data that shows that an important minority of soldiers returning from combat experience psychological illnesses such as PTSD, depression and substance abuse [18]-[20]. Others experience a variety of medically unexplained physical symptoms, an observation that initially emanated from Gulf War I, but is now largely recognized to have existed even before that particular conflict [153]. The diagnostic dilemma is further compounded by the fact that post-concussive symptoms are common in the general population and are non-specific [17]. Faced with a history of possible concussion during the deployment, the clinician is well advised not to assume that any current symptoms are a consequence of persistent neurologic injury.

The best scientific studies in the sports literature (primarily dealing with impact injuries) suggest that in the majority of cases of MTBI, symptoms and measurable neurological deficits resolve within a week [142], [154], and most other studies show resolution within a few weeks to months [22]. Although it was postulated that the clinical course of MTBI following primary blast wave exposure might differ from impact injuries, the evidence to date has not supported this assertion [155].

A minority of cases of civilian MTBI have persistent symptoms [15]. The more common of these symptoms often occur together and have been given varying terms such as post-concussion syndrome or post-concussion disorder [16]. There is little uniformity in the identification of predictors of delayed recovery after MTBI [15], because there is little consistency in the predictors studied and an absence of confirmatory studies. Moreover, the symptoms that may occur following concussion (e.g., headache, dizziness, fatigue, irritability, insomnia, memory or concentration difficulties) can overlap with symptoms of other conditions, further complicating the ability to attribute symptoms to a specific cause. This has been demonstrated in at least one prospective study in a civilian trauma population that showed that the prevalence of such symptoms was equivalent in trauma patients with and without head injury [17].

Within the military context, PTSD and depression are important mediators of the relationship between mild traumatic brain injury and physical health outcomes. A seminal study was published in 2008 that looked at health outcomes in US Army Infantry Soldiers 3 – 4 months after deployment [22]. The authors found that soldiers with mild traumatic brain injury, primarily those who had loss of consciousness, were significantly more likely to report poor general health, missed work days, medical visits, and a higher number of somatic and post-concussive symptoms that soldiers with other injuries. However, after adjustment for PTSD and depression, mild traumatic brain injury was no longer significantly associated with these physical health outcomes or symptoms, except for headache. Since then, four peer-reviewed publications, as well as our own unpublished analysis of Canadian Armed Forces personnel 3 – 6 months after deployment, have confirmed the observation that persistent symptoms following a history of MTBI in a military operational setting are almost entirely accounted for by the presence of a mental health diagnosis such as PTSD or depression [25], [68], [156], [157].

Moreover, there are few MTBI-specific therapies that have been shown to be efficacious for the treatment of persistent symptoms following concussion. A critical appraisal of the literature has shown that the majority of interventional studies employed weak methodologies [36], [158]. There is good evidence that early educational interventions that include reassuring information about the high probability of a good recovery and advice and encouragement on gradual return to regular activities helps improve symptoms in patients with MTBI [159].

Based on the preceding considerations, in 2008, the Canadian Armed Forces (CAF) advisory panel developed a strategy for the management of those with post-deployment symptoms following a history of in-theatre MTBI (see Figure 7). The pillars of this strategy are as follows:

- It is primary care centric, as opposed to specialty care centric;
- Given the high prevalence of mental health disorders in the post-deployment population, these are screened for and aggressively treated when present; and
- Late symptoms are managed using a symptom-based diagnostic and treatment approach, with application of symptom-specific evidence based treatments where possible.

While this strategy represented a unique approach when developed by the CAF advisory panel in 2008, the Ontario Neurotrauma Foundation has since independently published guidelines endorsing a symptom-based approach for post-concussive symptoms following a critical appraisal of the literature [160].

3.4 Netherlands

3.4.1 Netherlands In-Theatre Protocol

Based on increasing reports in the literature regarding MTBI following blast exposure, a 'Blast Tracking Database' was implemented which used helmet implanted blast dosimeters. Careful reporting of blasts occurrence as well as screening of blast exposed soldiers was considered essential to evaluate symptom onset and long-term effects.

A good assessment is essential to guarantee the health and availability of soldiers during deployment. The use of the Military Acute Concussion Evaluation (MACE) provided a structured opportunity for assessment of the effects of blast on the health of the individual and the troops. The MACE was conducted by specially trained personnel. From November 2009 until the end of Dutch participation in ISAF in Uruzgan, approximately 110 MACEs have been administered. Although the Netherlands adheres to NATO doctrine in the provision of health-care in deployed settings, and in line with other forces, MTBI guidelines were not developed by the specific Role/Echelon of health-care. Two guidelines are in use: the first is intended to be used by medics in more forward areas, while the second was targeted towards primary care providers.

So the US MACE screening tool was used as cornerstone of in-theatre evaluation [148]. A version was translated into Dutch. Medical personnel were trained in the use of the MACE prior to deployment. The MACE is a two-staged assessment. The first stage is oriented towards describing the injury event and current symptoms, while the second stage is oriented towards pragmatic bedside testing of attention, concentration and memory. It was acknowledged that there is limited validation data on the MACE, and use of it by the Netherlands Forces allows for comparison to research findings from the United States, as well as other forces using the instrument.

Cognitive testing in assessing fitness for duty is an element of the MACE, but the use of more detailed neuropsychological testing was left to the discretion of the clinician. The use of such testing is widely supported by expert opinion in the literature. However, it must be recognized that the incremental value of such tests on clinical decision-making has not been conclusively demonstrated. To date, the use of such tests in determining fitness for duty in a military operational context has also not been scientifically validated.

A minimum 24-hour rest period was mandated for individuals who likely had a concussion by history but were asymptomatic and had a normal MACE. Education on the guidelines for medical staff emphasizes that the 24-hour rest period was a minimum: many concussed individuals ended up being provided significantly longer periods of rest until they are free of symptoms and had a normal neurocognitive exam results, using the MACE.

3.4.2 Post-Deployment Protocol

All blast-exposed individuals were screened again at 3 and 12 months post-deployment. The assessment included screening for symptoms of PTSD, as well as for symptoms of fatigue and extensive neurocognitive testing. If symptoms persisted individuals were referred for treatment.

This protocol included good care as well a component of research. The goal of screening was to detect and treat individuals who had persistent symptoms of MTBI following deployment. The purpose of the research component was a picture of the epidemiology of health problems associated with blast exposure, evaluated and adjusted for the purpose of precautionary screening protocols and return.

For the above objective, implementation of MACE in theatre area:

1) **During Deployment**: Role 1/2. During the mission, all soldiers who were exposed to a blast had a MACE assessment completed by the GP, AMA or AMV and entered into the Defence Medical Information System (GUIDE).
2) **After Return**: Military Rehabilitation Centre. A return screening protocol prepared in cooperation between the disciplines of neurology, psychiatry, rehabilitation medicine. The return was a screening 3 months and 12 months after deployment. If symptoms were present on screening, then the individual was referred to the most appropriate medical specialist. Soldiers exposed to blast prior to the implementation of this protocol in 2009 were also assessed if they self-reported symptoms, but this assessment was not mandatory.

This screening was additional to and independent of the standard Behavioral Health Screener that is conducted 6 months after return.

Timeline and Implementation

1) **Pre-Deployment**: Approximately 2 – 4 weeks before departure; 2 hours of MACE training was given to medical personnel.

2) **Initial Assessment**: During deployment, in-theatre assessment by the medical officer takes place; in accordance with registration guidelines and criteria.

3) **Second Assessment**: Post-deployment I, about 8 – 12 weeks after return; all soldiers that were exposed to blast who were screened in-theatre by MACE.

4) **Third Assessment**: Post-deployment II, 12 months after return (or sooner if person leaves military).

Table 3: Details and Timelines of Dutch MTBI Assessment Protocol.

	First Assessment	Second Assessment	Third Assessment
When	Within 24 – 48 hours after the incident	Three months after returning from theatre	A year after the incident
What	Screening for brain injury and physical symptoms	Screening for PTSD and brain injury and physical complaints	Screening on PTSD
How	MACE Assessment and physical examination *Cave: hearing*	MACE/short NPA, Impact Events Scale, 4DKL, fatigue Assessment and physical examination *Cave: hearing*	TBD – Impact Events Scale, 4DKL, fatigue
Where	In theatre	MRC	MRC
Who	Physician, or trained nurse	Physician assistant	Physician assistant
Record	Sent to MRC	Archive MRC	Archive MRC

This research was coordinated by the MRC in Doorn, Military Mental Health and Central Military Hospital.

The Role of the Military Rehabilitation Centre in the Screening of IED

In the flowchart around the screening of those involved in an IED incident, was a role for the Military Rehabilitation Center. In the screening, three months after return home, the Military Rehabilitation took the lead.

This section shows how this part of the screening was designed:

a) Notification, registration of candidates for the screening was by invitation based on in-theater MACE lists. These soldiers received an invitation to the Military Rehabilitation Center (MRC). The soldier was then enrolled in the Military Rehabilitation. In case of absence of a response, a request was made on their Commander.

b) Nature and type of research – the entire examination took about 90 minutes and was aimed to detect any physical, cognitive or psychological problems. There was first a brief history by a physician, followed by a series of short tests that were conducted by a research assistant, and reviewed and debriefed by a neuropsychologist.

c) Following the findings of the investigations the next steps could include:
   - No evidence of any problem: no follow-up action;
   - Evidence of a physical problem: referral by the MRC to the appropriate medical specialist, e.g. to the neurology clinic;
   - Evidence of a cognitive problem: There is a more extensive neuropsychological testing; and
   - Evidence of PTSD or other psychiatric/psychological problems: Referral to MMH Utrecht place.

d) Processing of all the test data was performed at the Military Rehabilitation. The data was shared with the staff of the MMH, CMH or outpatient neurology. A letter was sent to provide feedback to the medical unit of the military.

Advantages and Disadvantages

Advantages for the individual soldier – screening and monitoring for possible health effects of blast exposure:

- Benefits for military organization;
- Evidence-based policy on blast effects;
- Availability of good data on development and follow up of health effects of blast;
- Health monitoring;
- Barriers for participating soldiers;
- Three screening interventions, including questionnaire (10 min) and clinical visits MRC Doorn; and
- Risk of stigmatization or not presenting problems (medicalization/iatrogenic injury).

The MACE is a good, useful assessment, seemingly most important for phase one, which contains careful history assessment as well as assessment of consciousness and first symptoms. However, the MACE lacks specificity and the scale is not validated. Yet, its use in theatre may prevent retrospective bias when patients present with symptoms later.

At Follow-Up (FU), after 3 – 6 months most soldiers volunteered to report that they were very satisfied with the assessment. It was remarkable that almost all of the soldiers that were reassessed at FU had no complaints. At this moment of assessment we could not find evidence of discrete mTBI (yet) by self-reported symptoms. Yet a significant portion of the studied population had a very weak performance on the neuropsychological battery that was used, in particular information processing and memory performance. This finding could be explained by several factors. First, the fact that they all were blast exposed, and so that the effect we measured was attributable to the blast. Several studies hypothesize a direct effect of blast on neurocircuitry involved in these processes. Secondly, it could be a secondary phenomenon. The soldiers could have scored low on these parameters pre-deployment. The Dutch military does not routinely screen with a neuropsychological performance assessment, or does this as standard screen prior to deployment. Other military services, e.g., the United States Army, use the ANAM in a militarized version to assess neuropsychological performance prior to deployment. We have tried to overcome the absence of a pre-deployment neuropsychological assessment by the comparison with a properly designed control group. This control group has been deployed in the same period, and is selected on the criterion of being in a treat. We chose a group which experienced a threatening event to control to what extent the psychological element of the blast incidence accounts for mTBI symptoms and cognitive performance. The criterion was based on questions in the aftercare research of the Dutch army completed 6 months after deployment. We included those who experienced a threat on the scale of sometimes to very often. However, the control group was tested once at the timing of the last screening of the blast group, being 12 – 18 months after deployment. We admit that this caused some problems with the interpretation of our results. A possible learning effect that could have occurred in the test group by the repetitive screening was absent in the control group. The late timing of testing could give an incomplete picture of the deployment stress because symptoms could have diminished over time.

Thirdly, demand characteristics could also contribute to the results. It could well be that participants were nervous, which contributed to a demand characteristic in which their performance was compromised. This could

have happened in the first screening of not only the blast group, but also during the single test of the control group.

Also it remains ambiguous if the neuropsychological tests are the best method for screening for long-term mTBI symptoms. Sustaining symptoms after concussion longer than 3 months are called post-concussive symptoms or post-concussive syndrome. It remains unclear how the blast mTBI symptoms evolve, in cases where they persist, they may be similar to post-concussive symptoms. Little research has been performed in blast-related post-concussive symptoms – but the few that existed provided us with interesting information. Brenner et al. (2010) tested 45 participants with and without sustaining mTBI symptoms on several neuropsychological tests. The conducted tests included the Stroop task and symbol digit task, which were also part of our research. They compared the outcomes of 27 soldiers with sustaining mTBI symptoms and 18 without. On the total of all tests were no significant effects, the Stroop and symbol digit modality task also did not show effects separately. These findings were supported by earlier self-reported mTBI versus post-concussive symptoms research which indicated that a history of symptoms did not increase the risk of poor performance on ANAM [73].

We concluded that careful reporting (e.g., in an electronic data reporting system) during a sustained blast exposure and targeted screening is essential to evaluate immediate impact and evaluate long-term effects. Of key importance is the implementation of a 'Blast Tracking Database' as well as a 'Wounded in Action' database (e.g., how many blasts, how many soldiers exposed, injured) in following up on the health and operational fitness of those that are injured (according to one of the recommendations of literature). This information can be difficult to obtain during combat operations, particularly since some of it may be classified. However, such information, together with helmet blast dosimeter data, would be extremely useful in order to better establish the potential health impacts of blast exposure.

Although the first signs of blast-induced neurotrauma usually appear immediately, it can sometimes take months or years after the initial trauma before they manifest. These are vague symptoms like extreme fatigue, attention and concentration problems, memory problems, irritability, insomnia, tinnitus, and mood swings. The wide variety of symptoms includes weight loss, hormonal problems, chronic fatigue, headaches and memory problems, speech and balance problems. These changes are often debilitating and slowly but surely start to interfere with daily activities. Because these complaints are underestimated, time is lost for secondary prevention and/or timely rehabilitation. It is unclear what component of the blast carries more impact on health and operational fitness in the longer term: physical, emotional or neuropsychological aspects.

In PTSD it is known that there is an autonomic dysregulation (manifesting in disorders of cognitive and emotional disinhibition, sleep and arousal) that drives the symptoms in the disorder. The neurobiological correlates are known, and the central and peripheral dysregulation has been well studied. This is also very well known in moderate and severe TBIs, but not yet sufficiently studied in the mild forms of TBI. There are candidate biomarkers, proteomics, for TBI (the UCH-L1 protein, MAP-2, and tau) which have the potential to establish a diagnosis of MTBI, particularly in milder forms. However, none of these have any proven diagnostic or prognostic value at this time.

In summary, careful reporting of effects of blast exposure through targeted screening is essential to evaluate symptom onset and long-term effects. Implementation of the MACE as a screening instrument for traumatic brain injury, as well as post-traumatic cognitive symptoms, can provide an opportunity for structured assessment of the effects of blast on the health and operational fitness of the individual soldier. Importantly, they should also contribute with guidelines to line Commanders when to call for return-to-duty when soldiers are exposed to an IED-related blast. Yet, we felt that there are still gaps in knowledge that prevent us from a complete and definite answer to the long-time impact of blast exposure on deployed soldiers. The outstanding research efforts that have been initiated over the last 5 years carry high expectations of being able to resolve at least some of these.

4.0 REFERENCES

[5] VA/DoD clinical practice guideline for the management of concussion/mild traumatic brain injury. J Rehabil Res Dev. 2009; 46(6):CP1-68.

[9] Guskiewicz, K.M., Bruce, S.L., Cantu, R.C., Ferrara, M.S., Kelly, J.P. and McCrea, M., et al. National athletic trainers' association position statement: Management of sport-related concussion. J Athl Train. 2004; 39(3):280.

[10] McCrory, P., Johnston, K., Meeuwisse, W., Aubry, M., Cantu, R. and Dvorak, J., et al. Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004. Br J Sports Med. 2005; 39(4):196-204.

[15] Carroll, L., Cassidy, J.D., Peloso, P., Borg, J., Von Holst, H. and Holm, L., et al. Prognosis for mild traumatic brain injury: Results of the WHO collaborating centre task force on mild traumatic brain injury. J Rehabil Med. 2004; 36(Suppl):84-105.

[16] McCauley, S.R., Boake, C., Pedroza, C., Brown, S.A., Levin, H.S. and Goodman, H.S., et al. Postconcussional disorder: Are the DSM-IV criteria an improvement over the ICD-10? J Nerv Ment Dis. 2005; 193(8):540.

[17] Meares, S., Shores, E.A., Taylor, A.J., Batchelor, J., Bryant, R.A. and Baguley, I.J., et al. Mild traumatic brain injury does not predict acute postconcussion syndrome. J Neurol Neurosurg Psychiatry. 2008; 79(3):300-6.

[18] Hoge, C.W., Castro, C.A., Messer, S.C., McGurk, D., Cotting, D.I. and Koffman, R.L. Combat duty in Iraq and Afghanistan, mental health problems, and barriers to care. N Engl J Med. 2004; 351(1):13-22.

[19] Afari, N., Harder, L.H., Madra, N.J., Heppner, P.S., Moeller-Bertram, T. and King, C., et al. PTSD, combat injury, and headache in veterans returning from Iraq/Afghanistan. Headache. 2009; 49(9):1267-76.

[20] Friedman, M. Posttraumatic stress disorder among military returnees from Afghanistan and Iraq. Am J Psychiatry. 2006; 163(4):586-93.

[22] Hoge, C.W., McGurk, D., Thomas, J.L., Cox, A.L., Engel, C.C. and Castro, C.A. Mild traumatic brain injury in US soldiers returning from Iraq. N Engl J Med. 2008; 358(5):453-63.

[25] Schneiderman, A.I., Braver, E.R. and Kang, H.K. Understanding sequelae of injury mechanisms and mild traumatic brain injury incurred during the conflicts in Iraq and Afghanistan: Persistent postconcussive symptoms and posttraumatic stress disorder. Am J Epidemiol. 2008; 167(12):1446-52.

[36] Belanger, H.G., Spiegel, E. and Vanderploeg, R.D. Neuropsychological performance following a history of multiple self-reported concussions: A meta-analysis. J Int Neuropsychol Soc. 2010; 16(2):262.

[41] Comper, P., Bisschop, S., Carnide, N. and Tricco, A. A systematic review of treatments for mild traumatic brain injury. Brain Inj. 2005; 19(11):863-80.

[43] Snell, D.L., Surgenor, L.J., Hay-Smith, E.J.C. and Siegert, R.J. A systematic review of psychological treatments for mild traumatic brain injury: An update on the evidence. J Clin Exp Neuropsychol. 2009; 31(1):20-38.

[68] Cooper, D.B., Kennedy, J.E., Cullen, M.A., Critchfield, E., Amador, R.R. and Bowles, A.O. Association between combat stress and post-concussive symptom reporting in OEF/OIF service members with mild traumatic brain injuries. Brain Inj. 2011; 25(1):1-7.

[98] Kashluba, S., Paniak, C., Blake, T., Reynolds, S., Toller-Lobe, G. and Nagy, J. A longitudinal, controlled study of patient complaints following treated mild traumatic brain injury. Arch Clin Neuropsychol. 2004; 19(6):805-16.

[138] Ponsford, J., Willmott, C., Rothwell, A., Cameron, P., Kelly, A. and Nelms, R., et al. Impact of early intervention on outcome following mild head injury in adults. J Neurol Neurosurg Psychiatry. 2002; 73(3):330-2.

[140] Knuth, T., Letarte, P., Ling, G., Moores, L., Rhee, P. and Tauber, D., et al. Guidelines for the field management of combat-related head trauma. Triage and transport decisions. New York (NY): Brain Trauma Foundation. 2005.

[141] Lew, H.L., Garvert, D.W., Pogoda, T.K., Hsu, P., Devine, J.M. and White, D.K., et al. Auditory and visual impairments in patients with blast-related traumatic brain injury: Effect of dual sensory impairment on functional independence measure. J Rehabil Res Dev. 2009; 46(6):819-26.

[142] McCrea, M., Guskiewicz, K.M., Marshall, S.W., Barr, W., Randolph, C., Cantu, R.C., Onate, J.A., Yang, J. and Kelly, J.P. Acute effects and recovery time following concussion in collegiate football players: The NCAA concussion study. JAMA. 2003; 290(19):2556-63.

[143] Ellemberg, D., Henry, L.C., Macciocchi, S.N., Guskiewicz, K.M. and Broglio, S.P. Advances in sport concussion assessment: From behavioral to brain imaging measures. J Neurotrauma. 2009; 26(12):2365- 82.

[144] Meares, S., Shores, E.A., Batchelor, J., Baguley, I.J., Chapman, J. and Gurka, J., et al. The relationship of psychological and cognitive factors and opioids in the development of the postconcussion syndrome in general trauma patients with mild traumatic brain injury. J Int Neuropsychol Soc. 2006; 12(6):792-801.

[145] Defense and Veterans Brain Injury Center working group on the acute management of mild traumatic brain injury in military operational settings: Clinical practice guidelines and recommendations.

[146] Barr, W.B. and McCrea, M. Sensitivity and specificity of standardized neurocognitive testing immediately following sports concussion. J Int Neuropsychol Soc. 2001; 7(6):693-702.

[147] Stiell, I.G., Clement, C.M., Rowe, B.H., Schull, M.J., Brison, R. and Cass, D., et al. Comparison of the Canadian CT head rule and the New Orleans criteria in patients with minor head injury. JAMA. 2005;294(12):1511-8.

[148] Smits, M., Dippel, D.W., de Haan, G.G., Dekker, H.M., Vos, P.E. and Kool, D.R., et al. External validation of the Canadian CT head rule and the New Orleans criteria for CT scanning in patients with minor head injury. JAMA. 2005; 294(12):1519-25.

[149] Jagoda, A.S., Bazarian, J.J., Bruns, J.J., Cantrill, S.V., Gean, A.D. and Howard, P.K., et al. Clinical policy: Neuroimaging and decision making in adult mild traumatic brain injury in the acute setting. Ann Emerg Med. 2008; 52(6):714-748.

[150] McCrory, P., Meeuwisse, W., Johnston, K., Dvorak, J., Aubry, M. and Molloy, M., et al. Consensus statement on concussion in sport–the 3rd international conference on concussion in sport held in Zurich, November 2008. J Athl Train. 2009; 44(4):434-448.

[151] Kelly, J.P. and Rosenberg, J.H. The development of guidelines for the management of concussion in sports. J Head Trauma Rehabil. 1998; 13(2):53-65.

[152] Pellman, E.J., Viano, D.C., Tucker, A.M., Casson, I.R. and Waeckerle, J.F. Concussion in professional football: Reconstruction of game impacts and injuries. Neurosurgery. 2003; 53(4):799-814.

[153] Jones, E., Hodgins-Vermaas, R., McCartney, H., Everitt, B., Beech, C. and Poynter, D., et al. Post- combat syndromes from the Boer war to the Gulf war: A cluster analysis of their nature and attribution. BMJ. 2002; 324(7333):321-4.

[154] Bleiberg, J., Cernich, A.N., Cameron, K., Sun, W., Peck, K. and Ecklund, L.P.J., et al. Duration of cognitive impairment after sports concussion. Neurosurgery. 2004; 54(5):1073-80.

[155] Belanger, H.G., Kretzmer, T., Yoash-Gantz, R., Pickett, T. and Tupler, L.A. Cognitive sequelae of blastrelated versus other mechanisms of brain trauma. J Int Neuropsychol Soc. 2009; 15(1):1-8.

[156] Polusny, M.A., Kehle, S.M., Nelson, N.W., Erbes, C.R., Arbisi, P.A. and Thuras, P. Longitudinal effects of mild traumatic brain injury and posttraumatic stress disorder comorbidity on postdeployment outcomes in national guard soldiers deployed to Iraq. Arch Gen Psychiatry. 2011; 68(1):79-89.

[157] Marx, B.P., Brailey, K., Proctor, S.P., MacDonald, H.Z., Graefe, A.C. and Amoroso, P., et al. Association of time since deployment, combat intensity, and posttraumatic stress symptoms with neuropsychological outcomes following Iraq war deployment. Arch Gen Psychiatry.

2009; 66(9):996-1004.

[158] Belanger, H.G., Curtiss, G., Demery, J.A., Lebowitz, B.K. and Vanderploeg, R.D. Factors moderating neuropsychological outcomes following mild traumatic brain injury: A meta-analysis. J Int Neuropsychol Soc. May 2005; 11(3):215-27.

[159] Borg, J., Holm, L., Peloso, P., Cassidy, J.D., Carroll, L. and Von Holst, H., et al. Non-surgical intervention and cost for mild traumatic brain injury: Results of the WHO collaborating centre task force on mild traumatic brain injury. J Rehabil Med. 2004; 36(0):76-83.

[160] Ontario Neurotrauma Foundation. Guidelines for mild traumatic brain injury and persistent symptoms. Canada: Ontario Neurotrauma Foundation. 2011.