Comparison of Two Co-Located Infantry Battalions during the 1918 Influenza Pandemic

The Australian Army’s Two ‘Traditional’ Diseases: Gonorrhea and Syphilis

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Front Cover
Title: “Stars over R2E”
Photo courtesy of James Savage

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Australasian Military Medicine Association

STATEMENT OF OBJECTIVES

The Australasian Military Medicine Association is an independent, professional scientific organisation of health professionals with the objectives of:

- Promoting the study of military medicine
- Bringing together those with an interest in military medicine
- Disseminating knowledge of military medicine
- Publishing and distributing a journal in military medicine
- Promoting research in military medicine

Membership of the Association is open to doctors, dentists, nurses, pharmacists, paramedics and anyone with a professional interest in any of the disciplines of military medicine. The Association is totally independent of the Australian Defence Force.
Editorial

Wither Nuclear?

In this issue, Heslop and Westphalen review medical chemical, biological, radiological and nuclear (CBRN) defence in the Australian Defence Force.1 The ongoing interest of militaries and non-state actors in these weapons, while waxing and waning over the last 100 years, continues, and requires appropriate military health preparations. While chemical, biological and, to a lesser extent, radiological weapons have received detailed attention, particularly since chemical weapons use in Syria, nuclear terrorism and nuclear war have received less attention. This may be based on the assumption that, with the exception of North Korea, these weapons are better controlled and less likely to be used. But, given recent tensions, are these assumptions valid?

Internationally, Australia and other countries are protected by a range of treaties designed to prevent the acquisition and use of nuclear materials and weapons, the most important of these being the Nuclear Non-Proliferation Treaty2. Other treaties, such as the International Convention for the Suppression of Acts of Nuclear Terrorism, which came into force in July 2007, and the Convention on the Physical Protection of Nuclear Material, which came into force in February 1987, are also important in increasing nuclear materials security and preventing the export of nuclear material and related technologies.3 There are, however, serious challenges in these areas, with growing fissile material stockpiles in India, Pakistan, China and Japan.4

Progress has been slower with other conventions. Bringing the Comprehensive Nuclear Test Ban Treaty into force would assist in reducing the numbers of nuclear weapons.5 Progressing the Fissile Materials Cutoff Treaty, first proposed in 2000, would also further restrict the availability of fissile materials and, ultimately, nuclear devices.6 Recent issues between Russia and the United States, however, have reversed some of the progress made with these treaties and will create further vulnerabilities. Alleged violations of the Intermediate-Range Nuclear Forces Treaty, no progress on the Strategic Arms Limitation Treaty, and plans for revitalisation of nuclear arsenals, including developing smaller tactical nuclear weapons, are also of concern.7 Closer scrutiny of this important area is required to ensure that we are better prepared for future conflicts.

Our first issue of 2019 contains a diverse range of articles from mental health and operational medicine through to infectious disease history. We continue to get a good range of articles, but other military and veterans’ health articles are always very welcome and we would encourage all our readers to consider writing on their areas of military or veterans’ health interest. We would particularly welcome papers based on our 2019 themes of recovery, rehabilitation and repatriation, but welcome any articles across the broader spectrum of military health.

Dr Andy Robertson, CSC, PSM
Commodore, RANR
Editor-in-Chief

References:
Comparison of two co-located Infantry Battalions during the 1918 influenza pandemic with very different mortality experiences

D Shanks, M Waller

Abstract

The 1918–1919 influenza pandemic was the greatest mortality event in recent history whose specific origins and mechanism remain largely unexplained. Wide ranges of mortality were observed in otherwise identical groups for unclear reasons. The 49th (n=1363) and 50th (n=1243) Battalions (BN) of the Australian Imperial Force (AIF) respectively had one of the highest and lowest influenza mortality rates of any Australian infantry unit. All non-combat mortality, specific pneumonia/influenza mortality and morbidity due to influenza-like illness were collected from both battalions 1916-1919. Mortality during the 1916-1917 epidemic of ‘purulent bronchitis’ was similar (8 deaths in both) whereas the 49th BN had 18 and the 50th BN had one pneumonia deaths during the influenza pandemic of late 1918-early 1919. Influenza morbidity was similar in both units except during mid-1918 when the 50th BN experienced more cases of a mild influenza-like illness (69 vs 103 cases in June). The 49th BN had more recorded cases of influenza than the 50th BN during the late 1918 pandemic (116 vs 62 cases in October). Recent influenza-like illness appeared to markedly decrease influenza mortality without greatly changing influenza morbidity in 1918.

Key words: influenza, pandemic, mortality, World War I

Introduction

Pandemic influenza can stop military operations when a large number of soldiers suddenly become ill. High mortality due to influenza in otherwise healthy adult males has only been observed during the 1918–1919 pandemic for uncertain reasons. More people died during the influenza pandemic than during World War I, including greater than 1 200 Australian soldiers in the Australia Imperial Force (AIF) deployed to Europe and the Middle East. The unexpected and still unexplained propensity of the 1918 influenza virus to kill young adult men remains a unique observation thought to be linked to the massive population disruptions associated with World War I.

In the absence of effective influenza vaccines, one’s immunity depends on previous influenza infections producing immunological memory in the form of either specific antibody or lymphocytes capable of killing infected respiratory cells. Influenza has certainly existed for centuries, but it did not cause annual epidemics until after 1918, likely due to limited population movements. Influenza rapidly changes its surface proteins (hemagglutinin H; neuraminidase N) requiring adaption of the host and/or annual revisions of influenza vaccine to respond to viral evolution. An individual’s particular lifetime experience with influenza virus largely determines how well the host is able to resist infection.

Although reliable mortality data have been collected for over a century, it is extremely difficult to link historical mortality with previous morbidity records due to influenza. Military medical systems are one of the few circumstances where one can confidently measure influenza morbidity and subsequent mortality in individuals using prospectively collected data over more than a single season. Only with this level of detail is it possible to suggest why the 1918 pandemic’s lethality was so different from all other known pandemics. We have examined the Australian National Archives online collection of AIF soldier...
records linked to both the AIF Database Project of the University of New South Wales and the Honour Roll of the Australian War Memorial in order to determine if previous influenza illness changed a soldier’s mortality risk during the 1918–1919 influenza pandemic. The specific question asks how might co-located infantry units, appearing otherwise identical, have such different influenza mortality rates?

Methods

This study is a part of a much larger effort originally reported in 2010 which the reader is referred to for details of the data collection methods and analytic approach used. During this previous work it was noted that 1,363 men of the 49th Battalion (BN) and 1,243 men of the 50th BN, despite being located in the same 13th Infantry Brigade in France in 1918, had very different influenza mortality rates (See Figures 1 and 2). Given the uniformity of infantry units, especially when co-located in the same brigade, detailed study of these two battalions was conducted to determine if previous influenza experience was a key determinant of subsequent mortality risk. The National Archives online (www.naa.gov.au) medical and administrative records of the men in these two infantry units were examined in detail collecting all recorded instances of influenza-like illness to which the reader is referred. Very accurate mortality information was available from the Roll of Honour from the Australian War Memorial (www.awm.gov.au) as well as detailed demographic information from the AIF Database Project of the University of New South Wales to which we were graciously given access by Prof Peter Dennis. Epidemic curves were constructed from these named individual soldier records measuring non-combat mortality, pneumonia/influenza specific mortality, and influenza-like illness morbidity 1916–1919.

Denominator data required considerable estimation due to the near constant movement of soldiers within the AIF.

Results

Figure 3 displays the resulting information gathered from both AIF infantry battalions. Influenza mortality was primarily seen during two periods of World War I in late 1916, early 1917, when it was labelled as ‘purulent bronchitis’ and in late 1918, early 1919, during the influenza pandemic. Most modern observers consider both episodes likely to have been caused by the same influenza virus that did not manage to spread globally until 1918. Pneumonia/influenza mortality in late 1916, early 1917, was identical (8 deaths) in both battalions (See Figure 3A). However, in late 1918, early 1919, there were 18 influenza deaths in the 49th BN and one death in the 50 BN, giving a calculated mortality rate of 7 out of 1000 men vs 0.8 of 1000 men. Figure 3B shows that half of all non-combat (mostly due to other infectious diseases but including accidents) mortality was due to pneumonia/influenza in 1916–1919. Non-combat deaths that were not caused by pneumonia/influenza were similar (23 vs 25) between the two units. Influenza morbidity was similar in both units except during mid-1918 when the 50th BN experienced more cases of a mild influenza-like illness (69 vs 103 cases in June) (See Figure 3C). The 49th BN had more recorded cases of influenza than the 50th BN during the late 1918 pandemic (116 vs 62 cases in October).

Discussion

Comparison of two co-located AIF infantry battalions showed that although influenza mortality was identical in the first epidemic in late 1916, early
Short Communication

Figure 3A–C: Epidemic curves in two co-located infantry battalions showing A. pneumonia/influenza deaths by month; during pandemic period this was a total of 18 deaths in 49th BN vs 1 in 50th BN. B. all non-combat deaths by month; 23 deaths in 49th BN vs 25 in 50th BN and C. influenza-like illness by week during 1916–1919 in France/Belgium during World War I.
1917, during the main wave of the influenza pandemic occurring in late 1918, early 1919, a ninefold difference in mortality was observed. There were no differences in non-combat deaths that were not attributable to pneumonia/influenza. Influenza morbidity differed during mid-1918 when the 50th BN had more cases of non-lethal illness. The situation was reversed in late-1918 when the 49th BN experience more influenza cases.

Could mild influenza infections occurring during mid-1918 have protected soldiers against death later in the same year? This was true when a larger dataset (n = 8840), which included both the 49th and 50th BN as well as medical officers, military nurses, engineers and flying corps, were studied using a Cox proportional hazards model. When a further case-control analysis was done with all known influenza deaths (n=1238) during the 1918-1919 pandemic matched to an equivalent number of surviving controls who joined the military at the same time, earlier influenza-like illness was protective against mortality (odds ratio, 0.37, 95% CI, 0.25 to 0.53). This indicates that mild infections during the mid-year wave were associated with protection against severe mortality later in the year.

These data have been previously reported. The remaining question was whether the same conclusion could be sustained when looking at two colocated infantry battalions over time. The epidemic curves presented in this sub-study show that the only difference that can be discerned between the two units was due to increased influenza morbidity in the 50th BN around mid-1918. This fits multiple descriptions made during the war of the widespread nature of non-lethal influenza in mid-1918 serious enough to cause such concern that sufficient well soldiers would not be available to stop the final German offensives on the Western Front. The French Army (approximately 4 million men) estimated their mortality during the two waves at less than 100 in mid-1918 and 28,000 deaths during late 1918, early 1919.

However, infection with mild influenza in mid-1918 did not protect against influenza morbidity in late 1918, a finding which has since been confirmed in two US military academies. The most parsimonious explanation requires the existence of at least two influenza viruses causing different pandemic events in 1918: one mild, the other lethal. Cross-protection occurred for mortality but not morbidity indicating the viral surface proteins were likely different. This interpretation is supported by mortality data from the different Australian states in 1919. Victoria and New South Wales had much greater mortality (two to threefold) in 1919 compared to the previous 1891 pandemic. In Tasmania, however, where the lethal pandemic arrived after nearly a year of mild influenza circulation through the island, influenza related mortality in 1919 was not greatly different from the previous 1860 and 1891 pandemics: particularly muted was the unique young adult mortality signature of 1919. Across the world, highly variable influenza mortality at the country and city level suggests that these otherwise similar social units had recent exposure to an influenza virus different than the lethal H1N1 virus of late 1918, early 1919.

The utility of military records to address historical epidemiological questions is obvious. What might these findings mean for the next influenza pandemic? Taken together, the severe mortality seen in 1918–1919 appears to have been driven by distinct epidemiological events which are very unlikely to reoccur. The global spread of influenza through the modern transportation network insures that many different viruses are simultaneously circulating: all humans, other than infants, likely have some immunity from a previous infection. The same globalisation that brings seasonal influenza is also what may be protecting us against severe mortality during the next pandemic.

Contributors

GDS was responsible for designing the epidemiological project, initiating this particular report as well as the writing of the first draft of the manuscript. MW was in charge of data collection and analysis. Both authors participated in writing the final manuscript.

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Corresponding Author: Dennis Shanks, dennis.shanks@defence.gov.au
Authors: D Shanks 1,2, M Waller 2
Author Affiliations:
1 Australian Defence Force Malaria and Infectious Disease Institute, Enoggera, Australia
2 University of Queensland, School of Public Health, Brisbane, Australia
Short Communication

References
The Australian Army’s Two ‘Traditional’ Diseases: Gonorrhoea and Syphilis — A Military-Medical History During the Twentieth Century

Ian Howie-Willis

Abstract

Two sexually transmitted diseases (STDs) marched in lockstep with the Australian Army in most, if not all, its overseas campaigns during the twentieth century. Gonorrhoea and syphilis, bacterial infections spread most commonly through sexual intercourse.

This article illustrates through reference to the Australian Army’s major overseas deployments: from the Boer War at the beginning of the century to the war in Vietnam, which ended in 1975.

The primary purpose of the paper is to demonstrate the scale of STD infections in the Army’s overseas deployments. There is, of course, a ‘human’ or ‘sociological’ aspect as well. When investigated, every STD episode can be seen to be a little disaster of its own; a mini-tragedy for the soldier contracting the STD, for the person who most often transmitted it to him and, beyond them, for their families. Subsequently, there is the medical aspect: the measures taken by the staff of the Army Medical Service to prevent the STDs and to treat those who contracted STDs.

Significant though the sociological and medical aspects of the Army’s experience of STDs are, this article does not dwell on them. Instead, the focus is statistical, showing the large scale of the STD problem during the Army’s overseas deployments of the twentieth century.

Key terms: sexually transmitted infection (STI), sexually transmitted disease (STD), venereal disease (VD), gonorrhoea, syphilis, twentieth century, Australian Army

Introduction: semantics of the ‘sexually transmitted infections’

The term sexually transmitted disease or STD became the preferred term among medical professionals during the mid-1970s. It replaced a previous collective term Venereal Disease or VD, used by previous generations. VD was part of common parlance in all English-speaking societies until the wish for a less values-laden phrase pushed doctors specialising in sexual health—itself a neologism—towards a semantic shift. Sexually transmitted disease has since been replaced by ‘sexually transmitted infection’ (STI) in the early twenty-first century.¹

Both STI and STD are euphemisms, ‘culturally sensitive’ terms for what are often distressing, debilitating and embarrassing diseases that can be passed on to the innocent partners and children of sufferers. A further reason for changing the terminology was that historically VD referred predominantly to syphilis and gonorrhoea, whereas STI includes conditions such as chancroid, lymphogranuloma venereum, chlamydia, HIV-AIDS and other infections transmitted sexually.

In this article, the older term VD will be used generally to reflect the accustomed term used at the time of most of the Army’s campaigns and deployments discussed.
Historical Article

Similar semantic changes have occurred in the terms used for medical practitioners specialising in the STIs. Until the mid-1970s, such specialists were known as venereologists and their specialisation as venereology. They later became known as sexual health physicians and their field of expertise as sexual health. Whatever the profession might call itself at any time, ‘pox doctor’, a derogatory 17th century term, remains extant, at least colloquially—as in the expression ‘all dressed up like a pox doctor’s clerk’.²

The venereal diseases

The Australia Army, like most others, has often suffered high incidences of VD, which for much Australian military history has meant principally gonorrhoea and syphilis, rather than any of the other STDs: of which there are least 14. Gonorrhoea and syphilis have always been the most common forms of VD in the Army and those causing the most concern.

There were various reasons for this concern, including:

• Until the advent of penicillin in the mid-1940s, both diseases were difficult to treat and cure. Approximately six weeks in hospital, undergoing daily treatment was the standard regimen. That meant a huge diversion of scarce resources to treat those infected.

• The time required for treatment entailed a huge loss of trained labour resulting in enormous costs for the replacement of those in hospital undergoing treatment.

• VD was essentially self-inflicted. For that reason, it caused much annoyance among Army commanders, who consequently saw it as a disciplinary as much as a medical matter.

• VD also exasperated the medical officers, who generally regarded their obligation to treat it as a diversion from their essential role in treating combat injuries and other infectious diseases.

• Those who suffered VD were the husbands, sons and brothers of Australian women, who would have been aghast to know that in many cases their men spent much of their time overseas in hospital being treated for diseases that were so taboo they could not be discussed around the family dinner table.

• There was a fear that soldiers returning from overseas service might bring VD with them and spread it through the Australian community.

Gonorrhoea

Gonorrhoea is caused by the gonococcus, a motile diplococcal bacterium, Neisseria gonorrhoeae. Infection sites are typically the areas of sexual contact—the soft, moist membranes of the penis, vagina, anus, rectum, throat and eyes. The gonococci move through bodily fluids by twitching their hair-like appendages and attaching themselves to tissue, which they then infect.³

Figure 1: Electron microscope image of Neisseria gonorrhoeae, the gonococcus causing gonorrhoea. (Source: US Centers for Disease Control and Prevention.)

In both men and women, gonorrhoeal infection commonly spreads along the genital and urinary tracts. The gonococci cause acute urethritis (infection and inflammation of the urethra), usually producing a discharge of pus from the urethra.

Before penicillin, the standard treatment was twice-daily irrigation of the urethra and bladder with a combination of powerful antiseptics. These included Argyrol (a silver nitrate compound) and Benetol (b-napthol, also called hydroxynaphthalene, a toxic compound chemically similar to phenol or carbolic acid, a corrosive antiseptic). These compounds were injected into the urethra and bladder and had to be retained there for several hours. The treatment was prolonged, messy, uncomfortable and embarrassing. It was also lengthy as a five to seven week hospital stay was usually required before a patient was free of symptoms.

Figure 2: Metal syringe, with curved metal urethral catheter, used for irrigating the urethra with antiseptic compounds. (Source: Wellcome Images, an online source of the Wellcome Trust.)

Syphilis

Journal of Military and Veterans’ Health
Syphilis is caused by Treponema pallidum, a spirochaete or small spiral-shaped bacterium. Like gonorrhoea, it can be congenital; passed from mother to unborn baby.

Syphilis acquired through sexual intercourse goes through a series of phases that may extend across decades. The first of these is an incubation period lasting an average of three weeks, during which no symptoms are apparent. The second stage, known as primary syphilis, is when the first symptom appears—often a chancre or hard, usually painless ulcer at the infection site. If left untreated, the chancre disappears.

Secondary syphilis subsequently appears, from two to four months after infection. The most common symptom is a rash of red, flat lesions occurring over the whole body as the spirochaetes multiply and spread via the blood to the skin, liver, joints, lymph nodes, muscles, brain, bones and mucous membranes of the mouth and throat. The rash heals within several weeks and the disease will enter a dormant phase that may last for many years.

Tertiary syphilis may appear in 30–40% of untreated individuals, in whom the spirochaetes reactivate, multiply and spread throughout the body. As they do, they irreversibly damage and eat away the parts of the body they attack, including the heart, eyes, brain, nervous system, bones, joints and facial appendages. The result is often gross disfigurement, insanity and then death.

Before penicillin, treatment was via intramuscular injections of highly toxic arsenic and mercury compounds. The side effects included severe mouth ulcers, the loss of teeth and kidney failure. Because of the toxicity of the treatment, the death of the patient was always a risk. In the US Army, patient mortality of less than one per cent was considered ‘good’. A cure could not be guaranteed; and so until penicillin the old adage remained true—‘An afternoon of Bacchus, an evening of Venus and a lifetime of Mercury’.

Recent trends in gonorrhoea and syphilis

The number of cases of gonorrhoea Australia-wide peaked at 12,352 in 1978 and syphilis at 3,594 cases in 1986. The incidence of both diseases subsequently fell away but then began climbing again. Figure 4 indicates the changing epidemiology of both diseases.

Epidemiologists and venereologists have debated the reasons for these trends. The emergence of antibiotic-resistant strains of the bacteria responsible for gonorrhoea and syphilis was one factor. Changing societal mores were another. Generations grown indifferent about the risks of casual sex and less the social and religious sanctions against promiscuity were probably unconcerned about the stigma that had blighted the lives of gonorrhoea and syphilis sufferers in earlier generations. The rising incidence of the Army’s ‘traditional’ STDs among the general Australian population is consequently of great concern to public health authorities.

Pre-Federation deployments

The incidence of the VD in the overseas conflicts to which the pre-Federation Australian colonies sent troops is unknown. These were the New Zealand land wars of 1845–46 and 1860–72, the Sudan campaign in 1885, the South African (or Anglo-Boer) War of 1899–1902 and the Boxer Rebellion in China in 1900–1901. Given the high rates of VD infection among Australian troops in later overseas deployments, it would be surprising if VD had not been a concern for the military-medical officers in these earlier conflicts as well.

The best documented of the late colonial era conflicts was the South African War, to which the colonies and then the new Australian Army sent contingents. The various histories of the war, both British and Australian, deal at length with the organisational arrangements made for the various field ambulances and stationary hospitals set up to treat injured and diseased soldiers.
sick soldiers. The only infectious diseases discussed in any detail are two other historical scourges of armies—dysentery and malaria. VD never rates a mention.

For reasons unknown, perhaps the prudery of the era, VD is ignored in official accounts of the South African War. Neither the 300-page report of the 1903 British commission of inquiry into the war, nor the 395-page 1904 official British government report on the medical arrangements for the war by the Army’s Surgeon-General include any reference to VD. Nor does the six-volume quasi-official British history of the war published by The Times newspaper of London.

Despite the official silence on VD, we might surmise that some of the Australian troops arriving in South Africa either brought VD with them, acquired VD in Africa and took VD back home after their departure, as this was certainly the situation during the next war 12 years later—World War I.

The most recent Australian historian of the war, Craig Wilcox, has suggested the possibility that some Australians might have contracted VD during their South African service. Wilcox describes the Australian colonial contingents arriving at the port of Beira in Mozambique, from where they caught trains into South Africa. The Australians generally thought the town ‘immoral;’ but many, appreciating the ‘free-flowing liquor’, went on ‘drunken sprees’. Did that lead to VD? Wilcox does not say, but the nexus between inebriated soldiers, readily accessible and cheap prostitutes and high rates of VD would be a common theme in the Army’s subsequent overseas deployments during the twentieth century.

Eventually the British Army did publish the VD figures for the South African War, but not until 1931 in the statistical volume of the official medical history of World War I. The 19,127 VD cases treated during the war amounted to 4.7 per cent of all 404,126 hospitalisations for disease. That many VD cases among the British troops strongly suggests that among Australian soldiers, too, VD was also problem for their medical officers.

Australian soldiers’ VD infection rates during World War I

The first conflict in which the Australian Army medical units kept comprehensive medical statistics was World War I. Officially there were 181 separate ‘disabilities’ which caused soldiers to be ‘rendered unfit, temporarily or permanently, for service’ in the Army. VD was among the most common of these. The Army’s losses to VD in World War I were enormous. An estimated 63,350 VD cases occurred among the 417,000 troops of the 1st Australian Imperial Force (AIF). That is, one in seven of the soldiers who joined the AIF contracted VD at some stage of the war. That many soldiers was the equivalent of three infantry divisions. Given that the average VD treatment time was six weeks, the high number of VD infections effectively meant that for six weeks of the war the AIF commanders had lost three infantry divisions. Little wonder that VD perturbed them greatly!

Figure 5: The Isolation Hospital at the Broadmeadows Army Camp, World War I, possibly 1914–15. Little is known about this ‘lock’ hospital. It was probably a secure section of a larger camp hospital at Broadmeadows, established to manage contagious diseases such as measles, influenza, tuberculosis, meningitis and VD until specialised infectious disease hospitals could be established elsewhere. Note the 5-strand barbed-wire perimeter fence to prevent patients from absconding. (Source: Australian War Memorial, photograph no. H18401.)

Egypt in World War I

The first known VD epidemic suffered by the Australian Army occurred in Egypt. It began almost as soon as the 1st AIF arrived there for training in the months before the Gallipoli campaign.

In 1915, the first year the Army spent in Egypt, 4,046 out of some 30,300 Australians, or over 13%, were admitted to hospital suffering from VD. The rates in Egypt remained high. In 1916, the rate was 14% of strength, and in the last full year of the war, 1918, it was 11%.
Figure 6: Soldiers (almost certainly staff) standing on the verandah of the X-ray and operating rooms of the No. 2 Australian Stationary Hospital at Moascar near Ismailia, Egypt, 1918. This hospital was the principal VD treatment centre for Australians serving in the Middle East. It was relocated several times, tending to move to where the troops were concentrated. (Source: Australian War Memorial, photograph no. B02450.)

Britain and the Western Front in World War I

The 1st AIF’s next VD epidemics occurred in Britain and on the Western Front between 1916 and 1919.13

Some 295 000 troops of the 1st AIF were deployed to the Western Front in France and Belgium during those years. In that time, Australian soldiers in the UK, France and Belgium suffered 584 248 disabilities requiring treatment by an Australian Army Medical Service unit. VD cases accounted for at least 48 880 of these, 22 265 in the UK and 18 165 in France and Belgium, i.e. 8.4% of all disabilities. Expressed as a rate per thousand of overall troop strength, the Army’s VD ‘episodes’ amounted to 166 cases per thousand soldiers.

The total incidence of VD cases among Australian soldiers in the UK 1916–1918, 22 265, was 20% higher than the 18 165 cases in France and Belgium. The rate of VD infection in the UK was also appreciably higher than in France and Belgium. For example, in the middle year of deployment to the UK and the Western Front, 1917, the rate in the UK was 148 cases per thousand troops, whereas the rate in France and Belgium was 73 per thousand, only half the rate in the UK that year.

The main reason for the disparity in the incidence and rate of VD between the UK and France and Belgium was opportunity for infection. Soldiers in the UK were not currently engaged in combat; those on the Western Front were and consequently had less time in which to contract VD. The discrepancy effectively illustrates the Army venereologists’ saying that ‘the incidence of VD among soldiers is inversely proportional to their amount of combat’.

VD was not the most common affliction suffered by the AIF, at least on the Western Front. Respiratory tract infections were far more prevalent, amounting to 110 650 cases or 37.5% of disabilities. That was more than four times higher than the rate for VD. The higher figure for respiratory infections was hardly surprising considering that the AIF fought amid the cold, rain and mud of three northern European winters, following which the worldwide 1918–19 wave of pandemic influenza swept over the troops.

Figure 7: Administrative headquarters of the No. 1 Australian Dermatological Hospital, Bulford, Wiltshire, April 1919. The hospital was the principal VD treatment facility for 1st AIF soldiers in Britain. Although a grim, depressing amenity for patients and staff alike, it undertook effective medical work. In its peak year of activity, 1918, it managed 9 404 patients. (Source: Australian War Memorial, photograph no. D00456.)

The Australian Army’s VD infection rates during World War II

During World War II, the 2nd AIF again suffered high VD infection rates. In the Middle East, the rate was 48 cases per thousand troops in 1941, the peak year. That was only two-thirds (65.7%) the rate among the 1st AIF on the Western Front in World War I; however, the Army’s commanders and medical officers agreed it was nevertheless ‘far too high’.14

Later in World War II, the Army’s VD infection rates were appreciably lower than in the Middle East. In the South West Pacific theatre, mainly the archipelagos to Australia’s north, the highest rate was only eight per thousand in 1945 or 0.08% of strength. Such a low rate reflected a lack of opportunity for infection.

The rates among troops in Australia were higher, for example 19 per thousand in 1942, which was only around half the rate in the Middle East the previous year. Nevertheless, that figure caused ‘considerable anxiety’ that the troops would spread their gonorrhoea and syphilis into the general population.

An estimated 34 180 cases of VD occurred among Australian troops during World War II. This was only 52% of the 63 350 cases of the 1st AIF during World
The Army vigorously promoted its ‘Blue Light’ Prophylactic Ablution Centres (PACs), i.e. units providing pre-emptive treatment for soldiers who had exposed themselves to the risk of VD infection.

The Army recruited specialist venereologists to staff its VD hospitals. Their availability to the ‘Blue Light’ PACs, and their training of the PAC medical orderlies, meant that the PACs functioned more efficiently than previously.

The availability of the ‘sulpha’ drugs, e.g. sulphanilamide, from the late 1930s. Such drugs were particularly effective against gonorrhoea, greatly reducing treatment times. Many soldiers contracting gonorrhoea treated themselves with sulphanilamide without reporting to Army medical units—and without consequently becoming ‘VD statistics’.

In the Middle East, where the 2nd AIF’s infection rates were the highest of the war, the Army introduced a system of controlled brothels in which the prostitutes were regularly examined for symptoms of VD.

Australian VD rates in the British Commonwealth Occupation Force in Japan

The Army’s first post-war overseas deployment was to Japan, as part of the British Commonwealth Occupation Force. The deployment lasted for six years (1946–1952). In that time, 16 500 Australian military personnel served with the Occupation Force. The Australians’ VD infection rate during this time was extraordinarily high. The number of individual Australians who contracted VD was 4 768 or 29% of the Australians who served with the force. There were 7 350 separate VD episodes or cases, which means that 2 582 soldiers suffered more than one episode. The record was 12 episodes, which means that that particular soldier must have spent at least 192 days out of his one-year deployment in hospital being treated for VD.

How were the Occupation Force soldiers able to tally such a high rate? The answer partly lies in the destitution of the Japanese population in the immediate post-war years. The Australians Forces were deployed to the Hiroshima Prefecture, the most devastated and therefore the most poverty-stricken, region in Japan. Japanese culture had traditionally tolerated prostitution and consequently, many
Japanese women resorted to prostitution to help their families survive their post-war deprivation and poverty. These Japanese prostitutes were usually infected with VD.

The other part of the answer lies with the soldiers themselves. Without a war to fight, the well-paid Australians had ample leisure, few recreational facilities and little to distract them from booze and sex, which usually went together. Pertinent here is the old Army venereologists’ adage that ‘Army VD rates are inversely related to the amount of battle activity’.

The Australian Army’s VD rates in Korea

The next major conflict to draw troops from Australia was the Korean War of 1950–1953. In the three years it lasted, some 17,000 Australian military personnel were deployed in Korea. They contracted VD at very high rates. The Australian rate, 386, was slightly above the overall Commonwealth figure but appreciably lower than the Canadian and New Zealand rates. However, comparatively ‘good’ that was, except for the recent Occupation Force in Japan, the rate was more than 2.5 times the previous ‘worst’, 148 in the UK in 1917. An estimated 4,110 Australian soldiers contracted VD while serving in Korea.¹⁶

Why was the rate in Korea so much higher than those in the First and Second World Wars? The high rates partly reflected the practice of sending the troops to nearby Japan for their recreation leave. As seen, prostitution at that time was commonplace in Japan and most prostitutes were infected with VD. As the official medical historian observed, resorting to prostitutes was ‘the normal reaction of young men spending five days’ leave in a big city, far from the hazards of war’.

The main factor, however, was the availability of penicillin. The widespread adoption of penicillin-based antibiotic drugs at the end of World War II had greatly lessened the burden of treating bacterial infections. In the case of gonorrhoea and syphilis, penicillin had obviated the previous messy, painful, protracted and toxic VD treatment regimens. Information about the efficacy of the new ‘wonder drug’ in rapidly curing VD filtered down to the level of the common soldier. Assured of a rapid cure, they were less concerned about contracting VD than soldiers in previous wars.

The Malayan Emergency and Australian VD rates

From 1955 to 1960, Australian soldiers fought with British troops on the Malayan Peninsula in a war known as the Malayan Emergency. The Emergency was essentially a Communist-led guerrilla war against British colonial rule and against the Malayan government that replaced it.¹⁷

As in the occupation of Japan and the Korean War in the recent past, the VD rates among the three Australian battalions successively deployed to Malaya were very high. The overall rate was 415 cases per thousand troops, or two-fifths of the soldiers sent to Malaya. An estimated 2,900 Australians serving in Malaya contracted VD.

VD rates in the Australian Army in Vietnam

A decade after the armistice in Korea, Australian troops were engaged in another and longer war, this time in Vietnam. The Australian involvement in the Vietnam War lasted for 11 years, from June 1962 until June 1973. The rates of VD infection were once again high. In the peak year for infection, 1967, the rate was an astounding 478 cases per thousand troops. The rate across all 11 years was 231 cases per thousand. An estimated 11,380 Australian soldiers contracted VD.

The reasons for the very high rate in Vietnam were perhaps similar to those in Korea in the early 1950s. The ‘mix’ included a reduced fear of VD among troops with ready access to effective antibiotics; an abundance of cheap prostitutes; high rates of
VD infection among the prostitutes; ample liquor in readily accessible bars that were almost always brothels as well; and the determination of virile young soldiers to ‘have fun’ during leave after the stress of front-line action. In Vietnam, there was also a reckless, hedonistic defiance, which the official medical historian of the war alluded to by writing that ‘the Australian servicemen displayed no inclination to exercise restraint or take precautions’.

Little is known of the Army’s post-Vietnam STD infection rates. The dearth of data reflects what one senior Australian Defence Force (ADF) medical officer has termed ‘the confidentiality crisis’ generated by the HIV epidemic. Sensitivities over the confidentiality of STD data was such that from the 1980s few anonymised data sets existed, much less made accessible to historians.

Vigilance over STD rates nevertheless remains a duty for the health professionals, military commanders and for individuals in the Armed Forces.

What measures did the Army adopt to reduce the incidence of its two ‘traditional’ diseases?

Over the 75 years this paper covers, the Army did everything possible to control and reduce the incidence of gonorrhoea and syphilis. At various times the Army commanders, administrators, medical officers and military police tried all of the following:

- Semi-criminalising the contraction of VD, notably by: (a) confining VD patients under guard to secure lock-hospitals; (b) stigmatising VD patients, e.g., by requiring them to use separate dining, ablution and toilet facilities; (c) treating VD patients in separate, isolated VD hospitals; (d) sending VD patients back to Australia in disgrace; (e) ensuring that the treatment regimens in the VD hospitals were harsh; (f) stopping the pay of VD patients while they were undergoing treatment; and (g) curtailing leave and other privileges of VD patients.

- Supervising soldiers’ off-duty time and behaviour to minimise their opportunities for fraternising or visiting brothels and picking up streetwalkers. Such measures included: (a) provision of sporting and recreation facilities; (b) declaring ‘red-light’ districts in towns frequented by soldiers to be out-of-bounds to troops; (c) military police patrols through such districts to round-up soldiers and send them back to camp; and (d) frequent bed checks after lights-out to ensure soldiers were in bed and not absent visiting prostitutes.

- Education and propaganda on the nature, causes and societal ramifications of VD infection, including: (a) lectures by chaplains on the moral experience were any guide, such post-Vietnam deployments would have yielded a continuing number of STD cases, including both gonorrhoea and syphilis and other ‘newer’ STDs such as HIV-AIDS and chlamydia.

Figure 10: Bar girls in the entrance to the ‘Texas Bar’, Vung Tau, chatting with American soldiers as a Vietnamese boy claims the attention of one soldier. The bar, effectively a brothel, was also much patronised by Australians. Note the ‘Approved Premises’ sign (arrowed) in the bar window. This indicated that the bar girls had been medically examined and were purportedly ‘VD-free’. In reality, the ‘hostesses’ of the ‘approved’ bars often still contracted VD as they were commonly infected by the customers they serviced after their examinations.

(Australian War Memorial, photograph P001510.021.)

In Vietnam, as in all the previous conflicts, the Army’s commanders and medical officers were concerned as much by manpower as by disciplinary, moral and medical considerations. A high VD rate has always meant a depleted fighting force because every soldier being treated in hospital for VD represented one less man available for duty. If the 11380 troops were withdrawn from normal duties for just two days’ treatment—the average time for VD cases—then 22760 ‘man-days’ or 62.4 ‘man years’ were lost in Vietnam. Another way of expressing the manpower cost of VD would be if the Australian force in Vietnam suffered 231 VD ‘casualties’ per thousand of strength, only 23% of the force would have been available for service throughout the year. Such a rate implied a large-scale reduction in military capability.

The STDs in the Army post-Vietnam

After the end of the Vietnam War in 1975 dozens of overseas deployments lay ahead of the Australian Army. They have included East Timor, Bougainville, the Solomons, Iraq and Afghanistan. If previous
aspects of VD infection; (b) lectures by Medical Officers on VD causes and prevention; (c) compulsory written examinations on the types, nature, symptoms and treatment of VD; and (d) anti-VD posters, pamphlets, films, information leaflets and articles in Army newspapers.

Regular medical inspections of the troops to check for telltale symptoms of VD infection.

Provision of free, well-publicised prophylactic measures, made available on a ‘no questions asked’ basis and preserving soldiers’ anonymity. These included: (a) issuing ‘Blue Light’ prophylactic kits containing condoms and antiseptic ointments to be rubbed into the genitals and surrounding areas immediately before and after sexual activity; and (b) conducting ‘Blue Light’ PACs at all major Army camps and in red-light districts frequented by soldiers. Ideally, soldiers visited the PACs as soon as possible after sexual contact so that their genitalia could be washed, irrigated with antiseptic compounds and dressed with antiseptic ointment.

Establishing venereological hospitals in Australia and the overseas theatres where Australian units were deployed. Staffed by specialist venereologists and trained medical orderlies, these hospitals provided treatment regimens that were the best available.

Regulating and punishing women accused of transmitting VD. Such measures included: (a) identifying the women who had been the source of particular soldiers’ infections, then locating them to insist on their treatment; (b) persuading civilian police to arrest and charge prostitutes, and have them convicted, imprisoned and compulsorily treated; and (c) removing from the vicinity of Army camps the ‘part-time’ and ‘amateur’ prostitutes who congregated there.

Authorising particular brothels and prostitutes to service Australian soldiers by issuing them with permits and regularly checking the for VD symptoms. In the Middle East in 1941-1942, and later in Vietnam, the Army effectively conducted its own Army-supervised brothels staffed by officially approved prostitutes.

Delaying the post-deployment return to Australia of VD-infected soldiers until there was certainty they were either cured or rendered non-infectious.

How many Australian soldiers contracted VD during the twentieth century?

Putting figures for VD infections on particular deployments is often problematic. For some deployments, no statistics are available; for others estimates must be made. Even where figures have been systematically compiled, inconsistencies exist. Further, often the statistics are understated because
The present author proffers no answers to such questions because he has none. Nevertheless, each deployment that contributed to the 125 270 total had its own specificity, which produced its own number of VD cases. The reasons why each deployment produced the VD incidence that it did were complex, relating to circumstances specific to the era and the nations in which the episodes occurred. All that can be said of the total is that VD was a major problem for the Australian Army throughout all its overseas deployments from the Boer War to Vietnam.

Author’s affiliations: Dr Ian Howie-Willis is an independent professional practising historian who lives in Canberra. In July 2018, he finished writing a manuscript with the working title ‘VD: The Australian Army’s experience of sexually transmitted diseases during the twentieth century’. This present article began as a paper presented to the ‘Lessons of War’ section of the Australian Historical Association’s annual conference at the Australian National University on 3 July 2018.

Some soldiers managed to conceal their symptoms; others escaped detection by self-treating; and others were privately treated by civilian doctors. In such cases, the number of VD cases could not be included in the tables compiled by the official medical historians.

Such provisos notwithstanding, the present author estimates that during the twentieth century Army medical units treated over 125 000 VD cases among Australian soldiers. Table 1 provides a summary.

The actual total, 125 270, was a nominal figure as it does not include the unknown statistics for four of the 10 sets of deployments. It was a very large sum—the equivalent of six World War I infantry divisions.

What might such a total signify? Does it reflect badly on the soldiers, on the Army that sent them to fight overseas, on the doctors who safeguarded their health, or on the nation of which they were citizens?

<table>
<thead>
<tr>
<th>Deployment</th>
<th>Estimated STD cases (rounded)</th>
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</thead>
<tbody>
<tr>
<td>Boer War, 1898–1902</td>
<td>Unknown</td>
</tr>
<tr>
<td>Boxer Rebellion, 1900–1901</td>
<td>Unknown</td>
</tr>
<tr>
<td>World War I, 1914–1918</td>
<td>65,350</td>
</tr>
<tr>
<td>World War II, 1939–1945</td>
<td>34,180</td>
</tr>
<tr>
<td>Occupation Force in Japan, 1946–1952</td>
<td>7,350</td>
</tr>
<tr>
<td>Korean War, 1950–1953</td>
<td>4,110</td>
</tr>
<tr>
<td>Malayan Emergency, 1955–1963</td>
<td>2,900</td>
</tr>
<tr>
<td>Indonesian Confrontation of Malaysia, 1965–1966</td>
<td>Unknown</td>
</tr>
<tr>
<td>Post-Vietnam deployments, 1976–2000</td>
<td>Unknown</td>
</tr>
<tr>
<td>Total STD cases, twentieth century</td>
<td>125,270</td>
</tr>
</tbody>
</table>
Abbreviations

1st AIF  the first Australian Imperial Force: the Australian Army formation established to enable soldiers to enlist for overseas service during World War I

2nd AIF  the second Australian Imperial Force, i.e. Army formation established to enable soldiers to enlist for overseas service during World War II

AIDS  Acquired immune deficiency syndrome

HIV  Human immunodeficiency virus

PAC  Prophylactic Ablution Centre(s): Army units during World Wars I and II, which provided pre-emptive treatment for soldiers who had exposed themselves to risk of VD infection

STD  Sexually transmitted disease(s)

STI  Sexually transmitted infection(s)

UK  United Kingdom

US  United States

VD  Venereal disease(s)

References

1 Terminological usage in the Medical Journal of Australia [MJA], the Australian medical profession’s general ‘news magazine’, will often reflect semantic shifts in medical phrases. Thus, from its foundation in 1914 until the mid-1970s, the MJA commonly referred to ‘Venereal Disease(s)’. The MJA first used the term ‘Sexually transmitted disease’ in an editorial in February 1975. Over the next two years, ‘sexually transmitted disease(s)’ progressively replaced ‘venereal disease(s)’ in MJA terminology. The MJA’s first reference to ‘sexually transmitted infection(s)’ was in a letter-to-the-editor in June 2002. After that, in the MJA if not elsewhere this term superseded ‘sexually transmitted disease(s)’.


4 see Hart G. op. cit., pp. 8–10.

5 Australian Bureau of Statistics. Australian Yearbooks, Canberra, years 1961–2010 (the years in which the data for the graph were published).

6 His Majesty’s Commissioners [on] the War in South Africa, Report of His Majesty’s Commissioners appointed to inquire into the military preparations and other matters connected with the War in South Africa, London, His Majesty’s Stationery Office, 1903.

7 Mitchell, T.J. and Smith, M.G., Medical Services: Casualties and Medical Statistics of the Great War, London, His Majesty’s Stationery Office, 1931, p. 273. (This book is Volume 1 in the 14-volume British official medical history of World War I)


Historical Article


11 The data on which this section is based is derived from the statistical tables of the official medical history of World War I, Butler AG. The Australian Army Medical Services in the War of 1914–1918, Volume III, Special Problems and Services, Australian War Memorial. Melbourne. 1943.

12 The material in this section is derived mainly from the official medical history of the war, see Butler AG. The Australian Army Medical Services in the War of 1914–1918, Volume I, The Gallipoli Campaign, The Campaign in Sinai and Palestine [and] The Occupation of German New Guinea, Australian War Memorial, Melbourne. 1938.

13 The material in this section is derived largely from the official medical history of the war, see Butler AG. The Australian Army Medical Services in the War of 1914–1918, Volume II, The Western Front Australian War Memorial, Melbourne. 1940.

14 This section is based on the official medical history of the war; see Walker AS. Clinical Problems of War, Australian War Memorial, Canberra. 1952; Middle East and Far East Australian War Memorial, Canberra. 1953; and The Island Campaigns Australian War Memorial, Canberra. 1957.

15 There was no official medical history of Australian participation in the Occupation of Japan. The material in this section is therefore based on archival sources in files held by the Australian War Memorial. See for example: (1) Thompson Lieutenant Colonel JS. (Deputy Provost Marshal, BCOF) to various BCOF recipients. 20 September 1946, 'Control — Venereal Disease' in AWM 114, item 267/6/17 (Part 1); (2) VD Control (Minutes of the Anti-VD Committee conducted on 13 May 1947) in AWM 114, item 267/6/17 (Parts 2 and 3); and (3) Administrative Instruction AG 108: Prevention of Venereal Disease–BCOF, 10 February 1948, in AWM 114, item 267/6/17, file BCOF. Control of Venereal Disease (Part 12).


19 O’Keefe B. op. cit., p.126.

20 Author’s correspondence: Shanks Professor G to Howie-Willis I. 17 July 2018.


22 The figures and the table are borrowed from the author’s unpublished manuscript, ‘VD — The Australian Army’s experience of sexually transmitted diseases in the twentieth century’ (2018).
The Effects of Current Cold Chain Management Equipment in Controlling the Temperature of Thermolabile Medications and Temperature Sensitive Diagnostics, Dressings and Fluids in A Routine Australian Defence Force Operating/Exercise Environment

E Daly, N Evans, S Holmes-Brown

Abstract

The purpose of this pilot study was to analyse the current cold chain storage methods of Class 8 stores, specifically thermolabile medications and temperature-sensitive diagnostics, dressings and fluids, for the Australian Army in a training area within Australia. This research was designed to identify deficiencies in current storage methods, including the inability to maintain recommended temperatures of pharmaceuticals in accordance with the Therapeutic Goods Administration (TGA), as well as foster communication between key stakeholders, such as the Royal Australian Army Medical Corps and the Department of Defence Joint Health Command, to develop a cold-chain protocol specific for the Australian Army.

This pilot study identified the common occurrence of breaches in a specific climate, resulting in thermolabile medications, and temperature-sensitive diagnostics, dressings and fluids being commonly exposed to temperatures outside the range recommended by manufacturers. The study’s findings relate mainly to the current storage equipment for Class 8 stores used by the Australian Army and, as a result, recommends the replacement of this mission essential equipment to ensure that cold chain storage meets the TGA guidelines. The study discusses the need for clearly defined guidelines with accountability on the stakeholders to ensure the provision of health support to all Australian Defence Force (ADF) personnel in the field is in accordance with the standard of care expected at a civilian health facility.

Key terms: cold chain storage, thermolabile medications, temperature sensitive, Class 8 stores, storage temperature

Ethical approval and conflict of interest

To ensure objectivity and transparency in conducting this pilot study, the Defence People Research – Low-Risk Ethics Panel was engaged to enquire if any ethical approval was required to conduct this study within the ADF. No ethical approval was required, as the research did not involve humans or animals, but focused on health materiel logistics. There was no identified conflict of interest for the study, which was undertaken by a RAAMC General Service Officer within work time with nil research grants or personal reimbursement provided.
BACKGROUND

Understanding the cold chain

The cold chain is the temperature-controlled aspect of the supply chain and refers to the uninterrupted storage of pharmaceutical products including thermolabile medications, and temperature-sensitive diagnostics, dressings and fluids. The cold chain commences from the time the product is manufactured, it includes transportation to the distribution point, and ends when the product is administered. An unbroken cold chain consists of an uninterrupted series of storage and distribution activities which maintains a given temperature range, based on the manufacturer’s recommended conditions for product stability and integrity stated on the Therapeutic Goods Administration (TGA) approved product packaging.

National storage and shipping requirements

The cold chain refers to the transportation, storage and distribution of pharmaceutical products within the temperature parameters, which are identified through the product packaging and documentation. The cold chain parameters are outlined in Table 1.

A ‘cold-chain breach’ or ‘adverse storage event’ refers to a situation in which a temperature-sensitive product has been exposed to temperatures outside the specified range for the product – excluding deviations of up to +12°C for less than 15 minutes that may occur when opening the refrigerator door routine use or restocking. The implications of a cold-chain breach can have extensive implications on the effectiveness of the product being administered.

When medicines stored at room temperature are exposed to higher temperatures, not only do their physical appearances change, in some cases, their efficacy and potency can also be reduced.

In accordance with the TGA, medications may be required to remain outside the specific temperature range for a temporary period due to a number of factors, including delivery, processing and refurbishment. Accordingly, Section 8.9 of the TGA states that these temporary breaches of the cold chain must be prevented by all means through forward planning including delivery time, climate and the recommended storage temperature (as per the product label). Any new equipment used for the storage of cold chain medicines should be commissioned according to the manufacturer’s written procedure and the storage conditions validated before becoming operational (TGA Sect 8.2). There is also the requirement for standard operating procedures (SOPs) to be established to ensure all personnel involved with the cold chain process are aware of what actions to take if a breach occurs, including loss or destruction of the products.

THE AUSTRALIAN DEFENCE FORCE

The Strategic Reform Program

The ADF’s primary focus is to protect and advance Australia’s strategic interests. This is achieved through maximising defence capabilities by conducting key training exercises, both domestically and internationally, in order to prepare and deploy personnel to military operations in regions including the Middle East and the South Pacific.

<table>
<thead>
<tr>
<th>Category</th>
<th>Parameters (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frozen</td>
<td>-25°C - 10°C</td>
</tr>
<tr>
<td>Cold</td>
<td>Not exceeding 8°C</td>
</tr>
<tr>
<td>Cool</td>
<td>8°C - 15°C</td>
</tr>
<tr>
<td>Temperature controlled</td>
<td>Thermostatically controlled at 20°C - 25°C</td>
</tr>
<tr>
<td>Room temperature</td>
<td>Not thermostatically controlled. Not exceeding 28°C</td>
</tr>
<tr>
<td>Warm</td>
<td>30°C – 40°C</td>
</tr>
<tr>
<td>Excessive heat</td>
<td>Exceeding 40°C</td>
</tr>
</tbody>
</table>

Table 1. Parameters of the cold chain. Reprinted from Reed, C. (2005). COLD CHAINS ARE HOT! Mastering the Challenges of Temperature-Sensitive Distribution in the Supply Chain. Chain Link Research.
The Strategic Reform Program (2009) was published to strategically plan for and implement changes to maximise the capability of the forces (Army, Navy and Air Force) while creating a more organised and efficient ADF. The overall goal of the Strategic Reform Program is to ‘implement techniques to eliminate duplication and waste in maintaining capabilities, increase their operational availability and reduce the cost of ownership’. In order to achieve these goals, three key elements are identified:

1. Improved accountability in defence through increasing transparency and accountability of the defence budget;
2. Improved defence planning through a strengthened link of planning and military preparedness and refinement of existing governance; and
3. Enhanced productivity in defence through improving the cost-effectiveness for military capability and procurement.

From a logistics perspective, the intent of the reform program is to implement better services and practices to improve the current logistics space. This includes the planning processes, forecasting, waste management and technologies. The end state is that the Department of Defence has improved logistics technologies, increased visibility on the supply chain and generated a return on savings.

Health logistics within the ADF

The ADF currently spends $5.2 billion per year across 23 categories of non-military goods and services from external suppliers. Health services are one of these categories and encompass the logistics of pharmaceutical supply and management. The Strategic Reform notes that no less than 60% of any savings on the current budget will be derived from the analysis of any changes to policy, usage and demand. As per Figure 1, the costs for health are currently at 100% of the mature yearly savings and need a thorough analysis to consider changes to current practices and processes.

Current state of health logistics in the Australian Army

From the early days of World War I, pharmacists in a military hospital setting were required to work beyond their role with additional responsibilities including the role of Medical Quartermasters. This added duty encompassed stocktaking, auditing, internal checking and writing off damaged or deficient stock. Within the Australian Army, logistics make up approximately 40% of the serving members. Health logisticians are tasked with ensuring the provision of health care is provided to all serving ADF personnel through organic medical assets, which include established medical facilities and field treatment teams and hospitals.

There is a considerable difference in the status quo for logistic management within the Army with the current divide of logistical personnel divided based on their trade or corps and not the ‘level’ of logistics at which one has served in their logistics career. This is evident in the current technologies being utilised within the health space, specifically the storage of pharmaceutical products required for the maintenance of the cold chain. The existing cold chain storage methods for close health clinicians, excluding the Haemacol fridges, are not designed specifically for the purpose, but are in accordance with the packing and storage instructions issued by the Land Engineering Agency (LEA) within the ADF and are limited to general-purpose polymer containers.

Role of the Land Engineering Agency

The purpose of the LEA is to ensure that every soldier is delivered equipment that is fit-for-service, safe and environmentally compliant while delivering project outcomes in accordance with the Defence Capability Plan and the Technical Regulatory Framework (TRF). The TRF places emphasis on the need for informed (technical) ‘judgements of significance’ to be made by appropriately qualified and competent staff. The
Packaging, Handling, Storage and Transportation (PHS&T) section of the LEA is responsible for ensuring that materiel system elements within the ADF are preserved, packaged, handled, stored and transported properly until required for use, including ensuring that materiel is protected from climatic, biological and physical hazards and in accordance with the Defence Electronic Supply Chain Manual (ESCM). The existing cold chain storage methods highlight the need for significant improvements, required by the LEA and PHS&T, of the fundamental requirements for maintaining the cold chain within the ADF.

Logistics Officers within the Army

Logistics Officers are forced to conduct detailed mission appreciation to ensure that the inflow of Combat Service Support (CSS) sustainment meets planned and unplanned mission demands. This planning is within the Army doctrine and while the General Service Officers serving in the Royal Australian Army Medical Corps (RAAMC) are classed as Logistics Officers, the limited training and exposure prior to commencing their roles at the respective health units has not set the corps up for success in regard to the current logistics processes. Furthermore, the lack of process and protocols regarding health logistics, specifically the cold chain management for close health clinicians, do not meet the ‘train the way we fight’ philosophy of the Army. Rather, the existing cold chain processes are not enforced in regards to the requirement to replenish and replace any drugs that exceed their recommended storage temperature, as the main effort for the ADF is identified as ensuring all training exercises are executed with limited interruption. Not only does this contravene existing national procedures, but it also increases the risk for all personnel participating in these training exercises.

Maintenance of the cold chain within the Australian Army

This study focused on the current methods employed for cold chain management within the Australian Army, specifically within the 1st Close Health Battalion (1 CHB). The research is being conducted as a result of a previous continuous quality improvement project focused on the storage of all non-refrigerated Class 8 stores during domestic training exercises.

The roles of 1st Close Health Battalion clinicians

1 CHB clinicians are responsible for initial and advanced treatment, including collection from point of injury (POI), resuscitation, stabilisation, and evacuation and emergency diagnostics to land forces as far forward as possible. As per Figure 2, this casualty evacuation (CASEVAC) process directs casualties from POI to appropriate health facilities based on required treatment, evacuation platform availability and capacity of the destination medical facility (DMF).

![Figure 2. Overview of CASEVAC within the ADF](source: Department of Defence. Defence Health Manual. 2016.)
The 1 CHB assets on the ground range from an integral medic at the POI (Figure 3a), an evacuation medic to move the patient (Figure 3b) and a treatment team, comprising of a doctor, nurse and three medics (Figure 3c). At all stages of the CASEVAC, the use of thermolabile medications and temperature-sensitive diagnostics, dressings and fluids are required to ensure that health support is effective and adequate.

Figure 3a. 1 CHB Integral Medic responds to a casualty at the POI. Source: Department of Defence. 1st Close Health Battalion. 2018

Figure 3b. 1 CHB Evac Medic loads a casualty in to the Protected Mobility Vehicle (Ambulance variant) for surface evacuation. Source: Department of Defence. 1st Close Health Battalion. 2018

Figure 3c. A 1 CHB Treatment Team stabilises a patient prior to Rotary Wing Aero-Medical evacuation. Source: Department of Defence. 1st Close Health Battalion. 2018

CURRENT 1 CHB STORAGE METHODS FOR THERMOLABILE MEDICATIONS AND TEMPERATURE-SENSITIVE DIAGNOSTICS, DRESSINGS AND FLUIDS

Shipment to the 1 CHB Pharmacy

All pharmaceutical products are shipped from either the Joint Logistics Unit (JLU) in NSW or the prime vendor to the pharmacy in its respective location (Darwin, Townsville, Adelaide or Brisbane). The method of transportation for products requiring refrigeration is a ‘cool cube’: a small expanded polystyrene container designed to maintain interior temperatures of 2°C to 8°C in an ambient temperature range of 5°C to 25°C for up to five days (if the cube remains unopened). The date and time group of when the cool cube was packed is detailed on the exterior of the container with suitable packing material such as foam or cardboard separating the products from the ice packs. A data logger is packed with the pharmaceutical products to continuously monitor the temperature. During transit, the cool cube is only to be removed for aircraft or vehicle stopovers and loading/unloading. It is required to be secured in an air-conditioned building or vehicle if it may be exposed to ambient temperatures outside the 5°C to 25°C range for more than one hour. Once delivered, the pharmacist is responsible for uploading the data logger to ensure that no cold-chain breaches occurred. If the delivery period is not met, or the consignment does not maintain the cold chain, pharmacists are to notify Health Systems Program
Office (HLTHSPO) or Joint Logistics Command (JLC), as appropriate, within 24 hours of delivery.(14)

The reporting by the pharmacist includes:

- basic description of the problem including the type of refrigerator or storage method;
- recording the length of time and temperature the stores have been exposed to once internal temperature exceeds 25°C;
- product details and expiry date recorded on the packaging; and
- approximate combined cost of affected stores.

A civilian contractor transports the shipment of thermolabile medications and temperature-sensitive diagnostics, dressings and fluids not requiring refrigeration with no temperature loggers or protocols implemented to report any breaches of storage temperature en route from the prime vendor to the respective 1 CHB pharmacist. The absence of quality control mechanisms is not conducive to the products maintaining their recommended storage temperatures noting the travel times from some vendors to the 1 CHB Pharmacy in Darwin is in excess of 3 days. Furthermore, products requiring shipment from the 1 CHB Pharmacy in Darwin to the 1 CHB Pharmacy in Adelaide, are sent through the Q-Store, which requires an additional 3 days of travel in a storage container without climate control.

Field exercises

The clinicians from 1 CHB are required to carry an extensive amount of medical equipment in addition to the basic soldier load list including rifle and ammunition. Dependant on the nature of the training exercise and the unit they are supporting, clinicians will be required to either carry all their equipment on them, have it loaded in an ambulance or be able to self-lift alongside the treatment team with all equipment packed into two vehicles. Specific to the storage of Class 8 supplies, the clinicians store the medications in the following defence issued equipment:

- **Integral medic** – Integral medics are dismounted and required to carry their Schedule 8 drugs in a Pelican Case (Figure 4). This equipment, measuring 211 mm x 109 mm x 57 mm, is designed for all weather protection and has foam cushioning to protect the medications. It is not able to provide any cooling mechanisms for the medications stored within.

![Figure 4. Pelican Case used for storage of Schedule 8 drugs by integral medics. Source: Pelican Products, Inc. USA, 2018.](image)

- **Evacuation medic** – In addition to the Pelican Case, evacuation medics carry a larger volume of medications stored in a standard issue, general-purpose polymer trunk measuring 620 mm x 550 mm x 550 mm. While durable in nature, they are not designed for thermoregulation and are stored in the side of an evacuation vehicle with no air conditioning.

![Figure 5. Issued trunk for storage of class 8 stores by the Treatment Team. Source: Department of Defence. Land Engineering Agency. 2018.](image)

- **Treatment team** – Treatment teams are configured to stock 7 days’ worth of supplies and are required to store these medications in a number of larger general-purpose polymer trunks measuring 1200 mm x 550 mm x 400 mm (Figure 5). They are also equipped with an Engel fridge (Figure 6) in temporary replacement of the Haemacool fridges, which are currently non-serviceable due to ongoing battery issues (which requires action through Chemtronics to JLU). The Engel fridges are not certified to store medicines and are graded for foodstuffs only as they fail to remain between 2°C to 8°C without active management, which is not feasible during the road moves from Army bases to training
areas (some of which can take four days). Out in the training areas, the access to power is also limited, which affects the ability to provide thermoregulation consistently. The treatment teams are set up in a non-thermoregulated canvas tent, which can experience ambient temperatures of greater than 50°C when deployed in the hotter months of the year.

Medications carried

The medications and diagnostic tests carried by 1 CHB clinicians span a diverse range of required storage conditions and methods of administration. Table 2 provides a number of examples of commonly carried Class 8 stores, which are representative of this diversity and provide the basis for determining conditions that would be considered a breach of recommended storage temperatures in the pilot study.

PRIMARY RESEARCH QUESTION

What are the effects of current cold chain management equipment in controlling the temperature of thermolabile medications and temperature-sensitive diagnostics, dressings and fluids in a routine Australian Army operating/exercise environment?

MATERIALS AND METHODS

Overview

The methodology used in this pilot study was a quantitative statistical analysis through continuous monitoring of ambient temperatures utilising an Environmental Stress Index Monitor (ESIM) and the placement of Tinytags in key storage equipment (Pelican Case, evacuation trunk and treatment team trunk) over a period of nine days within an Australian Army training area. Quantitative research is the preferred approach for testing objective theories

<table>
<thead>
<tr>
<th>Branded product name</th>
<th>Drug product</th>
<th>Dosage Form</th>
<th>Recommended storage temperature</th>
<th>Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bactroban ® 2% Ointment</td>
<td>Mupirocin 2%</td>
<td>Topical Ointment</td>
<td>Below 25°C</td>
<td>4</td>
</tr>
<tr>
<td>Morphine Sulphate Injection BP 10 mg – 1 ml</td>
<td>Morphine Sulfate 10 mg / ml</td>
<td>Solution for injection</td>
<td>Below 25°C</td>
<td>8</td>
</tr>
<tr>
<td>Sudafed</td>
<td>Pseudoephedrine HCL</td>
<td>Tablet</td>
<td>Below 30°C</td>
<td>4</td>
</tr>
<tr>
<td>Panadol</td>
<td>Paracetamol 500 mg</td>
<td>Tablet</td>
<td>Below 30°C</td>
<td>2</td>
</tr>
<tr>
<td>Amoxicillin</td>
<td>Penicillin 250 mg</td>
<td>Capsule</td>
<td>Below 25°C</td>
<td>4</td>
</tr>
<tr>
<td>Adrenaline (Epinephrine) Injection BP</td>
<td>Epinephrine 1 mg / ml</td>
<td>Solution for injection</td>
<td>Below 25°C</td>
<td>4</td>
</tr>
<tr>
<td>Pregnancy Test</td>
<td>Urine HCG sensitivity of 25 MIU / mL test</td>
<td>Diagnostic test</td>
<td>Below 30°C</td>
<td>Diagnostic test</td>
</tr>
</tbody>
</table>

Table 2. Manufacturer recommended storage temperature for scheduled medications and a diagnostic test carried out during EX WARFIGHTER
by examining the relationship among variables.\textsuperscript{16} The purpose of this methodology was to identify breaches in the cold chain management through the comparison of real-time data from a variety of different levels of health support and locations within the Townsville Field Training Area (TFTA).

The purpose of this continuous monitoring was to gather definitive data to:

- measure peak temperature;
- calculate the proportion of time medications and equipment spent above the manufacturers recommended storage temperature; and
- record the number of times the temperature exceeded 40°C within the storage containers.

**Sample size**

The health support provided during this research was 1 integral medic, 1 evacuation medic and 1 treatment team. This provided an opportunity to measure and compare the temperature of a Pelican Case carried by an integral medic, two smaller trunks carried by an integral medic and evacuation medic and a single large trunk carried by a treatment team. The ambient temperature monitoring by three different personnel (located in different locations within the training area) provided a mean temperature to compare the internal temperatures as well as a contingency if one of the members were to fail to record the temperatures correctly or at all.

**Stakeholders**

Each stakeholder involved in an analysis is commonly required to have a stake in the phenomenon under investigation.\textsuperscript{17} It is important to seek the engagement of multiple stakeholders during the planning process to identify and address changes required to improve system effectiveness and efficiency.\textsuperscript{18} The planning for this research was conducted through the involvement of Army pharmacists, the Battalion Operations Officers, the Senior Nursing Officers and the Senior Medical Officer to devise the terms of reference, key outcomes to analyse and what the proposed end state would be for the pilot study.

**Location and time**

The data was collected in February and March 2018, at the TFTA located 60km south-west of Townsville and spread out over 200 000 hectares of land. The average temperature during this period is 22–31°C\textsuperscript{19} with limited natural cover or shade. This location was utilised due to the timing of a field exercise, EX WARFIGHTER, whereby health support was required for the 800 soldiers deployed to this location for training.

**Continuous monitoring systems**

The ESIM is a portable heat stress monitoring device which calculates an environmental stress index as an equivalent to a wet bulb globe temperature (WBGT) (Figure 7).\textsuperscript{19} The waterproof and small design makes it the choice for the Army during training exercises to determine safe work rates. The internal data logging ensures that all data is automatically saved, reducing the requirement for manual recording of temperatures and reducing the risk of the incorrect temperature being manually recorded, or failing to be recorded.

Figure 7. ESIM for recording of ambient temperature
Source: Instrulabs Pty. Ltd.

Tinytag loggers are designed for measuring temperature and humidity in a variety of harsh, outdoor and industrial applications (Figure 8).\textsuperscript{20} Housed in robust, waterproof casings, they are deployed within the ADF for monitoring the storage temperatures of pharmaceutical products, both in barracks and out in the field. The Army pharmacist uploads the data, and graphs and tables portraying temperature changes over a specific period are generated.
The Tinytag was activated and placed in a consignment of refrigerated and non-refrigerated pharmaceuticals for the duration of the field exercise. Ambient temperatures during daylight hours were measured using the ESIM and manually recorded in a spreadsheet. It was also noted if the equipment was in transit and the method of transport. This data was used to compare the internal storage temperatures for the pharmaceutical stores and the impact of the ambient temperature. On return from exercise, the Tinytag data was downloaded and analysed by the pharmacist to determine the continued use or disposal of the refrigerated and non-refrigerated pharmaceuticals.

Continuous monitoring

With these continuous temperature-monitoring results, 1 CHB were able to identify temperature trends through the recorded data of the environments in which the products were stored, while informing on the actual conditions and quality of the current storage methods for the ADF medications. The recording of ambient temperature identified the impact of the training area climate on storage temperatures.

Method for data analysis

Creating ambient temperature profiles was an essential element for this research with the methodical study providing actual data on temperature hazards used to improve storage solutions and advice for the ADF to meet applicable regulatory requirements. The data collected (Appendices A–C) was used to identify the external temperatures experienced throughout the TFTA to provide analysis of the definitive data identified above. This was completed through daily profiling to identify the trends in the ambient temperature and impact on storage methods.

Using Microsoft Excel, each method of temperature collection was given its own recording column. This was used to create the temperature profiles targeting the frequency of occurrences of a particular temperature breach (30°C) and allowed abnormally distributed data to be analysed with a high degree of confidence.

While the data analysis included all hourly temperatures, some temperatures in the observed dataset were deemed not significant in the overall view of the profile and were not considered when creating the climate profiles due to the limited contribution. For example, anything below 25°C and above 41°C was classed as non-significant as these lows/highs contributed to less than 5% of the overall data collected with nil contribution to the profile in a meaningful and representative way. The confidence interval level for this pilot study was 95% as shown in Table 3.

<table>
<thead>
<tr>
<th>Pelican Case (°C)</th>
<th>Evac trunk (°C)</th>
<th>Treatment Team trunk (°C)</th>
<th>Ambient temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.97</td>
<td>21.70</td>
<td>21.34</td>
<td>22.94</td>
</tr>
<tr>
<td>3.99</td>
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<td>22.8</td>
</tr>
<tr>
<td>0.4</td>
<td>0.1</td>
<td>0.1</td>
<td>0.3</td>
</tr>
</tbody>
</table>

Table 3. Confidence interval levels
With the confidence interval and subsets established, the number of temperature occurrences for the Pelican Case and trunks versus ambient were calculated and a formula of ratios applied. This formula combined the effects of the temperature in the storage containers versus ambient to provide a representative, but usable, set of temperatures. From this, an overall summary was derived and is discussed below.

RESULTS

The analysis was performed with initial profiling created for each day based on the storage method. This was then consolidated to determine the median ambient and internal temperatures for each storage method (Figure 9). The median ambient temperature for this research was 29.4°C with a low of 22°C and a high of 34.9°C. It is noted that at the time of measurement, the region experienced the heaviest rainfall in 12 years, which resulted in lower ambient temperatures on some days and increased humidity on others. Overall, the data analysis indicated a correlation between the ambient temperature and the method of storage. The Pelican Case, on average, recorded 3.2°C higher than the ambient temperature and the evacuation trunk and treatment team trunks measured 2.1°C and 1.5°C cooler than the ambient temperatures within their containers. This data was utilised to identify the trend of temperature fluctuations based on the average temperature of the training area in order to identify if the cold chain and supply methods were breached during the training exercise.

Pelican Case

The Pelican Case had a median temperature of 32°C ranging from 24.4°C to 41.8°C. The temperature within the Pelican Case exceeded 30°C on 90 different occasions including exceeding 40°C twice. The percentage of time that the medications were stored beyond the manufacturer’s recommended storage temperatures (25°C–30°C) was 33% for the task duration (Figure 10).

Evacuation and Treatment Team trunks

The data collected for the evacuation and treatment team trunks were similar with a median temperature of 27.6°C (evacuation trunk) and 26.9°C (treatment team trunk). While the temperatures within these trunks did not exceed 30°C, it was consistently over 25°C, which is significant (Figures 11 and 12) given that many of the items stored in these trunks are not recommended to exceed 25°C.
DISCUSSION

Size and dimension implications

While the results showed a number of fluctuations of the ambient temperature, a few key insights and trends were derived from the results including the percentage of time each storage equipment spent within a temperature range and the median heating/cooling rate of each piece of equipment in response to the ambient temperature.

The first major feature of Figure 9 was the difference between the temperature measured in the Pelican Case versus the evacuation trunk and treatment team trunk. This considerable difference between the three storage methods and recorded temperatures is likely attributed to the size of the container with the Pelican Case, a smaller sized storage method, recording a considerably higher rate of temperatures, consistently exceeding the recommended storage guidelines. This can be linked to a higher heating rate due to the significantly smaller physical dimensions. When considering size as a determinant factor, the evacuation and treatment team trunks recorded almost exactly the same in regards to the management of their internal temperatures and it is assessed that this is due to their similar physical dimensions.

The Pelican Case is also insulated with foam, which may help retain heat in the container. Alternatively, it could be related to where an integral medic stores their Pelican Case versus where the treatment team and evacuation trunks are stored.

Recommendation

For robust statistical analysis to occur, much larger sample sizes deployed in the same training area are required. It is also necessary to assess how each storage method responds when subjected to exactly the same conditions to determine if it is the containers causing the difference or the individual storage conditions.

It is recommended that in future studies a larger number of storage containers are deployed and tracked in the one training area to provide a greater sample size for analysis based on the proportionate time to heat or cool (relative to their size).

Correlation of ambient temperatures

Within the sets of these different geometrics, the derived heating range was used to provide a basic guideline for the impact that the ambient temperature had on the current storage methods. Using Table 4
as a guide, it is hypothesised that current storage methods require review and potential replacement if operating in any environment over 26°C (Pelican Case) or 28°C (evacuation and treatment team trunks) as these temperatures have an impact on the effectiveness of the Class 8 supplies by breaching the recommended storage range (25°C) of most thermolabile medications and temperature-sensitive diagnostics, dressings and fluids carried.

<table>
<thead>
<tr>
<th>Ambient temperature (°C)</th>
<th>Pelican Case (°C)</th>
<th>Evac trunk (°C)</th>
<th>Treatment Team trunk (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>29.2</td>
<td>23.9</td>
<td>24.5</td>
</tr>
<tr>
<td>28</td>
<td>31.2</td>
<td>25.9</td>
<td>26.5</td>
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<td>30</td>
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<td>35.9</td>
<td>36.5</td>
</tr>
<tr>
<td>40</td>
<td>43.2</td>
<td>37.9</td>
<td>38.5</td>
</tr>
</tbody>
</table>

Table 4. Hypothesised correlation of heating / cooling range and ambient temperature

Recommendation

Further studies are required in other ADF domestic training areas including the Northern Territory, NSW and southern Queensland in order to provide a larger sample size for analysis. This data will be imperative to provide a robust discussion on the impact of the provision of health support if this health support is to be deployed to the Middle East Region, which has considerably higher ambient temperatures during summer than Australia, and what the ramifications are if no changes are made to the current storage methods.

IMPACT ON THERMOLABILE MEDICATIONS AND TEMPERATURE-SENSITIVE DIAGNOSTICS, DRESSINGS AND FLUIDS

Effect of high-temperature exposure on administration methods

As noted in the results, all thermolabile medications and temperature-sensitive diagnostics, dressings and fluids were exposed to storage temperatures beyond their recognised manufacturer guidelines, which can have adverse impacts on the effectiveness of the medication when administered in a clinical setting. The absence of temperature control can expedite the products to expire in a shorter period of time. The inability for the current cold chain storage methods to maintain this recommended temperature can result in adverse effects when administering health support in remote training areas. Not only can the medications become inactive, but adverse reactions may occur.

Risk to drug administration

While it is likely that the exposed medications have been compromised in shelf life and efficacy, the true risk of medication degradation and patient safety associated with temperature fluctuations can only be identified and realised with further technical evaluation of these substances and products. The impacts on the medications vary by type, with a number of changes to the potency and effectiveness of administration. Semisolids, including creams like Bactroban, have been shown to exhibit changes in consistency and, as noted by Atia, this can result in a change to how the drug is released. Tablets, when exposed to temperatures higher than recommended, can have changes in their appearance due to the disintegration and an increase in density. At low relative humidity, disintegration time is increased, while at high relative humidity disintegration time decreases.

Recommendation

It is recommended that a separate study be conducted to analyse any changes to the efficacy and potency of the medications that exceed the recommended storage temperature using medications issued to 1 CHB clinicians for the purpose of a task. It is noted that the degradation of biological medicines is not usually amenable to kinetic analysis and extrapolation from accelerated testing which may affect the ability to test certain medications.

Risk to provision of health support

Despite the true risk remaining unidentifiable until further analysis takes place, what is known is that the deployed clinical environment already exposes patients to a higher degree of risk than that within a tertiary health facility. Defence members are already being treated and managed in austere environments with no temperature control and often with junior clinicians who generally have poor access to reliable communications for diagnostic support. These factors, coupled with medications, diagnostic tests and fluids that have potentially degraded due to heat exposure, have the potential to create significant diagnostic confusion and may subsequently result in suboptimal medical management of patients.
As per the Defence Health Manual, any clinical incidents involving ADF members can be reported through a suite of systems to identify the issues with the health care being provided. This includes defined Severity Assessment Codes (SAC) (Table 5) and reporting on clinical incidents and near misses through submissions of an AD441 – Health Incident Report. At all times, clinical incidents that have a work health and safety component which potentially or actually injures a worker or visitor must be reported via Sentinel.

The regular breach of recommended storage temperatures of thermolabile medications and temperature-sensitive diagnostics, dressings and fluids, and the subsequent impact on the ability to provide effective health care is considered a clinical incident and should therefore, be included as a near miss. When utilising the SAC, the risk to the individual is moderate. However, the likelihood is certain, which demonstrates the requirement for an action plan to be enforced for this issue and tracked by Joint Health Command (JHC) and the ADF Pharmacy and Therapeutics Committee every time a breach of the cold chain occurs.

**Recommendation**

That an interim solution of cold chain storage methods is employed to assist in the prevention of any future breaches and clinical incidents. Furthermore, it is recommended a review of the JHC SAC is conducted to include cold-chain breaches as a reportable incident and all incidents included for reporting review in all ADF Pharmacy and Therapeutics Committee meetings.

**Drug waste costs**

In accordance with the TGA (Sect 8.9), if a storage temperature is found to deviate from the

<table>
<thead>
<tr>
<th>SAC Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>Patient member requiring treatment only for expenses incurred.</td>
</tr>
<tr>
<td>Moderate</td>
<td>Patient member requiring treatment only for expenses incurred.</td>
</tr>
<tr>
<td>Serious</td>
<td>Patient member requiring treatment only for expenses incurred.</td>
</tr>
</tbody>
</table>

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manufacturer’s recommended temperature the manufacturer is to be contacted and the suitability of the medicine for use should be determined and the outcome recorded. Furthermore, as per the Defence Health Materiel Manual pharmaceuticals must be destroyed and disposed of when storage has affected the integrity of the item. The stock controlling pharmacist is also required to record the destruction of medicines in the pharmacy information system.

If an extreme breach is recorded, the recommended outcome is the destruction of the drug, which will have a financial impact for the ADF. It has been previously demonstrated that inefficiency of drug use and waste production may lead to a distinct economic loss. Using the 1 CHB Integral Medic Load List with the HLTHSPO Catalogue, the total cost of replacing all Class 8 stores (excluding consumables such as plasters, bandages and cups) would be $1772.37. These costs include the Pelican Case and the Integral Trunk with the contents of the Pelican Case equalling $280. Noting that the temperature within the Pelican Case exceeded 30°C 44 times over the period of this pilot study, the cost of replacing the contents within the Pelican Case for the duration of the exercise would be $12320 (excluding additional costs of transport and labour to enact these replacements) if the TGA requirements were to be enforced and all medications were deemed unsuitable for use.

As per Item 4 of the ADF Pharmacy and Therapeutics Committee meeting held 13 March 2018, the FY 17/18 Budget Achievement indicates a slight increase over the previous three years of the actual budget and beginning to exceed the forecast budget. Noting that cost analysis above, the budget would continue to be exceeded if the ADF is held accountable by the TGA and these destructions were to occur on a regular basis throughout all ADF training areas.

The SAC includes financial loss as a consideration for assessing the consequences of clinical incidents. The financial loss of less than $100K is considered minor; however, given the frequency of breaches the likelihood is certain.

Recommendation

JHC and the ADF Pharmacy and Therapeutics Committee conduct an analysis into current wastage versus forecasted IAW TGA guidelines of disposal and compare to the costs of purchasing cold chain specific equipment. It is also recommended that the destruction of any medical kits due to a breach of the cold chain be classified as a reportable incident and included for reporting review in all ADF Pharmacy and Therapeutics Committee meetings.

OVERALL RECOMMENDATIONS

While cold chain management can vary greatly in the levels of complexity, there are three principal tenants taken from this pilot study that are simple in nature. 

1. The current storage methods for thermolabile medications and temperature-sensitive diagnostics, dressings and fluids are not in accordance with the TGA.

2. There is a lack of communication, coordination and policy across the ADF Health Logistics space in regards to providing a viable cold chain system that meets national standards.

3. There is a lack of monitoring to inform decisions adequately regarding medication disposals.

4. Further studies are required in the various training areas to increase data and to provide a more thorough analysis. It is recommended that from these studies, the following objectives be met in conjunction with the Strategic Reform Program and the TGA requirements.

OBJECTIVE 1 – COMMENCE TRIALS OF COLD CHAIN SPECIFIC TECHNOLOGIES OR EQUIPMENT

There are a number of existing specific cold chain technologies and equipment currently employed by coalition military forces and national health organisations that could be trialled to identify a suitable in-service solution; beyond the existing general polymer trunk, for the maintenance of temperature ranges over a prolonged period. This includes both continuous monitoring systems and storage solutions. This trial will require collaboration with the LEA to ensure that the capability is serviceable as per the standards within the Defence ESCM.

Continuous monitoring – FreshLoc Temperature Monitoring System

Health information systems can significantly bolster cold chain management. The FreshLoc Temperature Monitoring System (TMP), used by the US Army, functions by continuously monitoring and recording temperatures of medication storage spaces with the ability to relay the readings wirelessly to the healthcare personnel via text, email or a phone call. This enables temperatures to be tracked continuously and allows healthcare personnel to intervene rapidly to maintain the correct temperature within the storage space. The flexibility and scalability of the system mean that it can monitor any location, from
cold storage to incubators, in any size facility and could be utilised as a health information system for the ADF and their management of cold chain.

Storage solution – the Cryopak CryoCube

The Cryopak CryoCube, a robust and reusable temperature-controlled product, can sustain a cold chain for prolonged durations ranging from 36 hours to 120 hours (Figure 13). The reusable insulated cube maintains a 2°C–8°C range for 120+ hours. The trunks require insulation panels to be frozen for a minimum 48 hours prior to a task commencing with a variety of sizes available and adequate for the current load configurations of treatment and evacuation teams. The use of this product would reduce the number of cold-chain breaches, specifically during the travel time, and would ensure that the provision of health support is IAW the TGA.

OBJECTIVE 2 – DEVELOP A CLEAR AND CONCISE SET OF SOPS, ENDORSED BY JOINT HEALTH COMMAND AND IN LINE WITH THE TGA, AND IMPLEMENT COLD CHAIN SPECIFIC TRAINING FOR HEALTH LOGISTIC OFFICERS

Delegating responsibility is critical to managing the many moving parts of the cold chain. Army demands from its people, a range of knowledge, a level of competence, and a degree of accountability for actions in the performance of duties, and the involvement of JHC in compiling and endorsing a cold chain directive for all ADF health personnel that will ensure the responsibilities in managing the various complexities of the cold chain are delegated appropriately.

Poor compliance with cold chain assurance is both the responsibility of the individual health care professional and their supporting formation. The creation of a targeted education program for Health Logistic Officers, with a measurable competency for the management of the cold chain, will address the identified issues of health planning, prevention measures for cold-chain breaches, limited understanding of medication management and the processes that must be followed if a cold-chain breach occurs. This will significantly improve the accountability of the Health Logistic Officers in not only maintaining a cold chain in accordance with national guidelines, but through the reduction of risk to the delivery of health care in remote training locations and reducing the cost of waste from the destruction of medications which exceed the manufacturers recommended storage temperatures.

Summary

Meeting these objectives will enable the ADF to qualify and quantify the temperature exposure of the medications and stores and engage with key stakeholders to trial and apply new technologies and processes for the management of the cold chain. This will include working with the TGA to meet the guidelines regarding commissioning of new

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Figure 13. CryoCube
Source: Cryopak A TCP Company, 2016
equipment for the storage of cold chain medicines (Sect 8.2), utilisation of temperature-monitoring equipment that is capable of alerting staff before a temperature range has been compromised (Sect 8.4), and establishment of procedures detailing the actions to be taken in the event of a deviation outside the defined temperature range (Sect 8.9).1

CONCLUSION

The role of the RAAMC is to contribute to the ADF's operational capability through the conservation of manpower by promoting health and wellbeing, through the prevention of disease and injury, and through the care, treatment and evacuation of sick and wounded.14) The inability for the current storage methods of thermolabile medications and temperature-sensitive diagnostics, dressings and fluids to maintain the recommended temperature, fails to ensure that the care, treatment and evacuation of ADF personnel in training areas are being achieved. Rather, this initial pilot study has provided evidence that patients are being exposed to higher treatment risks in the field than a civilian health facility. When considering the physical dispersion of Australian Army members within the training area analysed and the proximity of a civilian health care facility being over 45-minute drive away, there is potential for these compromised medications to affect the patient through significant diagnostic confusion. This creates an unacceptable level of risk to patients and commanders and is not in line with the 'train the way we fight' theory.

The inability of the Army to meet cold chain requirements for medications relates mainly to a lack of suitable storage equipment. However, poor health planning, complacency and poor understanding of medication management also contribute to the problem. From a risk management perspective, steps need to be taken to address each of these factors. Further research is required in this area to ensure that cold chain management is in line with TGA requirements while meeting the conditions of the Strategic Reform Project.

Corresponding author: Elizabeth Daly. Elizabeth.daly@defence.gov.au
Authors: E Daly1, N Evans, S Holmes-Brown
Author Affiliations:
1 1st Close Health Battalion

References
Appendix A – Pelican Case Tiny Tag Results

Appendix B – Evac Trunk Tiny Tag Results
Appendix C – Resupply Trunk Tiny Tag Results

![](image-url)

**RBG WARFIGHTER RESUP**

- Temperature RBG WARFIGHTER RESUP
Combat, Posttraumatic Stress Disorder and Health of Australian Vietnam Veteran Conscripts and Volunteers in the Three Decades After Return

B O'Toole, K Pierse, B Friedrich, S Outram, M Dadds, S Catts

Introduction

Australia’s involvement in the Vietnam conflict from 1962 until troop withdrawal in 1972 placed Australians into longer periods of risk of contact with an enemy than at any time in Australia’s history since Gallipoli. The Australian Force Vietnam increased in size in 1965 and 1966 and, in conjunction with the troop build-up, the Australian Government introduced conscription for overseas service to enhance the previous all-volunteer Army to levels that would sustain the campaign. In the early years of the conflict, National Servicemen (NSM) were used sparingly in Vietnam; however, as the conflict continued, they became indispensable to the Australian effort and eventually constituted approximately 48% of the Australian Force Vietnam. Registering at age 18, being balloted at 20, enlisting in the Army and serving until 22 became the destiny of nearly 64 000 young men of whom more than 19 000 served in Vietnam.

In Australia, the chances of entering the Army after being called up, and medically and psychologically examined, was only of the order of 1 in 16. Compared with Regular enlistment, conscription inevitably produced a different makeup of the force, often more educated, with higher socioeconomic standing and more stable pre-enlistment occupations. Both groups were arguably physically fitter than their non-military peers and presumably with less emotional instability.

Continued enlistment in the military is contingent upon maintenance of physical fitness. Thus, soldiers with longer military careers may be expected to be healthier than others suggesting that, compared with NSM, Regular soldiers might be healthier for the duration of their service than NSM of the same age who are not in service. Alternatively, military life places physical burdens on soldiers that would be more wearing the longer the exposure, although they may have greater access to medical and health services than their non-military peers. The implications of these competing hypotheses are yet to be tested.

Earlier Australian research into the potential health effects of Vietnam Service focused on NSM recruited solely to the Army. More recently, cancer incidence and mortality have been examined in the whole Vietnam Veteran population, including the Navy and Air Force, specifically in NSM; however, NSM were not compared with Regulars in any of those studies. Therefore, there are gaps in knowledge due to the lack of previous research in Australia, or militaries elsewhere in the world, that has directly examined whether volunteers or conscripts are at a differential risk of ill health in later life and, in particular, whether they differed in combat experiences. Generalising from research on NSM to regular enlistees, or vice versa, is difficult in the absence of comparative empirical data.

Research into the health of Veterans has shown that exposure to combat increases the risk of physical and psychological injury, particularly post-traumatic stress disorder (PTSD). This disorder was first codified in the American Psychiatric Association Diagnostic and Statistical Manual (DSM) in 1980; its prime progenitor in Veterans is combat. The prevalence of PTSD in Australian Vietnam Veterans has been reported as 20-30%, and its prime progenitor in Veterans is combat. The prevalence of PTSD in Australian Vietnam Veterans has been reported as 20-30%, and in particular heart disease and circulatory disease
and arthritis, alcohol use disorder, dysthymia and other disorders. PTSD itself is associated with a range of physical health conditions. Given the varying conditions in Vietnam over the course of the conflict and the increased deployment of NSM, the degree of combat may have been different for Regulars and NSM. If so, this might suggest that NSM would have different risks for PTSD and other physical and psychological disorders known to be associated with combat. Apart from combat, other aspects of service known to increase risk for PTSD include age at first deployment, rank and duration of exposure to the conflict zone. Differences between NSM and Regulars in these factors may suggest a differential risk of PTSD. However, the competing expectations arising from these considerations are yet to be tested empirically.

This paper reports analysis of data from a cohort study of a random sample of Australian Vietnam Veterans who were assessed 20 and 35 years after homecoming. The physical and mental health status of the whole cohort has been published previously and compared with national norms. This paper now describes the experiences of Australian NSM and Regular enlists during and after the Vietnam conflict and their socioeconomic, physical health and psychiatric status at two periods up to three decades following the war. We hypothesise that NSM and Regulars have had differential education, military training, service histories, and combat and combat zone exposure and expect that these may be followed by differential health status, including PTSD and other physical and psychological disorders.

Materials and Methods

Veterans were identified from a computer file developed during the Australian ‘Agent Orange’ studies holding the Army Service numbers of all men who were posted to Vietnam. From the total of 57,643 postings, after removing duplicates, a random sample of 1,000 numbers was selected. The Army supplied the name and date of birth of each man for tracing, contact and in-person interview. All Veterans signed formal consent before interview. Interviews occurred across Australia in Wave 1 between July 1990 and February 1993, and in Wave 2 between April 2005 and November 2006. Wave 1 was conducted an average of 14.18 years (SD = 1.92) after first return to Australia; Wave 2 an average of 36.10 years (SD = 1.92) after, with an inter-interview interval average of 14.18 years (SD = 1.92). Deaths were identified from electronic searches of the National Death Index of the Australian Institute of Health and Welfare.

Interview assessments comprised standardised questionnaire instruments selected to permit direct comparison with national population statistics and administered by trained clinical and research interviewers. In both waves, the study relied on the Australian Bureau of Statistics (ABS) methods used to gather national statistics on the health of the Australian population at approximate corresponding times, which enabled computation of relative prevalences compared with the Australian population.

The content of the interviews in both waves comprised a physical health interview, a clinical assessment of PTSD and standardised diagnostic assessment of general psychiatric status. Physical health was assessed using the ABS National Health Survey (NHS) for physical health and associated risk factors that were current at the time (the 1989/90 NHS in Wave 1 and the 2004/05 NHS in Wave 2). Conditions were coded to prevailing ICD-9/10 rubrics. Combat-related PTSD was assessed using the Structured Clinical Interview for DSM-III (SCID) in Wave 1 and the Clinician-Administered PTSD Scale for DSM-IV (CAPS) in Wave 2. General psychiatric status was assessed using the Diagnostic Interview Schedule (DIS) in Wave 1 and the Composite International Diagnostic Interview (CIDI) in Wave 2. The version of the CIDI (V2.1) was that used by the ABS in the Australian National Survey of Mental Health and Wellbeing, 1997.

Prior to Wave 1, fieldwork data were extracted from the Central Army Records and Psychology Corps Records Offices on the cohort. Data included service details (postings, dates, service milestones), conduct and casualty information, pre-enlistment education and employment and the results of Army psychology classification tests.

Combat was assessed from Army records based on the roles that individual units played, as advised by military advisers to previous Australian studies of Vietnam Veterans. The Army Combat Index grouped the units that had been present in Vietnam into six, depending on their role, presence on the field and their experience of combat and casualty risk. These were then weighted by the length of time each soldier was posted to each unit, aggregated over all tours, to produce a continuous scaled measure of exposure to combat that was independent of Veterans’ self-report.

Members of the research team, volunteer counsellors from the Vietnam Veterans Counselling Service (VVCS) or volunteer officers of the Australian Army Psychology Corps conducted interviews with Veterans.
in Wave 1. In Wave 2, interviews were conducted by author A and independent clinician-counsellors recruited via their then affiliation with the VVCS or the Australian Centre for Military and Veteran Health. Ethics approvals for Wave 1 were obtained from the Human Research Ethics Committees (HRECs) of Sydney and Queensland Universities; for Wave 2 from the HRECs of the Repatriation General Hospital Concord in Sydney, The University of Sydney, The Australian Government Department of Veterans Affairs, and the Australian Institute of Health and Welfare.

Data Analysis

Bivariate statistical tests compared regular soldiers with NSM using $\chi^2$ tests for categorical data and $t$-tests for continuous data. Multivariate logistic regression was used to compute Regular-NSM odds ratios (ORs) in three hierarchical models: Model 1 adjusted for age at interview; Model 2 adjusted for age at interview and Army Combat Index; Model 3 added other potentially important confounding variables that were identified from bivariate analysis of Army data. Statistical analysis used SPSS V14.0; two-sided statistical significance was set at $\alpha = 0.05$.

RESULTS

In Wave 1, 641 Veterans participated, which was 87% of locatable Veterans and 67.5% of those not known to have died (n = 50). In Wave 2, 450 Veterans participated, which was 51.4% of those not known to have died (n = 125) and 79.4% of those who could be located; 391 Veterans participated in both waves. In Wave 1, 309 NSM and 332 Regulars were interviewed (67.6% and 67.5% of surviving NSM and Regulars respectively) and in Wave 2, 209 NSM and 241 Regulars were interviewed (48.6% and 54.2% of surviving NSM and Regulars respectively). There were no differences in response rates between NSM and Regulars at either wave.

Comparing respondents with alive non-respondents using the Army data revealed only two significant items: the (intelligence) test AGC (OR = 1.12, 95%CI: 1.06, 1.18) and having a charge of Absent Without Leave (AWOL) after return to Australia (OR = 1.52, 95%CI: 1.11, 2.09). A similar result was found for Veterans who responded in both waves (AGC: OR = 1.15, 95%CI: 1.09, 1.21; AWOL: OR = 1.93, 95%CI: 1.27, 2.93), indicating that respondents overall were generally more intelligent and more affiliative toward the armed services.

Table 1 shows temporal information on the Veterans: Regulars were born on average during World War II, five years before NSM and enlisted five years earlier at younger ages. Regulars had fewer years of school before enlistment, were older at first deployment to Vietnam and had longer pre-deployment Army Service. Their first tour was longer, their total duration in Vietnam was longer, and their durations of Army Service after Vietnam and overall were longer than the NSM. There was no difference in their AGC (intelligence test) scores but Regulars scored significantly higher on the Army Combat Index.

There were more Regulars (18.3%) than NSM (8.6%) who had a pre-enlistment ‘criminal record’ (mainly petty crimes; a serious record would preclude enlistment) (OR = 2.37, 95%CI: 1.61,3.50; $\chi^2 = 19.658$ (df = 1), $P <0.0005$) and more NSM (19.6%) than Regulars (8.6%) who had trade training before enlistment (OR = 2.60, 95%CI: 1.75, 3.87; $\chi^2 = 23.432$ (df = 2), $P <0.0005$). Corps allocation was dissimilar for NSM and Regulars ($\chi^2 = 12.819$, df = 4, $P = 0.012$); NSM were more likely to be in Infantry than Regulars were (OR = 1.40, 95%CI: 1.08, 1.80). Rank in Vietnam also discriminated NSM from Regulars ($\chi^2 = 231.246$, df = 4, $P <0.0005$): only 1.7% of NS were officers, compared with 12.2% of Regulars; no NSM were NCOs compared with 5.3% of Regulars; only 0.2% of NS were Sergeants compared with 15.1% of Regulars; 12.6% of NSM were Corporals compared with 25.8% of Regulars, but 85.5% of NSM were Privates compared with 41.6% of Regulars.

Table 2 shows the proportion deceased, the age at interview, the marital and employment status and incomes of NSM and Regulars. More Regulars were deceased by Wave 2, consistent with their birth cohort. Marital status was not different at either wave. More NSM were employed full-time and fewer were retired at both waves, but their income distributions were similar.

Tables 3–6 show prevalences of health conditions and ORs and 95% confidence intervals from hierarchical logistic regression models adjusted firstly for age, (Model 1), then age and Army Combat Index (Model 2), then age, Army Combat Index, plus an additional set of potential confounders. This strategy was chosen because age is an obvious confounder for health conditions and adding combat allows the comparison between NSM and Regulars to take into account different combat exposures and tests the effect of combat on each endpoint adjusted for age. The potential confounding variables comprised birth cohort (year of birth), age at deployment, durations of Army Service before, during, post-Vietnam and total, and rank in Vietnam.
Table 1. Means and Standard Deviations (in Parentheses) for Continuous Data From Army Records for Australian National Servicemen (NSM) (n = 309) and Regular Enlisted (n = 332) Vietnam Veterans, and t-statistics, degrees of freedom (in Parentheses) and statistical significance for t-tests comparing the two groups.

<table>
<thead>
<tr>
<th></th>
<th>NSM</th>
<th>Regular</th>
<th>t (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of birth</td>
<td>1947.25 (1.81)</td>
<td>1942.46 (7.18)</td>
<td>14.761 (595.971)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Enlistment date</td>
<td>1968.03 (1.70)</td>
<td>1962.57 (6.01)</td>
<td>19.921 (613.980)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Age at enlistment</td>
<td>20.78 (0.70)</td>
<td>20.11 (3.39)</td>
<td>4.411 (572.003)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Age at 1st deployment</td>
<td>21.81 (1.29)</td>
<td>25.81 (6.84)</td>
<td>13.132 (564.187)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Years of schooling</td>
<td>9.96 (1.30)</td>
<td>9.38 (1.43)</td>
<td>t = 6.079 (783.507)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>AGC Score</td>
<td>13.33 (3.63)</td>
<td>13.16 (3.44)</td>
<td>0.733 (856)</td>
<td>0.464</td>
</tr>
<tr>
<td>Years of service pre-Vietnam</td>
<td>1.04 (0.95)</td>
<td>5.70 (5.60)</td>
<td>18.791 (556.235)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Duration of first tour (yrs)</td>
<td>0.77 (0.25)</td>
<td>0.83 (0.31)</td>
<td>3.434 (983.672)</td>
<td>0.001</td>
</tr>
<tr>
<td>Total duration of Vietnam Service (yrs)</td>
<td>0.77 (0.25)</td>
<td>0.94 (0.43)</td>
<td>7.581 (562.6524)</td>
<td>&lt;0.0005</td>
</tr>
<tr>
<td>Duration of post-Vietnam Service (yrs)</td>
<td>0.62 (2.28)</td>
<td>7.64 (6.64)</td>
<td>22.799 (655.423)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Duration of Army Service (yrs)</td>
<td>2.43 (2.76)</td>
<td>14.60 (9.02)</td>
<td>29.418 (629.135)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Army combat index</td>
<td>2.88 (1.48)</td>
<td>3.47 (2.42)</td>
<td>3.126 (403.459)</td>
<td>.002</td>
</tr>
</tbody>
</table>

*AGC*  Army General Classification Test
Table 2. Demographic Characteristics of Australian NSM and Regular Enlisted Vietnam Veterans at Wave 1 (July 1990 - February 1993; n = 309 and 332 respectively) and Wave 2 (April 2005 – November 2006; n = 209 and 241 respectively) and Statistical Tests (t-statistics or Chi Square) and P-values for tests comparing the two groups.

<table>
<thead>
<tr>
<th></th>
<th>NSM</th>
<th>Regular</th>
<th>t or χ² (df)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deceased Wave 1</td>
<td>3.6%</td>
<td>6.3%</td>
<td>χ² = 3.846 (1)</td>
<td>.050</td>
</tr>
<tr>
<td>Deceased Wave 2</td>
<td>9.5%</td>
<td>15.2%</td>
<td>χ² = 7.756 (1)</td>
<td>.006</td>
</tr>
<tr>
<td>Mean (SD) age at Wave 1 (yrs)</td>
<td>44.11 (1.63)</td>
<td>48.85 (7.07)</td>
<td>t = 11.883 (368.461)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Mean (SD) age at Wave 2 (yrs)</td>
<td>58.25 (1.75)</td>
<td>62.35 (6.39)</td>
<td>9.556 (281.326)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Marital Status Wave 1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>86.3%</td>
<td>86.6%</td>
<td>χ² = 7.883 (4)</td>
<td>.096</td>
</tr>
<tr>
<td>Widower</td>
<td>0.0%</td>
<td>1.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>3.4%</td>
<td>3.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>5.1%</td>
<td>6.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Married</td>
<td>5.1%</td>
<td>2.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Marital Status Wave 2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>78.8%</td>
<td>77.5%</td>
<td>χ² = 3.016 (4)</td>
<td>.555</td>
</tr>
<tr>
<td>Widower</td>
<td>2.4%</td>
<td>2.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated</td>
<td>2.9%</td>
<td>5.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Divorced</td>
<td>12.0%</td>
<td>9.2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never Married</td>
<td>3.8%</td>
<td>5.0%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean (SD) annual income Wave 1</td>
<td>838 064 (17 343)</td>
<td>838 289 (23 751)</td>
<td>t = 0.134 (577.928)</td>
<td>.893</td>
</tr>
<tr>
<td>Mean (SD) annual income Wave 2</td>
<td>852 596 (111 598)</td>
<td>840 539 (38 831)</td>
<td>t = 1.560 (440)</td>
<td>.119</td>
</tr>
<tr>
<td>Employment Wave 1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed full-time</td>
<td>27.1%</td>
<td>17.5%</td>
<td>χ² = 29.831 (4)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Employed part-time</td>
<td>10.6%</td>
<td>6.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not employed</td>
<td>21.7%</td>
<td>22.1%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanently unable</td>
<td>40.6%</td>
<td>43.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Retired</td>
<td>0.0%</td>
<td>10.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employment Wave 2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employed full-time</td>
<td>27.2%</td>
<td>17.6%</td>
<td>χ² = 29.905 (4)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Employed part-time</td>
<td>10.7%</td>
<td>6.3%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not employed</td>
<td>21.8%</td>
<td>21.8%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanently unable</td>
<td>40.3%</td>
<td>43.5%</td>
<td></td>
<td></td>
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<tr>
<td>Retired</td>
<td>0.0%</td>
<td>10.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking status Wave 1:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>32.0%</td>
<td>37.7%</td>
<td>χ² = 22.379 (2)</td>
<td>&lt;.0005</td>
</tr>
<tr>
<td>Former smoker</td>
<td>35.6%</td>
<td>45.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>32.4%</td>
<td>16.4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoking status wave 2:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>18.3%</td>
<td>20.7%</td>
<td>χ² = 2.191 (2)</td>
<td>.334</td>
</tr>
<tr>
<td>Former smoker</td>
<td>54.3%</td>
<td>57.9%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>27.4%</td>
<td>21.5%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diagnosis</td>
<td>NSM (n = 309) (%)</td>
<td>Regular (n = 332) (%)</td>
<td>Model 1 OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------</td>
<td>----------------------</td>
<td>------------</td>
<td>----------</td>
</tr>
<tr>
<td>Infectious &amp; parasitic disease</td>
<td>3.6</td>
<td>4.8</td>
<td>1.92</td>
<td>0.86, 4.28</td>
</tr>
<tr>
<td>Cancer</td>
<td>7.4</td>
<td>8.1</td>
<td>0.95</td>
<td>0.49, 1.82</td>
</tr>
<tr>
<td>Hypercholesterolaemia</td>
<td>11.3</td>
<td>10.8</td>
<td>0.91</td>
<td>0.53, 1.58</td>
</tr>
<tr>
<td>Diabetes</td>
<td>3.2</td>
<td>4.5</td>
<td>0.90</td>
<td>0.35, 2.36</td>
</tr>
<tr>
<td>Gout</td>
<td>10.7</td>
<td>8.1</td>
<td>0.47*</td>
<td>0.24, 0.91</td>
</tr>
<tr>
<td>Other endocrine conditions</td>
<td>5.8</td>
<td>6.3</td>
<td>1.27</td>
<td>0.64, 2.54</td>
</tr>
<tr>
<td>Nerves</td>
<td>11.0</td>
<td>10.8</td>
<td>1.13</td>
<td>0.67, 2.54</td>
</tr>
<tr>
<td>Depression</td>
<td>2.9</td>
<td>1.5</td>
<td>0.58</td>
<td>0.18, 1.92</td>
</tr>
<tr>
<td>Other mental disorders</td>
<td>6.1</td>
<td>4.5</td>
<td>0.79</td>
<td>0.37, 1.69</td>
</tr>
<tr>
<td>Disorders of refraction</td>
<td>44.0</td>
<td>53.3</td>
<td>1.06</td>
<td>0.75, 1.50</td>
</tr>
<tr>
<td>Deafness</td>
<td>28.5</td>
<td>31.9</td>
<td>0.95</td>
<td>0.65, 1.39</td>
</tr>
<tr>
<td>Migraine</td>
<td>7.1</td>
<td>6.6</td>
<td>1.13</td>
<td>0.59, 2.17</td>
</tr>
<tr>
<td>Other nervous system</td>
<td>11.0</td>
<td>14.2</td>
<td>1.11</td>
<td>0.65, 1.88</td>
</tr>
<tr>
<td>Hypertension</td>
<td>16.2</td>
<td>20.5</td>
<td>1.11</td>
<td>0.71, 1.88</td>
</tr>
<tr>
<td>Heart disease</td>
<td>1.3</td>
<td>5.7</td>
<td>3.77*</td>
<td>1.19, 11.95</td>
</tr>
<tr>
<td>Haemorrhoids</td>
<td>11.3</td>
<td>13.6</td>
<td>1.25</td>
<td>0.75, 2.95</td>
</tr>
<tr>
<td>Other circulatory conditions</td>
<td>4.2</td>
<td>11.1</td>
<td>2.35*</td>
<td>1.16, 4.76</td>
</tr>
<tr>
<td>Hayfever</td>
<td>21.4</td>
<td>16.9</td>
<td>0.73</td>
<td>0.47, 1.13</td>
</tr>
<tr>
<td>Asthma</td>
<td>3.6</td>
<td>4.2</td>
<td>1.13</td>
<td>0.46, 2.74</td>
</tr>
<tr>
<td>Bronchitis</td>
<td>8.1</td>
<td>9.0</td>
<td>0.95</td>
<td>0.51, 1.78</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>NSM (n = 309) (%)</td>
<td>Regular (n = 332) (%)</td>
<td>Model 1 OR 95% CI</td>
<td>Model 2 OR 95% CI</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------------</td>
<td>-----------------------</td>
<td>-------------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Other respiratory</td>
<td>4.9</td>
<td>4.2</td>
<td>0.85</td>
<td>0.37, 1.95</td>
</tr>
<tr>
<td>Ulcer</td>
<td>7.1</td>
<td>6.6</td>
<td>1.23</td>
<td>0.28, 1.25</td>
</tr>
<tr>
<td>Hernia</td>
<td>6.8</td>
<td>9.6</td>
<td>1.23</td>
<td>0.65, 2.34</td>
</tr>
<tr>
<td>Other digestive disorders</td>
<td>8.1</td>
<td>9.9</td>
<td>1.09</td>
<td>0.59, 2.00</td>
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<tr>
<td>Genitourinary diseases</td>
<td>2.9</td>
<td>4.2</td>
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<td>0.55, 3.54</td>
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<tr>
<td>Skin rash</td>
<td>5.5</td>
<td>8.1</td>
<td>1.87</td>
<td>0.96, 3.61</td>
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<td>Eczema</td>
<td>15.2</td>
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<tr>
<td>Other skin conditions</td>
<td>6.1</td>
<td>7.8</td>
<td>1.40</td>
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<tr>
<td>Arthritis</td>
<td>8.7</td>
<td>21.1</td>
<td>2.47**</td>
<td>1.48, 4.12</td>
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<td>Rheumatism</td>
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<td>3.0</td>
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<td>0.64, 5.49</td>
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<td>Back disorder</td>
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<td>Other musculoskeletal</td>
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<td>0.95</td>
<td>0.12, 7.34</td>
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<td>Injury</td>
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<td>0.81, 3.04</td>
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<td>Symptoms and signs</td>
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<td>0.71</td>
<td>0.39, 1.30</td>
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* P < 0.05  ** P < 0.01
Table 4. Prevalence of ICD-10 conditions in Wave 1 and ORs and 95% CIs Comparing NSM with Regular Enlistees; Model 1 adjusted for age, Model 2 adjusted for age and combat, Model 3 adjusted for age, combat, date of birth, age at deployment, durations of Army Service before, during and post-Vietnam, and rank in Vietnam.

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSM (%) (n = 309)</th>
<th>Regular (%) (n = 332)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
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</thead>
<tbody>
<tr>
<td>Infectious and parasitic disease</td>
<td></td>
<td></td>
<td>0.98</td>
<td>0.34, 2.81</td>
<td>1.01</td>
<td>0.35, 2.94</td>
<td>1.18</td>
<td>0.30, 4.60</td>
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<tr>
<td>- Skin</td>
<td>40.4</td>
<td>39.3</td>
<td>0.90</td>
<td>0.59, 1.36</td>
<td>0.92</td>
<td>0.60, 1.40</td>
<td>1.00</td>
<td>0.59, 1.68</td>
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<td>- Melanoma</td>
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<td>9.5</td>
<td>1.14</td>
<td>0.56, 2.29</td>
<td>1.19</td>
<td>0.58, 2.45</td>
<td>1.20</td>
<td>0.49, 2.94</td>
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<tr>
<td>- Prostate</td>
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<td>1.78</td>
<td>0.1, 6.28</td>
<td>1.89</td>
<td>0.53, 6.75</td>
<td>0.60</td>
<td>0.12, 3.05</td>
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<td>Endocrine, nutritional and metabolic diseases:</td>
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<td>- Disorders of the thyroid gland</td>
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<td>2.5</td>
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<td>1.91</td>
<td>0.51, 7.19</td>
<td>3.18</td>
<td>0.67, 15.03</td>
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<td>- Diabetes Mellitus Type 2</td>
<td>7.7</td>
<td>15.7</td>
<td>2.32*</td>
<td>1.21, 4.45</td>
<td>2.32*</td>
<td>1.19, 4.49</td>
<td>2.27*</td>
<td>1.02, 5.06</td>
</tr>
<tr>
<td>- High sugar levels in blood or urine</td>
<td>9.1</td>
<td>6.2</td>
<td>0.84</td>
<td>0.40, 1.75</td>
<td>0.82</td>
<td>0.39, 1.73</td>
<td>0.76</td>
<td>0.28, 2.07</td>
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<tr>
<td>- High cholesterol</td>
<td>43.3</td>
<td>40.5</td>
<td>1.02</td>
<td>0.68, 1.54</td>
<td>1.04</td>
<td>0.69, 1.58</td>
<td>0.97</td>
<td>0.57, 1.63</td>
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<tr>
<td>Mental and behavioural problems</td>
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<td></td>
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<tr>
<td>- Alcohol and drug problems</td>
<td>17.3</td>
<td>14.0</td>
<td>1.00</td>
<td>0.58, 1.70</td>
<td>0.96</td>
<td>0.55, 1.65</td>
<td>1.10</td>
<td>0.55, 2.20</td>
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<tr>
<td>- Mood (affective) problems</td>
<td>43.8</td>
<td>32.6</td>
<td>0.81</td>
<td>0.53, 1.22</td>
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<td>0.47, 1.11</td>
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<tr>
<td>- Anxiety and related problems</td>
<td>54.8</td>
<td>49.6</td>
<td>1.10</td>
<td>0.73, 1.66</td>
<td>0.97</td>
<td>0.64, 1.48</td>
<td>1.14</td>
<td>0.68, 1.94</td>
</tr>
<tr>
<td>- Other psychological problems</td>
<td>1.9</td>
<td>2.9</td>
<td>1.95</td>
<td>0.55, 6.97</td>
<td>2.10</td>
<td>0.58, 7.59</td>
<td>3.11</td>
<td>0.69, 14.05</td>
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<td>Diseases of the nervous system:</td>
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<tr>
<td>- Migraine</td>
<td>10.1</td>
<td>9.9</td>
<td>1.33</td>
<td>0.69, 2.54</td>
<td>1.31</td>
<td>0.68, 2.54</td>
<td>1.06</td>
<td>0.44, 2.57</td>
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<tr>
<td>- Other diseases of the nervous system</td>
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<td>2.1</td>
<td>0.71</td>
<td>0.19, 2.65</td>
<td>0.82</td>
<td>0.21, 3.14</td>
<td>0.52</td>
<td>0.08, 3.36</td>
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<tr>
<td>Diseases of the eye and adnexa:</td>
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<tr>
<td>- Cataract</td>
<td>2.9</td>
<td>9.9</td>
<td>2.45</td>
<td>0.90, 6.63</td>
<td>2.36</td>
<td>0.86, 6.50</td>
<td>2.35</td>
<td>0.73, 7.53</td>
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<tr>
<td>- Glaucoma</td>
<td>1.0</td>
<td>2.5</td>
<td>1.82</td>
<td>0.30, 10.93</td>
<td>1.45</td>
<td>0.22, 9.43</td>
<td>2.72</td>
<td>0.36, 20.56</td>
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<tr>
<td>- Other disorders of the choroid and retina</td>
<td>1.4</td>
<td>2.1</td>
<td>0.73</td>
<td>0.13, 4.28</td>
<td>0.82</td>
<td>0.14, 4.82</td>
<td>1.27</td>
<td>0.17, 9.74</td>
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### Diseases of the eye and adnexa

<table>
<thead>
<tr>
<th></th>
<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td>Astigmatism</td>
<td>3.8</td>
<td>3.3</td>
<td>1.09</td>
<td>0.39, 1.19</td>
<td>0.42, 0.49</td>
<td>0.10, 2.44</td>
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<tr>
<td>Presbyopia</td>
<td>47.1</td>
<td>41.3</td>
<td>0.76</td>
<td>0.51, 0.75</td>
<td>0.50, 0.89</td>
<td>0.51, 1.58</td>
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### Diseases of the ear and mastoid:

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<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
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</thead>
<tbody>
<tr>
<td>Complete or partial deafness</td>
<td>4.3</td>
<td>2.1</td>
<td>1.12</td>
<td>0.72, 0.98</td>
<td>0.63, 0.93</td>
<td>0.53, 1.64</td>
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<tr>
<td>Tinnitus</td>
<td>46.2</td>
<td>43.8</td>
<td>0.97</td>
<td>0.65, 0.91</td>
<td>0.60, 0.79</td>
<td>0.47, 1.33</td>
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### Diseases of the circulatory system:

<table>
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<tr>
<th></th>
<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertensive disease</td>
<td>39.9</td>
<td>45.0</td>
<td>1.23</td>
<td>0.82, 0.82</td>
<td>1.85, 1.84</td>
<td>0.82, 2.36</td>
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### Ischaemic heart disease:

<table>
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<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angina</td>
<td>6.7</td>
<td>12.4</td>
<td>1.63</td>
<td>0.79, 0.73</td>
<td>0.73, 1.51</td>
<td>0.62, 3.64</td>
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<tr>
<td>Other ischaemic heart disease</td>
<td>7.7</td>
<td>17.8</td>
<td>1.97*</td>
<td>1.01, 1.88</td>
<td>0.96, 2.36*</td>
<td>1.07, 5.20</td>
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### Cerebrovascular disease:

<table>
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<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tachycardia</td>
<td>10.6</td>
<td>17.8</td>
<td>0.75</td>
<td>0.37, 0.79</td>
<td>0.39, 0.65</td>
<td>0.26, 1.60</td>
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### Oedema and heart failure:

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<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases of arteries, arterioles and capillaries</td>
<td>8.7</td>
<td>9.1</td>
<td>0.91</td>
<td>0.44, 0.97</td>
<td>0.47, 0.76</td>
<td>0.30, 1.97</td>
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### Haemorrhoids:

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<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varicose veins</td>
<td>5.3</td>
<td>8.7</td>
<td>1.82</td>
<td>0.79, 0.70</td>
<td>0.83, 2.62</td>
<td>0.98, 6.97</td>
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### Low blood pressure:

<table>
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<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
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<tbody>
<tr>
<td>Other diseases of the circulatory system</td>
<td>1.0</td>
<td>2.1</td>
<td>1.94</td>
<td>0.33, 1.59</td>
<td>0.25, 0.69</td>
<td>0.06, 7.62</td>
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### Symptoms and signs involving the circulatory system:

<table>
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<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
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<tbody>
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*NSM: Not Specified Medical
*CI: Confidence Interval
<table>
<thead>
<tr>
<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
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<tbody>
<tr>
<td><strong>Cardiac murmurs and sounds</strong></td>
<td>5.8</td>
<td>9.9</td>
<td>1.13</td>
<td>0.49, 2.59</td>
<td>0.97</td>
<td>0.41, 2.29</td>
<td>0.99</td>
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</tbody>
</table>

**Diseases of the respiratory system:**

**Chronic lower respiratory disease:**

- Bronchitis | 12.0 | 12.0 | 0.88 | 0.47, 1.66 | 0.87 | 0.46, 1.66 | 0.93 | 0.42, 2.07 |
- Emphysema | 5.8 | 6.6 | 1.22 | 0.53, 2.78 | 1.18 | 0.51, 2.75 | 1.74 | 0.64, 4.73 |
- Asthma | 11.1 | 15.3 | 1.25 | 0.68, 2.31 | 1.21 | 0.65, 2.26 | 0.87 | 0.39, 1.92 |

**Other diseases of the respiratory system:**

- Hayfever and allergic rhinitis | 23.1 | 21.5 | 1.10 | 0.69, 1.77 | 1.07 | 0.66, 1.74 | 1.04 | 0.57, 1.92 |
- Chronic sinusitis | 25.5 | 24.4 | 1.06 | 0.67, 1.68 | 1.09 | 0.68, 1.74 | 0.92 | 0.50, 1.67 |
- Other diseases of the respiratory system | 12.5 | 13.2 | 0.95 | 0.52, 1.76 | 0.94 | 0.50, 1.75 | 0.95 | 0.44, 2.06 |

**Diseases of the digestive system:**

**Diseases of the oesophagus, stomach and duodenum:**

- Diseases of the oesophagus | 4.8 | 4.1 | 1.17 | 0.45, 3.04 | 1.10 | 0.41, 2.94 | 1.15 | 0.32, 4.21 |
- Stomach/duodenal/gastrointestinal ulcer | 9.1 | 12.4 | 1.24 | 0.64, 2.42 | 1.21 | 0.61, 2.38 | 1.32 | 0.57, 3.02 |
- Hernia | 13.5 | 16.5 | 1.13 | 0.64, 2.01 | 1.08 | 0.60, 1.95 | 1.27 | 0.63, 2.60 |

**Other diseases of the intestines:**

- Irritable bowel syndrome | 1.4 | 2.9 | 1.91 | 0.44, 8.25 | 2.07 | 0.48, 9.02 | 0.62 | 0.08, 4.99 |
- Gallstones | 1.4 | 2.9 | 2.41 | 0.59, 9.89 | 1.75 | 0.40, 7.74 | 1.60 | 0.27, 9.66 |

**Diseases of the skin and subcutaneous tissue:**

- Dermatitis and eczema | 3.4 | 2.5 | 0.88 | 0.28, 2.82 | 0.73 | 0.22, 2.47 | 0.18 | 0.02, 1.36 |
- Psoriasis | 8.7 | 5.4 | 0.66 | 0.30, 1.46 | 0.69 | 0.31, 1.55 | 0.89 | 0.31, 2.50 |
- Other diseases of the skin and subcutaneous tissue | 6.7 | 6.2 | 0.88 | 0.38, 2.01 | 0.84 | 0.36, 1.96 | 1.09 | 0.39, 3.08 |

**Diseases of the musculoskeletal system and connective tissue:**

**Arthropies:**

- Gout | 23.1 | 22.7 | 0.80 | 0.49, 1.31 | 0.75 | 0.45, 1.25 | 0.69 | 0.37, 1.31 |
### Table: Prevalence of Diseases

<table>
<thead>
<tr>
<th>Disease Category</th>
<th>NSM (n = 309) (%)</th>
<th>Regular (n = 332) (%)</th>
<th>Model 1 OR 95% CI</th>
<th>Model 2 OR 95% CI</th>
<th>Model 3 OR 95% CI</th>
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<tbody>
<tr>
<td><strong>Osteoarthritis</strong></td>
<td>27.9</td>
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<td>1.63, 2.82</td>
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<td><strong>Rheumatoid arthritis</strong></td>
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<td>0.83, 2.29</td>
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<td>0.34, 2.06</td>
<td>0.96, 2.81</td>
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<td><strong>Arthritis other and type unknown</strong></td>
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<td>1.41, 2.66</td>
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<td></td>
<td>0.75, 2.66</td>
<td>1.39, 3.02</td>
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<tr>
<td><strong>Other arthropies</strong></td>
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<td>0.74, 6.90</td>
<td>2.21, 6.86</td>
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<td>0.71, 6.86</td>
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<td><strong>Soft tissue disorders</strong></td>
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<tr>
<td><strong>Rheumatism</strong></td>
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<td><strong>Other soft tissue disorders</strong></td>
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<td>0.52</td>
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<td>0.59, 3.63</td>
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<td>0.97, 7.27</td>
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<td><strong>Dorsopathies</strong></td>
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<td><strong>Disc disorders</strong></td>
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<td>1.54, 2.46</td>
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<td>0.97, 2.46</td>
<td>1.74, 3.11</td>
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<td><strong>Back pain/problems</strong></td>
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<td>40.5</td>
<td>1.00</td>
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<td>0.99, 1.51</td>
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<td>1.00, 1.69</td>
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<td><strong>Diseases of the genitourinary system</strong></td>
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<td><strong>Urinary calculus</strong></td>
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<td>0.87, 2.64</td>
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<td></td>
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<td>0.29, 2.64</td>
<td>0.43, 1.90</td>
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<tr>
<td><strong>Symptoms, signs and conditions nec</strong></td>
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<td><strong>Speech difficulties</strong></td>
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<td>1.86</td>
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<td>1.49, 12.69</td>
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<td><strong>Allergy- (undefined)</strong></td>
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<td>0.49, 2.88</td>
<td>1.55, 4.84</td>
</tr>
<tr>
<td><strong>Other symptoms and signs not elsewhere classified</strong></td>
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<td>9.5</td>
<td>1.27</td>
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<td>1.32, 2.74</td>
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<td>0.64, 2.74</td>
<td>1.38, 3.38</td>
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</tbody>
</table>

* P < 0.05  ** P < 0.01
Table 5. Prevalence of DSM-III-R conditions in Wave 1 and ORs and 95% CIs Comparing NSM with Regular Enlistees; Model 1 adjusted for age, Model 2 adjusted for age and combat, Model 3 adjusted for age, combat, date of birth, age at deployment, durations of Army Service before, during and post-Vietnam, and rank in Vietnam.

<table>
<thead>
<tr>
<th>Condition</th>
<th>National Service man (%)</th>
<th>Regular (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol abuse or dependence</td>
<td>39.8</td>
<td>41.3</td>
<td>1.40</td>
<td>0.99, 1.98</td>
<td>1.35</td>
<td>0.95, 1.92</td>
<td>1.55</td>
<td>0.99, 2.45</td>
</tr>
<tr>
<td>Drug abuse or dependence</td>
<td>2.3</td>
<td>2.2</td>
<td>1.40</td>
<td>0.48, 4.06</td>
<td>1.40</td>
<td>0.47, 4.14</td>
<td>4.52*</td>
<td>1.12, 18.16</td>
</tr>
<tr>
<td>Depression</td>
<td>6.8</td>
<td>5.1</td>
<td>0.90</td>
<td>0.45, 1.82</td>
<td>0.89</td>
<td>0.43, 1.81</td>
<td>1.34</td>
<td>0.54, 3.28</td>
</tr>
<tr>
<td>Depression (NOS)</td>
<td>11.4</td>
<td>7.7</td>
<td>0.94</td>
<td>0.54, 1.63</td>
<td>0.96</td>
<td>0.56, 1.73</td>
<td>1.73</td>
<td>0.82, 3.64</td>
</tr>
<tr>
<td>Melancholia</td>
<td>4.2</td>
<td>2.7</td>
<td>0.84</td>
<td>0.34, 2.06</td>
<td>0.81</td>
<td>0.32, 2.02</td>
<td>1.41</td>
<td>0.43, 4.56</td>
</tr>
<tr>
<td>Dysthymia</td>
<td>10.0</td>
<td>7.8</td>
<td>0.85</td>
<td>0.47, 1.54</td>
<td>0.80</td>
<td>0.44, 1.47</td>
<td>1.21</td>
<td>0.56, 2.56</td>
</tr>
<tr>
<td>Gambling disorder</td>
<td>4.5</td>
<td>3.3</td>
<td>1.07</td>
<td>0.48, 2.42</td>
<td>1.10</td>
<td>0.48, 2.51</td>
<td>0.96</td>
<td>0.25, 3.72</td>
</tr>
<tr>
<td>Antisocial personality disorder</td>
<td>4.5</td>
<td>6.6</td>
<td>2.02</td>
<td>0.99, 4.11</td>
<td>1.88</td>
<td>0.91, 3.90</td>
<td>3.64*</td>
<td>1.51, 8.80</td>
</tr>
<tr>
<td>Generalised anxiety disorder</td>
<td>9.4</td>
<td>5.1</td>
<td>0.68</td>
<td>0.36, 1.31</td>
<td>0.63</td>
<td>0.32, 1.24</td>
<td>0.73</td>
<td>0.29, 1.84</td>
</tr>
<tr>
<td>Posttraumatic stress disorder</td>
<td>21.8</td>
<td>20.1</td>
<td>1.13</td>
<td>0.75, 1.70</td>
<td>1.09</td>
<td>0.71, 1.65</td>
<td>1.93*</td>
<td>1.14, 3.29</td>
</tr>
<tr>
<td>Obsessive Compulsive disorder</td>
<td>2.6</td>
<td>2.4</td>
<td>0.29</td>
<td>0.06, 1.40</td>
<td>0.31</td>
<td>0.06, 1.50</td>
<td>0.42</td>
<td>0.01, 1.51</td>
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<tr>
<td>Panic disorder</td>
<td>4.2</td>
<td>2.1</td>
<td>0.72</td>
<td>0.28, 1.84</td>
<td>0.66</td>
<td>0.25, 1.74</td>
<td>1.99</td>
<td>0.45, 8.96</td>
</tr>
<tr>
<td>Agoraphobia</td>
<td>7.4</td>
<td>4.2</td>
<td>0.60</td>
<td>0.29, 1.28</td>
<td>0.60</td>
<td>0.28, 1.29</td>
<td>1.33</td>
<td>0.53, 3.31</td>
</tr>
<tr>
<td>Phobia</td>
<td>25.9</td>
<td>16.6</td>
<td>0.61*</td>
<td>0.40, 0.94</td>
<td>0.60*</td>
<td>0.39, 0.92</td>
<td>0.84</td>
<td>0.43, 1.65</td>
</tr>
<tr>
<td>Social phobia</td>
<td>18.8</td>
<td>9.9</td>
<td>0.54*</td>
<td>0.33, 0.89</td>
<td>0.54*</td>
<td>0.33, 0.90</td>
<td>0.98</td>
<td>0.52, 1.85</td>
</tr>
<tr>
<td>Simple phobia</td>
<td>11.7</td>
<td>8.4</td>
<td>0.73</td>
<td>0.41, 1.29</td>
<td>0.69</td>
<td>0.38, 1.25</td>
<td>0.83</td>
<td>0.39, 1.76</td>
</tr>
<tr>
<td>Somatoform pain disorder</td>
<td>15.9</td>
<td>16.9</td>
<td>1.24</td>
<td>0.79, 1.93</td>
<td>1.21</td>
<td>0.76, 1.91</td>
<td>1.26</td>
<td>0.69, 2.28</td>
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</tbody>
</table>
Table 6. Prevalence of DSM-IV lifetime Conditions in Wave 2 and ORs and 95% CIs Comparing NSM with Regular Enlistees; Model 1 adjusted for age, Model 2 adjusted for age and combat, Model 3 adjusted for age, combat, date of birth, age at deployment, durations of Army Service before, during and post-Vietnam, and rank in Vietnam.

<table>
<thead>
<tr>
<th>Condition</th>
<th>NSM (%)</th>
<th>Regular (%)</th>
<th>Model 1 OR</th>
<th>95% CI</th>
<th>Model 2 OR</th>
<th>95% CI</th>
<th>Model 3 OR</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol dependence</td>
<td>23.6</td>
<td>17.9</td>
<td>1.16</td>
<td>0.72,</td>
<td>1.18</td>
<td>0.72,</td>
<td>1.21</td>
<td>0.65,</td>
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<td>1.89,</td>
<td></td>
<td>1.93</td>
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<td>2.82</td>
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<tr>
<td>Alcohol abuse</td>
<td>29.8</td>
<td>34.6</td>
<td>1.48</td>
<td>0.96,</td>
<td>1.48</td>
<td>0.96,</td>
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<td>0.94,</td>
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<td>2.89</td>
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<td>2.30</td>
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<td>2.81</td>
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<tr>
<td>Cannabis abuse</td>
<td>3.8</td>
<td>2.9</td>
<td>1.93</td>
<td>0.66,</td>
<td>2.43</td>
<td>0.81,</td>
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<td>5.63</td>
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<td>7.26</td>
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<td>Severe depression (single+recurrent)</td>
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<td>18.8</td>
<td>0.86</td>
<td>0.49,</td>
<td>0.83</td>
<td>0.46,</td>
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<td>Dysthymia</td>
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<td>Posttraumatic stress disorder</td>
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<td>2.31</td>
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<td>Generalised anxiety disorder</td>
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<tr>
<td>Obsessive Compulsive disorder</td>
<td>1.9</td>
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<td>1.51</td>
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<tr>
<td>Panic with agoraphobia</td>
<td>0.5</td>
<td>1.3</td>
<td>1.20</td>
<td>0.17,</td>
<td>1.24</td>
<td>0.17,</td>
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<td>50.57</td>
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<tr>
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<td>1.9</td>
<td>2.9</td>
<td>1.39</td>
<td>0.41,</td>
<td>0.97</td>
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<td>4.73</td>
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<td>3.62</td>
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<td>5.10</td>
</tr>
<tr>
<td>Agoraphobia without panic</td>
<td>2.9</td>
<td>5.4</td>
<td>1.66</td>
<td>0.61,</td>
<td>1.91</td>
<td>0.70,</td>
<td>3.13</td>
<td>0.98,</td>
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<td>4.53</td>
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<td>5.23</td>
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<td>9.99</td>
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<tr>
<td>Animal phobia</td>
<td>3.4</td>
<td>2.5</td>
<td>1.27</td>
<td>0.40,</td>
<td>1.18</td>
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<td>3.81</td>
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</tr>
<tr>
<td>Social phobia</td>
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<td>1.20</td>
<td>0.52,</td>
<td>1.04</td>
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<td>2.76</td>
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<td>2.47</td>
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<td>4.16</td>
</tr>
</tbody>
</table>
Table 3 shows the prevalence of ICD-9 long term or chronic physical health conditions assessed in Wave 1. Gout was significantly less prevalent among Regulars in Models 1 and 2, but not when the other variables were controlled for. Endocrine conditions became significant only after full adjustment. Heart disease, circulatory conditions and arthritis were more prevalent among Regulars in all models. Apart from these, no other condition discriminated NSM from Regulars.

Table 4 shows the prevalence of ICD-10 physical health conditions assessed at Wave 2. Type 2 diabetes was more prevalent among Regulars in all models; ischaemic heart disease also in Models 1 and 3; cerebrovascular disease in Model 1 only; osteoarthritis in Models 1 and 2; and rheumatism in all models. Otherwise, no other conditions discriminated NSM from Regulars.

Table 5 shows the Wave 1 DSM-III diagnoses. Drug abuse or dependence and antisocial personality disorder were significant only in Model 3. On the other hand, phobia and social phobia were significant only in Models 1 and 2. PTSD risk was not different in Models 1 and 2, indicating that PTSD rates were similar even after adjusting for combat exposure. However, in Model 3, Regulars assumed a significant risk over NSM. Thus, after adjusting for the longer periods spent in the Army before, during and after deployment, and for later age at deployment and higher rank, PTSD risk was significantly elevated in Regulars compared with NSM.

However, PTSD has been reported to shorten military careers, so that reduced Army Service post-Vietnam may be a marker of PTSD rather than a confounder, and adjusting for it may represent over-adjustment. There was no difference in length of service after repatriation for NSM and Regulars in Models 1 and 2, indicating that PTSD rates were similar even after adjusting for combat exposure. However, in Model 3, Regulars assumed a significant risk over NSM. Thus, after adjusting for the longer periods spent in the Army before, during and after deployment, and for later age at deployment and higher rank, PTSD risk was significantly elevated in Regulars compared with NSM.

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However, PTSD has been reported to shorten military careers, so that reduced Army Service post-Vietnam may be a marker of PTSD rather than a confounder, and adjusting for it may represent over-adjustment. There was no difference in length of service after repatriation for NSM with or without PTSD (M = 0.58 yrs, SD = 2.45 for NSM with no PTSD and M = 0.33 yrs, SD = 0.38 for NSM with PTSD at Wave 1: t(276.047) = 1.511, p = .132), but Regulars with PTSD had significantly shorter service than Regulars without PTSD (M = 8.96yrs, SD = 7.00 for Regulars with no PTSD and M = 6.42yrs, SD = 6.58 for Regulars with PTSD; t(105.259) = 2.77, p = .007). When the modelling was repeated with post-Vietnam Service duration removed, the NSM-Regular odds ratio was reduced to insignificance (OR = 1.64, 95%CI = 0.89, 3.01; p = .112).

When post-Vietnam Service was removed from Model 3 for other significant outcomes of drug abuse and dependence, phobia, social phobia and antisocial personality disorder, the differences between NSM and Regulars were also no longer significant for drug abuse and dependence (OR = 2.17, 95%CI = 0.59, 8.02; p = 0.247), for phobia (OR = 0.71, 95%CI = 0.44, 1.15; p = .177), or for social phobia (OR = 0.68, 95%CI = 0.38, 1.20; p = .183), but antisocial personality disorder remained significant (OR = 2.59, 95% CI = 1.13, 5.92; p = .025). We can therefore conclude that longer service in the Army after repatriation is associated with decreased risk of these conditions, in addition to PTSD.

Table 6 shows the prevalence of DSM-IV psychiatric conditions assessed in Wave 2 did not differ statistically between NSM and Regulars in any model. NSM and Regulars did not differ in the number of diagnoses and there was no difference in PTSD rates between NSM and Regulars in Wave 2 in any model.

Discussion

It is well known that participation in war, particularly combat, has demonstrable consequences on the physical and mental health of former warriors. The question of whether this is borne equally by volunteers and conscripts has not previously been addressed. The overall results suggest little difference between men who enlisted voluntarily and those who were conscripted in terms of economic, marital, physical and psychiatric health two and three decades after return. Previous findings from this cohort indicate that combat was a risk factor for arthritis and heart and circulatory disease, osteoarthritis, angina and cerebrovascular disease, and disc disorders and joint injuries were associated with durations of service pre- and post-Vietnam. Given that Regulars saw more combat and spent more time in the Army, their risk of these conditions should be expected to be higher. In the Wave 2 cohort results, Regular enlistment and duration of post-Vietnam Service were associated with osteoarthritis in regression prediction models; these results are confirmed here. It is also likely that military service carries an increased burden of cardiovascular disease and musculoskeletal problems in later life.

Demographically, the differences at interviews included age and employment status but not marital status or annual income. Notable is the lack of difference in economic circumstances, since the higher educational attainments of NSM and briefer military careers would suggest that NSM might have had better career prospects that translated into higher incomes. The pattern of health risk factors also differed between the groups. Regulars had less education and trade training before enlistment, they saw more combat and spent longer in the war zone, all of which should increase their risk in particular of PTSD compared with NSM. In contrast, Regulars...
had more Army experience before deployment, were deployed at older ages and at higher ranks, and were less likely to be posted to Infantry Battalions, all of which would be expected to reduce their risk of PTSD compared with NSM. While these patterns of risk factors varied between the groups, the rates of PTSD did not. This suggests that the lower risk of PTSD conferred by longer training, older age at deployment and higher rank is counterbalanced by a higher risk from combat and length of deployment in Regulars. Conversely, in NSM the lower risk of PTSD conferred by advantages of higher education, shorter exposure to the conflict zone and lower combat seem to be countered by higher risk conferred by shorter training and deployment to Infantry. If these two opposed forces balance each other to provide equality with the increased risk of PTSD borne by the Regulars due to their higher combat and exposure to the conflict zone, then this suggests that NSM may have been more vulnerable to PTSD, in spite of having seen less combat.

An interesting finding was the reduction to insignificance of the ORs for several conditions after removing one of the potential confounders, duration of service post-repatriation. Drug abuse and dependence, phobia and social phobia were rendered non-significant, while antisocial personality disorder maintained significance. It is possible that this latter disorder is predictive of a preference for serving in the armed services, compared with randomly selected young men from the general population. It is also possible that differential screening and selection imperatives during recruitment of NSM and Regulars acted to reduce the prevalence in NSM. It also suggests that length of service is a significant confounder of the NSM-Regular comparison.

The study here is not without weaknesses. Response rates were not perfect, and the two waves produced slightly different samples at each wave. Thus, between-wave differences may be due to slightly different samples. Secondly, a large number of statistical tests were conducted, of which 5% could be expected to be significant by chance. However, the pattern of results is cogent and points to consistency of findings between the waves. However, some differences may have been missed due to small sample sizes; a number of lower confidence intervals bordered 1.0 and narrower confidence bands from larger samples may have led to 95% CIs that did not contain 1.0.

In conclusion, compared to volunteers, differential advantages of conscripts did not improve their post-discharge socioeconomic status, nor protect them from adverse mental health outcomes post-discharge. PTSD may have been borne disproportionately by Regulars at Wave 1 but this differential dissipated over time. In addition, the similar rates of PTSD in NSM and Regulars may hide a vulnerability conferred by shorter training and Infantry Service among NSM. The notion that Army Service is overtaxing on the body and may raise the risk of cardiovascular and musculoskeletal disease the longer it continues is supported. Otherwise, there appear to be very few overall differences in health between National Service and Regular Vietnam Veterans in later life.

Corresponding Author: Brian O’Toole, brian.otoole@sydney.edu.au
Authors: B O’Toole1, K Pierse2, B Friedrich1,6, S Outram3,4, M Dadds1, S Catts1,5
Author Affiliations:
1 University of Sydney, Brain and Mind Centre
2 ANZAC Research Institute
3 University of Newcastle School of Medicine and Public Health
4 Health Behaviour Sciences
5 University of Queensland, Psychiatry
6 Research Department of Epidemiology & Public Health, University College London

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Compensation in the Australian Defence Force

Neil Westphalen

Introduction

This article follows previous papers by the author, regarding occupational and environmental medicine in the Australian Defence Force (ADF). They assert that high rates of workplace illness and injury indicate the need to improve the management of hazards associated with ADF workplaces, with better emphasis on prevention. They also advocated that the ADF’s health services should be premised on an occupational and environmental health paradigm, which would require reassessing the fundamental inputs to capability for both Joint Health Command (JHC), and Defence’s Work Health and Safety branch.

The papers argue that such a reassessment could lead to a holistic and sustainable workforce-based health service delivery model by 2030. This timeframe is based on the current state of the ADF’s occupational and environmental health services, and the small number of civilian specialist practitioners within the Australasian Faculty of Occupational and Environmental Medicine. These considerations suggest that a mature health delivery model would take 10–15 years’ sustained effort with respect to occupational and environmental physicians alone.

This article expands on these papers, with respect to facilitating the compensation of ADF personnel for their Service-related illness and injuries.

Civilian worker’s compensation

Civilian worker’s compensation claims in Australia are subject to multiple federal, state and territory jurisdictions. Collating their data is not straightforward; for example, Safe Work Australia states that during 2012–13, Australia had 10,599 million employees,2 while the Australian Bureau of Statistics’ Work-related Injuries Survey infers there were 12,367 million employees.3

The Work-related Injuries Survey indicated that during this time, an estimated 531 800 workers (4.3%) experienced a work-related incident. 348 600 of these workers did not receive compensation, either because no application was made, or the application was rejected.4 Of the remaining 183 200 workers, Safe Work Australia showed that 117 815 were for serious worker’s compensation claims (requiring a work absence of one working week or more), or approximately 11 claims per 1000 employees.5

The median time off work was 5.2 working weeks for male and 6 working weeks for female employees. The agriculture, forestry and fishing industry had the highest civilian serious claim incidence rate (21 per 1000 employees), followed by the transport, postal & warehousing industry (19.1 per 1000 employees).

Employees working as labourers had the highest serious claim incidence rate of all civilian occupations (27 per 1000 employees), followed by machinery operators and drivers (24.4 per 1000 employees).

The most common causes of serious claims were manual handling accidents (33%), followed by slips, trips and falls (22%). The most commonly injured part of the body was the back (22%), while other common locations were hands, fingers and thumbs (13%), shoulders (10%) and knees (9%).

Despite comprising 52% of the total civilian workforce, 63% of serious workers’ compensation claims were by male employees. Musculoskeletal injuries made up 90% of these claims, while another 6% were for mental health disorders.

Although there is no equivalent ‘serious claim incidence rate’ for Defence members, the nature of the ADF workforce and its workplaces, as previously described by the author,6 suggests that it would be comparable to – and in fact, almost certainly significantly exceed – the maximal civilian industrial and occupational rates.

Safe Work Australia indicates that the median cost7 of these civilian claims in 2011–12 was $8 900.9 The Work-related Injuries Survey showed that the total economic cost was estimated to be $81.8 billion (4.1% of GDP),10 or $85 000 to $85 800 per Australian civilian employee.
ADF compensation legislation

The ADF is not responsible for determining compensation entitlements for either current or ex-Service personnel; this is a Department of Veterans’ Affairs (DVA) responsibility. Determining eligibility is complex, as it may depend on up to three separate pieces of legislation.

**Veteran’s Entitlements Act (VEA).** The VEA covers wartime Service and certain operational deployments, as well as certain peacetime Service between 7 December 1972 and 30 June 2004. For peacetime Service eligibility, a Defence member who had not completed a qualifying period of three years’ Service prior to 7 April 1994 is not covered, unless they were medically discharged. Eligible personnel may receive:

- a disability pension, if a disability is accepted as having been caused or aggravated during an eligible period of Service
- a service pension at age 60 if they have Qualifying Service, whereby they were allotted to, and have served in, an operational area or warlike service area
- a White Repatriation Health Card for one or more medical conditions deemed to be Service-related, or a Gold Repatriation Health Card that provides treatment for all medical conditions, including those that are not Service-related.

**Safety, Rehabilitation and Compensation (Defence-Related Claims) Act 1988 (SRCA).** The SRCA provides rehabilitation as well as compensation coverage, for injuries and diseases suffered as a result of peacetime and peacekeeping Service up to, and including, 30 June 2004, and operational Service between 7 April 1994 and 30 June 2004. These personnel may be eligible for:

- a lump sum compensation benefit, if they are permanently impaired
- weekly compensation benefits, if they are unable to work because of an accepted injury, disease or illness
- DVA payment of all medical, hospital, pharmaceutical and other treatment costs that they may reasonably require due to their compensable injury, disease or illness
- some additional rehabilitation services in specific circumstances where they have an accepted claim for a Service-related injury. These entitlements are limited to the provision of household services, aids and modifications and attendant care. The household services may include house cleaning, laundry, ironing, gardening and lawn mowing. The attendant care services may be provided for the essential and regular personal care of the injured member
- help with the cost of vocational retraining to help Reserve and ex-Service members return to the work force, or with other forms of rehabilitation to help them cope with the effects of their injury, disease or illness.

**Military Rehabilitation and Compensation Act 2004 (MRCA).** The MRCA provides rehabilitation as well as compensation coverage for all Permanent, Reserve and other entitled personnel, who served on or after 1 July 2004. MRCA benefits may include:

- vocational and other rehabilitation services
- choice of periodic payments or lump sum compensation or a combination of both for permanent impairment (non-economic loss)
- incapacity benefits, which are periodic payments of compensation for economic loss due to incapacity for Service or work
- choice of a Special Rate Disability Pension (SRDP) ‘safety net’ payment for life or incapacity payments up to age 65 (conditions apply)
- vehicle modifications or assistance with the cost of a vehicle under the Motor Vehicle Scheme
- compensation for household services
- compensation for attendant (personal) care services
- telephone allowance (conditions apply)
- compensation for dependants in the event of a member’s death (conditions apply)
- funeral benefits
- bereavement payments
- assistance with the cost of financial advice obtained in relation to certain permanent impairment, SRDP and death benefit choices
- DVA White or Gold Cards in certain cases or otherwise payment of reasonable treatment costs related to accepted medical conditions for those who are not eligible for a White or Gold Card
- pharmaceutical allowance
- travel and accommodation costs associated with medical appointments for treatment and rehabilitation assessments and programs.
Compensation Entitlements. Which Act(s) apply when claiming for compensation, and the benefits that may be received, depend on the:

- date of the injury or illness (for SRCA and MRCA purposes), and/or
- period of service that the injury or disease relates to (for VEA purposes).

Additionally, the Safety, Rehabilitation and Compensation Legislation Amendment (Defence Force) Act 2017 (DRCA)\(^{16}\) replicates the current SRCA entitlements for current and ex-Service ADF members, with eligibility being determined by the Minister for Veterans' Affairs rather than the Minister for Employment. The DRCA does not affect VEA or MRCA eligibility or entitlements.

Finally, in accordance with its Non-Liability Health Care provisions, ADF members with even one-day’s Service can get immediate ongoing treatment from DVA for up to five mental health conditions.\(^{17}\) The purpose of these provisions is to ensure the member’s safety, without the delays inherent to assessing their eligibility.

Repatriation Medical Authority

The Repatriation Medical Authority was established in accordance with the VEA, as an independent statutory authority responsible to the Minister for Veterans' Affairs. It comprises five renowned practitioners in the field of medical science. Their role is to determine Statements of Principles (SoPs) for any disease, injury or death related to military service, based on sound medical-scientific evidence. The SoPs state the factors that ‘must’ or ‘must as a minimum’ exist to cause the particular disease, injury or death.\(^{18}\)

Each condition determined by the RMA has two SoPs that list the factors relating the condition to ADF service. These SoPs are based on two separate legal standards as to the weighting of the medical evidence. The more generous SoP is based on the ‘reasonable hypothesis’ standard, which is applicable to current and ex-Service ADF members with operational or warlike service. The marginally less generous SoP is based on the ‘balance of probabilities standard’, which generally applies to claims where the veteran or ADF member does not have operational service.\(^{19}\)

Specialist Medical Review Council

The Specialist Medical Review Council (SMRC) was also established in accordance with the VEA, as another independent statutory authority responsible to the Minister for Veterans' Affairs. Its role is to review RMA determinations on request from an eligible person or organisation. It comprises a pool of medical practitioners and scientists appointed as Councillors by the Minister. The Specialist Medical Review Council Convener select three to five Councillors to conduct each review as required, based on the relevance of their expertise.\(^{20}\)

ADF Veterans

The author has previously noted that in 2015, Australia had approximately 339 000 veterans, including 150 200 with peacetime-only Service.\(^{21}\) Of the total, 61.4% were receiving health care services from DVA for Service-related conditions, costing $5.525 billion in 2014-15. If the cost was borne (and funded) by Defence rather than DVA, it would constitute 15.9% of a recalculated Defence budget, compared to around 9.5% of GDP in health costs for the entire Australian population.\(^{22}\)

A striking characteristic of ADF Service, therefore pertains to the high treatment cost of Service-related medical conditions (even for personnel with peacetime-only Service), despite high recruiting and retention health standards.\(^{23}\)

Furthermore, these figures exclude another $3.22 billion spent by DVA on non-health disability services and compensation.\(^{24}\) To this end, 96 493 people received a VEA disability pension in 2015; while another 4 291 people received a weekly incapacity payment and an additional 18 537 received one-off permanent impairment payments per the SRCA or MRCA.\(^{25}\)

This means that, of approximately 440 000 current and ex-serving ADF members, approximately 270 per 1000 received some form of compensation payment for at least one Service-related medical condition. This is at least 20 times the average civilian serious claim incidence rate, and 10 times the highest civilian serious claim incidence rate, by both industry and occupation.

The size of the total DVA budget also means that the per capita cost of treatment, disability services and compensation for these 440 000 current and ex-Serving ADF members is $19 875, which is up to four times the median civilian Safe Work Australia and Work-related Injuries Survey rate. This figure is consistent with the estimated average cost of $22 700 per gold card, and $2600 per White Card in 2015-16.\(^{27}\)

Notwithstanding the differences between Defence and civilian compensation entitlements, these
of all claims, 53% of which were rejected as non-Service-related. This suggests that the focus by JHC on healthy lifestyle promotion (per the College of General Practitioner’s ‘Red Book’), at the expense of workplace illness and injury prevention, is generally misplaced, especially if 36% of Permanent ADF members serve for less than five years (6.25%) of their estimated 80-year lifespan.

Compensation and the ADF’s health services

The author has previously noted that the ADF appears unique in that unlike other employers, its health services provide employee healthcare without ascertaining whether their clinical presentations are work-related. For example, JHC clinical records routinely document patient details such as their Service and rank but not their rate (Navy), corps (Army) or mustering (Air Force) that indicate the jobs they perform.

Furthermore, JHC at present does not collect or report work-related illness/injury data, or record lost time or restricted duties, or identify the ensuing health care costs. Although some – but by no means all – of this information is provided via Defence’s Work Health and Safety Compensation and Reporting (WHSCAR) System, a recent study indicates that only 11 to 19 percent of all Army Reserve and

Medical conditions

Table 1 lists the 15 most frequently claimed conditions under the VEA (based on the RMA SoPs) in 2015. These made up 61.5% of all conditions claimed under the VEA.

Table 1 suggests that, generally consistent with the author’s original article, at least 22% of all VEA claims were for musculoskeletal conditions, while at least another 9% were for mental health issues (including alcohol abuse). Other conditions, for which a relatively straightforward relationship to ADF employment exists, include hearing disorders secondary to workplace noise (16%), skin disorders secondary to sun exposure (7%), and a small number of eye disorders secondary to ultraviolet-light exposure (e.g. arc welding).

However, Table 1 also indicates that lifestyle-related conditions such as hypertension, ischaemic heart disease and chronic bronchitis (much of which can be attributed to smoking), make up only 5% of all claims, 53% of which were rejected as non-Service-related. This suggests that the focus by JHC on healthy lifestyle promotion (per the College of General Practitioner’s ‘Red Book’), at the expense of workplace illness and injury prevention, is generally misplaced, especially if 36% of Permanent ADF members serve for less than five years (6.25%) of their estimated 80-year lifespan.

Table 1: 15 most frequently claimed conditions under the VEA in 2014–15

<table>
<thead>
<tr>
<th>Disability</th>
<th>Claims accepted</th>
<th>Acceptance rate</th>
<th>Claims rejected</th>
<th>Total claims</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osteoarthritis</td>
<td>1 623</td>
<td>76%</td>
<td>514</td>
<td>2 137</td>
</tr>
<tr>
<td>Sensorineural hearing loss</td>
<td>1 372</td>
<td>99%</td>
<td>14</td>
<td>1 386</td>
</tr>
<tr>
<td>Tinnitus</td>
<td>1 307</td>
<td>98%</td>
<td>26</td>
<td>1 333</td>
</tr>
<tr>
<td>Lumbar spondylosis</td>
<td>930</td>
<td>84%</td>
<td>181</td>
<td>1 111</td>
</tr>
<tr>
<td>Solar keratosis</td>
<td>640</td>
<td>99%</td>
<td>9</td>
<td>649</td>
</tr>
<tr>
<td>Post-traumatic stress disorder</td>
<td>472</td>
<td>76%</td>
<td>151</td>
<td>623</td>
</tr>
<tr>
<td>Non-melanotic skin cancer</td>
<td>533</td>
<td>99%</td>
<td>7</td>
<td>540</td>
</tr>
<tr>
<td>Depressive disorder</td>
<td>270</td>
<td>56%</td>
<td>211</td>
<td>481</td>
</tr>
<tr>
<td>Alcohol use disorder</td>
<td>218</td>
<td>55%</td>
<td>176</td>
<td>394</td>
</tr>
<tr>
<td>Hypertension</td>
<td>100</td>
<td>31%</td>
<td>219</td>
<td>319</td>
</tr>
<tr>
<td>Cervical spondylosis</td>
<td>82</td>
<td>28%</td>
<td>211</td>
<td>293</td>
</tr>
<tr>
<td>Ischaemic heart disease</td>
<td>154</td>
<td>53%</td>
<td>139</td>
<td>293</td>
</tr>
<tr>
<td>Acquired cataract</td>
<td>223</td>
<td>100%</td>
<td>1</td>
<td>224</td>
</tr>
<tr>
<td>Rotator cuff syndrome</td>
<td>70</td>
<td>32%</td>
<td>150</td>
<td>220</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>124</td>
<td>60%</td>
<td>84</td>
<td>208</td>
</tr>
<tr>
<td>Totals</td>
<td>8 118</td>
<td>79%</td>
<td>2 093</td>
<td>10 211</td>
</tr>
</tbody>
</table>
Regular work-related injuries and illnesses are being reported. It seems likely that WHSCAR reporting by the other Services would be comparable.

Collecting this baseline health information at the point of treatment is essential, not only for monitoring the effectiveness of the ADF’s occupational and environmental health services, or to account for the healthcare costs incurred by JHC, or to account for the compensation and veteran care costs incurred by DVA, but documenting the work-relatedness – and therefore compensation eligibility – of each member’s illness or injury in the first place.

A previous article noted that JHC does not include occupational and environmental physicians as part of its multidisciplinary rehabilitation teams, despite anecdotal evidence suggesting that only 20-40% of ADF clinical presentations are for (generally non-compensable) conditions typically seen in an equivalent Australian civilian population. It also referred to the limitations of general practitioners with respect to medical fitness-for-work certification managing long-term work absence, work disability and unemployment and balancing the needs of commanders against those of their patients.

However, the previous article also noted that occupational and environmental physicians have skills and expertise that can complement general practitioners, with respect to facilitating compensation as intrinsic to providing primary healthcare for the ADF workforce. Perhaps more importantly, they can also facilitate local command compliance with the Work Health and Safety Act 2011, thereby preventing compensable workplace illness and injury in the first place.

In summary, facilitating each ADF member’s future compensation entitlements by considering the work-relatedness of their illness or injury at the time of presentation, is clearly intrinsic to their overall healthcare. However, at present it is not recognised as such from a clinical management perspective, with respect to the fundamental inputs to capability for either JHC’s garrison health services, or for the Defence Work Health and Safety branch.

Conclusion

With ADF personnel arguably exposed to the most diverse range of occupational and environmental hazards of any Australian workforce, high rates of preventable workplace illness and injury indicate the need to improve the management of occupational and environmental health hazards, with added emphasis on prevention above treatment.

This suggests that the ADF’s health services should be premised on an occupational and environmental health paradigm, with revised fundamental inputs to capability that would lead to a genuinely holistic and sustainable workforce-based ADF health service delivery model by 2030.

This paradigm would entail Defence medical officers who accept the requirement to facilitate the compensation entitlements of ill and injured ADF personnel, as intrinsic to providing primary healthcare for a workforce. This specifically refers to the timely and accurate documentation of the work-relatedness of every ADF patient presentation.

It also entails occupational and environmental physicians who can help prevent high rates of compensable workplace illnesses and injuries (potentially up to 20 times the average civilian rate), by facilitating local command compliance with the Work Health and Safety Act.

Author

Dr Neil Westphalen graduated from Adelaide University in 1985 and joined the RAN in 1987. He is a RAN Staff Course graduate and a Fellow of the Royal Australian College of General Practitioners, the Australasian Faculty of Occupational and Environmental Medicine, and the Australasian College of Aerospace Medicine. He holds a Diploma of Aviation Medicine and a Master of Public Health.

His seagoing Service includes HMA Ships Swan, Stalwart, Success, Sydney, Perth and Choules. Deployments include DAMASK VII, RIMPAC 96, TANAGER, RELEX II, GEMSBOK, TALISMAN SABRE 07, RENDERSAFE 14, SEA RAIDER 15, KAKADU 16 and SEA HORIZON 17. His Service ashore includes clinical roles at Cerberus, Penguin, Kuttabul, Albatross and Stirling, and staff positions as J07 (Director Health) at the then HQAST, Director Navy Occupational and Environmental Health, Director of Navy Health, Joint Health Command SO1 MEC Advisory and Review Services, and Fleet Medical Officer (2013-2016).

Commander Westphalen transferred to the Active Reserve in July 2016.

Disclaimer

The views expressed in this article are the author’s and do not reflect those of the RAN or any of the other organisations mentioned.
Original Article

Corresponding Author: Neil Westphalen, neil.westphalen@bigpond.com
Authors: N Westphalen 1,2
Author Affiliations:
1 Royal Australian Navy Reserve
2 Navy Health Service, C/O Director Navy Health

References


5 Safe Work Australia explains that the definition used for the term ‘serious worker’s compensation claims’ is: ‘A workers’ compensation claim for an incapacity requiring an absence from work of one working week or more, lodged in the reference year, and accepted for compensation by the jurisdiction by the date the data are extracted for publication. Claims in receipt of common law payments are also included.’ Claims arising from a journey to or from work or during a recess period are not compensable in all jurisdictions, and are excluded.’


7 Safe Work Australia explains that, because a small number of uncharacteristically long absences or high payments can skew the average (mean), median payment and median time lost from work of serious workers’ compensation claims approximate to a ‘typical’ claim.

8 Safe Work Australia explains that the median time lost and median payments for 2012–13, as those claims are likely to be open and the claimant may accrue more time off and payment in subsequent years.

9 Safe Work Australia explains that payments include compensation paid to claimants for: benefits paid to an employee or the employee’s surviving dependents; outlays for goods and services such as medical treatment, funeral expenses, rehabilitation services; non-compensation payments such as legal costs, transport and interpreter services; and common law settlements, which may incorporate estimates of future liability and indirect costs such as loss of productivity.


See Defence Health Manual (DHM) Volume 2 Part 5 Health Standards and Assessments - Entry and Transfer, and DHM Volume 2 Part 6 Health Standards and Assessments - Serving Members (both only available on Defence intranet).


Original Article


32 JeDHI Helpdesk email Defence eHealth System - Occupational Aetiology - Quick Reference Guide dated 1503 12 July 2018 refers:

It seems no guidance was provided for Defence health staff to ensure consistency as to what should and should not be considered work-related:

Workplace- and sports-related injuries are not recorded separately, which precludes differentiating work- versus sports-related treatment costs or Lost Time Injury Frequency Rates’ and

It does not initiate the compensation claims process (which still has to be done separately).

Hence, most of the remaining shortfalls identified in this paper remain extant.


Medical CBRN Defence in the Australian Defence Force

Major David J Heslop, Commander Neil Westphalen

Introduction

This article focuses on a specialist area of military medicine, following a series of recently published papers regarding occupational and environmental medicine in the ADF. They assert that high rates of preventable workplace illness and injury indicate the need to improve the management of occupational and environmental hazards associated with ADF workplaces, with better emphasis on prevention rather than treatment.

These papers advocate that, rather than replicating the treatment services used for Australian civilians, the ADF’s health services should be premised on an occupational and environmental health paradigm. For this to occur, the health capability gaps in the current ADF health service delivery model demand reassessment of the fundamental inputs to (health) capability, for both Joint Health Command (JHC) and Defence’s Work Health and Safety Branch.

Such a reassessment, with implementation of necessary changes, could lead to a holistic and sustainable workforce-based ADF health service delivery model by 2030. This timeframe is based on the current state of the ADF’s occupational and environmental health services, and the small number of civilian specialist practitioners within the Australasian Faculty of Occupational and Environmental Medicine (AFOEM). These considerations suggest that a mature health delivery model would take 10–15 years’ sustained effort, with respect to occupational and environmental physicians alone.

This article expands on the previous papers, with respect to how such a paradigm is essential to the ADF’s defensive medical Chemical, Biological, Radiological and Nuclear (CBRN) capabilities.

Global CBRN Threats

Hunter-gatherer communities have used biological weapons such as poisoned-tipped spears and arrows since prehistoric times. However, the first documented use of a biological agent for warlike purposes was in 1346, when plague-infected corpses were catapulted into the city of Caffa (now Feodosia in Crimea) by besieging Mongols. Even so, it was not until the mid-19th century that investigators, such as Louis Pasteur in France and Robert Koch in Germany, demonstrated that microorganisms could cause disease, while research into the industrialised weaponising of potential biological agents only began during World War I (WWI).

Lethal chemical weapons were first used in 1915 by the Germans near Ypres on the Western Front. The century since has seen many nations develop, and sometimes utilise, a chemical weapons capability. Although nuclear weapons were used twice in 1945, other radiological weapons have so far not been employed on a mass scale.

Since the end of the Cold War, most CBRN events have usually entailed the use of chemical and biological weapons by non-state terrorist organisations. Examples include the 1995 attack on the Tokyo subway by the Aum Shinrikyo cult using sarin, and the 2001 attack on the US Senate and two media outlets by unknown perpetrators using anthrax.

The development, production, stockpiling and use of chemical weapons is prohibited by the 1997 Chemical Weapons Convention, while the 1975 Biological Weapons Convention likewise prohibits that for biological weapons. Nuclear weapons are presently subject to the 1963 Partial Nuclear Test Ban Treaty and the 1970 Nuclear Non-Proliferation Treaty.

However, several nations have not signed or ratified some or any of these treaties. In addition, North Korea withdrew from the Nuclear Non-Proliferation Treaty in 2003, and has recently threatened several regional neighbours, including Australia, with nuclear weapons. Moreover, these treaties lack relevance with respect to compliance by non-state non-signatories, such as terrorist organisations. CBRN weapons therefore, remain an important global threat.

Furthermore, the goals and actions of non-state terrorists in recent years have made the use of CBRN weapons more likely, while technological advances...
have made their use more feasible. Given the victims of a CBRN attack may vary from individuals to whole populations – which may include military personnel as well as civilians – defending against these weapons has become an important public health issue.

Many nations including Australia have therefore focused their defensive CBRN measures against the public health threat posed to their civilian populations by terrorist organisations, particularly after the 2001 World Trade Center terrorist attacks. This approach predicates managing health responses to deliberate CBRN terrorist attacks that are intended to cause harm, on comparable terms as for accidental hazardous material incidents.

This article therefore, contends that occupational and environmental medicine has an important role with respect to commanders applying a risk management approach to the prevention and treatment of CBRN casualties, while maintaining ADF operational capability.

Civilian CBRN Defence in Australia

Within Australia, the primary responsibility for protecting life, property and the environment lies with the states and territories. Each of these have their own plans and arrangements to respond to, and recover from, natural and human-caused emergencies. To this end, some state and territory health departments have dedicated disaster management units.

To complement their efforts in responding to emergencies, the Australian Government can also provide physical and financial assistance. This is an Attorney-General’s Department responsibility through Emergency Management Australia (EMA).

Australia’s civilian CBRN defensive measures are generally incorporated into a unified ‘All Hazards’ approach, for a range of different emergencies. Local authorities initially respond to these emergencies, followed by a series of escalatory stages. In addition, EMA has specific health guidance for dealing with CBRN hazards.

ADF CBRN Defence

For a medium-sized power, Australia’s involvement with CBRN issues has been surprisingly intimate. This began in WWI, where 323 Australian Imperial Force (AIF) personnel died and 16,426 were wounded by gas on the Western Front. Although they were not used, Australia stockpiled its own chemical weapons during WWII, as a deterrent against the Japanese. Australia then provided three sites and about 15,000 personnel for 12 British nuclear weapons tests between 1952 and 1957.

More recently, the Australian deployments before and during the 1990-91 Gulf War were conducted in what was assessed as a high-threat chemical and biological warfare environment. Australians then participated in a series of United Nations CBRN weapons inspections in Iraq.

The ability of ADF personnel at sea, on land and in the air to maintain operational capability before, during and after a CBRN attack remains fundamental to defending Australian interests. To this end, all ADF personnel undergo basic CBRN defensive training on entry and periodically thereafter (typically every five years). It usually takes only one day and is generally limited to describing the various types of CBRN hazards and practical demonstrations of respirators and other CBRN equipment. Navy incorporates this training into its non-CBRN shipboard damage control courses.

Additional training is provided for the relevant instructors and for specific deployments that are assessed as posing a greater CBRN threat.

ADF health support in CBRN environments is based on self- and buddy-aid, which are time-critical and complicated by the risk of further contamination. After decontamination, casualties require further specialist CBRN treatment, perhaps concurrently with resuscitation for other life-threatening injuries.

Current ADF operational doctrine for CBRN defence is therefore predicated on five pillars – Detection, Identification and Monitoring (DIM); Warning and Reporting (W&R); Physical Protection; Hazard Management and Medical Countermeasures (MCM); and Medical Support. Although the medical contributions are predominantly centred on the final pillar, they still include all the others, which can be summarised as:

CBRN occupational screening. This ensures that at-risk personnel meet the appropriate physical, medical and psychological standards. This particularly refers to personal protective equipment suitability, fitting and kitting. The standards are difficult to justify, and are often subsumed within broader medical standards, where their justification can be lost.

CBRN medical preparation. This includes physical conditioning activities, vaccinations, providing personal medical countermeasures and CBRN first aid items. Apart from high readiness elements, this is
usually conducted ‘just-in-time’. It is also contingent on sufficient quantities of in-date vaccinations and CBRN medications being available when required, typically when other nations are competing for the same items simultaneously.

CBRN medical training. This refers to the medical theory and recognition of CBRN agents, how to use personal medical countermeasures, protocols for self- and buddy-aid, casualty evacuation, decontamination and integrating each of these individual medical activities into overall CBRN defences. This training tends to have a heavy theoretical component, is generally scenario-based and is difficult to access.

In support of integrating wider activities across these pillars and their related medical activities, the ADF has an extensive range of non-health CBRN policy references. Additional guidance is also available from a range of NATO and other references.

The development and maintenance of CBRN-related health policy, doctrine and procedures, and providing health input into strategic CBRN policy and doctrine, is a JHC responsibility. However, at present, JHC lacks the dedicated specialist health staff necessary to perform these tasks. Furthermore, JHC does not have a dedicated ADF CBRN health manual. Instead, extant guidance is dispersed among and within multiple operational health references.

Current recruiting health standards for ADF members do not include factors such as CBRN respirator compatibility with their spectacles, CBRN personal protective equipment compatibility with their height and weight, or medical conditions that may restrict their ability to use CBRN countermeasures. While these factors may not affect their ability to undertake their normal duties, it may limit or preclude ADF members from doing so in a CBRN environment. Such cases should therefore be identified before they are called upon to do so.

Apart from self- and buddy-aid, basic periodic CBRN training does not include on-scene casualty treatment or specialist toxicological and emergency management; since 2012, these capabilities have resided only within Army’s Special Operations Engineer Regiment (SOER). SOER originated in 1999 as the Joint Incident Response Unit (JIRU), as part of the ADF’s security arrangements for the 2000 Sydney Olympics. JIRU was formed from amalgamating several specialised Royal Australian Engineer units, including its Chemical Biological Radiological Response (CBRR) Squadron.

The intent of CBRN training for military health personnel is to conserve fighting strength, continue providing non-CBRN health services and support to the maximum extent possible, protect health personnel from CBRN injuries, minimise CBRN morbidity and mortality, avoid the spread of contamination into health vehicles and facilities, and provide command advice.

To this end, various Army and Navy units have conducted medical officer CBRN courses over many decades. Apart from a hiatus in 2003, these courses were centralised at the Army Logistic Training Centre from 1994 until 2007. Besides Australian CBRN subject matter experts, these courses employed presenters from the US Army Medical Research Institute of Infectious Diseases (USAMRIID), the US Army Medical Research Institute of Chemical Defense (USAMRICD) and the US Armed Forces Radiobiology Research Institute (AFRRI). These together arguably constitute the Western world’s centres of medical CBRN expertise.

CBRN training for ADF health personnel has been a JHC responsibility since 2009. To this end, the ADF Medical Officer CBRN course was updated in 2011 to incorporate advances in technology and medical practice. Its intent was to teach Permanent and Reserve medical officers, nursing officers and senior ADF medics how to apply their existing medical skills to treat CBRN casualties. Although the updated CBRN Health Course was piloted in 2012, it has not been conducted since.

Implications

Like many other military organisations, for many years it has been ADF practice to deliver basic defensive CBRN instruction during entry training, followed by limited periodic refresher CBRN courses. Additional training is provided for the relevant instructors and for specific deployments that are assessed as posing a greater CBRN threat.

The rationale for this approach stems from the substantial personnel and other resources necessary to sustain a high level of CBRN preparedness. While this gives every permanent and many reserve ADF members at least some CBRN familiarity, it does not provide the specialist medical or non-medical expertise required to develop and implement strategic-level CBRN policy and doctrine.

Furthermore, nearly 30 years after it ended, the current ‘just-in-time’ approach still reflects Cold War doctrine, despite the goals and actions of non-state terrorists making the use of CBRN weapons more feasible and likely. In particular, this approach does not address unforeseen CBRN threats to ADF
personnel that may arise mid-deployment or even within Australia.

The ADF’s ability to treat its own and other military CBRN casualties is presently constrained to that which can be provided by SOER, which is limited to its supporting and enabling role for Special Operations in general. Additional training is required for health staff who support and enable the ADF’s non-Special Operations capabilities, in particular its Role 2 health units46 such as Army’s 1st Close Health Battalion47 and Navy’s Maritime Operational Health Unit.48

Yet, the fact that there has been no CBRN health course since 2012 means that JHC’s ability to conduct one has probably atrophied, to the point where it would more-or-less entail starting from scratch. Even with overseas assistance, reconstituting the breadth and depth of specialist health CBRN expertise within the ADF to conduct this course will take several years, at a time when the use of CBRN weapons by terrorist organisations in particular, is more feasible and likely.

In any event, future ADF CBRN health courses should still employ the expertise provided by USAMRIID, USAMRICD and AFRRI, either directly to course participants, or indirectly through ‘train-the-trainer’ courses. Additional clinical CBRN refresher training should be also provided on the same terms as other clinical refresher training, such as the Advanced Trauma Life Support course.

The lack of CBRN expertise within JHC also compromises CBRN health policy currency and precludes providing higher-level CBRN policy and doctrine health input. Furthermore, incorporating extant CBRN health policies into JHC’s generic operational health guidance implies that they are not considered a high priority.

The relevance and importance of occupational and environmental medicine to the broader ADF has previously been highlighted.49 In this instance, among their other attributes, occupational and environmental physicians undergo comprehensive theoretical and practical education with respect to applying a risk management approach to the medical aspects of preventing, assessing, managing, treating and advising on biological, chemical, radiological and other hazards.50

Military occupational and environmental physicians therefore, already possess many of the skill sets required to provide specialist CBRN health training, policy development and command advice. Their participation would also be predicated on managing CBRN hazards on comparable terms as other military occupational and environmental hazards. As applied to the ADF population, this approach is consistent with current national guidance for managing CBRN attacks on Australian civilians, while also maintaining ADF operational capability.

This paper therefore contends that, in collaboration with other occupational and environmental health practitioners and CBRN subject matter experts, occupational and environmental physicians have much to offer the ADF, with respect to leading and sustaining a holistic and time-critical responsive CBRN health planning, preparation and operational response capability.

Conclusion

With ADF personnel arguably exposed to the most diverse range of occupational and environmental hazards of any Australian workforce, high rates of preventable workplace illness and injury indicate the need to improve the management of occupational and environmental health hazards with better emphasis on prevention than treatment. This includes the accelerated pace and reduced warning of future CBRN threats to ADF personnel.

These considerations suggest that the ADF’s health services be premised on an occupational and environmental health paradigm, with revised fundamental inputs to capability that would lead to a genuinely holistic and sustainable workforce-based ADF health service delivery model by 2030.

Among other attributes, this paradigm would entail military occupational and environmental physicians, who already possess many of the specialist skills to manage CBRN hazards, on comparable terms as other occupational and environmental hazards.

Many nations, including Australia, have focused their CBRN defensive measures against the civilian public health threat posed by terrorist organisations. Military occupational and environmental physicians can apply the same approach to the ADF population, with respect to the prevention and treatment of CBRN casualties, while also maintaining operational capability.

Authors

Major David Heslop graduated his PhD in medicine in 2004 and medicine in 2006 from The University of Sydney as part of the ADF Graduate Medical Scheme, is a Fellow of the Royal Australasian College of General Practitioners and active clinician, and an advanced fellowship trainee with the Australasian
His seagoing service includes HMA Ships Swan, Stalwart, Success, Sydney, Perth and Choules. Deployments include DAMASK VII, RIMPAC 96, TANAGER, RELEX II, GEMSBOK, TALISMAN SABRE 07, RENDERSAFE 14, SEA RAIDER 15, KAKADU 16 and SEA HORIZON 17. His service ashore includes clinical roles at Cerberus, Penguin, Kuttabul, Albatross and Stirling, and staff positions as J07 (Director Health) at the then HQAST, Director Navy Occupational and Environmental Health, Director of Navy Health, Joint Health Command SO1 MEC Advisory and Review Services, and Fleet Medical Officer (2013-2016).

Commander Westphalen transferred to the Active Reserve in July 2016.

Disclaimer

The views expressed in this article are the authors, and do not necessarily reflect those of the Australian Army, the RAN or any of the other organisations mentioned.

Corresponding Author: Neil Westphalen, neil.westphalen@bigpond.com
Authors: N Westphalen¹, D Heslop²

Author Affiliations:
1 Royal Australian Navy Reserve
2 University of New South Wales, School of Public Health and Community Medicine

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5 During the interwar period, chemical weapons were used by the Italians against Ethiopians, and by the Japanese against the Chinese. Since WWII, they have been used by the Egyptians against Yemenis, Iraqis against Iraqi Kurds and Iranians, and most recently by the Syrians against rebels in 2013 and 2017. See Evison, D, Hinsley D, Rice P. ‘Chemical weapons’, British Medical Journal, 09 February 2002, Vol 324 No 7333 pp 332-335 available from https://www.ncbi.nlm.nih.gov/pmc/articles/


10 A probable exception was the assassination of Kim Jong-nam, in Kuala Lumpur on 13 February 2017 using VX nerve agent. His assassination has not been ascribed to a non-government terrorist organisation, but the North Korean government. See Colvin, M, ‘Nerve agent VX used to kill estranged half-brother of Kim Jong-un’, ABC News, 24 February 2017, available from http://www.abc.net.au/content/2016/s4625889.htm.


33. See RANSSSS Training Management Package: Standard Combat Survivability dated 22 Apr 2014, (only available on Defence intranet).

34. See Australian Defence Doctrine Publication Chemical, Biological, Radiological and Nuclear Defence, 2011: Australian Army Land Warfare Procedures – General LWP-G 7-2-5 Conduct of Chemical, Biological, Radiological and Nuclear Training dated 28 April 2014; LWD 3-9-7 Operations in a Chemical,
Biological, Radiological and Nuclear Environment dated 13 May 2005; LWP-G 3-9-10 Chemical, Biological, Radiological and Nuclear Defence dated 6 December 2005; Australian Book of Reference 5476 — Volume 1 Royal Australian Navy Shipboard Combat Survivability—Damage Control Policy dated 09 August 2016, (all only available on Defence intranet).


36 See Defence Instruction (General) Operations 15-1 Australian Defence policy for the development of the capability to conduct operations in a Chemical, Biological, Radiological and Nuclear Environment AL2 dated 29 Jan 2006 (only available on Defence intranet).

37 Guidance with respect to immunisation against biological warfare agents is in Volume 1 Part 7 Chapter 1 of the Defence Health Manual. Volume 2 Part 7 has 16 chapters on various operational health matters, of which only six pertain to CBRN.

38 Defence Health Manual Volume 2 Part 5 Health Standards and Assessments - Entry and Transfer (only available on Defence intranet).

39 For instance, personnel with immune disorders may not be able to be vaccinated against biological agents, while personnel who lack an enzyme called pseudocholinesterase, are more susceptible to nerve agents and are less responsive to nerve agent pre-treatment and post-exposure medications. For another example, personnel with asthma may be at an increased risk of an asthma attack on exposure to chemical agents, yet they cannot use their asthma medication while wearing a respirator. Some personnel may also have an increased risk of heat stress while wearing Mission Oriented Protective Posture (MOPP) suits.


44 ‘Chemical, Biological, Radiological and Nuclear (CBRN) Health Course’, ADF Headquarters Joint Health Command website (only available on Defence intranet).

45 It is understood a brief (one-day) medical CBRN session was conducted during Exercise BLUESTOKES at HMAS Penguin on 16-20 April 2018, while another was conducted prior to the 2018 Australasian Military Medicine Association Conference. These sessions cannot be considered in any way comparable to the pre-2012 Health Officer CBRN Course (two weeks).


Introduction

During the last decade, over 2.5 million United States (US) and coalition troops have deployed to Iraq and Afghanistan. In addition to combat injuries, late health effects of operational service are well recognised, particularly psychological and physical effects of deployment exposures. There is also increasing evidence suggesting a higher prevalence of respiratory conditions among international military personnel deployed to the Middle East Area of Operations (MEAO). Although no specific risk factors other than deployment have been definitively linked to these respiratory health outcomes, there are many characteristics of deployment that may raise the risk of adverse respiratory health effects, including exposure to various airborne contaminants, burn pits, dust, particulate matter, industrial fires and traumatic exposure. In addition, evidence suggests tobacco smoking, physical activities and other individual susceptibility factors such as age, sex, body mass index (BMI), blood pressure, physical fitness, pre-existing conditions and personal characteristics may also increase the risk of respiratory symptoms and may enhance susceptibility to environmental exposures.

Although many studies have reported increases in respiratory conditions and symptoms among military personnel, existing knowledge regarding underlying aetiology is yet to be fully clarified. Therefore, a systematic review of research into the impacts of deployment on respiratory function among contemporary military Veterans was undertaken. The findings from this review suggest that deployment-related environmental, psychological trauma exposures and other military factors such as physical activity, increased tobacco use and individual susceptibility markers could contribute to respiratory conditions and other health effects not yet identified.

Key words: respiratory conditions, Middle East, military veterans, deployment, risk factors, exposure

Abstract

Current international literature suggests a higher prevalence of respiratory conditions in military personnel during and following deployment to the Middle East for reasons that are not well understood. Therefore, a systematic review of research into the impacts of deployment on respiratory function among international and Australian contemporary military Veterans was undertaken.

The findings from this review suggest that deployment-related environmental, psychological trauma exposures and other military factors such as physical activity, increased tobacco use and individual susceptibility markers could contribute to respiratory conditions and other health effects not yet identified.

Systematic Review of The Impact of Deployment on Respiratory Function of Contemporary International and Australian Veterans’
Key findings of articles, country of origin, measurement, population and sample size are presented in Appendix 1. Where possible a military comparison group was preferred; however, broader criteria were used to provide the most comprehensive overview of available published research. Due to the limited research in this area, studies of lower levels of evidence addressing issues of interest were retained, although findings were interpreted with caution and used as supporting rather than primary evidence sources. A total of 172 papers were evaluated by the lead author, with ~50% (n=87) also evaluated by the second author. Following this process, a total of 85 papers were included in this review (see Figure 1).

Figure 1: Studies obtained from initial database searches

Initial database searches n= 3630 (3526 from databases+104 by pearling)  
Removed duplicates: n= 1029  
Excluded based on title, abstract: n=2320  
Excluded based on relevance and full text screening: n=109  
Excluded following evaluation: n=86  
Total number of included papers: n=85

Results

Preliminary assessment of studies identified the following key areas where the impact of deployment on these respiratory outcomes could be examined.

- **Environmental and/or chemical exposures** including; particulate matter (including metal particles), burn pits and air pollution
- **Trauma and combat exposures** including; blast, trauma/stress
- **Other exposures/factors** including; physical activity, smoking and individual susceptibility factors.

Papers were grouped accordingly. An assessment of the available evidence was summarised for each outcome, and conclusions regarding the state of evidence in the area as a whole presented, including an overview of notable gaps. Key study information and findings, organised by topic, are summarised in Appendix 1.
Respiratory health outcomes in deployed military populations

International studies have documented an increased incidence of respiratory disorders in military personnel who served in the Middle East compared with non-deployed populations.\(^5,6,7\) Overall, studies have reported increased rates of non-specific respiratory symptoms, asthma and constrictive bronchiolitis in deployed military personnel, with evidence that exposures while on deployment contribute to this via direct actions and by disturbance of the immune system.

In a study of the causes underlying respiratory symptoms in military personnel returning from duty in Iraq and Afghanistan by Morris et al. (2013), 42% of US Veterans reported non-specific respiratory symptoms, although most did not reach the threshold for a specific clinical diagnosis.\(^13\) The majority of patients who did receive a specific diagnosis had evidence of asthma or nonspecific airway hyper-reactivity. This may have reflected aggravation of pre-existing disease\(^13\) or hyper-activation of the immune system.\(^14\) Smith et al. (2009) also reported that deployment was associated with respiratory symptoms in both US Army and Marine Corps personnel, independent of smoking status and deployment length was positively associated with increased symptom reporting in Army personnel. This study concluded that specific exposures rather than deployment in general are determinants of post-deployment respiratory illness.\(^6\) Further recent US studies have also implicated inhalational exposures during deployment as predictors of constrictive bronchiolitis and new-onset asthma in Veterans.\(^15,16\)

In this review, we describe the most prevalent respiratory health outcomes reported among military personnel including asthma, constrictive bronchiolitis (CB), chronic obstructive pulmonary disease (COPD), respiratory infection and acute eosinophilic pneumonia (AEP).

Asthma

Asthma, a form of reversible bronchospasm, is usually connected to allergic reaction or other forms of airway hypersensitivity. Given the nature of deployment exposures, deployed populations may be at risk of increased inflammation, which in turn can impact on respiratory function.\(^17\) Since 2004, US military candidates diagnosed with asthma after the age of 13 have been excluded from military enlistment unless exempted via medical waiver.\(^16\) Entry to the Australian Defence Force (ADF) for people with asthma similarly changed post 2007. Currently candidates with mild asthma may be considered for entry to the ADF subject to certain criteria, including normal spirometry and negative bronchial provocation testing.\(^18\) However, rates of asthma among serving military personnel are generally low, in comparison to the general population. Despite low asthma rates at intake into the military, asthma diagnoses have increased in the US military since the beginning of the Iraq Afghanistan war.\(^6,19\) The US Department of Defense reported that 13% of US Army Medical visits in Iraq were for new-onset acute respiratory illness.\(^16\)

Recently, an increasing number of studies have reported consistent positive associations between psychosocial stress and asthma\(^6,13,16,20\) suggesting that, in the context of military service and deployment specifically, both environmental exposures and also the psychological stress of deployment should be considered as important contributing factors. In relation to deployment specifically, several studies provide evidence of an association between deployment and new-onset asthma and other respiratory symptoms.\(^8,16,19\) A retrospective review of medical diagnoses by Szema et al. (2010) of more than 6 000 US military personnel deployed and subsequently discharged from military active duty, reported that deployment to Iraq was associated with a higher risk of having a new International Classification of Diseases-9 (ICD-9) diagnosis of asthma post deployment.\(^16\) Similar findings were documented in occupationally exposed first responders to the World Trade Center disaster.\(^21,23\)

In a case control study, Abraham et al. (2012) reported an increase in post-deployment respiratory symptoms and medical encounters for obstructive pulmonary diseases, relative to pre-deployment rates, in the absence of an association with cumulative deployment duration or total number of deployments, indicating that it may be more specific exposures having an impact rather than deployment alone.\(^24\) However, in contrast, DelVecchio et al. (2015) evaluated 400 US Army personnel with a clinical diagnosis of asthma and found that there was no significant relationship between rates of diagnosis or severity based on history of deployment.\(^25\) The findings from this retrospective study may indicate that deployment-related lung conditions are subtle and require careful evaluation over time to determine the long-term impacts of deployment on the development of respiratory disease. Furthermore, this study did not focus on deployment-related environmental exposures, which may explain why no association was found.

Despite screening processes in many international militaries, pre-existing disease may also play a role...
in the development of respiratory symptoms. In a prospective study Morris et al. (2007) examined airway hyper-reactivity in asymptomatic US military personnel. Asymptomatic airway obstruction had a prevalence of 14% in young military personnel with evidence of worsening obstruction during exercise. This suggests that rates of asymptomatic asthma may be higher than previously recognised. Results of a cross-sectional study by Roop et al. (2007) suggested that asthmatics with good baseline symptom control are similar to non-asthmatics in their risk of developing worsening respiratory symptoms or functional limitations during deployment.

Overall some studies show increased rates of asthma, which may or may not be related to deployment. There are also suggestions that asymptomatic asthma may be underestimated, therefore deployment could possibly be exacerbating, rather than causing the condition. However, in the absence of mandated pre-enlistment lung function testing, it is difficult to determine the true prevalence of asthma or hyper-reactive airways in the enlistment population.

Constrictive bronchiolitis (CB)

Constrictive bronchiolitis (CB) is a recognised form of non-reversible obstructive lung disease in which bronchioles are compressed and narrowed by fibrosis and/or inflammation. In a descriptive case series by King et al. (2011), 49 soldiers that returned from the Middle East with unexplained respiratory symptoms underwent lung biopsy. Thirty-eight of these soldiers subsequently received diagnosis of CB, an otherwise uncommon diagnosis. The majority of biopsy samples showed polarisable material consistent with the inhalation of particulate matter, even though most of the soldiers were lifelong non-smokers. In addition, thickening of the arteriolar wall or occlusion in adjacent arterioles was observed, which may have been the result of toxic inhalation.

Chronic obstructive pulmonary disease (COPD)

A small number of participants in a prospective study of Australian military personnel deployed to the MEAO were found to meet the global initiative for COPD criteria. A slight but statistically significant change to lung function between pre-and post-deployment was also observed among this group, specifically between small decreases in the lung function and reported exposure to different chemical and/or environmental exposures. In a retrospective review by Matthews et al. (2014), military personnel diagnosed with COPD were investigated. Despite evidence of increased respiratory symptoms in deployed military personnel, this study reported that the impact of deployment on increased diagnosis or severity of COPD appears minimal.

Infection

Respiratory infections are the leading cause of outpatient treatment during deployment and account for 25–30% of infectious disease hospitalisations in US Army personnel. Solis et al. (2009) found that 39% of soldiers have had at least one respiratory infection while on deployment. The deployment environment may facilitate transmission of respiratory infections, thereby accounting for higher incidence rates than comparable civilian populations. Service members may be exposed to high level of stress, contagious novel pathogens, harsh environmental conditions as well as overcrowding and inadequate hand-washing facilities. Respiratory bacteria and viruses are transmitted person-to-person via respiratory droplets, and typically result in acute self-limiting infections. However, highly virulent and transmissible strains of pathogens can lead to morbidity and mortality.

Combat training programs are demanding, involving not only prolonged periods of physical activity but also exposure to psychological stressors, sleep deprivation, shifts in daily rhythm, and exposure to thermal extremes and high-altitude environments. The effects of such challenges on a soldier’s health are complex, resulting in a broad spectrum of changes in the immune system, which may predispose to various diseases, predominantly of the respiratory tract. Although recent attention has been directed towards acute morbidities as a result of respiratory infections, the adverse long-term effects of respiratory infections are not well understood, specifically in military populations. Given the potentially high rates of respiratory infection in deployed personnel, this is an important area for further research.

Acute Eosinophilic pneumonia (AEP)

Acute eosinophilic pneumonia (AEP) is an uncommon, idiopathic lung disease. The diagnosis is typically based upon clinical testing that include bronchoalveolar lavage, blood test or smear and chest radiograph. Lung biopsy is rarely necessary. AEP is characterised by general respiratory symptoms, alveolar and or blood eosinophilia, and peripheral pulmonary infiltrates on chest imaging. In most cases the acute illness lasts less than four weeks. Dry cough, dyspnoea and fever are present in almost every patient. Associated symptoms and signs can include malaise, myalgia, night sweats, chills and chest pain. Some studies suggest that AEP is an
acute hypersensitivity reaction to an unknown inhaled antigen in an otherwise healthy individual.\(^{36}\) Eighteen cases of AEP (including two fatalities) were reported among over 180,000 military personnel deployed in or near Iraq between March 2003 and March 2004. All AEP patients were smokers with 78% recently beginning to smoke during deployment and all but one patient had significant exposure to fine airborne sand or dust; no other common source exposure could be identified. The study concluded that recent exposure to tobacco may prime the lung in some way such that a second exposure or injury, e.g., in the form of dust, triggers a cascade of events that culminates in AEP.\(^{5, 37}\) AEP was also reported in at least one firefighter following the collapse of the World Trade Center towers in 2001.\(^{38}\)

As outlined above, current literature, including case reports and retrospective cohort studies, suggest a potentially higher prevalence of respiratory symptoms and respiratory illnesses including asthma.\(^{5, 16, 26}\) CB,\(^{15}\) COPD,\(^{1, 37}\) and AEP\(^{37}\) among deployed military personnel. Specific deployment-related exposures such as environmental (particulate matter, metal particles, burn pit, air pollution), combat (blast, stress) and other exposures (smoking, physical activity, military living conditions) may relate to these impairments in respiratory function\(^{5, 10, 11, 15, 37, 40-44}\) and are discussed below.

Environmental and/or chemical exposures

Military personnel who have served in Iraq and Afghanistan have expressed concern about possible long-term health effects associated with environmental exposures during deployment, including toxic industrial chemicals, local combustion sources and poor air quality.\(^{5, 41, 42, 45-47}\) US Veterans seeking treatment at Department Veterans Affairs (DVA) clinics after deployment, have reported a high prevalence of environmental exposure and exposure concerns, although whether this concern translates to actual adverse respiratory health outcomes is unclear.

In line with these concerns, researchers have hypothesised that there may be a relationship between deployment exposures and respiratory symptoms.\(^{21, 43, 46, 47}\) Korzeniewski et al. (2013) reported that the prevalence of respiratory diseases was closely related to environmental factors on deployment, such as exposure to sand and dust storms, extreme temperature changes and poor public health measures.\(^{7}\) A medical research working group formed to consider lung disease in US soldiers returning from Iraq and Afghanistan identified a number of potential risks for developing lung disease post deployment. These include type, severity and duration of exposure to environmental hazards, such as desert dust storms, proximity and duration of exposure to burn pits or fires, and frequency of exposure to air pollution.\(^{5}\)

Air pollution

Air sampling studies, conducted by US researchers suggest that multiple sources of air pollution including smoke from oil well fires, sand and dust storms, and not exclusively burn pit emissions, contribute to poor air quality in the deployed environment.\(^{36, 48}\) These findings are supported by independent work from investigators outside of the US;\(^{47, 49}\) however, there is no data available from longitudinal research studies with objective pulmonary assessments comparing lung function between those deployed to the Middle East and non-deployed personnel. A review article by Falvo et al. (2015) summarised current knowledge about the impact of service and environmental exposures on respiratory health of military Service members deployed to Iraq and Afghanistan.\(^{21}\) The report reviewed 19 studies published from 2001 to 2014. While studies of environmental exposures, in particular airborne pollutants, have shown an association with an increased burden of acute respiratory symptoms, studies reporting chronic respiratory diseases do not provide conclusive results, mainly because of the non-representative sample of the study populations. Data associating airborne hazard exposures to respiratory disease are similarly inconclusive. Therefore, there is insufficient evidence to support any association between air pollution in the deployed environment and respiratory health of military personnel.\(^{21}\)

Particulate matter (PM)

US data suggests that deployment to both Iraq and Afghanistan may pose additional risk factors to respiratory health because of the high levels of airborne PM and geologic dusts inherent in those regions.\(^{50}\) A majority (94%) of US Service personnel deployed to OIF and OEF reported exposure to high levels of airborne PM from a range of sources that may have exceeded environmental, occupational and military exposure guidelines,\(^{43, 51}\) indicating that these pose a real risk to health. McAndrew et al. (2012) reported that among MEAO deployed personnel, the most prevalent exposures were air pollution (94%), vaccines (86%) and petrochemicals (81%).\(^{43}\) Exposures and concern about exposures were both related to greater somatic symptom burden, and concern about exposure was highly correlated with symptom burden.
Metal particles

Another exposure of relevance to the deployed environment is metal PM. Biopsied lung tissue from selected deployed US soldiers with unexplained respiratory symptoms and history of inhalational exposure, identified the presence of metals including iron, titanium and crystalline material. This deployment’s inhalational exposure was thought to be the cause of unexplained exertional dyspnoea and diffuse CB conditions in these soldiers. Exertional dyspnoea is excessive shortness of breath and mainly reflects poor ventilation or oxygen deficiency in circulating blood. CB is a rare, small airway fibrotic respiratory disease. The cause of this condition is still unknown, although it is thought that environmental factors and genetic susceptibility could be major contributors to the development of the disease. King et al. (2011) found that in 38 of 49 previously healthy soldiers with unexplained exertional dyspnoea and diminished exercise tolerance after deployment, an analysis of biopsy samples showed diffuse CB, possibly associated with inhalational exposure.

Burn pit

A further identified exposure for respiratory insult, again common in the MEAO, is open-air burning of rubbish and other waste. Although the extent of the chemicals released in burn pits is unknown, ambient air sampling performed in selected Middle East regions has revealed that smoke from burn pits is a major source of air pollution. Some air pollutants such as dioxins, carbon monoxide, volatile organic compounds from burning of trash, vehicle/generator exhaust, oil well fires, gases from industrial facilities, and contaminants from dust containing silica, asbestos, lead, aluminium and manganese are well recognised carcinogens. Other acute agents may irritate the respiratory system causing acute cough or shortness of breath, hypersensitivity pneumonitis, irritant induced asthma and CB, especially when exposures are repetitive or exceed recommended concentrations.

Evidence to support long-term adverse effects of exposure to burn pits is controversial. Although some studies have found that deployment may be associated with a subsequent risk of developing respiratory conditions. Abraham et al. (2014) suggests that elevated medical encounter rates (visits to medical centres for respiratory outcomes including general respiratory system and other chest symptoms, asthma, COPD, bronchitis, emphysema, bronchiectasis and extrinsic allergic alveolitis) were not uniquely associated with burn pits. In this study, medical encounter rates among personnel deployed to burn pit locations were compared directly to those among personnel deployed to locations without burn pits. No significant differences in respiratory outcomes between these groups were found.

Furthermore, findings from Smith et al. (2012) do not support an elevated risk for respiratory outcomes among personnel deployed within proximity of documented burn pits in Iraq. Comparing burn pit exposed and non-exposed groups, this study observed similar proportions of newly reported CB and emphysema (1.5% vs 1.6% respectively), newly reported asthma (1.7% vs 1.6%), and respiratory symptoms in 2007 (21.3% vs 20.6%). Similarly, a study by Baird et al. (2012) reported that while potential exposure to sulphur plant fires was positively associated with self-reported health concerns and symptoms, it was not associated with an increase in clinical encounters for chronic respiratory health conditions. Powell et al. (2012) found no increase in chronic multi-symptom illness (CMI) symptom reporting in military personnel deployed to three selected bases with documented burn pits compared with other deployment sites. However, limitations in standardising exposures may have biased these results.

Toxicological, epidemiological and clinical data are limited and prevent reliable evaluation of the prevalence or severity of adverse effects of inhalational exposures to PM or burn pit combustion products in military personnel deployed to Iraq and Afghanistan. The current clinical evidence on the effect of deployment on respiratory health is primarily retrospective and does not provide clarity regarding specific causative factors or the effect on the deployed population as a whole. Taken together, these findings suggest that environmental exposures including burn pits and air pollution may be associated with subjective physical health symptom reporting, but there is no evidence of increased rates of objective respiratory health outcomes.

Regardless of the source, it seems likely that higher levels of air pollution are common in many deployment areas and could contribute to future pulmonary and other health effects not yet identified. Together, these findings indicate that while deployment appears to be associated with adverse respiratory outcomes, this cannot be reliably attributed to environmental exposures. Other deployment exposures that should also be considered include trauma, particularly blast trauma and psychosocial stress associated with a combat environment.
Combat exposures

**Blast**

In addition to air pollution and smoke from burn pits, military Veterans who have served in Iraq and Afghanistan may have been exposed to other significant respiratory stressors, such as aerosolised metals and chemicals from improvised explosive devices (IEDs), or to traumatic respiratory insult such as blast overpressure or shock waves to the lung.54

Concern about the effects from embedded metal fragments from IEDs used in the Middle East conflicts has been raised among Service members. As a result, the US DVA established a special registry in 2008 for medical surveillance and management of Veterans with retained metal.51 Some of the embedded metal contaminants, including aluminium, arsenic, cobalt, chromium and nickel, may have immunogenic respiratory health effects. In a recent report from the Toxic Embedded Fragment Surveillance Centre, of 89 urine samples tested, 47% exceeded the reference value for aluminium and 31% for tungsten.55

Recently, publication of an unusual case report of chronic beryllium disease (CBD) was described in a 41-year-old Israeli soldier who suffered mortar shell injury with retained shrapnel in the chest wall. This report raised the possibility of shrapnel-induced CBD from long-term exposure to the surface of retained aluminium shrapnel fragments in the body.56

It has been proposed that Service members who sustained subclinical blast injury may be susceptible to long-term sequelae. Apart from direct consequences of blast injuries such as blast pressure wave, fragments of debris or injuries due to acceleration or deceleration, there are also less obvious injuries caused by a blast including psychological trauma, burns and toxic-substance exposure from inhalation of hot contaminated air.57,58 Such injuries can have unpredictable long-term outcomes including permanent fibrosis of the bronchial mucosa.59

Despite the high plausibility of long-term adverse effects following acute pulmonary blast injury, there is an absence of data on the long-term outcomes. Furthermore, the possibility of other long-term pulmonary consequences of blast exposure, such as the effect of explosion-related dust exposure, and other exposures such as smoking, has not been adequately examined. Overall there is limited data to support a conclusion regarding an association between exposure to blast and long-term respiratory outcomes.57

**Trauma/stress**

In addition to the frequent and proximate exposures to ambient airborne hazards, factors unique to military service that may make military personnel more vulnerable to greater respiratory health risk include high levels of psychological stress.21 Vocal cord dysfunction (VCD) refers to abnormal closing of the vocal cords when inhaling or exhaling. It is often misdiagnosed as asthma in the clinical setting and has been reported in military personnel.50 A study of exertional dyspnoea in US military personnel demonstrated that 12% of patients evaluated had evidence of VCD, most of which was exercise related. Morris et al. suggested that the development of VCD in the deployed environment might be related to nonspecific upper airway irritation, underlying psychiatric conditions and/or significant stress attributed to the combat environment.50

There is also growing evidence for an association between exposure to traumatic stress, including childhood maltreatment or combat experience and pulmonary diseases such as asthma, CB and COPD.60-63 This relationship was also demonstrated in adult research populations exposed to the 11 September 2001 World Trade Center terrorist attack. More specifically, moderate associations between probable post-traumatic stress disorder and respiratory symptoms have been observed in first responders to the World Trade Center disaster.22, 23

A cross-sectional study conducted by Spitzer et al. (2011), analysed the associations between lung function, trauma exposure and post-traumatic stress disorder (PTSD) in 1 772 adults from the general population using standardised questions and spirometry test.45 Those with a diagnosis of PTSD had a significantly greater risk of having asthma symptoms than those without PTSD. However, those with a history of psychological trauma, but no diagnosis of PTSD, did not have an elevated risk, suggesting the association is specific to disorder status rather than symptomatology or trauma exposure. Analyses indicated that subjects with diagnosed PTSD had a significantly increased risk for airflow limitation independent of its definition.

One possible mechanism underpinning the association between stress and reduced respiratory function could be increased levels of systemic inflammatory markers.20, 65-68 Excessive pro-inflammatory responses may cause airway damage and consequently structural and functional pulmonary changes.31 Hypothetically, higher levels of stress during deployment among personnel may.
in part, explain the increased rate of respiratory symptoms reported in recent studies. There is increasing evidence of associations between stress related mental disorders such as PTSD and altered immune responses, and elevated circulating inflammation. The direction of this association is not conclusive, however. Regardless, low level inflammation and altered immune response provide plausible mechanisms by which trauma exposure may be associated with respiratory symptoms.\textsuperscript{20, 60, 65-68}

Other exposure factors

In addition to deployment specific risks, evidence suggests other military factors such as physical activity, increased tobacco use and other individual susceptibility factors may increase the risk of respiratory symptoms and enhance susceptibility to environmental and trauma exposures in this population.

Physical activity

Researchers have suggested that physical activity performed in stressful environments alters immune function.\textsuperscript{17} Light physical activity or moderate environmental stress stimulate immune responses, but exhausting physical activity or severe environmental stress can have immune suppressant effects, manifested by a temporary increase in susceptibility to respiratory infections.\textsuperscript{3} Multiple physical and psychological stressors, such as those encountered on deployment, may induce alterations in immune parameters (as discussed above) and/or neurological and endocrine responses; these common exertion-induced pathways could result in respiratory tract syndromes.\textsuperscript{8}

Smoking

Cigarette smoking has been associated with morbidity and mortality in a number of studies.\textsuperscript{6-7, 21, 31, 69, 70} Pathological mechanisms of smoking and its adverse health effects generally overlap with environmental air pollution. Smoking has also been related to increased susceptibility to respiratory insult from airborne hazards.\textsuperscript{70} Interestingly, there is no clear evidence of direct effects of smoking on respiratory outcomes in deployed military populations. For example, Sanders et al. found that approximately 70\% of US military personnel deployed to Iraq and Afghanistan reported at least 1 episode of an acute respiratory illness and 15\% reported 3 or more incidents of respiratory illnesses during their deployment.\textsuperscript{31} There was, however, no observed relationship between cigarette smoking and self-reported respiratory illnesses during deployment; suggesting that factors other than tobacco use were likely to contribute to the observed respiratory symptoms and morbidity.

Findings from a prospective study of Australian military personnel deployed to the MEAO showed that those respondents who began or resumed smoking while on deployment were also likely to have more co-morbidities compared to those who did not smoke on deployment.\textsuperscript{1} Similarly, those who smoked more than usual were likely to have more co-morbidities compared to those who did not smoke.\textsuperscript{1} However, the relative impact of different exposures and other non-smoking related risk were not examined in this population.

Since the 1960s, the rate of tobacco smoking has declined in the US including in the military.\textsuperscript{71} However, the rate of tobacco smoking among active duty military personnel remains higher (32\%) compared to the general population (~20\%).\textsuperscript{71} Within the US military population, the prevalence of smoking is approximately 40\% higher among Veterans and 50\% higher among deployed military personnel compared with their non-deployed counterparts.\textsuperscript{71} In a cross-sectional study by Sanders et al. (2005), it was reported that 47.6\% of US military personnel deployed to Iraq and Afghanistan began or resumed smoking while deployed and ~40\% smoked half a pack of cigarettes or more per day.\textsuperscript{31} High rates of tobacco smoking are not restricted to US military personnel but are also increased 40\%-60\% among coalition militaries.\textsuperscript{72}

While specific factors contributing to smoking rates have not been ascertained, the significant smoking uptake observed in a number of studies is thought to relate to deployment stress particularly among those with prolonged deployments, or combat exposures.\textsuperscript{73} Combat exposure, military stressors and PTSD have all been identified also as predictors for cigarette smoking.\textsuperscript{74, 75} As discussed above, these psychological risk factors and mental health disorders have also been associated with respiratory symptoms, abnormal lung function and diseases such as asthma.\textsuperscript{20, 76} Although tobacco smoke may differ in many respects from the ambient air pollution in deployed settings, the contribution of tobacco smoke exposure to military personnel’s cumulative exposures to airborne hazards while on deployment cannot be underestimated, given the prevalence and intensity of tobacco use in stressful combat situations.\textsuperscript{21} The potential for smoking to interact with and/or exacerbate other environmental or stress exposures is of importance to examine.
Individual susceptibility factors

Studies regarding the association between respiratory health conditions and individual factors (age, sex, BMI, blood pressure, physical fitness, pre-existing conditions and personal characteristics) in general the population and deployed military personnel generally focus on single respiratory outcomes and are usually assessed using different methods.

In a cross-sectional study, data collected from a European Community Respiratory Health survey of 16 countries were examined. The aim of this study was to estimate the age and sex-specific incidence of asthma from birth to the age of 44 in men and women across several countries, and to evaluate the main factors influencing asthma incidence in young adults. This study demonstrated that there are different patterns of asthma incidence in men and women. During childhood, girls had a significantly lower risk of developing asthma than did boys. Around puberty, the risk was almost equal in the two sexes, while after puberty, the risk in women was significantly higher than that in men.\(^{77}\)

In a case control study of active duty and retired US military members, increasing BMI, younger age, gender, non-active duty beneficiary status and arthritis were significant independent predictors of asthma in this population.\(^{78}\) Similarly, Abraham et al. (2012) reported that gender, enlisted and Army personnel remained independent predictors of having a new obstructive pulmonary disease encounter.\(^{79}\) Age and combat occupations were not statistically significantly associated with a post-deployment obstructive pulmonary disease diagnosis. The way in which these factors might interact with deployment exposures to influence respiratory health outcomes has not been thoroughly studied. This deserves further attention in larger epidemiological studies, particularly given emerging evidence of their influence on physical and psychological health.

Limitations

Due to the limited research regarding respiratory health of MEAO deployed Service members, studies of lower levels of evidence addressing issues of interest were discussed in this review, although findings were interpreted with caution and used as supporting rather than primary evidence sources.

A number of studies in this review were of cross-sectional design; consequently, any respiratory health issues in existence before an exposure were not accounted. Without baseline data, it is not possible to accurately assess the impact of specific deployment exposures on a person’s respiratory health. Cross-sectional studies are carried out at one period and do not indicate the series of events, therefore it is difficult to determine the relationship between exposure and outcome as it lacks the time element.

Previous studies have largely relied on self-report data to measure the impact of exposures on respiratory health. This type of measurement is open to recall bias, particularly when data is collected well after exposures have occurred.\(^{31, 26}\) Medical record reviews are predominantly retrospective\(^{16, 39}\) and therefore also subject to potential biases (reflected in documentation and health care seeking).

Discussion

Long-term psychological and physical health effects following deployment are of concern to Veterans, healthcare providers and the community. While some international literature suggests a higher prevalence of respiratory conditions in military personnel during and following deployment to the Middle East, findings are equivocal and the exact reasons underpinning any elevated respiratory health consequences are not well understood. Some inconsistencies in findings could be due to difficulties retrospectively standardising for exposure; reliance on self-reported symptoms or conditions, or inconsistent application of ICD codes, making it difficult to say with certainty which conditions are increasing in incidence or prevalence. Furthermore, many studies have focused on limited exposure and outcome variables. The potential interaction of these factors, and their effects on multiple respiratory outcomes, has not been thoroughly considered.

Current evidence (mainly from US studies) indicates that deployment-related environmental (PM, burn pit, air pollution, metal particles), combat (blast, stress) and other exposures (smoking, physical activity, military living conditions), and psychological trauma more generally, may be associated with several respiratory conditions in military personnel, such as asthma,\(^{5, 16, 26}\) CB,\(^{15}\) COPD,\(^{1, 29}\) sinusitis,\(^{40}\) and AEP.\(^{27}\) These associations may be via direct actions and by disturbance of the immune system. Psychological stress, while highly prevalent in relation to deployment, is a less investigated risk factor for respiratory health outcomes and its contribution to respiratory health outcomes and potential mechanisms underlying associations, as well as potential predictors of good or poor health over time, are not well understood.\(^{61, 68, 79, 85}\)

Taken together, further prospective and cross-sectional analyses are needed to clarify relationships
between the individual and combined impacts of environmental and psychological exposures on deployment, and any potential moderating or mediating effects of other factors on respiratory outcomes.

References


Review Article

### Appendix 1: Key findings of the systematic review of the impact of deployment on respiratory function of contemporary international and Australian Veterans

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Measurement</th>
<th>Design</th>
<th>Level of evidence</th>
<th>Population</th>
<th>Sample size</th>
<th>Key Findings</th>
</tr>
</thead>
</table>
| 8 Korzeniewski K| Environmental factors, immune changes and respiratory diseases in troops during military activities| 2013| Poland| NA| Literature review| NA| NA| NA| - The effects of deployment challenges on a soldier’s health are complex  
- Could result in a broad spectrum of changes in the immune system and numerous cases of various diseases, with a predominance of respiratory tract infections. |
| 22 Banauch IG| Persistent Hyperreactivity and Reactive Airway Dysfunction in Firefighters at the World Trade Center| 2003| USA| - Presence of bronchial hyperreactivity  
- Respiratory objective measures at 1, 3 and 6 months post exposure| Retrospective cohort| III-2| - World Trade Center (WTC) rescue workers| 179| - Development and persistence of hyper-reactivity and reactive airways dysfunction were strongly and independently associated with exposure intensity  
- Hyper-reactivity shortly post-collapse predicted reactive airways dysfunction at 6 months in highly exposed workers |
| 23 Glaser MS| Estimating the Time Interval Between Exposure to the World Trade Center Disaster and Incident Diagnoses of Obstructive Airway Disease| 2014| USA| - Demographic data (FDNY employee database)  
- Physician diagnoses (electronic medical records)  
- Self-reported health questionnaires, obtained information regarding WTC exposures, smoking status, and current respiratory symptoms| Prospective cohort| II| - FDNY firefighters who first arrived at the WTC site| 8 930| - There were higher rates of new-onset obstructive airway disease (OAD) among the high exposure group during the first 15 months and, to a lesser extent, throughout follow-up |
| 24 Abraham JH| A Case-Crossover Study of Ambient Particulate Matter and Cardiovascular and Respiratory Medical Encounters Among US Military Personnel Deployed to Southwest Asia| 2012| USA| - Personnel and medical record  
- Meteorological data  
- ICD-9 codes  
- Linked ambient PM data with personnel, medical and meteorological data| Case-crossover| III-1| - US military personnel in southwest Asia| 2 838 cases| - No statistically significant associations between PM and cardiorespiratory outcomes were observed in young, relatively healthy, deployed military population |
<table>
<thead>
<tr>
<th>Study Number</th>
<th>Authors</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>Textual Description</th>
</tr>
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<tbody>
<tr>
<td>41</td>
<td>Engelbrecht JP</td>
<td>Characterizing Mineral Dusts and Other Aerosols from the Middle East—Part 1: Ambient Sampling</td>
<td>2009</td>
<td>USA</td>
<td>USA</td>
<td>Scanning electron microscopy with energy dispersive spectroscopy was used to analyse the chemical composition of small individual particles.</td>
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<tr>
<td>42</td>
<td>Abraham JH</td>
<td>A Retrospective Cohort Study of Military Deployment and Post-deployment Medical Encounters for Respiratory Conditions</td>
<td>2014</td>
<td>USA</td>
<td>Retrospective cohort</td>
<td>Medical record review, ICD-9 codes 490–496, 786.</td>
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<tr>
<td>44</td>
<td>Baird CP</td>
<td>Respiratory Health Status of US Army Personnel Potentially Exposed to Smoke From 2003 Al-Mishraq Sulphur Plant Fire</td>
<td>2012</td>
<td>USA</td>
<td>Retrospective cohort</td>
<td>Health survey questionnaire at pre- and post-deployment.</td>
</tr>
<tr>
<td>45</td>
<td>Smith B</td>
<td>The Effects of Exposure to Documented Open-Air Burn Pits on Respiratory Health Among Deployers of the Millennium Cohort Study</td>
<td>2012</td>
<td>USA</td>
<td>Retrospective cohort</td>
<td>Health survey questionnaire at baseline and follow-up.</td>
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<tr>
<td>46</td>
<td>Helmer DA</td>
<td>Health and exposure concerns of veterans deployed to Iraq and Afghanistan</td>
<td>2007</td>
<td>USA</td>
<td>Retrospective study</td>
<td>Review of clinical notes in the DVA Computerized Patient Record System (CPRS).</td>
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<tr>
<td>Year</td>
<td>Country</td>
<td>Title</td>
<td>Methods</td>
<td>Findings</td>
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<tr>
<td>2012</td>
<td>Sweden</td>
<td>Broad Exposure Screening of Air Pollutants in the Occupational Environment of Swedish Soldiers Deployed in Afghanistan</td>
<td>Active air sampling</td>
<td>High concentrations of PM were identified as the main potential health hazard, with PM2.5 and PM10 exceeding both long-term marginal Air-MEGs and short-term negligible Air-MEGs outdoors</td>
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<td>2011</td>
<td>Sweden</td>
<td>Characterization of the size-distribution of aerosols and particle-bound content of oxygenated PAHs, PAHs, and n-alkanes in urban environments in Afghanistan</td>
<td>As part of 'Health risks in military operations', research project</td>
<td>Characterisation of PM revealed large differences between the Afghan cities</td>
<td></td>
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</tr>
<tr>
<td>2012</td>
<td>USA</td>
<td>Prospective Assessment of Chronic Multi symptom Illness Reporting Possibly Associated with Open-Air Burn Pit Smoke Exposure in Iraq</td>
<td>Prospective</td>
<td>There was no increase in CMI symptom reporting in those deployed to three selected bases with documented burn pits compared with other deployers</td>
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<td>2007</td>
<td>Poland</td>
<td>Late consequences of respiratory system burns</td>
<td>Retrospective cohort</td>
<td>A significant decrease in DLCO was observed in the victims (98.4% vs. 85.4%), but not in the control group</td>
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<td>A significant decrease in FEV1 (96.4% vs. 83.4%) was observed in the control subjects</td>
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<td></td>
<td></td>
<td></td>
<td>This finding is likely due to smoking and exposure to heavy pollution</td>
<td></td>
</tr>
<tr>
<td>64</td>
<td>Farfel M</td>
<td>An Overview of 9/11 Experiences and Respiratory and Mental Health Conditions among World Trade Center Health Registry Enrollees</td>
<td>2008 USA</td>
<td>Cross-sectional IV</td>
<td>- The WTCHR protocol, including the baseline survey completed using computer-assisted telephone interviewing (CATI) and computer-assisted in-person personal interviewing (CAPI)</td>
<td>- World Trade Center Health Registry (WTCHR) enrollees</td>
</tr>
<tr>
<td>76</td>
<td>Luft BJ</td>
<td>Exposure, probable PTSD and lower respiratory illness among World Trade Center rescue, recovery and clean-up workers</td>
<td>2012 USA</td>
<td>Cross-sectional IV</td>
<td>- Data were derived from the initial examinations that took place ~4 years after 11 September 2001 - Structural equation modelling (SEM) were used to explore patterns of association among exposures, other risk factors, probable WTC-related PTSD based on PCL, physician-assessed respiratory symptoms arising after 9/11, and abnormal pulmonary functioning defined by low forced vital capacity</td>
<td>- 8 508 police and 12 333 non-traditional responders to WTC terrorist attack</td>
</tr>
<tr>
<td>79</td>
<td>Weese CB</td>
<td>Potential health implications associated with particulate matter exposure in deployed settings in southwest Asia</td>
<td>2009 USA</td>
<td>Literature review NA</td>
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<tr>
<td>Author</td>
<td>Title</td>
<td>Year</td>
<td>Country</td>
<td>Measurement</td>
<td>Design</td>
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</table>
| Morris MJ  | Diagnosis and management of chronic lung disease in deployed military personnel | 2013 | USA          | NA                   | Literature review | NA                | NA         | NA          | - Current data not adequate to reliably evaluate the prevalence or severity of adverse effects of inhalational exposures to PM or burn pit combustion products  
- The current clinical evidence is primarily retrospective in nature and does not provide any clear information on specific causative factors or the effect on the deployed population as a whole |
| Shephard RJ | Immune changes induced by exercise in an adverse environment         | 1998 | Canada       | NA                   | Literature review | NA                | NA         | NA          | - Light physical activity or a moderate level of environmental stress stimulates the immune response  
- Exhausting physical activity or more severe environmental stress have a suppressant effect, manifested by a temporary increase in susceptibility to viral infections |
| Douwes J   | Asthma nervosa: old concept, new insights                           | 2011 | New Zealand  | - Editorial review    | Editorial review  | NA                | NA         | NA          | - Emotional stress, anxiety and PTSD precedes the development of asthma both in children and adults  
- There is evidence that asthma precedes panic disorders and that panic disorders may exacerbate pre-existing asthma (adjusted for smoking, socioeconomic status, BMI and familial and genetic factors) |
<p>| DeVecchio SP| The impact of combat deployment on asthma diagnosis and severity     | 2014 | USA          | - Electronic medical record | Retrospective     | III-2             | 400        |             | - Among active duty military personnel with career limiting asthma, there is no significant relationship between rates of diagnosis or severity based on history of deployment to SWA |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Study Type</th>
<th>Design</th>
<th>Sample Size</th>
<th>Findings</th>
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<tr>
<td>58</td>
<td>Mackenzie IMJ</td>
<td>Blast injuries to the lung: epidemiology and management</td>
<td>2010</td>
<td>UK</td>
<td>Case series</td>
<td>IV</td>
<td>- Military casualties admitted to University Hospital Birmingham's critical care services, during the period 1 July 2008 to 15 January 2010</td>
<td>- The majority of casualties with blast-related lung injury have been very successfully managed with conventional ventilatory support employing a lung protective strategy. - Only a small minority requiring non-conventional support in the form of high-frequency oscillatory ventilation.</td>
</tr>
<tr>
<td>60</td>
<td>Spitzer C</td>
<td>Association of airflow limitation with trauma exposure and post-traumatic stress disorder</td>
<td>2011</td>
<td>Germany</td>
<td>Cross-sectional</td>
<td>IV</td>
<td>- Adults from the general population: with PTSD (n=28), - With trauma (n=887), - With no trauma (n=857)</td>
<td>- Findings suggest an association of trauma exposure and PTSD with airflow limitation, which may be mediated by inflammatory processes.</td>
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<td>61</td>
<td>Bandoli G</td>
<td>Psychosocial stressors and lung function in youth ages 10–17: an examination by stressor, age and gender</td>
<td>2016</td>
<td>USA</td>
<td>Cross-sectional</td>
<td>III-3</td>
<td>- Adolescents in the Los Angeles Family and Neighborhood Survey</td>
<td>- Study observed reductions in lung function in males related to the absence of a father in the house and family conflict. - Associations were stronger in older males ages 15–17 years for each stressor.</td>
</tr>
<tr>
<td>62</td>
<td>Goodwin R</td>
<td>Association between childhood trauma and physical disorders among adults in the United States</td>
<td>2004</td>
<td>USA</td>
<td>Cross-sectional</td>
<td>IV</td>
<td>- Individuals aged 15 to 54 in the non-institutionalised population</td>
<td>- Childhood physical abuse was associated with increased risk of lung disease peptic ulcer and arthritic disorders. - Childhood sexual abuse was associated with increased risk of cardiac disease. - Childhood neglect was associated with increased risk of diabetes and autoimmune disorders.</td>
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<tr>
<td>63</td>
<td>Scott K</td>
<td>Childhood Adversity, Early-Onset Depressive/Anxiety Disorders, and Adult-Onset Asthma</td>
<td>2008</td>
<td>USA</td>
<td>Cross-sectional</td>
<td>III-3</td>
<td>- Colombia 2104 - Belgium 980 - France 1326 - Germany 1283 - Italy 1698 - Netherlands 1017 - Spain 2006 - Japan 856 - Mexico 2064 - USA 4969</td>
<td>- Childhood adversity and early-onset depressive/anxiety disorders independently predict adult-onset asthma, suggesting that the mental disorder-asthma relationship is not a function of a shared background of childhood adversity.</td>
</tr>
<tr>
<td>Reference</td>
<td>Study Title</td>
<td>Year</td>
<td>Country</td>
<td>Methods</td>
<td>Study Design</td>
<td>Findings</td>
<td></td>
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<tr>
<td>Provençal N</td>
<td>The effects of early life stress on the epigenome: From the womb to adulthood and even before</td>
<td>2014</td>
<td>Germany</td>
<td>NA</td>
<td>Literature review</td>
<td>- There is increasing evidence for a prominent role of epigenetic mechanisms in embedding long-term effect of stress at different developmental stages as well as across generations - These epigenetic mechanisms are distinct for the different stages of stress exposure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ha Ensel A</td>
<td>Inflammation as a psychophysiological biomarker in chronic psychosocial stress</td>
<td>2010</td>
<td>USA</td>
<td>NA</td>
<td>Literature review</td>
<td>- Job stress, low socioeconomic status, childhood adversities as well as life events, caregiver stress and loneliness were all shown to exert effects on immunologic activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wright RJ</td>
<td>Epidemiology of Stress and Asthma: From Constricting Communities and Fragile Families to Epigenetics</td>
<td>2011</td>
<td>USA</td>
<td>NA</td>
<td>Epidemiological review</td>
<td>- Evidence increasingly links psychosocial stress to asthma, atopic disorders more broadly and lung function</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carroll D</td>
<td>Generalized Anxiety Disorder is Associated With Reduced Lung Function in the Vietnam Experience Study</td>
<td>2011</td>
<td>USA</td>
<td>NA</td>
<td>Cross-sectional</td>
<td>- One-year prevalence of Generalized Anxiety Disorder (GAD) and major depressive disorder (MDD) was determined using DSM-III criteria - Forced expiratory volume in 1 second was measured by spirometry - Participants from the Vietnam Experience Study - Entered military service between 1965-1971; served only one term of enlistment; served at least 16 weeks of active duty - 4 256 - In models that adjusted for age and height, both GAD (p=0.001) and MDD (p = 0.004) were associated with lower FEV1 - In models additionally adjusting for weight, service, ethnicity, marriage, smoking, alcohol consumption, income, education and major illness, GAD was still associated with poorer lung function (p = 0.01), whereas MDD was not (p = 0.18)</td>
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<tr>
<td>Author</td>
<td>Title</td>
<td>Year</td>
<td>Country</td>
<td>Measurement</td>
<td>Design</td>
<td>Level of evidence</td>
<td>Population</td>
<td>Sample size</td>
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</tr>
<tr>
<td>McKinney WP</td>
<td>Comparing the Smoking Behavior of Veterans and Nonveterans</td>
<td>1997</td>
<td>USA</td>
<td>- Self-reported questionnaire data from the 1987 National Medical Expenditure Survey (NMES)</td>
<td>Cross-sectional</td>
<td>III-3</td>
<td>- Random sample of veterans and the civilian, non-institutionalised population of the United States.</td>
<td>- 3 372 veterans vs 18 606 non-veterans</td>
</tr>
<tr>
<td>Bray I</td>
<td>Smoking prevalence amongst UK Armed Forces recruits: changes in behavior after 3 years follow-up and factors affecting smoking behavior</td>
<td>2013</td>
<td>UK</td>
<td>- Survey of the health behaviours</td>
<td>Cohort 3 years follow-up</td>
<td>- UK recruits in 1998/1999</td>
<td>- 10 531</td>
<td>- There were clear differences between service, rank and trade groups in smoking prevalence at recruitment.</td>
</tr>
<tr>
<td>Smith B</td>
<td>Cigarette Smoking and Military Deployment A Prospective Evaluation</td>
<td>2008</td>
<td>USA</td>
<td>- The incidence of new smoking in baseline never-smokers and the prevalence of resumed smoking in baseline past smokers were calculated</td>
<td>Prospective</td>
<td>II</td>
<td>- US military personnel</td>
<td>- 48 304</td>
</tr>
<tr>
<td>De Silva VA</td>
<td>Smoking among troops deployed in combat areas and its association with combat exposure among navy personnel in Sri Lanka</td>
<td>2012</td>
<td>Sri Lanka</td>
<td>- The 28 page questionnaire used in the study “Health of UK military personnel deployed to the 2003 Iraq war” was used as the data collection instrument</td>
<td>Cross-sectional</td>
<td>IV</td>
<td>- SLN Special Forces and regular forces deployed in combat areas</td>
<td>- 259 Special Forces - 412 regular navy personnel</td>
</tr>
</tbody>
</table>

- Current smoking was strongly associated with current alcohol use.
- Prevalence of current smoking was less among military personnel than in the general population.
- Prevalence of smoking was significantly higher among Special Forces personnel.
<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Measurement</th>
<th>Design</th>
<th>Level of evidence</th>
<th>Population</th>
<th>Sample size</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harte CB</td>
<td>Prospective examination of cigarette smoking among Iraq-deployed and nondeployed soldiers: prevalence and predictive characteristics</td>
<td>2014</td>
<td>USA</td>
<td>- Smoking Characteristics, Alcohol Use, Sociodemographic, Military Characteristics, Deployment-Related Stressful Experiences, Nondeployment-Related Stressful Experiences, Traumatic Stress</td>
<td>Prospective II</td>
<td>1082 US Army soldiers</td>
<td>n total = 1082</td>
<td>- Approximately 48% of participants smoked at both time points, with 6% initiating smoking and 6% quitting smoking initiation was associated with warzone stress exposure; - female gender and high military unit support predicted cessation - Military rank and alcohol use were associated with both smoking initiation and cessation</td>
<td></td>
</tr>
<tr>
<td>Allem JP</td>
<td>South Korean Military Service Promotes Smoking: A Quasi-Experimental Design</td>
<td>2012</td>
<td>USA</td>
<td>- Telephone interview questionnaire regarding smoking status and behaviour before, during and after military service</td>
<td>Observational IV</td>
<td>Data were drawn from a population-based probability telephone sample of Korean adults in California</td>
<td>n total = 475</td>
<td>- Military service is strongly associated with smoking</td>
<td></td>
</tr>
</tbody>
</table>

### Respiratory health outcomes

<table>
<thead>
<tr>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Measurement</th>
<th>Design</th>
<th>Level of evidence</th>
<th>Population</th>
<th>Sample size</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hyams CK</td>
<td>War Syndromes and Their Evaluation: From the U.S. Civil War to the Persian Gulf War</td>
<td>1996</td>
<td>USA</td>
<td>NA</td>
<td>Literature review article</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>- Poorly understood war syndromes have been associated with armed conflicts (Fatigue, shortness of breath, headache, sleep disturbance, forgetfulness and impaired concentration) - Many types of illness were found among evaluated veterans, including well-defined medical and psychiatric conditions, acute combat stress reaction, PTSD, possibly the chronic fatigue syndrome</td>
</tr>
<tr>
<td>5</td>
<td>Rose C</td>
<td>Overview and Recommendations for Medical Screening and Diagnostic Evaluation for Postdeployment Lung Disease in Returning US Warfighters</td>
<td>2012</td>
<td>USA</td>
<td>NA</td>
<td>Literature review and Recommendations</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>6</td>
<td>Smith B</td>
<td>Newly Reported Respiratory Symptoms and Conditions Among Military Personnel Deployed to Iraq and Afghanistan: A Prospective Population-based Study</td>
<td>2009</td>
<td>USA</td>
<td>- Health survey questionnaire at baseline and follow-up</td>
<td>Retrospective cohort</td>
<td>III-2</td>
<td>Millennium Cohort Study participants</td>
<td>55,021</td>
</tr>
<tr>
<td>7</td>
<td>Korzeniewski</td>
<td>Prevalence of Acute Respiratory Tract Diseases Among Soldiers Deployed for Military Operations in Iraq and Afghanistan</td>
<td>2013</td>
<td>Poland</td>
<td>- Medical record review</td>
<td>Retrospective cohort</td>
<td>III-2</td>
<td>Polish Military Contingents relocated to Iraq and Afghanistan</td>
<td>6,071</td>
</tr>
<tr>
<td>13</td>
<td>Morris MJ</td>
<td>Study of Active Duty Military for Pulmonary Disease Related to Environmental Deployment Exposures (STAMPEDE)</td>
<td>2014</td>
<td>USA</td>
<td>- Pulmonary function testing, cardiopulmonary exercise testing, methacholine challenge test, bronchoalveolar lavage, impulse oscillometry system testing and high resolution computed tomography imaging</td>
<td>Descriptive case series</td>
<td>IV</td>
<td>Returning US military personnel</td>
<td>n total=50</td>
</tr>
</tbody>
</table>

- The Working Group recommended:
  1. Standardised approaches to pre- and post-deployment medical surveillance
  2. Criteria for medical referral and diagnosis
  3. Case definitions for major deployment-related lung diseases

- New-onset respiratory symptoms higher in deployers (14% vs. 10%), rates of obstructive disease similar at 1%
- Deployment length was linearly associated with increased symptom reporting in Army personnel
- Elevated odds of symptoms were associated with land-based deployment as compared with sea-based deployment

- Respiratory tract diseases were the most common health problem treated on an outpatient basis, with a prevalence ranging from 46 to 63 cases per 100 persons
- The prevalence of respiratory diseases was closely related to the environmental factors, extreme temperature changes, unsatisfactory sanitary conditions

- 42% had non-diagnostic evaluation
- 20% had airway hyper-reactivity
- 66% had mental health and sleep disorders
<table>
<thead>
<tr>
<th>ID</th>
<th>Author</th>
<th>Title</th>
<th>Year</th>
<th>Country</th>
<th>Study Design</th>
<th>Study Details</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Flierl MA</td>
<td>The role of C5a in the innate immune response after experimental blunt chest trauma</td>
<td>2008</td>
<td>Germany</td>
<td>Clinical/Observational study using animal model</td>
<td>Wistar Rats</td>
<td>4-8 for each experimental condition</td>
</tr>
<tr>
<td>15</td>
<td>King MS</td>
<td>Constrictive Bronchiolitis in Soldiers Returning from Iraq and Afghanistan</td>
<td>2011</td>
<td>UK</td>
<td>Descriptive case series</td>
<td>US soldiers from Kentucky, with inhalational exposures during service in Iraq and Afghanistan</td>
<td>49</td>
</tr>
<tr>
<td>16</td>
<td>Szema AM</td>
<td>New-onset asthma among soldiers serving in Iraq and Afghanistan</td>
<td>2010</td>
<td>USA</td>
<td>Retrospective</td>
<td>All US soldiers deployed and discharged from military service during 2004-2007</td>
<td>920 deployed, 5335 state-side-stationed troops (not deployed)</td>
</tr>
<tr>
<td>19</td>
<td>Morris MJ</td>
<td>Airway Hyperreactivity in Asymptomatic Military Personnel</td>
<td>2007</td>
<td>USA</td>
<td>Baseline spirometry examination</td>
<td>Healthy, asymptomatic, US military personnel with no previous history of asthma and &lt;1 year on active duty status</td>
<td>222</td>
</tr>
<tr>
<td>21</td>
<td>Falvo MJ</td>
<td>Airborne Hazards Exposure and Respiratory Health of Iraq and Afghanistan Veterans</td>
<td>2015</td>
<td>USA</td>
<td>Epidemiologic review</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ID</td>
<td>Last Name</td>
<td>Title</td>
<td>Year</td>
<td>Country</td>
<td>Study Design/Methodology</td>
<td>Data Sources</td>
<td>Findings/Notes</td>
</tr>
<tr>
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</tr>
<tr>
<td>26</td>
<td>Roop SA</td>
<td>The Prevalence and Impact of Respiratory Symptoms in Asthmatics and Nonasthmatics during Deployment</td>
<td>2007</td>
<td>USA</td>
<td>Cross-sectional IV</td>
<td>Health survey questionnaire</td>
<td>- Non-asthmatics, and asthmatics active duty soldiers and Department of Defense contractors returning from OEF</td>
</tr>
<tr>
<td>28</td>
<td>Pazzaglia LTG</td>
<td>Recent trends of pneumonia morbidity in US Naval personnel</td>
<td>1983</td>
<td>USA</td>
<td>Retrospective III-3</td>
<td>Medical record data</td>
<td>- Active duty Naval personnel admitted for pneumonia by primary diagnosis</td>
</tr>
<tr>
<td>30</td>
<td>Soltis BW</td>
<td>Self-Reported Incidence and Morbidity of Acute Respiratory Illness among Deployed U.S. Military in Iraq and Afghanistan</td>
<td>2009</td>
<td>USA</td>
<td>Cross-sectional IV</td>
<td>Health survey questionnaire during deployment</td>
<td>- US troops deployed to Iraq, Afghanistan and the surrounding region</td>
</tr>
<tr>
<td>31</td>
<td>Sanders JW</td>
<td>Impact of illness and non-combat injury during Operation Iraqi Freedom and Enduring Freedom (Afghanistan)</td>
<td>2005</td>
<td>USA</td>
<td>Cross-sectional IV</td>
<td>Health survey questionnaire on return from deployment</td>
<td>- US Military personnel who were deployed to Iraq or Afghanistan in 2003-2004</td>
</tr>
<tr>
<td>37</td>
<td>Shorr AF</td>
<td>Acute Eosinophilic Pneumonia Among US Military Personnel Deployed in or Near Iraq</td>
<td>2004</td>
<td>USA</td>
<td>Descriptive case Series</td>
<td>Morbidity, mortality related to AEP</td>
<td>- US military personnel deployed in or near Iraq</td>
</tr>
<tr>
<td>39</td>
<td>Abraham JH</td>
<td>Does Deployment to Iraq and Afghanistan Affect Respiratory Health of US Military Personnel?</td>
<td>2012</td>
<td>USA</td>
<td>Nested case-control III-3</td>
<td>Medical record review - ICD-9 codes 490-496</td>
<td>- US military personnel with post-deployment medical records</td>
</tr>
<tr>
<td>ID</td>
<td>Author</td>
<td>Title</td>
<td>Year</td>
<td>Country</td>
<td>Study Design</td>
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<tr>
<td>40</td>
<td>Barth SK</td>
<td>Prevalence of Respiratory Diseases Among Veterans of Operation Enduring Freedom and Operation Iraqi Freedom: Results From the National Health Study for a New Generation of U.S. Veterans</td>
<td>2014</td>
<td>USA</td>
<td>Retrospective cohort</td>
<td>US veterans</td>
<td>Deployed veterans are at increased risk for sinusitis compared to nondeployed. (odds ratio = 1.3) There was no significant difference in asthma or bronchitis risk between deployed and nondeployed veterans</td>
</tr>
<tr>
<td>50</td>
<td>Morris MJ</td>
<td>Vocal Cord Dysfunction Related to Combat Deployment</td>
<td>2013</td>
<td>USA</td>
<td>Retrospective review/Descriptive case series</td>
<td>US military personnel (OIF,OEF) evaluated at Landstuhl Regional Medical Center with a new VCD diagnosis post-deployment</td>
<td>48% had a truncated flow-volume loop, 83% had a negative methacholine challenge test, 3 of 48 had abnormal spirometry test results</td>
</tr>
<tr>
<td>51</td>
<td>Rose C</td>
<td>Military Service and Lung Disease</td>
<td>2012</td>
<td>USA</td>
<td>Literature review</td>
<td>NA</td>
<td>Respiratory illnesses affect mission readiness, burden active duty military and veterans’ health care systems, and may lead to significant morbidity and mortality</td>
</tr>
<tr>
<td>65</td>
<td>Gan Q</td>
<td>Association between chronic obstructive pulmonary disease and systemic inflammation: a systematic review and a meta-analysis</td>
<td>2004</td>
<td>Canada</td>
<td>Systematic review</td>
<td>NA</td>
<td>Reduced lung function is associated with increased levels of systemic inflammatory markers, which may have important pathophysiological and therapeutic implications for subjects with stable COPD.</td>
</tr>
<tr>
<td>80</td>
<td>Krefft SD</td>
<td>Emerging spectrum of deployment-related respiratory diseases</td>
<td>2015</td>
<td>USA</td>
<td>Literature review</td>
<td>NA</td>
<td>Investigators from Vanderbilt University, Nashville, TN, found constrictive bronchiolitis on 38 surgical lung biopsies in a case series of army deployers with unexplained chest symptoms. In a group of 50 consecutive deployed patients evaluated at San Antonio Military Medical Center, 36% were found to have airway hyperreactivity, whereas 42% were undiagnosed.</td>
</tr>
<tr>
<td>Page</td>
<td>Author</td>
<td>Title</td>
<td>Year</td>
<td>Location</td>
<td>Study Design</td>
<td>Study Details</td>
<td>Findings</td>
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<tr>
<td>81</td>
<td>Szema AM</td>
<td>Respiratory Symptoms Necessitating Spirometry Among Soldiers With Iraq/Afghanistan War Lung Injury</td>
<td>2011</td>
<td>USA</td>
<td>Retrospective cohort</td>
<td>III-2</td>
<td>- Compared Iraq/Afghanistan war veterans to veterans deployed stateside (all soldiers deployed and discharged from military service during March 1, 2004, to December 1, 2010)</td>
</tr>
<tr>
<td>83</td>
<td>Panos RJ</td>
<td>Patient Reported Determinants of Health: A Qualitative Analysis of Veterans with Chronic Obstructive Pulmonary Disease</td>
<td>2013</td>
<td>USA</td>
<td>Qualitative study focus group</td>
<td>IV</td>
<td>- Veterans with COPD and high utilisation of VHA healthcare</td>
</tr>
<tr>
<td>84</td>
<td>Korzeniewski K</td>
<td>Respiratory tract infections in the military environment</td>
<td>2015</td>
<td>Poland</td>
<td>Literature review</td>
<td>NA</td>
<td>- ~40–70% of all soldiers participating in recent military operations in Iraq and Afghanistan report to medical treatment facilities due to upper respiratory tract infections - Respiratory health hazards: extreme air temperatures, desert dust, emissions from burn pits, industrial pollutants and airborne contaminants originating from degraded soil</td>
</tr>
</tbody>
</table>
Homeless Indigenous Veterans and the Current Gaps in Knowledge: The State of the Literature

J Serrato, H Hassan, C Forchuk

Abstract

Background & purpose: The unique experiences of homelessness for Indigenous Veterans are currently understudied. The purpose of this review was to assess the current literature on homelessness among Indigenous Veterans, to identify the gaps in the existing knowledge base and to provide an insight into future research.

Materials & methods: Electronic databases including CINAHL, PsycINFO, ScienceDirect, Scopus, Homeless Hub and the Journal of Military, Veteran and Family Health were searched for relevant research studies. Search terms included 'Aboriginal', 'Indigenous', 'First Nations', 'Native', 'Métis', 'homeless', 'homelessness' and 'Veterans'. References within articles were also searched. To meet inclusion criteria, articles needed to focus specifically on homeless Indigenous Veterans, and be written in English.

Results: The initial search resulted in 32 research articles. No previous systematic or literature reviews were identified, making this review the first of its kind. One study from the United States (US) met inclusion criteria. This identified study reported that homeless Indigenous Veterans were more likely to use alcohol and spent a greater number of days intoxicated but were less likely to use drugs and experience psychiatric problems compared to white homeless Veterans.

Conclusion: There is currently an inadequate amount of research to draw concrete conclusions, thus further investigation is urgently needed. Only one paper was identified indicating that this is not solely a lack of North American literature, but also a lack of research conducted by the international community. This review encourages greater emphasis on future research for potential policy change and recommends an increase in cultural-specific services.

Keywords: Homelessness, Veterans, Aboriginal, Indigenous, Mental Health, Addiction.

Conflict of Interest Statement: The Homelessness Partnering Strategy, Employment and Social Development Canada supported this research.

Introduction

Homelessness among Veterans has become a significant issue for many Western countries yet there has been a lack of censuses investigating the number of homeless individuals and the demographics of such individuals. This is largely due to the challenging nature of enumerating the hidden homeless population with no fixed address, no method of communication and who can migrate nationally as well as locally. There are also differences in defining homelessness based on duration (particularly as housing status can change rapidly) and the type of shelter utilised. As well as research methods, such as point-in-time counts and night-time counts lacking in validity and reliability. Mobility among Indigenous homeless individuals in Canada has been found to be frequent with over 40% of respondents stating they had moved more than three times in 6 months and 18% reporting returning to their home communities seasonally. In Canada, it is estimated there are 2,250 Veterans who use homeless shelters every year exact numbers are currently unknown; especially as not all homeless...
people use shelters. Recent statistics in Canada suggest that Indigenous peoples make up 28% to 34% of the homeless population despite only accounting for 4.3% of the Canadian population with a tendency for higher rates of homelessness in western and northern communities in Canada.\(^5\) In a study conducted across four Canadian cities (Calgary, London, Toronto and Victoria), it was found that Indigenous and Métis Veterans made up 9.7% of the homeless Veterans sample.\(^6\) Currently there is a lack of research investigating homeless Veterans within Canada but in particular there is a dearth of literature specifically focusing on homeless Indigenous Veterans.

There are unique experiences living in Canada as there is differentiation among various Indigenous groups (First Nations, Inuit, Métis) as well as geographical and housing differences (on-reserve, off-reserve, rural, urban, Northern Territories).\(^3\) Given this, it is important to investigate the issue of Veteran Indigenous homelessness from a Canadian perspective. Gaetz et al. note that although the Truth and Reconciliation Commission report of 2015 does not specifically discuss homelessness, the report states that the legacy of residential schools used for cultural assimilation has resulted in Indigenous individuals being disproportionately affected by ineffective child protection services, poorer health outcomes, greater rates of substance misuse and an overrepresentation within the criminal justice system;\(^4\) all of which may be potential factors in increasing the likelihood of homelessness occurring. Unfavourable historical occurrences such as residential schooling may play a role in influencing the homeless rates of Indigenous Veterans. Similarly, the ‘Sixties Scoop’, during which Indigenous children were removed from their families’ homes by social workers and adopted by non-Indigenous families, may have influenced homelessness among Indigenous Veterans in Canada. The problematic issues that arose included a lack of social identity, physical abuse and racism (perceived and experienced) within adoptive homes.\(^7\) This was supported by Ray and Abdulwasi\(^8\) (as cited by Abdulwasi, Evans, & Magalhaes)\(^7\) who performed a secondary analysis of data obtained from a previous study\(^9\) and reported that Indigenous Veterans considered their adoptions as contributing factors towards homelessness with many reporting physical and emotional abuse as children, and a lack of connection and belonging to their culture and biological families.\(^8\) Further research is required to investigate the underlying causes of homelessness within this population. Difficulties in studying and analysing homelessness among Indigenous individuals can be due to a number of issues including, but not limited to, the lack of identification of ethnicity across services and agencies, an unwillingness to self-identify as Indigenous for fears of discrimination, a lack of Indigenous-led/Indigenous-specific services (including a lack of dissemination regarding these services), which has been found to lead to sampling and recruitment difficulties, and differences in social policy development between municipal/provincial/federal and on-Reserve/Indigenous governance which can lead researchers to make errors.\(^10\) As such, it makes the task of identifying specific demographics (i.e. Veteran status) within this population even more difficult to ascertain. Further, Kramer et al. highlighted the issue of Veteran identification in the US across Veteran health services, revealing that 32 259 of Indigenous Veterans were enrolled on the Veterans Health Administration database but only 44% of this sample was identified as having Veteran status according to the Indian Health Service National Patient Information Reporting System.\(^11\) Although literature from the US exists regarding these particular issues among Veterans, Indigenous participants are often underrepresented; less than 2% of the sample.\(^12\,13\) Additionally, similar studies that have been conducted in the US report participants that do not identify as white, black or Hispanic are considered ‘other’.\(^14\)

In Canada, it has been noted that alcoholism and other substance misuse have been cited as key factors in contributing to homelessness among Veterans followed by mental health issues and difficulty in successfully transitioning from the military to civilian life.\(^5\,15\) To ease this transition from military life to civilian life, Forchuk et al. note that an integrated approach to adopting the housing first model, that is, assisting in the attainment of housing as well as intensive case planning and support to assist with independent living skills and health, as well as harm reduction practices can improve access to addiction and mental health treatments in addition to income support.\(^6\) Among Indigenous adults in Eastern Canada, one study revealed that 71% of the sample consumed alcohol and 29% endorsed needing help with alcohol consumption.\(^16\) Previous research in the US has reported that alcohol dependency, suicidal behaviour, and mental health issues such as depression, anxiety and post-traumatic stress disorder (PTSD) have been found to be more prevalent among Indigenous peoples compared to the general population.\(^16\,17\) Despite the findings from these latter two studies, there has been extremely limited literature regarding addiction and the psychiatric needs specific to homeless Indigenous Veterans. A survey by the Wilder Research Group of
Figure 1. Flow chart of search strategy and study selection

Citations retrieved from CINAHL, ScienceDirect, Scopus, PsycInfo, Homeless Hub, CIMVHR and reference lists
n=32
Abdulwasi et al., Bourque et al., Boyd et al., Finlay et al., Gaetz et al., Goldstein et al., Grant & Brown, The Homeless Hub, Jacobson & Eckstrom, Jarvis, Kasprz & Rosenheck, Kaufman et al., Koegel et al., Kramer & Barker, Kramer et al., Ledesma, Manson, Montgomery et al., Noe et al., Peters & Robillard, Peters, Ray & Abdulwasi, Ray & Forchuk, Shore et al., Thurston et al., Tovar et al., Tsai et al., Whitbeck et al.

Excluded:
Duplicate citations (n=3): Kasprz & Rosenheck, Kasprz, Kasprow & Rosenheck.

Title and abstract review

Full text review
n=29
Abdulwasi et al., Bourque et al., Boyd et al., Finlay et al., Gaetz et al., Goldstein et al., Grant & Brown, The Homeless Hub, Jacobson & Eckstrom, Jarvis, Kasprz & Rosenheck, Kaufman et al., Koegel et al., Kramer & Barker, Kramer et al., Ledesma, Manson, Montgomery et al., Noe et al., Peters & Robillard, Peters, Ray & Abdulwasi, Ray & Forchuk, Shore et al., Thurston et al., Tovar et al., Tsai et al., Whitbeck et al.

Excluded:
Did not focus on, or stratify, Indigenous veterans (n=9): Bourque et al., Boyd et al., Gaetz et al., Jacobson & Eckstrom, Jarvis, Koegel et al., Montgomery et al., Ray & Forchuk, Tsai et al.

Did not focus on homelessness (n=8): Abdulwasi et al., Kaufman et al., Kaufmann et al., Koegel et al., Kramer et al., Ledesma, Noe et al., Shore et al., Tovar et al.

Did not focus on veterans (Homelessness only) (n=6): The Homeless Hub, Kramer & Barker, Peters & Robillard, Peters, Thurston et al., Whitbeck et al.

Discussed Indigenous Veterans and homelessness but separately (n=3): Finlay et al., Grant & Brown, Manson.

Currently unpublished (n=1): Ray & Abdulwasi.

Met inclusion and exclusion criteria (published):
n=1
Kasprz & Rosenheck.

Gray literature n=16

Excluded:
Did not focus on Indigenous veterans (n=5): Kelly, Neuman, Press, Seguert & Bauer, Toohey, Veteran Affairs Canada.

Subjective opinion piece/Blog (n=1): Joseph.

Studies included in review
n=1
Kasprz & Rosenheck.

Gray literature n=9
homeless and near-homeless people on Indigenous tribal reservations in Minnesota revealed that 8% of men had served in the military and not only demonstrated higher rates of physical and mental health concerns, but were also twice as likely to consider themselves alcohol or drug dependent compared to non-Veterans. Furthermore, in the US, policy conflicts between the 1996 Native American Housing and Self-Determination Act and the Housing Act of 1937 has prevented Indigenous Veterans from using rent vouchers for federally subsidised houses on reservations. As most reservation housing is federally subsidised, this results in homelessness or inadequate housing.

The objective of this review is to provide an overview and assess the literature regarding homeless Indigenous Veterans. It is hoped this will inform policy and interventions, and highlight the gaps in current knowledge that need to be addressed by future research. This review aims to examine the issues surrounding homelessness among Indigenous Veterans and places a primary focus on homeless Indigenous Veterans’ unique needs and risk factors that predispose them to, or as a result of, becoming homeless.

Method

Search strategy

The search strategy for this review of all literature published up until 14 February 2017, utilised five academic databases; CINAHL, The Homeless Hub, PsycINFO, ScienceDirect, SCOPUS as well as the official journal of the Canadian Institute for Military and Veteran Research (CIMVHR), The Journal of Military, Veteran and Family Health. Searches were conducted using the terms ‘Homeless or Homelessness’, ‘Veterans’ and ‘Native, Aboriginal, Indigenous, First Nations or Métis’. To supplement the search, additional articles were retrieved by investigating references cited within articles obtained from the database search. Grey literature was also sought through searches on the Veteran Affairs Canada (VAC), US Department of Housing Development (HUD), US Department of Veterans Affairs (VA), Australian Department of Veterans Affairs and New Zealand Veteran Affairs websites as well as a generic Google search. Identifying grey literature was considered to be important to the search strategy as there was potential for there to be a less-developed body of literature concerning homeless Indigenous Veterans. Two reviewers conducted the database searches, reviewed the database results, arbitrated disagreement and consensus was reached after discussion.

Figure 1 outlines the literature selection process. In order to meet the inclusion criteria for this study, peer-reviewed articles had to focus on homeless Indigenous Veterans specifically, be written in English, and not have been included in a prior review as prior systematic and literature reviews were included. Articles that were perceived to be potentially useful or contained a title pertaining to homeless Veterans or Indigenous were initially included. After reading the full text, articles were excluded if they did not focus specifically on homeless Indigenous Veterans, or if they did not stratify the results of homeless Indigenous Veterans from the rest of the study sample. Articles that described homeless Veterans or Indigenous Veterans separately were excluded. Furthermore, no exclusion criteria were set for research design, type of intervention, country of origin, nation served or the age of the sample. Grey literature was included; however, opinion pieces were excluded due to their subjective nature.

Selection of articles and data extraction

Articles found as part of the search strategy we reviewed by title and abstract to assess whether the article was relevant to the purposes of this review. Duplicates were also removed at this stage. The remaining articles were then read in full to determine whether they met inclusion criteria. Grey literature was observed and selected for background context using the same selection approach but was not included in the review. It was planned that identified studies would be categorised into one of the following topic areas: epidemiology, health and services access/utilisation and quality care/effectiveness.

Variables extracted from the identified articles included study design, the objective of the study, participant demographics, sample size, methodology, whether an intervention was provided (and if so, what the intervention was) and the results of the study. An evidence table was created with these variables (see Table 1). For the purpose of this review, an epidemiological study was defined as any study that included estimates of the size of the population and prevalence of homelessness among Indigenous Veterans, characteristics of homeless Indigenous Veterans, factors associated with the likelihood of an Indigenous Veteran to experience homelessness, or other epidemiological information concerning homelessness among Indigenous Veterans.
Results

Search results

Of the databases and reference lists searched, 32 articles were identified. This number reduced to 29 once duplicates had been removed and was further reduced after the full text of the articles had been read and verified. Of the 29, nine articles did not focus on Indigenous Veterans and only focused on homeless Veterans in general, eight did not investigate homelessness but did focus on Indigenous Veterans, six did not focus on Veterans and three explored Indigenous Veterans and homelessness but independently of each other. One article had not been published at the time of the search and therefore the full text could not be accessed. The results of this unpublished study were discussed in a later article by one of the authors'. This resulted in only one epidemiological paper being identified. There were no previous literature review or systematic review papers found, making this review the first of its kind. Sixteen articles were identified in the search for grey literature. Eight were news articles from newspapers or online news outlets, two were press releases from the HUD, one was a report from the VAC concerning future plans for Veteran homelessness, one was a report on homelessness on tribal reservations in Minnesota, USA, one was a grants report from the VA, one was a doctoral dissertation and one was a blog post. Of this literature, six were not specific to Indigenous Veterans and the blog post was excluded due to the subjective nature, thus leaving nine used to supplement this review.

Summary of study

The only study identified for the purposes of this review was conducted by Kasprow and Rosenheck who investigated alcohol and drug misuse among Indigenous Veterans at 71 Veteran Affairs Health Care for Homeless Veterans (VA-HCHV) sites across the US. However, the study did not focus on the causal factors for homelessness, instead providing an insight as to the struggles of homeless Veterans. The Indigenous Veterans in the study (n=950) were stratified from the total sample population which included other ethnicities including white, black and Hispanic (n=36 938). From a prevalence perspective, there were significantly fewer Indigenous Veterans who were 'literally homeless' compared to white Veterans (p<0.010). However, when a comparison was made between the number of Indigenous Veterans in the VA-HCHV program and the proportion of Native American Veterans in the 1992 National Survey of Veterans, it was revealed that there were approximately 19% more Indigenous Veterans reporting homelessness than expected. The difference between these two estimates of homelessness reached statistical significance (p=0.044). This would suggest that there is an overrepresentation of Indigenous Veterans experiencing homelessness.

Experiences of homeless Indigenous Veterans compared with the non-Indigenous homeless Veteran population

Kasprow and Rosenheck reported that Indigenous Veterans were notably more likely to consume alcohol and averaged a significantly greater number of days under the influence of alcohol in the past 30 days (both p<0.010). This finding was further supported by clinician ratings of alcohol dependency with Indigenous homeless Veterans demonstrating a higher odds ratio (OR=1.46) when compared with white Veterans. Overall, Indigenous Veterans' scores on all alcohol misuse and dependency measures were approximately 40% greater than white homeless Veterans.

However, it was also reported that Indigenous Veterans were less likely than white Veterans to report drug misuse and there was no significant difference between Indigenous and white homeless Veterans in regards to the number of days of drug misuse. In addition, Indigenous Veterans demonstrated the lowest rates of hospitalisations due to drug dependency compared to all other ethnic groups. Homeless Indigenous Veterans reported significantly fewer cases of psychiatric problems and psychiatric hospitalisations than white homeless Veterans (both p<0.001). Furthermore, clinician ratings of psychiatric problems verified the latter findings as the ratings suggested serious psychiatric problems were lower for Indigenous Veterans compared to white Veterans (also p<0.001). However, it should be noted that this does not imply that Indigenous Veterans demonstrated low rates of psychiatric issues. All of the homeless Veterans in the study reported high levels of psychiatric problems but the results reveal that significant differences between ethnic groups were observed.

Discussion

The purpose of this review was to review the literature concerning homeless Indigenous Veterans. Of concern, only one paper was identified that had been conducted in 1998 within the US. This is an alarming amount of time to pass with little to no research conducted on this specific population. Of course, this is not to suggest that no research has been conducted at all as our search demonstrated a number of studies assessing Indigenous Veterans
Table 1. Overview of Identified Literature

<table>
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<tr>
<th>Study</th>
<th>Year</th>
<th>Design</th>
<th>Method</th>
<th>Participants</th>
<th>Sample</th>
<th>Objective</th>
<th>Intervention</th>
<th>Outcomes</th>
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| Kasprow & Rosenheck (USA) | 1998 | Case Control | Data collected during intake interviews when entering the HCHV program was obtained and analysed. Assessment was conducted at intake using an 87-item including psychiatric diagnoses based on DSM-IV criteria. | Indigenous (n=950): Male=919, Female=31. Mean Age=44.9+9.7yr Literally homeless=684 Days worked in past 30d = 3.3+6.7d | 36,938 | To estimate the proportion of Indigenous people among homeless Veterans and compare the prevalence of alcohol, substance and psychiatric issues among other ethnicities. | N/A          | - The number of Indigenous Veterans who were literally homeless was sig. less compared to white Veterans (p<0.010).  
- Indigenous Veterans were sig. more likely to report alcohol use than white Veterans (p<0.010) and averaged more days of intoxication in the past 30 days (5.4 days vs 3.9 days, p<0.010).  
- Indigenous Veterans did not differ sig. from white Veterans regarding drug abuse.  
- Indigenous Veterans reported significantly fewer cases of psychiatric problems and psychiatric hospitalisations compared to white Veterans (both p<0.001).  
- Clinicians' ratings of serious psychiatric problems were sig. lower among Indigenous Veterans compared to white Veterans (p<0.011). |
### Disease Patterns

<table>
<thead>
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<th>Study</th>
<th>Method</th>
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| Kasprow & Control (n=950):                | homeless was significantly less compared to white Veterans when entering among homeless:  
  Indigenous people were significantly more likely to report alcohol abuse than white Veterans (p<0.010) and averaged more days of intoxication in the past 30 days obtained and (5.4 days vs 3.9 days, p<0.010) analyzed Veterans regarding drug abuse was conducted issues among other.... |
| Literally at intake using homeless=684    | hospitalisations compared to white Veterans (both including p<0.001)  
  Clinicians' ratings of serious psychiatric problems based on DSM-54 were significantly lower among Indigenous Veterans compared to white Veterans (p<0.001).... |
| Objective 41,43,50                        | number of Indigenous Veterans who were literally homeless=684... |
| Case Year for future studies             | The number of Indigenous Veterans who were literally homeless=684 in the US reported that being an Indigenous Veteran and their families... |
| Outcomes 87-item hospitalisation         | Veterans in the US were also found to have a higher rate of diabetes compared to previously published data on the general homeless population (19% vs 8%)..... |
| Design 21 years ago                      | homeless population in the US were also found to have a higher rate of diabetes compared to previous studies (19% vs 8%). Furthermore, it has been found that Veterans experiencing homelessness for the first time were significantly associated with heart disease, hypertension and joint pain disorder.... |

**A literature review written in the US by Tovar, Patterson Silver Wolf and Stevenson suggests that community rituals and ceremonies can help bring a sense of belonging for Veterans by reaffirming tribal identity and to absorb any trauma the Veterans have experienced. Culturally-informed rehabilitation has also begun to rise with the VA in the US providing transportation for Indigenous Veterans attending VA facilities and the opening of a tribal VA clinic. This represents a shift in healthcare by providing for a specific population that requires greater assistance. In addition, Kaufmann, Buck, Floyd and Shore reported that the VA has implemented a community outreach program designed to engage Indigenous Veterans in the US with VA information and assist with paperwork as well as encouraging Veterans to seek help through the VA's American Indian Telemental Health Clinics. The program has since expanded across the US, including remote areas of Alaska. Although these studies represent promising signs of improvement for Indigenous Veterans’ healthcare, there still appears to be a lack of additional services specifically aimed at homeless Veterans. Cultural-specific services and treatment may be recommendable as a recent study in the US reported that being an Indigenous Veteran was associated with lower odds of treatment entry compared to white Veterans. The interventions described by Tovar et al. and Kaufmann et al. have been implemented in the US, but not in Canada.**

Despite the lack of research, the grey literature identified in this review revealed that homeless Indigenous Veterans are receiving more recognition and that further assistance is being provided. The VAC have reported that homelessness and the transition from the military to civilian life will be addressed with a series of planned initiatives starting in 2015 and 2016 through to 2019 and 2020 including improved identification of homeless Veterans, new employment strategies and greater mental health support for Veterans and their families. Although a much-needed and welcomed sign of progress, there was no further detail as to how Indigenous service providers and Veterans would be supported specifically. Given the issues highlighted by Thurston et al. earlier in this review, it is conceivable that these issues could also be applicable to Indigenous Veterans. It would also appear that action is being taken in the US as $5.9 million in grants from the HUD and the VA has been awarded to 26 tribes to provide permanent housing and support services to homeless Veterans including rental assistance vouchers, as well as an expansion of the HUD-VA Supportive Housing program to Veterans living on tribal lands. Overcoming the legislative barriers in place, as outlined by Graeff and Sylvester, is a promising step in providing greater support for Indigenous homeless Veterans in need.

As this review has demonstrated, there is a great need for further Canadian research. The key limitation for this review is the fact that no Canadian research articles were identified for analysis. Future research needs to explore the cultural-specific causes of homelessness among Indigenous Veterans in order to fill the gaps in the current knowledge. In doing so, post-discharge services can better equip Indigenous Veterans upon transitioning into civilian life and address the risk factors for homelessness. Further, as Kasprov and Rosenheck revealed, the consequences linked with being a homeless Indigenous Veteran also require greater attention such as the health-compromising behaviours associated such as alcoholism, drug use and psychiatric disorders. As the article was conducted in the US 21 years ago, a modern analysis within a Canadian context is certainly warranted. However, it is clear that this is not just an issue specific to Canada, but for other Indigenous populations across the Western world as international literature was also found to be lacking. This suggests that ethnographic research would be essential in identifying the cultural differences of homeless Indigenous Veterans in their transition to civilian life. Ethnographic research would also allow a greater understanding of the challenges faced by Indigenous Veterans and of what more can be done in targeting this specific group of the homeless population. There is also a need for an Indigenous-led community-based study to provide further context in order to enhance the current knowledge of homeless Indigenous Veterans. Qualitative research studies are needed to understand the unique experiences of Indigenous Veterans and their perspectives on homelessness. Not only would this allow for a rich source of data directly acquired from Indigenous Veterans, it may also be possible to further inform future interventions, services and policy in the prevention and support of homelessness for this distinct group within the homeless population. With further investigation could highlight the social, health and psychological issues, could provide greater emphasis and inspiration for future studies internationally.
Conclusion

The present state of the literature is alarmingly inadequate in assessing the prevalence and needs of homeless Indigenous Veterans. There seems to be a greater volume of attention towards homeless Indigenous Veterans in the US. The only study identified in the search was conducted in the US and suggested that homeless Indigenous Veterans are at great risk of homelessness and alcoholism compared to white homeless Veterans but may demonstrate fewer psychiatric concerns and lower rates of drug dependency. Further research is required to assess the current trends in homelessness among Indigenous Veterans and greater attention from policymakers in working with this population.

References


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| April 2019 – 100 Years On – Recovery
27  2  April 2019  1 January 2019  1 March 2019
| July 2019 – 100 Years On – Rehabilitation
27  3  July 2019  1 April 2019  1 June 2019
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