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- Peer Outdoor Support Therapy (POST) for Australian Contemporary Veterans
- On Return from Peacekeeping
- Army Malaria Institute - its Evolution and Achievements. Fourth Decade (1st Half): 1995-2000

The Journal of the Australasian Military Medicine Association

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Australasian Military Medicine Association

STATEMENT OF OBJECTIVES

The Australasian Military 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.

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Inside this edition

Just over a hundred years ago, on 28th February 1914, the E class submarines HMAS AE1, captained by LCDR T. F. Besant, RN, and HMAS AE2, captained by LCDR H. H. G. D. Stoker, RN, were commissioned in Portsmouth, England. Both submarines had been laid down in Vickers Yard, Barrow-in-Furness, England, with AE1 being launched on 22 May 1913 and AE2 on 18 June 1913. Two days later, on 02 March 1914, they departed Portsmouth for Australia. On 24 May 1914, they arrived in Sydney. The passage of 83 days was, at the time, the longest journey ever undertaken by a submarine. Even at this stage, various militaries around the world were gearing up for an expected war. Unfortunately, within a year, both submarines had been lost on active service, with AE1 lost during the campaign in German New Guinea, and AE2 lost in the Sea of Marmora during the Gallipoli Campaign.

In the lead up to 100th anniversary of the commencement of the Great War (World War I), we will be publishing a number of historical papers looking at military health services in the war. In particular, our next issue in April 2014 will focus on the tremendous service provided, and the challenges faced, by our military and naval medical services during the initial stages of the war. I would encourage all our readers to consider researching and publishing on this important period in medical history, which saw the development of many medical advances and helped set the foundations of medicine for the next 100 years.

In this issue, we have some excellent review articles on returning from peace-keeping and veterans support. There are also articles on the evolution of the military medic, a further article on the history of the Army Malaria Institute, and a personal commentary on medico-legal challenges in military health, which should invoke discussion in this important area.

We encourage all our authors to consider submitting articles, with themed issues on veterans' health (July 2014), tropical medicine (October 2014), mental health (January 2015) and trauma management (April 2015) coming up in the next 12 months. All articles are welcome, from original military health studies to reviews to operational perspectives. Articles are peer-reviewed and now completely available online at http://jmvh.org/. We are also progressively making all the articles from the Journal over the last 21 years available online in the next few months.

I look forward to your contribution.

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

President's message

Greetings and welcome to the first Journal of Military and Veterans' Health for 2014. As the Journal goes to press, AMMA council is preparing to meet in Sydney to finalise some of the arrangements for our Annual Conference (17-19 October). 2014 marks a 100 years since the beginning of World War I, and it is perhaps timely that we remember the sacrifice of those who served Australia in that war and conflicts since. This year's theme is "100 Years on, and your country still needs you", for we should never forget the volatile nature of international relations and the potential to harm Australia's interests.

This year it is the intent of Council to commission an external review of the Journal to look into all aspects of its operation. We hope that this review will provide some guidance to ensure that the Journal improves and provides members with a quality publication.

Our Journal remains a fundamental function of the Association and Council is committed to its publication and improvement. We would encourage anyone in the military community to submit and article for publication whether it is a randomised control trail or a case report; from medical officers to medical assistants. The journal is willing to assist, mentor, and encourage first time and junior authors as it has an extensive editorial and consultative board.

Finally, I would like to congratulate Bruce Waxman (OAM), Geoffrey Quail (OAM) and Len Brennan (AM) on being recognised for their outstanding work and generosity in the Australia Day honours.

Greg Mahoney
AMMA President

Peer Outdoor Support Therapy (POST) for Australian Contemporary Veterans: A Review of the Literature

Kendall Bird

Abstract

Peer outdoor support therapy (POST) is one approach utilised in Canada, the United States and the United Kingdom to address mental illness and distress amongst contemporary veterans. In the current paper several areas of veteran psychological therapeutic treatment are reviewed.

Research studies for therapist-led treatments and standard practice recommendations are summarised, then critiqued within the wider literature taking into account unique veteran need and known challenges to treatment which can impact responsiveness, reluctance and retention.

Research review results regarding peer support interventions and outdoor therapy interventions for non-veteran and contemporary veteran populations are outlined, alongside an overview of known POST programs for veterans.

The implications of the reviewed literature and research are discussed, particularly the need for further research into the role outdoor peer support may play for the Australian veteran population alongside other veteran mental health services.

Conflict of Interest/Acknowledgements

The literature review was completed within the context of a research article thesis submission for partial requirements for the degree of Masters of Psychology (Clinical), under supervision from Dr Nadine Pelling Senior Lecturer, School of Psychology, Social Work and Social Policy and Clinical Psychologist. The research article included an evaluation of Trojan's Trek, a POST program. Funding was provided by Trojan's Trek to the University of South Australia in relation to this evaluation. No stipulations regarding research outcomes or use of funds was attached to the provision of funding. The author had no relationship to this organisation prior to completion of this research and review.

Introduction

The unique requirements of military deployment and its impact on mental health have been well established[1-4]. Given this association and the challenges to treatments with the veteran population, identifying effective approaches for treatment and early intervention to address veteran mental illness through evidence-based research is needed.

The aims in the current paper are to review peer outdoor support therapy (POST) approaches and their use with contemporary returned post-deployed (CRPD) veterans, and to contribute to the debate regarding the role such approaches play alongside the current standard practice in providing effective, culturally-suited treatment. This paper is a review of the literature and includes a research bibliography. The search methods used are included in Appendix A and the List of Terms in Appendix B.

The effects of deployment, review of current standard practice and research for psychological therapy and the literature regarding veteran reluctance to seek therapy and potential low responsiveness to some treatments are outlined. Current research evidence regarding the effectiveness of peer support, outdoor and POST approaches for non-veteran populations and CRPD veterans experiencing mental illness are reviewed and discussed.

Effects of Deployment for Contemporary Veterans

Australia's involvement in Vietnam demonstrated that many veterans experience significant reductions in mental health and wellbeing as a result of combat deployment as well as issues transitioning to post-deployment life[1,2]. This remains a significant health issue for CRPD veterans, given the known link between military experience and reduced mental health and functioning and increased suicide risk[1-4], which is

being exposed in the course of ongoing research. The Australian Department of Veteran's Affairs (DVA) review of research identified a significant, consistent association between deployment and post-traumatic stress disorder (PTSD), anxiety and depressive disorders, alcohol misuse, suicide post-deployment and relationship conflict[3].

Bleier et al.[5] surveyed 5,911 current and former Australian Defence Force (ADF) personnel and found that deployment was significantly associated with negative mental health as measured by self-report clinical questionnaires when compared to those who were not deployed. The researchers found that multiple deployments had a cumulative negative effect on mental health ($p < 0.01$). This link was not found by Hodson et al.[6] in their 2010 ADF Mental Health and Wellbeing Study (MHWS), which utilised only current serving personnel and not veterans. More recently, Warren Snowdon, Minister for Defence, Science and Personnel, stated that as of June 2012, 32% of all ADF soldiers medically discharged after deployment to the Middle East were discharged due to mental health conditions directly resulting from deployment[7].

Military service alone is associated with higher mental illness rates, regardless of deployment. The 2010 ADF MHWS showed PTSD rates for 24,481 currently serving ADF personnel were almost double that of the non-military Australian population and total mental health disorder rates were significantly higher[6]. Kaplan and colleagues estimated that the suicide rate for male veterans is double that of the non-veteran population[8], thus also indicating a higher vulnerability for those who have left military service. In acknowledgement, transition from service is recognised as a key commitment area within the 2011 ADF Mental Health and Wellbeing Strategy[9].

In particular, CRPD veterans experience situations which may result in a higher mental health risk than previously experienced. For example, the heightened use and efficiency of modern improvised explosive devices (IEDs) in civilian centres amongst other challenges not experienced in previous wars require hypervigilance[10,11]. One study found that a significant increase in errors of memory and attention (scanned before and 4 months after combat deployment) was seen in Dutch military deployed to Afghanistan compared with those not deployed (22 deployed, 26 in training)[12]. These deployed personnel also exhibited weaker neurobiological connections and pre-frontal cortex brain tissue damage compared to the non-deployed and these were not related to blast impacts or other causes. Most reduction in functioning was reversed after 1.5 years, except for the connection strength between the midbrain and prefrontal cortex, potentially indicative of ongoing function reduction resulting in a permanent heightened susceptibility to future stress[12]. ADF re-deployment rates are often more frequent than a minimum of 1.5 years and that recommended by the intergovernmental military alliance North Atlantic Treaty Organisation (NATO). Deployments are also longer than experienced by the ADF previously[5], indicating that returning service personnel may not be given the time required for their neurological function to recover.

When mental health issues occur as a result of military experience as outlined above, such military-related stress can be defined as "any persistent psychological difficulty resulting from operational duties" (p. 266)[13.] This includes the experience of anxiety, depression and PTSD. It is not only the cumulative trauma from deployment but the readjustment process required after returning from deployment which often results in experiences of emotion dissociation, hyper-arousal and vigilance and aggression. Such states are necessary and useful functions within deployment[14] and are encouraged within the significant physiological and mental preparation for military service. However they become maladaptive once such skills are no longer required and, when maintained long-term, are indicators of PTSD. For many, the autonomic nervous system threat-arousal response is chronically heightened after returning from combat, resulting in cumulative physiological effects of stress or 'allostatic load', greatly increasing the risk of physical and mental illness for veterans[3,15]. Difficult for many to unlearn, such states affect long-term individual and relationship functioning, including affect shut-down to avoid anger and they reduce engagement and therapy success[16-18].

Therapist-led Psychological Treatment for Veterans

Current Standard Practice and Treatment Reviews

Individual prolonged-exposure (PE) and trauma-focused cognitive behaviour therapy (CBT) are recommended first-line interventions for both military-induced PTSD and PTSD in Australian non-military populations[19-23]. Although it is controversial to compare veteran experiences across countries, international studies have been included in the current review given the small number of Australian studies available relating to CRPD veterans. Rothbaum et al.[11] conducted a review of evidence-based treatments for CRPD veterans with PTSD from the United States (U.S.), Iraq and Afghanistan deployments. The authors concluded that CBT exhibited the greatest empirical support with non-military populations. Warfe et al.[24] also reviewed the

international literature into individual PE therapy, cognitive therapy and cognitive restructuring for CRPD veterans. Twenty systematic reviews, 34 randomised controlled trials (RCTs) and other non-RCT studies were found which supported the recommendations above; however very few utilised CRPD veteran or current serving military.

Primary Veteran and Military Population Treatment Studies

Twelve studies into therapeutic treatments with CRPD veterans were found and are summarised in Table 1. Please refer to the Table for intervention and population details and main findings. Four were RCTs with two incorporating non-treatment waitlist controls. Four of the longitudinal studies involved either U.S. or Australian veterans returned from Iraq or Afghanistan deployments and Vietnam veterans. Two studies used only Vietnam veterans, while five did not indicate the deployment era. All included predominantly male participants.

All of the studies found show reductions in PTSD or improvement in wellbeing. Of the research found, one small-sample RCT showed individual PE therapy was effective for reducing PTSD symptoms for Vietnam veterans from the US, but not in reducing behavioural avoidance or increased sleep[25]. Group PE therapy has been found in two studies to be associated with reductions in PTSD symptoms and depression and improved functioning in sleep for Vietnam, Gulf War and Iraqi deployed U. S. veterans, with one study showing 36% no longer met PTSD diagnosis criteria[26,27]. Both studies were small with no control group. Khoo, Dent and Oei's longitudinal study found that self-reported reductions in PTSD, depression, anxiety, anger, alcohol use, and quality of life were maintained at 12-month post-group CBT treatment for 496 veterans, with only marriage satisfaction not significantly different[28]. Changes were independent of concurrent individual treatment.

Two studies found U. S. veterans receiving individual cognitive processing therapy (CPT) exhibited reduced PTSD symptoms more rapidly and decreased avoidance, compared to waitlist controls[29]. Morland et al. found that group therapy was effective regardless of the mode (face-to-face or via teleconference)[30]. Blevins, Roca and Spencer noted 63 U. S. veterans who attended an acceptance and commitment therapy (ACT) workshop showed significantly less depression, anxiety and PTSD symptoms and increased relationship satisfaction when compared to control participants[31]. Providing PE via virtual reality has also been researched. Reger and Gahm present a case study[32] and a U.S. RCT with 19 active military personnel from Iraqi and Afghanistan deployments

Table 1. Summary of quantitative research into main treatment approaches (non-POST) for veterans experiencing combat-related stress.

Authors and year	Research trial	Intervention	Veteran population	Main findings	P value	Effect size d
Beidel et al.[25] 2011 U.S.	RCT (no treatment control)	Individual - 'trauma management therapy' (TMT) exposure therapy (14 weeks) + group social emotional rehab (14 sessions) vs. individual exposure	30 male Vietnam veterans with chronic PTSD. 14 TMT, 16 control.	Post-treatment: Reduction in PTSD symptoms (CAPS), anxiety and depression both groups Increase in social activity for TMT No difference: hours of sleep or behavioural avoidance	p<0.001	Not measured
Blevins et al.[31] 2011 U.S.	Longitudinal with control	Acceptance and Commitment Therapy (ACT) group workshop	144 veterans (63 ACT, 81 control)	Significant declines in depression, and increased relationship satisfaction	p < 0.01 p < 0.01	Not measured
Chard et al.[34] 2010 U.S.	Longitudinal between-groups	Individual Cognitive processing therapy – various treatment lengths (I & A veterans M 10.67 sessions; V veterans M 13.24 sessions.	101 male veterans. 51: Iraq and Afghanistan wars. 50: Vietnam war	Post-treatment. No difference between veteran groups. Not significant change pre-post treatment.	None.	Not measured
Creamer et al.[73] 2006 AUST	Longitudinal 2 years post-treatment (no control)	12 week group DVA 'specialised veteran PTSD treatment' + 6-12 individual sessions	1508 Vietnam veterans at 24 months	2 years post-treatment: Sustained reduction from baseline PTSD Anxiety Depression	p<0.001 p<0.05- 0.01	0.85 0.5 0.5
Khoo et al.[28] 2011 AUST	Longitudinal (no control)	Group CBT (6 weeks)	496 veterans	At 12 months compared to baseline: reduced PTSD, depression, anxiety, anger, alcohol use, increased quality of life. No change marriage satisfaction.		PTSD = 0.68 Others = med MS = 0.2

Authors and year	Research trial	Intervention	Veteran population	Main findings	P value	Effect size d
Macdonald et al.[29] 2011 U.S.	RCT	Individual CPT (12 sessions over 6 weeks) vs waitlist	60 veterans with PTSD (6 female)	3, 6 and 10 week measures: more rapid decline of PTSD symptoms,	p=0.03	0.05
				decrease in avoidance	p=0.04	
McGuire et al.[22] 2011 AUST	Longitudinal (no control)	DVA funded PTSD group treatment programs	984 veterans	9 months compared to baseline: Significant reduction of scores PTSD checklist military version, increased quality of life, psychological, family functioning and reduced anxiety and depression and anger	p<0.0001 P=0.0004 P=0.004 P=0.002	
McLay et al.[32] 2011 U.S.	RCT	Virtual reality exposure therapy once a week over 10 weeks.	19 active military personnel Iraqi and Afghanistan conflicts	Significant reduction in PTSD in 70% of virtual reality participant symptoms measured by CAPS, compared to treatment as usual participants whose symptoms had changed. Mean PTSD reduced significantly however no overall difference before or after treatment between groups.	p<0.01 p<0.05	
Morland et al.[30] 2011 U.S.	RCT (no treatment control)	Group CPT. Face to face or teleconference (12 sessions over 6 weeks).	10 veterans (5 face to face; 5 teleconference).	No difference between groups.	p>0.05	Not measured
				Reductions in PTSD symptoms post-treatment, and at 6 month follow up	p=0.004 p=0.005	
Ready et al.[26] 2012 U.S.	Longitudinal (no control)	Group-based exposure therapy 16 weeks, twice a week	30 (3 groups of 10) 27 Vietnam, 2 Iraq, 1 Gulf war/Panama	Follow up 7-11 months post-treatment:		
				PTSD symptoms sign lower.		0.89
				Reduction in depression.		0.70
				36% no longer met criteria for PTSD.		
Swanson et al.[27] 2009 U.S.	Longitudinal (no control)	Group CBT exposure therapy and rescripting (10 sessions)	10 Vietnam and Gulf war veterans	Last session compared to baseline:		
				increased sleep efficiency		1.01
				increased sleep onset latency		0.89
				reduced insomnia		1.14
				reduced weekly nightmare distress		1.7
				reduced nightmare frequency		0.49
				increased sleep quality		0.73
				reductions in PTSD		0.42
Yoder et al.[74] 2012 U.S.	Longitudinal between-groups	Individual PE therapy (varied session length)	112 total (9 female) Vietnam (34), Iraq and Afghanistan (61) Gulf War (17)	All groups – significant reduction in PTSD symptoms. Gulf war veterans, reduced rate of change compared to other veteran groups.	p<0.01 p<0.01	Medium

Note: d= Cohen's d for effect size (Cohen, 1988)86 0.2 = small, 0.5 = medium, 0.8 = large

showed significant reductions in PTSD symptoms for 70% of participants compared to treatment as usual, although no overall group differences were evident[33].

Studies which utilised CRPD veteran participants had a small sample size, used a convenience sample and had no control group, increasing the risk of bias and errors. General limitations also exist given the number of studies where no deployment era was mentioned, or utilised Vietnam veterans only. For example Chard et al. found positive therapeutic change in U.S. veterans from the Iraqi, Afghani and Vietnam conflicts involved in individual PE therapy[34]. Their study showed younger veterans exhibited a trend toward reduced PTSD post- CPT compared to Vietnam veterans, after accounting for sessions attended and initial PTSD severity, indicating that contemporary veterans may be more responsive to treatment regardless of symptoms severity.

The individual studies show clinical significance supporting the use of individual PE therapy and CPT with veterans. However, while the treatment recommendations are clear, there are limitations as listed above, and they appear based predominantly on empirical research with non-military populations generalised to military and veteran groups. Although supporting the current first-line recommendations for standard practice with veterans, several review authors concluded that research into therapies directly utilising military populations is insufficient. Available trials for their reviews were mostly with Vietnam veterans and limited in sample size, limiting general application to the CRPD population[11,15,22].

Challenges in the treatment of military veterans

Despite empirical support for the treatments outlined above, evidence suggests that many CRPD veterans affected by PTSD may be reluctant to seek treatment and show reduced responsiveness and low retention in individual therapist-led treatments. Help-seeking may be impaired by attempts to maintain a strong self-view, fear of prejudice in current or future work opportunities, and mistrust factors regarding therapist likeness-to-self, given military cultural group identity[13,35,36]. In addition, if veterans perceive indifferent or ignorant responses when initially help-seeking this may hinder future help-seeking and treatment responsiveness[17,37].

Military culture promotes emotional toughness, strength and camaraderie where mental illness is still seen as malingering or weakness[17,19] despite recent awareness efforts, inconsistent with help-seeking behaviour and treatment responsiveness. While necessary for survival in combat, such a culture often means that acknowledging a mental health issue is counter to one's self-identity[15], creating social isolation in dealing with a negative mental health experience[16,17]. The MHWS showed for example that 48.8% of current serving military personnel who met the criteria for PTSD were not receiving treatment. Of those meeting criteria for a generalised anxiety disorder, 24.4% were not receiving treatment, nor were 85% who meet criteria for an alcohol disorder[6].

Creamer and Forbes[15] concluded that psychological treatments, although beneficial, appeared less effective for veterans than for non-veteran populations. Creamer et al.[19] observed that effect sizes for change for veteran populations are often lower than for non-veteran populations for the same treatment approach. This review also indicated that the military training and the requirement to shut-off emotion to be able to complete combat tasks is a key factor in reduced treatment response[15]. Arousal mal-adaption is seen in the pairing of stress with anger, and veterans may use numbing and dissociation to avoid anger in civilian life, particularly with loved ones. They argue that veterans with mental illness may show less responsiveness to PE therapies until such arousal pairing is addressed first, thus general CBT and some PE therapy approaches may be ineffective[26]. In addition, Garcia et al. showed in their study that 68% of 117 U. S. veterans returning from Iraq and Afghanistan terminated treatment before completion[38]. This highlights the need to consider carefully when using general CBT and PE approaches with this unique group.

Evidence for POST with Non-military Populations

Although autobiographies such as Exit Wounds[37] and other public media exposures may slowly change the stigma of mental illness in the Australian military[39], the unique experience of CRPD veterans indicates a need to explore the evidence-base for innovative interventions provided outside of the clinical and hospital context, particularly when addressing seeking treatment, retention/engagement and responsiveness. In particular, peer and outdoor group approaches for treating PTSD and depression may illuminate effective alternative treatment approaches that will engage veterans.

Peer Support Intervention Evaluation

Peer support is a widely used intervention for mental illness within non-military populations. Table 2 summarises 15 research studies found which measured peer support approaches with non-military populations, including intervention, population and their main findings.

In the U.S. 47% of 13,513 substance abuse treatment facilities surveyed in 2009 offered some form of peer-support service[40]. It is also estimated

Table 2. Summary of research into peer mentor approaches for non-military populations.

Authors and year	Research trial	Intervention	Population	Main Findings	P value	Effect size
Berrick et al.[75] 2011 U.S.	Qualitative	Parents reunified with children mentor for parents first entering child protection system	25 mentees, 6 mentors.	Themes - value of shared experience, communication, support. Both mentors and mentees experienced benefit		
Dorgo et al.45 2009 U.S.	RCT	Peer mentor groups (1:1) vs qualified student led group. Fitness session content the same (14 weeks)	131 older adults – 87 peer mentor, 44 student mentor condition	At 14 weeks: Self-reported physical, mental and social functioning improved for peer mentored except for bodily pain Change but not significant for student mentored Both groups improved fitness significantly.	p<0.05 p>0.06 p<0.03.	
Herrera, Grossman, Kauh & McMaken[76] 2011 U.S.	RCT	Mentoring Big Brothers Big Sisters	1139 students age 9-15 from 10 schools. 554 mentors. Self and teacher reports and school academic records.	Presence of a special adult only significant change from baseline which lasted over time. 9 months: Short term sign better with academic performance and perceptions of abilities. 1.5 years compared to baseline: no impact on effort, self-worth, relationships with parents peers or teachers, rate of problem behaviour.	p<0.01 p<0.05	
Ljungberg, Kroll, Libin & Gordon[60] 2011 U.S.	Longitudinal (no control)	Peer mentoring (1 year weekly, fortnightly then weekly contact)	24 patients with spinal cord injury. Self-report to mentor	At 6 months: Reduction in Dr visits pre-test, reduction in self-reported medical complications. No sign of difference from self-efficacy score	p<0.01 – 0.001	
Lucksted et al.[43] 2009 U.S.	Longitudinal (no control)	Peer mentor program (9 2hr group sessions led by mentors).	138 with diagnosed mental illness - bipolar disorder, depression, schizophrenia, schizoaffective	Immediately after treatment compared to baseline: Increased confidence re own knowledge and management of illness, less powerlessness, more confident re decision making, connection with others. No difference for relationships, attitude to medication, spirituality, money management, housing planning, education or employment planning.	p<0.01	
Ott and Doyle[77] 2005 U.S.	Longitudinal (no control)	Social norming workshop re peer substance use.	414 students across school.	One week later compared to baseline: changes in perception of norm for smoking cigarettes, alcohol and marijuana towards more accurate rate.	p<0.001	
Purcell et al.[78] 2007 U.S.	RCT	Peer mentor groups for HIV transmission reduction – or video discussion (10 sessions)	966 injection drug users.	At 12 months vs baseline: Both groups sign reduction in injection and sexual risk behaviours. No sign difference between groups. No change in medical outcomes. No change using care or adherence to medication.	p < 0.01	
Robinson and Niemer[79] 2010 U.S.	Longitudinal Controlled	Peer mentor tutoring vs no tutoring (1 year weekly contact) 1:5 ratio.	97 'at-risk' nursing student participants vs control (rest of that year level (number not defined)	Peer mentor group - increased academic performances – grades – test scores, significantly compared to controls	p<0.001	
Rowe et al.[44] 2007 U.S.	RCT longitudinal	Group treatment peer support and citizen training + standard vs standard treatment (8 weeks course, 4 months peer support)	114 adults with drug use diagnosis and criminal history. 41 control, 73 group treatment	12 months post-treatment: Peer group participants - reduced alcohol use. Drug use and criminal charges reduced in both groups.	p< 0.005 p<0.05 p<0.05	0.05
Rowe et al.[80] 2009 U.S.	Qualitative	Group treatment with peer mentorship, 5 month citizens program group becomes participant led. 21 classes	3 case studies	Positive affect on substance use, criminal justice contact, transition to community supports, community living for people with dual-diagnosis and criminal justice history.		

Authors and year	Research trial	Intervention	Population	Main Findings	P value	Effect size
Sledge et al.[45] 2011 U.S.	RCT	Peer mentoring with standard care vs standard care alone. Ongoing weekly contact 9 months	74 psychiatric patients (38 peer mentor condition, 36 standard care). 8 mentors.	Sign of fewer re-hospitalisations at 9 months for peer-mentored patients. Reduced days in hospital.	p=0.042 p<0.03	
Smith[81] 2004 U.S.	RCT. One post-test survey	Student social norming lecture re alcohol use.	774 students – 390 standard, 384 standard + lecture	No sign of difference between groups re personal drinking self-report.	p=0.56 and p=0.62	79% power to find d=0.2.
Stewart, et al.[82] 2010 U.S.	Longitudinal	Group and one-one peer support (14 weeks)	23 women nicotine addicted	3 months post-treatment: Self-reported decrease in tobacco and nicotine use and dependence, maintained No difference self-efficacy	p= 0.002	
Thrasher et al.[47] 2010 Canada	RCT	Social support factor for exposure therapy (ET) (20 people), cognitive restricting treatment and ET (19), CR (18) vs relaxation control (20).	77 adults with PTSD	More support predicted better outcome in therapy – reduction in PTSD. Not helpful for relaxation condition control. Accounted for 33% of variance.	p< 0.001	
Tracy et al.[83] 2012 U.S.	Longitudinal (no control)	Peer mentor weekly group and individual contact (12 week)	30 participants. 10 mentors. Both diagnosis of alcohol abuse, mentors 6 months abstinent.	From baseline to week 12 Frequency of alcohol use reduced, drug use reduced	p<0.01 p<0.01	

Note: d= Cohen's d for effect size (Cohen, 1988)86 0.2 = small, 0.5 = medium, 0.8 = large

that more people in the U.S. use self-help groups for substance abuse than any other mental health support combined[41]. They found that self-help participation was associated with reduced substance use, increased psychosocial functioning, and reduced health care costs.

Hogan, Linden & Najarian conducted a review of 100 studies into social support interventions addressing substance abuse, parenting skills, weight loss and cancer for non-military populations[42]. They concluded there was some support for the usefulness of social support. However, no studies were rigorous enough to be ranked as clearly efficacious. They noted issues with the study in general, the lack of control groups and randomisation. However the authors outlined that social support interventions were generally better than no treatment. Twelve studies showed superior orequal results to alternative treatments, 22 had partial benefits, 17 had no benefits and in 2 studies participants got worse, indicating the importance of matching intervention type to need and with mindfulness of the setup of groups[42].

Within the individual studies, evidence supporting the peer approach was seen by Lucksted et al., who conducted a longitudinal study using a peer support intervention for 138 people with mental illness (bipolar, schizophrenia and other diagnoses)[43]. They found that participation was significantly associated with increased confidence regarding knowledge and management of their illness, less powerlessness, more confidence regarding decision making, and greater connection with others. Many participants wanted to become involved in advocacy and in the educating others as a result of participation. Another randomised trial compared standard clinical treatment to treatment plus group intervention involving peer support and citizen training for 114 adults with dual-diagnosis mental health disorders and criminal history. Although drug use and criminal charges were reduced in both groups, the study showed that peer support was effective for decreased alcohol use beyond standard treatment at 6 months and at 12 months post treatment[44]. In addition, a study by Sledge et al. showed peer support was associated with significantly reduced re-hospitalisations and number of days in hospital after 9 months of support for patients with psychiatric diagnosis as compared to standard care[45]. They showed peer support was an effective adjunct to treatment to engage mental health patients with social network preventing relapse.

One study in particular outlined how peer-led approaches can be more effective than professional-led. Dorgo, Robinson & Bader conducted a randomised control study into peer-support for 131

older adults when an identical fitness program was provided either by peers or by a qualified student[46]. Although both groups' fitness improved significantly, peer-led fitness groups showed significantly better outcomes in self-reported physical and mental wellbeing, social functioning, general health, vitality and the ability to carry out physical and emotional roles. They speculated that peer-led interventions may increase adherence to programs, providing positive role modelling and dispelling negative stereotypes about age and ability.

The presence of supportive social relationships alone has been shown to predict better outcomes in therapy for PTSD exposure therapy and cognitive restructuring treatments[47]. These results strengthen the argument that peer support is valuable in role modelling, health, challenging stigma, and isolation around PTSD experiences. Such approaches may be particularly beneficial if the participant identifying as a group member feels ostracised or judged by the wider society, which may be the case for many veterans. In such situations, peer-led groups may decrease isolation and enable trust and connection with others[11,15,24].

Outdoor Therapy Intervention Evaluation

Various U.S. review studies have shown outdoor therapy with at-risk youth, focusing on changing negative behaviours and building team and leader skills, is associated with increased self-worth, self-regulation, physical health effects, reduction in anxiety and stress and sleep issues, improved participant social skills, improved critical thinking and reductions in antisocial/ delinquent behaviour[48-50]. There is also some evidence of reduced depression and drug and alcohol misuse[20,50], with greater outcomes seen for participants involved in peer leadership opportunities[50].

An Australian longitudinal evaluation of Operation Flinders (OF), an 8-day camp for at-risk youth, found that participants at higher risk of offending showed significant improvement on self-reports for self-esteem, anger, attitude toward police and de-identification with criminals compared to those at lower risk[51]. Raymond evaluated OF, using a non-randomised control group design comparing 58 participants with 55 non-participants and showed that although improvements on most measures were seen, these changes were not significant compared to controls[52].

Very few studies have been completed with non-youth. Walker et al.[53] conducted an evaluation of an Australian outdoor adventure program for 11 adults with severe brain injury and found a trend toward improved mental health. The 18-month program involved peer planning for a 9-day camp run in conjunction with Outward Bound Australia (OBA). Results were not statistically significant, although qualitative personal goal achievement was attained for 10 of the 11 participants. Lastly, Stuhlmiller completed a qualitative evaluation of an Australian camp to reduce mental health stigma among student nurses[54]. Two hundred students and 100 mental health service consumers participated in the week-long camp. Student nurse attitudes about mental health consumers shifted in a positive direction.

Lubans et al.'s review of 15 camp evaluations for at-risk youth concluded that while outdoor adventure programs had the potential to improve wellbeing, the findings were mixed[48], due to research design limitations resulting in a high risk of bias. Therefore, empirically determining program efficacy is difficult if attempting to compare to other approaches where more controlled research is possible.

POST Approaches for the Veteran Population

Therapist-led Outdoor Therapy Intervention Evaluations

There have been several research studies into therapist-led outdoor therapy for post-deployed veterans. Table 3 summarises research into both outdoor therapy and peer support utilising military populations. Please refer to Table 3 for details of intervention, measures used and main findings.

There is some evidence that outdoor programs (non-peer led) are linked to positive change for veterans; however the available research results are mixed. Hyer et al.[55] published results from a control-group evaluation of Outward Bound for Veterans Program (OBVP) for veterans with chronic combat-PTSD. The camp is non-clinical, is focused on outdoor activity and developing leadership qualities[56]. Participants included 108 in OBVP and 111 in clinical hospital group therapy and psychiatric support. All were interviewed using high reliability clinical measures before treatment, directly after, and at exit from treatment. They found no significant difference between those in the camp treatment versus the control group, indicating OBVP was equivalent to clinical therapy. Results indicated greater effectiveness for those with lower clinical PTSD scores. Participants reported positive changes to self-esteem and indicated the important role social support played for their wellbeing[55].

More recently, Ewert et al.[57] evaluated OBVP, assessing 142 CRPD personnel deployed to Iraq and Afghanistan and 175 non-veterans post-participation using scale course evaluation

Table 3. Summary of quantitative and qualitative research into peer mentor, outdoor and POST approaches for military populations.

Authors and year	Research trial	Intervention	Population	Measures	Main Findings	P value	Effect size
ACPMH[8] 2010 AUST	Longitudinal and qualitative program evaluation	Trojan's Trek 6 day peer outdoor support therapy (POST)	10 participants and spouses from TT 2009.	DASS21 AUDIT PNI HILDA Life Satisfaction. Self-efficacy GSE. Qualitative Interviews.	Trend toward mental health improvement. 50% completed follow-up questionnaires. Those who did not complete follow-up showed initial higher ratings of unhappiness with life than those who completed follow-up questionnaires. Effective in addressing participant goals for managing day to day problems and achieving life goals such as managing anger and improving communication.		
Department of National Defence and Veterans Affairs Canada[67] 2005 Canada	Program evaluation	Operational Stress Injury Social Support (OSISS) (peer)	900+ current serving and veterans.		46% serving members or receiving veteran pensions. 54% retired members. OSISS only source of continuous social support for retiring personnel with OSI		
Dustin et al.[35] 2011 U.S.	Qualitative	River Running. 4 day outdoor therapy river camp (non-peer)	10 male, 3 female veterans with PTSD diagnosis.	method not mentioned	Re-experiencing of traumas appeared to diminish over the time of the camp for participants from journal entries, avoidance and numbing replaced with 'joyful involvement' (pg. 335) in the trip experience, hyper-arousal replaced with fatigue from physical activity.		
Ewert et al.[57] 2010 U.S.	Control group post-program comparison	Outward Bound for Veterans Program (OBVP) (non-peer). Wilderness-based courses – natural world, teamwork, challenge-based activity.	142 Iraqi and Afghanistan conflict veterans. 175 non-veterans.	9 Likert-scale course evaluation questions (non-clinical and no reliability or validity testing).	Post-participation questionnaire only. Veterans showed higher levels of agreement for increased confidence, physical ability, emotional state and success compared to non-veteran participants, and lower levels in leadership skills, compassion, teamwork and accepting responsibility compared to non-veterans	Not given	
Ewert et al.[57] 2010 U.S. and Ewert et al.58 2011 U.S.	Longitudinal survey	OBVP (non-peer)	266 veterans from 32 difference OBVP sessions	11 item Outward Bound Outcomes instrument (no reliability or validity published). Sense of Coherence	Significant change of between p= .05 or 0.01 levels with effect sizes from .26 to .74 for 11 leadership quality constructs. The authors do not explain which constructs showed most significant change, and in what direction. Effect size range from 0.40-.095 (not defined to constructs) Sense of Coherence improvement Alpha = .86	p=0.05 p=0.01	
Greden et al.[36] 2010 U.S.	Participation surveys	Buddy to Buddy trains veterans to provide peer support and links to resources to other CRPD veterans (peer)	926 returned deployed current serving personnel and veterans and spouses.	Survey, interviews and program evaluation.	50% stated they had used resources/services suggested by their buddy and more than 20% self-referred to formal treatment as a result of participation who were not previously accessing any formal treatment		
Hawkins et al.[59] 2011 U.S.	Qualitative	3 day Paralympic military sports camp for 50 current serving personnel with physical injury. (non-peer)	10 veterans interviewed from Iraqi, Afghanistan deployments. age 20-40.	Semi-structured interviews, transcribed by three researchers.	Social comparison assisted participant engagement and change with improvements in sense of competence and autonomy. Themes from participation in camp: (a) perceptions of disability and normalisation (see beyond injury, self-acceptance); (b) finding motivation (through participation and through social comparison); (c) experiencing a sense of relatedness and social connection (with others in similar situation and to family); (d) establishing a connection with previous interests (transfer of skills confidence) (e) improved health, fitness, and general well-being; (f) improved sense of competence; and (g) increased autonomy (ie freedom of choice).		

Authors and year	Research trial	Intervention	Population	Measures	Main Findings	P value	Effect size
Hyer et al.[55] 1996 U.S.	Controlled group longitudinal	OBVP versus hospital group therapy. Outdoor activity and developing leadership qualities. Non clinical. (non-peer).	108 OBVP participants, 111 hospital group participants, from two hospitals.	Combat Exposure Scale, Mississippi Scale for Combat Related PTSD, Impact of Events Scale, Hamilton Depression and Anxiety scales. SCL-90 Rotter Locus of Control, State Trait Anxiety Scale.	Pre-, post and follow-up. no significant difference between those in the camp treatment versus control group. However, results indicated greater effectiveness for those with lower clinical PTSD scores and qualitatively measured participants showed positive changes to self-esteem and indicated the important role social support played for participant's wellbeing.	ANCOVA – no significant . group effects.	
Lebeau et al.[68] 2008 Canada	Qualitative	Operational Stress Injury Social Support (OSISS) (peer)	26 current serving personnel with serious OSI, 8 family members	Focus group content analysis	Main themes for areas of need: peer support, family support, home coming and recovery, assisting officers, medical care, reservists needs, decompression, and prioritizing of injuries.		
Lundberg et al.[84] 2011 U.S.	Quantitative longitudinal	Higher Ground. Paralympic adaptive sports one week therapy program. (non-peer).	18 Iraqi and Afghanistan conflict injured veterans	WHO's Quality of Life Assessment. Profile of Mood States-Brief. Perceived Competence Scale.	Significant reductions in self-reported mood disturbance, tension, depression and anger post-camp compared to pre-camp. Increase in perceived competence No significant difference was found for self-reported quality of life in general, or for physical health, social relationships or environment. Psychological health of QOL showed a significant increase. Alpha = .0038	All p<0.001 p= 0.001 p =0.044 p= 0.024	
Mowatt and Bennett[71] 2011 U.S.	Qualitative	Rivers of Recovery outdoor therapy run by Vietnam vet's for CRPD veterans. POST program .	67 male participants	Analysis of letters	Four themes: camaraderie is necessary while receiving treatment, there was ongoing regret experienced by veterans, reflection was involved in process of memory reconciliation, and participants saw benefits from involvement in outdoor recreational activity.		
Mosack et al.[85] 2012 U.S.		1 year health management program (peer-led).	219 veterans, hypertensive	Participation rates	No outcome data available. Model of engagement presented.		
Pietrzak et al.[4] 2010 U.S.	Survey correlation	Once-off survey questionnaire	272 Iraqi and Afghanistan conflict veterans	PTSD and depression screening measures, and questionnaires assessing resilience, social support, and psychosocial functioning.	Self-reported lower unit support and post-deployment social support associated with increased PTSD and depressive symptoms, decreased resilience and psychosocial functioning. Path?? analyses: resilience fully mediated the association between unit support and PTSD and depressive symptoms. Post-deployment social support partially mediated the association between PTSD and depressive symptoms and psychosocial functioning.	p< 0.001	
Price et al.[23] 2011 U.S.	RCT + correlation survey	Social support measured for participants in individual exposure therapy. In- person or telehealth (8 weeks).	69 contemporary veterans from Iraq and Afghani conflicts experiencing PTSD symptoms.	Medical Outcomes Study Social Support Survey Form	At 8 weeks compared to baseline: Increased self-reported 'emotional/information support' and 'positive social interactions' associated with greater rate of PTSD symptom reduction. No significant associations for 'affectionate' or 'tangible' support.	p<0.05	

Authors and year	Research trial	Intervention	Population	Measures	Main Findings	P value	Effect size
Wynn, G. (n. d.)[72] U.S.	Longitudinal	Rivers of Recovery Outdoor therapy retreat for CRPD veterans led by Vietnam veterans. (POST)	67 men, 2 women returned deployed veterans with PTSD diagnosis	Pos Affect and Neg Affect Schedule (state mood). Brief Symptom Inventory – dep, anx and somatic stress in past week. Perceptual Stress Scale, PTSD Checklist Military Version, Pittsburgh Sleep Quality Inventory.	1 month prior, last day of retreat, 1 month follow up. Significant reductions in perceived stress, PTSD symptoms (19% reduction, with some no longer meeting PTSD diagnosis)	p<0.001	
					and sleep issues, compared to the initial baseline prior to camp participation (Prestwich, 2010??), and	p=0.002	
					significant reductions in anxiety, depression and somatic stress symptoms	p<0.001	
					and also negative mood states, with a significant increase in positive mood states.	p<0.001. p<0.001.	
					Results also showed a significant reduction in daily cortisol production (stress measure) between the first and second days for 23 participants as measured by salivary cortisol, urinary catecholamines (e.g., epinephrine and norepinephrine) and immune function (salivary immunoglobulins).		
Travis et al.63 2010 U.S.	Longitudinal	Telephone based mutual peer support (12 weeks). Patients with depressive symptoms paired together, used telephone computer platform to contact (peer).	Community treatment centres 22 veterans, 32 non veterans	BDI-II Quality of Life Enjoyment and Satisfaction Questionnaire Short Form SF-12 – health related quality of life General Self-Efficacy Scale	At 12 weeks compared to baseline: BDI score Reduced	p< 0.02	
					Improvement in perception of disability	p=0.02	
					Qual of life increased	p=0.04	
					Psychological health increased	p<	
					Qualitative – found meaning and support.	0.001	
					Veterans significantly greater retention – less drop out.	p < 0.0001	
Westwood et al.[62] 2013 Canada	Longitudinal and qualitative	Groups of 6-8 veterans, residential program 80 hours over weekends therapy 'course'. Peer support and exposure-therapy focused. (peer)	18 male military personnel aged 32-73 years old, two peer facilitators with three non-military facilitators.	Trauma Symptom Inventory, Beck Depression Inventory–II and Self-Esteem Rating Scale. Interviews for content analysis	Before, after and three months follow up measures. Trauma symptom inventory:		
					A reduction in Tension Reduction behaviour,		0.95
					Anger/Irritability		0.45
					Dysfunctional sexual behaviour		0.55
					Impaired self-reference		0.44
					Anxious arousal		0.19
					Depression		0.19
					Defensive avoidance		0.2
					Reduction in BDI score between first and second administration		0.75
					and first and third administration		0.55
					Increase in self-esteem between first and second administration		0.19
					and first and third administration		0.17
					No significant change in depression between second and follow up administration.		0.07

Note: d= Cohen's d for effect size (Cohen, 1988)86 0.2 = small, 0.5 = medium, 0.8 = large

questions. The assessment tool was non-clinical and with reliability or validity reported. Veterans showed significantly higher levels of agreement for increased confidence, physical ability, emotional state and success compared to non-veteran participants, and lower levels in leadership skills, compassion, teamwork and accepting responsibility compared to non-veterans. Ewert et al.[58] also studied 266 OBVP veteran participants before and after participation, using the same assessment tool, and showed significant change of between p = .05 and p = 0.01 with effect sizes from .26 to .74 for 11 leadership quality constructs. The authors did not indicate which constructs showed the most significant change.

River Running, a therapist-led 4 day outdoor therapy river camp focused on utilising nature to manage distress and promote relaxation, was qualitatively evaluated by analysing journals and was completed by 10 male and 3 female veterans with diagnosed PTSD[35]. Participants were selected by defence health staff, and 17 professional staff were present. They reported that the re-experiencing of traumas appeared to diminish over the duration of the camp, avoidance and numbing replaced with "joyful involvement" (p. 335) in the trip experience and hyper-arousal replaced with fatigue from physical activity for the participants[35]. However, no method details were outlined in the report regarding their analysis approach and no follow up data were assessed, thus it is uncertain whether these effects were sustained after participation.

Hawkins, Cory & Crowe conducted a qualitative analysis of a 3-day Paralympic military sports camp for 50 injured contemporary U. S. personnel[59]. Ten participants volunteered to be interviewed using a semi-structured model. Researchers found that social comparison assisted participant engagement and change with improvements in the sense of competence and autonomy. Another week long Paralympic therapeutic adaptive sports and recreation program called Higher Ground for 18 recently returned injured U.S. veterans from the Iraq and Afghanistan conflicts was evaluated. The quantitative pre-post no control sample study showed significant reductions in self-reported mood disturbance, tension, depression and anger post-camp compared to pre-camp[60]. No significant difference was found for self-reported quality of life in general, nor for physical health, social relationships nor environment, although the subscale of psychological health showed a significant increase (p = 0.024).

To summarise, while published research indicates that outdoor therapy (non-peer) for non-military veteran populations appear to show promise in increasing mental health, they however show methodological limitations. These include small self-selected sample sizes and a lack of randomised controlled groups, resulting in a convenience sample bias[56,48]. However, this is not unlike other treatment studies with veterans outlined earlier in this paper. Difficulty exists in finding a sufficient evidence-base because outdoor therapy is often run intentionally with small participant numbers. It is also difficult to draw conclusions regarding the effectiveness of the outdoor therapy approach and general application due to program diversity. It appears, however, that the clinical or self-reported qualitative change noted is of importance and the peer relationships formed and subsequent benefit of social modelling, social support and peer mentoring may be an important area not adequately studied within these outdoor therapy evaluations.

Peer Support Approaches for Veteran Populations

While peer support approaches show a good evidence-base with non-military populations and show potential applicability to veterans, our interest was in finding direct research with veterans as opposed to generalising from the non-military data. Several studies were located evaluating peer support interventions for PTSD and mental health with veteran populations, see Table 3 for detail of intervention, measures and main findings.

Social support for veterans can act as a protective factor, but also appears important for clinical change as a deliberate adjunct to other therapies[60]. For example Pietrzak et al.[61] showed that lower self-reported unit support and post-deployment social support was associated with decreased resilience and psychosocial functioning and greater depression and PTSD for 272 contemporary U.S. Iraq and Afghanistan deployed combat veterans. Unit support association with PTSD and depression was mediated by personal resilience. Price et al.[23] also completed research into the effect of four types of social support on the outcome of exposure therapy for 69 U. S. CRPD veterans experiencing PTSD symptoms from the Iraq and Afghanistan conflicts. They found that positive treatment response was significantly associated with emotional or informational support and positive social interactions, rather than affectionate or tangible support. These elements of support are often intentionally included in peer support models of therapy[62].

Based on such studies, if therapy responsiveness is enhanced for CRPD veterans through peer support approaches there is a possibility for improved veteran wellbeing. Travis et al.[63] conducted a longitudinal study into telephone-based mutual peer support

with 22 veterans and 32 psychiatry outpatients and community mental health centre consumers who experienced ongoing depressive symptoms. Depression, quality of life, and psychological health all significantly improved over time. Of particular significance, veterans had significantly better adherence to treatment than non-veterans (2 veterans dropped out compared to 20 non-veterans).

A sense of camaraderie, important in any therapeutic setting[64], is significant within veteran culture particularly[11,15,24] and seen by Travis et al. where veterans felt they could censor themselves less. A high majority of participants, 94%, stated they would be more satisfied with their general care if they had peer support routinely available. Participants reported having someone who could relate, and who had common experiences, was of particular importance. Based on the quantitative and qualitative results, the authors concluded that this form of support may be considered valuable and more meaningful for veterans than for non-veterans[63]. This study demonstrated that veterans may be particularly well suited to this type of intervention support and is thus a potential treatment in combating compliance issues with veterans.

Veteran peer mentor programs in particular have shown to assist treatment adherence and enhance outcomes, improve behaviour and motivation for self-care, potentially de-stigmatise veteran mental illness, correct stereotypes of the mentally weak person, and act as a stress buffer in reducing psychological despair[13,65]. An increased uptake and responsiveness to other clinical treatment options is also seen[36]. Significant support exists for the peer approach with veterans, when conducted in a structured, formal and accountable way where appropriate training is provided[13]. For example, in evaluating the group peer support Veterans Transition Program in Canada with 18 male military personnel returning to civilian life post-combat, Westwood et al.[62] found that participation was associated with decreased trauma-related symptoms including defensive avoidance, anxiety, anger and depression.

Although a peer support program exists for ADF military personnel in their first year of service[9], a wide-scale program for ADF veterans does not appear available. In contrast, veteran programs such as Shoulder to Shoulder (STS)[66] in the UK and Buddy to Buddy (BTB)[36] in the U.S. utilise the peer support framework. Whereas STS utilises civilian volunteers to support veterans, BTB trains veterans to provide peer support to CRPD veterans, and views peer mentoring and social support as an integral component to the treatment approach for veterans. Preliminary research into the BTB program showed that after participation, 50% stated they had used resources/services suggested by their buddy and more than 20% self-referred to formal treatment as a result of participation when they had not previously accessed any formal treatment[36]. A Canadian veteran program, Operational Stress Injury Social Support (OSISS), also provides peer and family support to current serving personnel and veterans in one-on-one and in group formats[13,67,68]. A program evaluation completed by the Department of National Defence and Veterans Affairs Canada[67] indicated that over 900 personnel and veterans were utilising the service and OSISS appeared to be the only form of ongoing social support for many veterans.

POST for Veteran Populations

Bringing both outdoor therapy and peer support together, POST approaches addressing veteran wellbeing have been in operation for many years, but as yet not formally or systematically evaluated. Of those programs evaluated, many remain organisational reports and not subject to peer-review and journal publication. Given the limited published literature, relevant organisational reports have been included in this review. Examples of non-evaluated POST approaches for CRPD veterans are outlined in Table 4.

POST programs for veterans that have been evaluated are included in Table 3 with details of materials and findings. Rivers of Recovery (ROR) is a U.S. fly-fishing camp run by Vietnam veterans for CRPD veterans. ROR also includes a focused post-camp outreach program to aid veteran mental health[69,70]. The program provides more than 200 CRPD veterans with camps for men and women and couples every year69. Mowatt and Bennett analysed the content of letters written by 67 male participants of ROR during 2010 to their sponsors, who assisted financially for camp attendence[71]. The authors found four themes: camaraderie is necessary while receiving treatment; veterans experienced ongoing regret; reflection was involved in the process of memory reconciliation; participants saw benefits from involvement in outdoor recreational activity. A high risk of bias in results appears evident in this research however, because participants may have felt obligation to justify the sponsor's costs and express gratitude.

Research available on the ROR website appears rigorous and uses sound within-subject longitudinal methodology[72]. The participants, 67 men and 2 women post-deployed veterans with PTSD diagnosis, were assessed 1 month prior to the fly fishing excursion (baseline), the last day of the fly fishing retreat, and at 1 month follow up using reliable self-report questionnaires[72]. The study found statistically

Table 4. Non-evaluated POST approaches for CRPD veterans

Program Title	Country	Format	Detail	Website Link
Challenge Aspen	US	Veteran camps	For physical injury and PTSD but include therapist support	http://www.operationwearehere.com/WoundedWarriorRehabTherapy.html
Coming Home	Australia	12-day bush camp	Focusing on companionship and utilising a buddy system plus ongoing counselling post-camp participation. Young Diggers is a Returned and Services League (RSL) initiative.	http://www.youngdiggers.com.au/home
Expedition Balance	US	one-week outdoor therapy	Health retreat, veterans on the board of directors. Uses health and fitness and creative expression to address PTSD. Using a model similar to the evidenced based Post-Traumatic Stress Disorder Day Treatment Program, Landstuhl Regional Medical Centre, Germany, in an outdoor camp setting.	http://www.expeditionbalance.org/
In and Out	Australia	Fitness Program	Run by an Australian veteran to address the transition back to civilian life and support mental health in veterans	http://www.youngdiggers.com.au/and-out-fitness-program
Pandanus Park	Australia	Veteran retreat	Annual group retreat and camp sites open to veterans	http://www.pandanusparkinc.com/
Soldiers to Summits	US	Outdoor trips	Outdoor trips run by soldiers and civilians for address disability due to combat	http://soldierstosummits.org/
Summit for Soldiers	US	Peer-led outdoor therapy program	Camps for veterans, raising PTSD awareness	http://www.tmgherd.webs.com/
Veterans Expeditions	US	Peer-led outdoor challenge program	Expressly not therapeutically focused but hopes nonetheless to reduce suicide rates in recent returned veterans through social connection and team challenge involving national and international trips.	http://vetexpeditions.com/
Veterans in Action	UK	Adventure therapy	Outreach and outdoor trips by veterans and civilians	http://www.v-i-a.org.uk/index.php

significant reductions in perceived stress, PTSD symptoms (19% reduction, with some no longer meeting PTSD diagnosis) and sleep issues, compared to the initial baseline prior to camp participation[70]. Significant reductions in anxiety, depression and somatic stress symptoms and negative mood states, with a significant increase in positive mood states were also found. Results also showed a significant reduction in stress indicated by daily cortisol production between the first and second days for 23 participants. This was measured by salivary cortisol, urinary catecholamines (e.g., epinephrine and norepinephrine) and immune function (salivary immunoglobulins). The research is however limited due to being an organisational report with no control group reported.

Closer to home, Trojan's Trek (TT) appears to be the only Australian program evaluated and available for review. This evaluation is also an organisation report and has not been subject to peer-review and not available via standard journal publication. Data from TT's first camp in 2009 was evaluated by ACPMH[56] using self-report questionnaires and interviews with 10 participants and their partners before camp, immediately after camp and at 2-months follow-up. Outcomes showed a trend toward mental health improvement. However, only 5 participants completed post-intervention questionnaires, limiting statistical analysis. Some respondents showed diminished perceived benefit of camp involvement after 2 months compared to immediately after the camp, and those who did not complete follow-up showed initial higher ratings of unhappiness with life than those who completed follow-up questionnaires. Due to the small sample size, self-selection and the lack of a control group, conclusions could not be drawn regarding the camp's effectiveness. However, positive qualitative results from diary and interviews were evident. The most common goals at the start of the trek were managing anger and improving communication and the camp was most effective in managing day to day problems and achieving these goals[56].

Programs for veteran populations such as TT and ROR both utilised medallions as symbols for belonging, accomplishment, and legacy-making[69], providing culture specific meaning-making important in many therapy approaches with veterans[14]. TT and ROR are two evaluated examples of where peer support programs have been applied within an outdoor therapy setting for veterans.

Discussion

In this paper the effects of deployment, standard treatment for veterans, and challenges to treatment with CRPD veterans experiencing military-related mental illness have been outlined. The evidence for the effectiveness of outdoor therapy, peer support approaches and POST with non-military and

contemporary veteran populations has also been reviewed.

CRPD veterans experience a relatively high level of mental health issues in contrast to the non-military population[3,5,6]. Despite recommendations for individual and group PE and CBT therapies supported by research these appear predominantly from the generalisation of non-military population studies to military and veteran populations. Such therapies may be under-utilised by a section of the veteran population, given the unique characteristics and reluctance of this population to engage with these approaches[17]. Treatment response and retention may be lower than for other populations accessing similar treatment due to the nature of deployment-related PTSD and the culture of military service.

Currently only a very small number of peer-reviewed research into POST approaches exist compared to other approaches, despite being commonly used, particularly in the U.S. The evidence for veteran POST approaches are organisational based reports without peer review and publication in academic journals. The methodology strengths are mixed, with some outdoor therapy (non-peer) evaluations supporting positive outcomes but which are limited in reliability, not unlike other research into therapeutic approaches with veterans. The conclusions which can be directly drawn about POST approaches are thus somewhat limited given this and the inherent design limitations with using small group therapies. However, the quantitative research available to date which directly explores the POST approach with veterans, supports its use.

In contrast, the research for structured peer support with veterans is promising. There is strong evidence to indicate that therapies which include structured peer support for veterans are efficacious based on the research with both veteran and non-veteran populations is outlined in Tables 2 and 3. In particular, veterans show greater engagement in mutual peer support and may be well suited to this therapy approach[61]. Although there are practical and ethical risks in any peer support approach, and also in generalising methods across diverse U. S. and Australian veteran cultures, the peer support approach is promising in its potential application to Australian CRPD veterans for a number of reasons. From the reviewed literature and studies into peer support approaches, it is reasonable to conclude that veteran peer-mentor interventions have the potential to: (a) be perceived as more accessible than professional-led therapies, (b) directly impact positive therapeutic change and retention for veterans, and (c) encourage access to professional mental health support. Existing veteran social support programs build on the camaraderie which naturally develops as an aspect of deployment and provide social norming and modelling[23,36] which could lead to more sustained and meaningful change for participants. In addition, under well-structured programs, veterans may benefit from having a strong identification with peers and leaders[56,11,24].

Thus, further research is warranted into the efficacy of POST approaches with veterans where structured peer support is a core aspect of the outdoor therapeutic approach. Such research would add further to current knowledge and treatment practice regarding the potentially significant role POST approaches could play within the wider context of treatment for the veteran population.

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On Return from Peacekeeping: A review of current research on psychological well-being in military personnel returning from operational deployment

Dr Karen Brounéus

Introduction

The number and size of UN and Allied peacekeeping deployments have increased dramatically since the end of the Cold War[1], as have the budgets that support them. The UN budgeted 7.23 billion USD for the 2012-2013 fiscal year for UN Peacekeeping operations[2]. An explanation for this increase is likely to be found in two global trends seen in armed conflict in recent years: first, that nearly all wars in the world today are fought within countries, and second, the unprecedented rise in peace agreements as a means to end conflict[2]. Both of these factors present new challenges for peace-building as former enemies must continue living side by side when the conflict has ended, in a continuous negotiation for peace.

Research suggests that international peace support operations indeed have the potential to improve the chances for preventing further conflict. In the first global, quantitative analysis on the effect of peacekeeping operations (PKOs), Doyle and Sambanis found a significant and substantial effect of peacekeepers on peacebuilding two years post conflict [3]. This finding is similar to later studies. For example, Fortna demonstrated that the risk of further conflict drops by 75%–85% with the presence of a PKO[4,5]. Other research has found that PKOs limit the temporal and spatial contagion of conflict[6], and can also have a preventive effect, reducing the risk of genocidal violence[7]. However, recent research has also found that peacekeeping operations in settings where there is not yet peace or stability, such as Afghanistan, may entail the risk of spurring violence against civilians by rebel groups if the deployment does not have an explicit mandate to protect civilians[8]. Similarly, when looking at other definitions of success aside from the prevention of further conflict, such as meeting the goals of the mandate, or establishing basic democracy and stability – a governance goal for most current deployments – the impacts of operational deployments are less clear[9,10].

With regards to the peacekeepers themselves and the effect these missions have on psychological health and well-being, an extensive body of literature has studied returned American servicemen from Vietnam and Somalia, Iraq and Afghanistan, covering issues of psychological ill-health from alcoholism and suicide to the adverse effects of a negative homecoming experience[11,12]. As this review will show however, less is known of soldiers from other countries as well as the long-term effects of peacekeeping on psychological well-being. With the notable exception of the US millennium cohort study[3], longitudinal studies in the field are rare but increasingly called for[13]. In the following, an overview of current research in a range of areas concerning the psychological well-being of returning peacekeepers will be presented, and some research gaps highlighted.

Psychological health in returning soldiers

In general, most returning Service personnel do well in the months after deployment. In a recent review covering 68 articles based on research conducted on Canadian, Danish, Finnish, US, Swedish, Norwegian, and UK peacekeepers, Sareen and colleagues studied the association between deployment on a PKO and subsequent psychological health, finding that most Service personnel cope well after such a deployment[14]. For those returning soldiers who do encounter post deployment difficulties, however, the study importantly identifies four correlates to distress and post traumatic stress disorder (PTSD): 1) level of exposure to traumatic events during deployment, 2) number of deployments, 3) pre-deployment personality traits or disorder, and 4) post-deployment stressors. Pietrzak et al. similarly found in a review of 18 longitudinal studies on mental health outcomes in military personnel that it was combat exposure rather than deployment as such that had a negative impact on mental health[13]. Combat exposure and young age in male soldiers has been found to be significantly linked to increased alcohol misuse in returning soldiers[15,16]. As substance abuse is highly

correlated with PTSD – alcohol may serve as a coping mechanism after trauma[16] – any comorbidity should be carefully determined. In returning soldiers, the Sareen et al. study further found that perceived meaningfulness of mission, post-deployment social support, and a positive perception of homecoming was associated with a lower likelihood of distress after deployment[14], buffering post-deployment psychological ill health[14,17]. In a 2010 Mental Health and Well-being report, the Australian Defence Force (ADF) found no differences in mental health between deployed and non-deployed personnel[18]. The report did find, however, that the prevalence of affective and anxiety disorders was significantly higher in ADF personnel than in the general Australian population, with depression levels at 6.4% for ADF personnel versus 3.1% in the Australian public, and PTSD levels at 8.3% in ADF personnel versus 5.2% in the public. The reasons for this difference are yet unknown but due to the potential of trauma exposure during deployment, the authors call for more research to determine whether differences in deployed and non-deployed personnel might have been masked if healthier people are deployed, or if the ADF's preventive work is successful in mitigating mental ill-health in returning personnel[18].

Mirfin (2004) found that levels of PTSD and depression symptoms increased in New Zealand soldiers with longer deployment to Bosnia, an increase that did not take place in the control groups who were not deployed. Interestingly, the most stressful period for the deployed soldiers in this study was at six months following their return to New Zealand[19]. This finding supports other research which suggests that the transition period from operational deployment to life at home can be lengthy, and is likely to be the point where ongoing mental health and health behaviour issues relating to deployment arise[20,21]. However, little is known of how soldiers are faring in life further along than 6 months after deployment. Recent research from the USA suggests that initial post-deployment screening may underestimate the mental health burden of returning soldiers and there is a call for more longitudinal data to determine the long-term implications of deployment[22,23]. The finding of Hoge et al. that mental health problems after deployment are significantly associated with attrition from the military again emphasizes the importance of longitudinal studies[24]: those who stay and deploy again may represent a more resilient group (the "healthy soldier effect"[25])[26] while those who leave fare ill, and fall off the radar for help.

Mild Traumatic Brain Injuries (mTBI)

The positive news that most soldiers do well after operational deployments has been challenged of late. Recently, numerous studies on soldiers returning from the various operational missions in the former Yugoslavia, and several studies based on the ongoing missions in Iraq and Afghanistan, demonstrate an increase of PTSD rates in these particular conflicts[27]. A growing number of studies since the Iraq/Afghanistan conflicts are further linking psychological ill-health with Mild Traumatic Brain Injuries (mTBI)[22] – the frequency of which has risen with the growth in use of high kinetic blast energy weapons such as improvised explosive devices (IED) and roadside bombs. Improved personal protective equipment (PPE or body armour) and vehicle armour combined with improved medical systems has increased the survivability of troops, decreasing battle fatalities but increasing the numbers of wounded and long term disabled veterans[28]. It has been suggested that up to 33% of US soldiers with a combat injury also had mTBI[24,29]. Symptoms of mTBI include memory loss, anxiety, nausea, and irritability[30]. In most cases, symptoms will resolve within days or weeks of the trauma ; however, in a minority (<5%-24%) of cases, symptoms persist. There is high comorbidity between mTBI and PTSD and depression. Among military personnel with mTBI, between 32%-66% also meet the criteria for PTSD, and between 13%-33% of mTBI patients within the military also meet the criteria for depression[15,31].

Suicide

The question of whether soldiers and returning soldiers from operational missions are at increased risk of suicide has flourished in the scholarly literature as well as in international media in the recent past[15,18,27,32,33]. Grossman (2008) cites statistics showing that more US Vietnam veterans committed suicide during their tour of duty and since their return home than were killed by enemy action in theatre. The US military began seeing a sharp increase in suicides amongst their armed forces personnel in 2005, from a baseline rate of around 10.3 per 100,000 persons to approximately 18 per 100,000 persons since 2009[32]. However, to date, research suggests that there is no higher likelihood of suicide in previously deployed military personnel than in the general population[14,17]. The latest and possibly largest study on suicide in the military came in the August 2013 edition of JAMA, wherein data from the US Millennium Study were analyzed. Based on data on more than 151,000 US military personnel, this prospective, longitudinal study found that the risk factors for suicide within the US military were male sex and mental disorders, the same as those in the civilian population. Contrary to expectation, none of the military or deployment-related factors (combat experience and deployment length or number) were

associated to suicide risk[32]. Two exceptions exist thus far: one longitudinal study with Finnish Service personnel amongst whom suicide rates were higher compared to controls in those who had repatriated early[30], and one study on Norwegian personnel where suicide rates were higher amongst those who were involuntarily repatriated from the peacekeeping mission[31].

Homecoming and postdeployment stress

Recent studies confirm that more longitudinal data is needed to determine the long-term implications of deployment[22]. For example, in a study on Swedish peacekeepers in Bosnia, it was found that those who had experienced traumatic events in Bosnia as well as stressful life events in the post-deployment period reported the poorest mental health; however, the strongest predictor for poor mental health one year later was post-deployment stress[34]. In US Vietnam veterans, Johnson et al. found that the most significant predictor for PTSD was homecoming stress[35]. The challenges of post-deployment adjustment have been reported from a host of countries such as Australia, Canada, the Netherlands, UK, and the US (for an excellent overview of this research see[36]). Indeed, several studies suggest delayed onset of post deployment trauma and ill-health, with some soldiers displaying no symptoms until their release from service[37].

Factors associated with positive post-deployment adjustment include good military unit leadership and comradeship; if the individual remains a serving member of the military; and reasonable work place demands[36]. A number of studies mention the connection between supporting attitudes in family and community and healthy reintegration at home[12,38]. UK soldiers returning from peacekeeping noted that having people to talk with was a significant factor in dealing with their stress[39], while Schok et al. note that in particular, having social support from comrades who have also served is particularly important[38].

Factors associated with a potentially more difficult transition include opposite circumstances: a sense of being caught between two worlds, one of which is characterised by poverty and violence; a sense that people at home are not interested in their experiences[38]; significant anger and disappointment with their service[40]; and a sense that their Service lacked meaning[38]. As well as adjustment issues, returning soldiers must cope with the everyday stressors of life such as relationships, financial concerns, parenting, and possibly relocating and new roles[41,42]. This added layer of stress may increase the adjustment difficulties experienced as a result of deployment. Recently, it has been increasingly forwarded that the discussion on homecoming and post-deployment should also address the impact that operational deployment has on the family of the returning soldier as the long-term negative impact of veterans' PTSD on the health of their partner's mental health has been demonstrated[23,43,44].

Non-combat related stress

Current literature almost exclusively deals with psychological ill-health resulting from combat related trauma. Some research focuses on trauma related to 'close range interpersonal violence' and the 'price of overcoming the resistance to killing'[45]; whilst some research addresses the effects of fear, anxiety and trauma related to being proximate to combat, witnessing death and dealing with human remains[44]. However, while the literature often acknowledges other stressors such as separation from family, boredom and isolation, it seldom deals with issues such as frustration, anger, helplessness and feelings of futility – issues that have been suggested to be frequently associated with low threat missions rather than combat operations. Very few studies exist that specifically address the deployment effects of low threat missions[36,44]. One study[29], specifically aimed to determine if non-traumatic stress associated with deployments had an effect on psychological health. This study concluded that non-traumatic stress can have an effect on psychiatric health, co-morbidity, and family and interpersonal relationships; all of which were significant correlates of Service discharge.

Related to non-combat stress is the issue of discrepancy between the soldiers' expectations of their role and the reality of the deployment. American peacekeepers in Macedonia raised concerns about the difference between their training and the actual work of peacekeeping[46]; many found the work 'insufficiently military', or that their training had provided them with unrealistic expectations of what the deployment would hold. Whitworth examined primarily Canadian military peacekeepers and described the way many perceived their peacekeeping deployments as insufficiently military and insufficiently masculine[47]. In summary, more research would be needed to investigate the nature and prevalence of non-combat related stressors, and the impact of non-combat related stress on the health of returning peacekeepers.

Meaningfulness of mission

A perceived sense of meaningfulness of mission is important for how returning veterans deal with their experiences in and from the deployment[12,35,38].

Research suggests that for deployed personnel, meaning is associated with a sense of being able to help the people in the communities in which they serve; indeed, many peacekeepers report that their motivation to serve on these missions came from a desire to help others[48].

Britt[12] found that the belief personnel have of benefiting from their deployment was linked to their sense that their experiences were meaningful. Factors associated with reported meaning included making sense of their situation, the opinions of their friends and family and wider society on their deployment, the relevance they perceived of deployed operations to their work or career, the way military leaders explained the operation, and their ability to find benefit from stressful events.

Schok and colleagues found that Dutch peacekeepers in Cambodia who reported higher levels of trauma were more affected by the poverty they saw, by a sense of injustice of the whole situation, and struggled to find meaning[38]. Lack of meaning was associated with higher degrees of post deployment stress. Conversely, the former peacekeepers who reported little or no post deployment stress thought their experiences were meaningful and positive, indicated a higher sense of personal strength and self-reliance, as well as a sense of fulfillment in their work in Cambodia. Schok et al. suggest that the struggle to find meaning is the major contributor to post deployment stress, rather than the actual events experienced. Murphy[36] also notes the importance of meaningful work post deployment as contributing to post deployment well-being.

Conclusion

Current research on the psychological health of soldiers returning from peacekeeping operations suggests that in the short-term after homecoming, most fare well. However, less is known of the long-term effects: recent research has demonstrated that the initial post-deployment screen may underestimate the mental health burden of returning soldiers[23]. In addition, as mental health problems after deployment have been found to be significantly associated with attrition from the military[24], longitudinal studies are of the essence. Longitudinal research comparing mental health and well-being across the deployment cycle at pre-deployment, during deployment and post-deployment, preferably following a cohort of veterans until after their retirement, would be invaluable to provide insight into psychological well-being in peacekeeping soldiers – also after they have taken off their boots.

Further, considering that many of the current multidimensional peacekeeping operations are of a low-threat and non-combat nature, a study focusing on non-combat related stress would be of importance.

Finally, little is known of female soldiers' experiences of returning from peacekeeping missions. Evidence demonstrates a "double jeopardy" for women in the military – women face dangers of being killed or wounded by the enemy but are also facing the risk of sexual violence from their own side[49]. However, few studies on returning soldiers hold a gender perspective, and subsequently little is known on the experience of deployed women[50,51]. Studies – quantitative and qualitative – on women's experiences both during and post-deployment would be of great importance.

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Army Malaria Institute - its Evolution and Achievements. Fourth Decade (1st Half): 1995-2000

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Abstract

During the 1995-2000 quinquennium, the Army Malaria Research Unit (AMRU) was re-named the Australian Army Malaria Institute (AMI) and re-located from Sydney to a modern purpose-built facility in Brisbane. Its international recognition as a centre of excellence for malaria research was further enhanced by the establishment of a molecular parasitology laboratory to investigate drug resistance. During this period AMI deployed outbreak management teams in response to the hundreds of soldiers who suffered from malaria in Bougainville and Timor Leste due to inadequate personal protection and chemoprophylactic measures. Between 10-20% of affected soldiers experienced their first attack of falciparum or vivax malaria overseas for failing to comply with doxycycline prophylaxis or, possibly, for taking doxycycline which had been degraded by exposure to adverse environmental conditions. By contrast, 80-90% of primary episodes of malaria did not occur until after return to Australia, simply because the 14-day post-exposure primaquine course was either ineffective in eradicating residual liver stages of *Plasmodium vivax* or had not been taken as prescribed. Field studies with tafenoquine, a slowly-eliminated analogue of primaquine, indicated that this drug might eventually replace primaquine and even prevent malaria while overseas. In a further field study, atovaquone/proguanil (Malarone®) proved to be just as effective as doxycycline, suggesting that it could be used as an alternative drug for malaria prophylaxis. Laboratory-based studies with Mannich base, artemisinin, and third-generation antifolate compounds provided further evidence of their potential value for the control of drug-resistant falciparum malaria. Progress was also made in evaluating drug resistance and diagnostic procedures and in identifying molecular markers of parasite resistance to antimalarial drugs, such as atovaquone. Two novel insect repellents and a self-erecting low-profile bednet provided good protection against mosquito bites. Surveys on the distribution and speciation of anopheline mosquitoes in Papua New Guinea were extended to another five provinces and, whilst DNA analysis was still in progress, early findings indicated a marked diversity of genotypes in anopheline species. Towards the end of the quinquennium, AMI became involved in efforts to provide Australian Defence Force personnel with better protection against other mosquito- borne diseases, such as Ross River virus, dengue and Japanese encephalitis.

Background

The malaria situation during the 1990s showed little improvement or worsened in many countries.[1] Although numerically Africa accounted for 90% of malaria cases worldwide, the southwest Pacific region continued to be a hotbed for malaria, with the Solomon Islands being considered one of the most malarious countries in the world. With an increased interest in regional security, and continued support for peace keeping operations throughout the world, Australian Defence Force (ADF) personnel continued to be deployed to malarious areas. As exemplified repeatedly, the ability of the ADF to operate at maximum efficiency in such areas depended on the effective protection of its personnel against this potentially fatal disease.

After its modest beginnings in the mid-1960s,[2] the Army Malaria Research Unit (AMRU) was playing an increasingly important role in providing optimum protection against malaria for ADF personnel deployed to malarious areas overseas.[3,4] Substantial progress in this regard was also made during the 1990-1995 quinquennium.[5] Based on observations by AMRU that pyrimethamine/dapsone (Maloprim®) was no longer able to protect soldiers deployed to Papua New Guinea (PNG), doxycycline became the standard drug used for malaria prophylaxis. During the deployment of almost 2000 Australian soldiers to Cambodia, Somalia and Rwanda, only 8 soldiers developed malaria, probably due to inadequate compliance with the daily prophylactic regimen. Between 1-2% of soldiers were placed on weekly mefloquine prophylaxis because of gastrointestinal intolerance, sun-sensitisation, or other side-effects

or contra-indications associated with the use of tetracyclines. Although generally effective as a malaria prophylactic drug, mefloquine was no longer able to suppress or cure falciparum malaria in some parts of Southeast Asia, as was observed by non-Australian contingents deployed to Cambodia with the United Nations Transitional Authority in Cambodia (UNTAC).

Doxycycline and mefloquine, whilst generally effective in preventing falciparum malaria and suppressing vivax malaria, did have drawbacks. Furthermore, the constant threat of the emergence of drug resistance emphasised the need to search for alternative drugs and drug regimens in collaboration with various national and international institutions. Laboratory, clinical or field investigations were carried out with doxycycline and other antibiotics, halofantrine (new drug), proguanil combined with dapsone or atovaquone (new drug combination), artemisinin compounds, PS-15 (experimental third generation antifolate compound) and Mannich bases (experimental compounds).

Although active against multidrug-resistant *Plasmodium falciparum*, none of the above- mentioned drugs were likely to have any activity against residual liver dormant stages (hypnozoites) of *P. vivax*. The 14-day primaquine eradication course continued to be the only means of preventing acute attacks of vivax malaria after return to Australia. But even with good compliance in taking this cumbersome drug regimen, hypnozoites failed to be eliminated in an increasing number of soldiers who had been infected with vivax malaria. To meet this challenge, preliminary investigations were started with tafenoquine, a long-acting analogue of primaquine.

Rapid changes in the patterns of parasite susceptibility to drugs underscored the importance of knowing the extent and degree of drug resistance in malarious areas of possible future deployment. Accordingly, new or improved methods to assess drug resistance were developed in the laboratory and then applied in the field.

Additional collaborative studies were also carried out to determine the potential value of a non-microscopic method for diagnosing falciparum malaria.

Efforts to improve personal protection against arthropod-borne diseases were continued by assessing the effectiveness of various formulations of insect repellents applied to skin, uniforms and bednets. Surveys concerning the distribution and biology of anopheline malaria vectors previously conducted in northern Australia were extended to four provinces in PNG, with the expectation that they would lead to a better understanding of the epidemiology of malaria and thereby help to control this disease in local communities as well as in military personnel deployed to these areas.

Staff and facilities

During the 1995-2000 quinquennium, AMRU was re-named the Australian Army Malaria Institute (AMI). In early 1997, it was moved from Sydney to a more appropriate purpose-built facility of about 2100 square metres in Brisbane. This was consistent with the evolution of AMI to a major centre for malaria research and training. Located at Gallipoli Barracks, Enoggera, AMI became affiliated with the Australian Centre for International and Tropical Health and Nutrition (ACITHN), a joint venture established by the University of Queensland (UQ) and the Queensland Institute of Medical Research (QIMR).

Research and other malaria activities continued under the overall leadership of Professor Rieckmann. Lieutenant Colonel Sweeney retired in December 1996 after 27 years of outstanding service to AMRU. His place as Deputy Director and Commanding Officer was filled by Lieutenant Colonel (previously Major) Michael Edstein, a member of AMRU since 1975.

The move to Brisbane was associated with the loss of 9 out of 20 full-time staff and, as may be expected, the whole re-location process interrupted research activities for quite a while. However, by the end of 1997, 6 of the positions had been filled. New staff members included Dr Qin Cheng and Major Peter Nasveld.

Dr Cheng established a molecular parasitology laboratory which enabled AMI to avail itself of recent technological advances in molecular malaria diagnosis, epidemiology and monitoring of drug resistance. After graduating in medicine, Dr Cheng had embarked on a research career in molecular parasitology, culminating with a PhD and five years post doctoral experience in malaria research at QIMR. She was joined in April 1998 by Dr Nanhua Chen, also a molecular parasitologist with post doctoral experience at QIMR.

Major Nasveld joined AMI to head up clinical studies and surveillance activities, with an emphasis on field activities in Bougainville. During his 8-year service as a medical officer with the Army, Dr Nasveld had become well acquainted with the prevention and treatment of malaria while on the Australian Defence Staff based at the Australian High Commission in PNG. In 1998, he was joined by Major Scott Kitchener who had served in the Middle East and in PNG as a medical officer until 1997. First as a reservist, and then returning to full-time Army service, Dr

Kitchener played a leading role in AMI's outbreak management team to control malaria and dengue in the forward area of operations in Timor Leste.

Other additions to the staff included Lieutenants Bruce Russell (1998), Alyson Auliff (2000) and Michael Korsinczky (2000). Captain David Kocisko (US Army) started a 2-3 year exchange posting at AMI in October 1998 to undertake drug analysis investigations.

Major Steve Frances returned to AMI in 1995 after a 3-year exchange assignment with the US Component of the Armed Forces Research Institute of Medical Sciences (AFRIMS) in Thailand and continued his investigations with insect repellents and other personal protection measures. Major Robert Cooper, a long- standing member of AMI, carried out further ground-breaking investigations on the distribution and speciation of anopheline mosquitoes in PNG.

Major Ivor Harris commenced army reserve duty as veterinary officer for the animal colony in 1997, before transferring to the regular Army in 2000 to become AMI's administrative/scientific officer. Following the move from Sydney, the primate colony was re-located to 'state of the art' facilities (with an outdoor recreation area attached to the new AMI building in Brisbane). It consisted of approximately 30 owl monkeys *(Aotus griseimembra)*, descended from animals imported from the USA in 1982, and approximately 25 squirrel monkeys *(Saimiri sciureus)*, obtained from Commonwealth Serum Laboratories in the mid-1990's. After obtaining valuable additional information about the potential value of new drugs against human malaria, the squirrel monkeys were retired to a nearby zoo in 2000.

Various studies involving non-human primates were reviewed and approved by an active Animal Experimentation Ethics Committee, in conformity with national codes and state laws. Following the move to Brisbane, Ms Lynette Shanley, a leading member of the International Primate Protection League (later "Primates for Primates"), continued to visit the primate facility and provided most helpful advice on various aspects of animal husbandry and welfare.

After re-location to Brisbane, new members were selected to serve on the Army Malaria Research Advisory Board. In conformity with established procedures, all investigations involving human volunteers continued to be subject to approval by the Australian Defence Medical Ethics Committee (ADMEC).

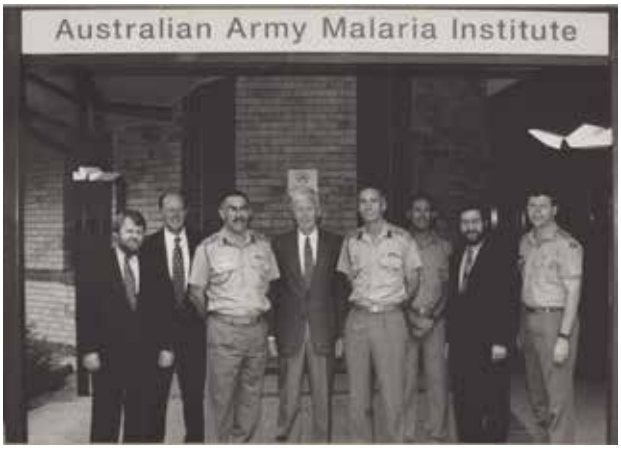

Figure 1: Army Malaria Research Advisory Board (1998)

From left: Prof John Mackenzie, Prof Tony Sweeney, BRIG Paul Buckley, Prof Karl Rieckmann, COL Wayne Ramsey, LTCOL Michael Edstein, Prof Alan Saul, LTCOL David Hutton.

Malaria situation

In May 1996, the 49th World Health Assembly (WHA) requested that increased resources be made available to enhance the World Health Organization's (WHO) action in malaria control and training programs. Shortly thereafter, the WHO Director-General's Task Force on Malaria Prevention and Control was established, Professor Rieckmann being one of its nine members.[6] Recognising WHO's leading role in providing technical guidance, support and training to member countries, the Task Force underscored the importance of WHO having the necessary resources to strengthen the ability of countries to implement the Global Strategy. However, 'the Task Force also recognised that the control of malaria is not only a difficult task, but a long one', and 'it stressed the urgent need for a comprehensive, long-term initiative to reassess the trends of the fast-deteriorating malaria situation'.[6] Since multidrug resistance was often largely responsible for the worsening malaria situation, it was obviously appropriate for AMI to intensify its efforts to monitor and investigate drug resistance, to develop improved chemoprophylactic/ treatment regimens, and to prevent exposure to malaria by conducting epidemiological and mosquito control investigations.

During the first half of the quinquennium, there were no large-scale ADF deployments to malarious areas. Consequently, the Central Malaria Register, maintained at AMI, recorded only 20 malaria infections (4 *P. falciparum*; 16 *P. vivax*) over this period. Of these, 14 were acquired in PNG, 2 in the Solomon Islands, and 4 in Southeast Asia.[7] In addition to infections acquired during short-term visits overseas, malaria attacks were also reported

among ADF personnel and their dependants during longer-term postings to PNG, particularly the Morobe Province. The ADF was confronted with many more malaria infections during the second half of the quinquennium when hundreds of infections were documented during and following the deployment of about 7000 personnel to Bougainville and Timor Leste (formerly East Timor).

Bougainville

In late 1997, about 300 ADF personnel were deployed to Bougainville to form the main component of a multi-national contingent to monitor peace-keeping after a decade of conflict on the island. Their close interaction with local communities exposed them to a particularly high malaria risk (about 40% and 10% of fever patients at 4 surveyed health clinics were infected with *P. falciparum* and *P. vivax*, respectively). Although *P. falciparum* was the predominant species in the local population, it was responsible for only 5 of the 50 malaria infections observed in military personnel during the ADF deployment (ending in 2004).[8] The remaining 45 soldiers succumbed to *P. vivax* malaria, but had their initial acute attack of malaria only after returning to Australia, with 8 of them experiencing relapses (1 to 3 further attacks) over the next 12 months.

Doxycycline prophylaxis had obviously suppressed the blood stages of both *P. falciparum* and *P. vivax* while they were in Bougainville, but had not suppressed development of the residual liver stages (hypnozoites) of *P. vivax*. Consequently, after completing prophylaxis, soldiers suffered a malaria attack every time parasites were released from the liver into the blood circulation. Fortunately, most infected soldiers would have had their hypnozoites eliminated by the post-exposure course of primaquine taken after leaving Bougainville. But these soldiers demonstrated, once again, that a more effective and less cumbersome drug regimen was needed to prevent vivax malaria after return to Australia.

The collection of blood samples for on-the-spot malaria microscopy and treatment at the 4 health clinics was well received by local communities, reminding older villagers of similar surveys conducted during past malaria control efforts. Blood samples collected by AMI staff were also used for further field assessment of a non-microscopic rapid diagnostic test (see below) and for DNA analysis (see below). Fingertip specimens of blood were also collected from malaria patients to determine the *in vitro* susceptibility of *P. falciparum* to a range of antimalarial drugs (see below). This provided both ADF and local health staff with up-to-date information regarding drug resistance patterns in these areas, and resulted in some modification of drug regimens used for malaria prophylaxis and treatment. Information was also obtained on the distribution and density of different anopheline and culicine species in close proximity to the military field sites and surrounding villages (see below). As a result, appropriate measures were introduced to lessen the risk of acquiring malaria and arboviral infections such as dengue.

In efforts to improve personal protection methods, a few soldiers participated in a study to compare the effectiveness of a new self-erecting bednet, developed by the US Army, with the current ADF bednet (see below). Many soldiers also volunteered to participate in the evaluation of two new antimalarial drugs – Malarone® and tafenoquine (see below).

Timor Leste

Between September 1999 and April 2000, over 5000 ADF soldiers led the International Force in East Timor (InterFET) in a peace-keeping role following the referendum for self determination in the former Indonesian province. Although little epidemiological information was available, both *P. falciparum* and *P. vivax* (2:1 ratio) were known to be seasonally endemic in the area. However, it soon became apparent that soldiers were suffering a significant number of non-battle casualties from malaria. At the request of Lieutenant Colonel Nasveld, who had been posted from AMI to assume the role of Senior Medical Officer for the forward Brigade (3BDE), the AMI deployed an outbreak management team led by Major Kitchener. By the end of InterFET in February 2000, 67 ADF personnel had developed malaria in Timor Leste.[10] Far fewer personnel would have been affected if more attention had been given to better compliance with mosquito protection measures and doxycycline prophylaxis.

About two-thirds of the infections were caused by *P. falciparum* and the remainder by *P. vivax*. This could not be attributed to parasites having become resistant to doxycycline because treatment with the prophylactic daily dose of 100 mg for 7 days was uniformly effective in curing falciparum infections. Obviously, these soldiers had missed taking their daily prophylaxis on more than a few occasions or, possibly, doxycycline capsules in the blister packs had been degraded by adverse environmental conditions.

Nevertheless, the vast majority of soldiers had not been seriously remiss in taking their doxycycline prophylaxis. This became quite obvious when 298 soldiers experienced their initial attack of vivax malaria following their return to Australia.[11] After completing their prophylaxis, doxycycline was no

longer present to eliminate parasites entering the blood stream from the liver. Apart from drawing attention to the urgent need for more effective drug regimens against the liver stages of *P. vivax*, the delayed onset of these infections indicated the high exposure to malaria encountered by military personnel during InterFET.

What would have happened if doxycyline prophylaxis had not been available to suppress malaria? Not only would all initial attacks of vivax malaria have occurred in Timor Leste, but medical and command personnel would also have been confronted with 500 to 600 cases of potentially fatal falciparum malaria (based on the fact that falciparum malaria was twice as common as vivax malaria among non-compliant soldiers). With up to 1000 soldiers incapacitated by malaria, this may very well have jeopardised the successful outcome of the InterFET mission.

As observed in Bougainville, vivax malaria manifested itself in a high proportion of soldiers after their return to Australia. These delayed malaria attacks indicated that the post-exposure course of primaquine (7.5 mg thrice daily for 2 weeks) had either failed to eradicate hypnozoites from the liver or that it had not been taken as prescribed. Parasite tolerance to this primaquine regimen was undoubtedly responsible for many of these infections because 63 soldiers had another attack of vivax malaria, 14 had a second relapse, and 2 had a third relapse.[11] Most of these soldiers would have received the drug under clinical supervision and, not wanting to experience another attack of malaria, would have been sufficiently motivated to comply with the prescribed primaquine regimen. Although tolerance to primaquine was a problem, many other vivax infections were due to inadequate compliance with the cumbersome primaquine regimen. This highlighted the need for increased preventive medicine and command support to improve drug compliance and for further efforts to develop more user-friendly malaria eradication regimens.

Operation Ausindojaya

In addition to substantial commitments in Bougainville and Timor Leste, AMI participated in Operation Ausindojaya between 11 May and 9 June 1998. As part of Australia's aid to the famine relief program in PNG, Joint Task Force (JTF) 108 was deployed to Wamena, Irian Jaya and played a vital role in the distribution of food to famine stricken villagers. As there was a severe malaria epidemic in some parts of the famine relief area, Major Cooper was deployed with the JTF to determine the malaria risk to its personnel and to provide assistance to District and Provincial Health authorities in the management and future monitoring of malaria in the region. Although field investigations showed that the risk of JTF personnel being exposed to malaria at Wanema was minimal, *Anopheles punctulatus* was prevalent in areas adjacent to the Wamena Valley and malaria was present in over half the villagers. Advice regarding malaria control activities was provided to local health workers and recommendations were made in a report regarding various steps that should be taken to monitor and manage future outbreaks of malaria.

Activities

AMI continued to pursue its mission to ensure that ADF personnel are able to have the best possible protection against malaria. In addition, investigations were initiated to control other vector-borne diseases (VBDs) which were jeopardizing the health of ADF personnel in Australia and overseas. As mentioned previously,[5] many investigations at AMI were carried out in collaboration with other institutions. In broad terms, activities during the 1995-2000 quinquennium were performed under one of the following headings:

1. Drug resistance and diagnostics;
2. Drug development and evaluation;
3. Vector control, biology and geographical distribution;
4. Arboviral disease control;
5. Technical advice and training;
6. Collaboration and engagement with military and civilian organisations.

Figure 2: Mr Joseph Kabui, interim Head of the Bougainville Government, visiting members of the AMI team in Bougainville (March 1999) From left: CPL Michael Reid, MAJ Peter Nasveld, MAJ Robert Cooper, WO2 John Staley, Mr Joseph Kabui, SGT Mac Hartman (Preventive Medicine), SGT Andrew Campbell, LT Bruce Russell, LTCOL Michael Edstein.

Some planned research activities were disrupted during the re-location from Sydney to Brisbane and the assignment of a substantial number of AMI personnel to field activities in Bougainville and Timor Leste. Nevertheless, the overseas deployments provided AMI personnel with the opportunity to acquire otherwise unobtainable information regarding malaria epidemiology and the effectiveness of various antimalarial measures.

1. DRUG RESISTANCE AND DIAGNOSTICS

Previously described *in vitro* tests and bioassays continued to be used to assess parasite resistance to various antimalarial drugs.[4,5] Following the establishment of a molecular parasitology laboratory, various DNA based methods were introduced which provided high sensitivity and throughput for diagnosing malaria infections. DNA fingerprinting to identify different strains of *P falciparum* could now also be used to differentiate between true treatment failures and newly-acquired infections during epidemiological and antimalarial drug studies. Moreover, molecular markers for identifying mutations and/or expressional changes in drug resistant parasites could be used to detect and monitor the development and spread of drug resistance.

Drug resistance in the Solomon Islands

The WHO *in vitro* microtest[12] once again proved useful for determining the 'true' intrinsic drug susceptibility of parasites. The results of the *in vitro* test showed a marked degree of parasite resistance to chloroquine and pyrimethamine plus sulfadoxine, strongly suggesting that these commonly-used drugs would not cure patients with little or no immunity to falciparum malaria. However, parasites were sensitive to quinine, mefloquine and atovaquone, indicating that these drugs would be suitable for treatment/prophylaxis of malaria.

Assessment of *P. falciparum* susceptibility to artemisinin and its derivatives

Artemisinin and its derivatives (artesunate, artemether, dihydroartemisinin) were starting to be used more widely because of their higher potency and faster action compared with other drugs in controlling acute attacks of multidrug-resistant malaria. However, short courses of treatment (<5 days) were not effective in curing these infections. Clearly, further investigations were required to determine the parasite susceptibility and pharmacokinetic properties of this group of antimalarials.

In vitro assessment of parasite susceptibility to various artemisinins showed a very high correlation (r value between 0.97-0.99) between the standard WHO *in vitro* microtest[12] and the radioisotopic technique.[13] Although the radioisotopic technique is a convenient method for processing a large number of samples in well-endowed laboratories, the microtest requires only finger-tip specimens of blood and can be performed in field laboratories having access to a microcope. *In vitro* tests provide information on the intrinsic parasite susceptibility to drugs without having to consider whether recrudescence of parasitaemia after treatment is due to inadequate ingestion/absorption of the medication or simply due to a new infection. As the test is not affected by a patient's degree of immunity acquired during a previous malaria infection, the influence of immunity on treatment outcome (better in immune than non-immune patients) also does not need to be considered.

Prior to adding the artemisinins to the repertoire of drugs used in the *in vitro* test, the stability of the artemisinin compounds in pre-dosed 96-well microplates had to be determined under different environmental conditions. The antimalarial activity of artesunate and dihydroartemisinin (DHA) remained stable during 52 weeks of storage at 4C, whereas artemisinin and artemether showed a significant reduction in activity during prolonged storage. Furthermore, the activity of the first two drugs was reduced only slightly when sealed wells of pre-dosed microplates were used a second time (very common under field conditions) following 48 hours at 37°C with high humidity (as during incubation).[7] Further investigations also revealed that the inhibitory concentrations (IC50 and IC90) of all the artemisinins were higher at 50% serum than 10% serum (usually employed for *in vitro* test).

In vivo assessment of the artemisinins requires the ability to measure serum/plasma drug concentrations after drug administration. As described previously,[5] good progress had been made in developing a sensitive bioassay for this purpose. Similar to other bioassays, this required determination of the inhibitory concentrations of the artemisinin and estimation of the maximum inhibitory dilutions of serum/plasma samples. Since the latter is usually determined when serum concentrations are closer to 50% than 10%, inhibitory concentrations for this bioassay was determined at serum concentrations similar to those present *in vivo*.

In order to validate the value of the bioassay, plasma samples were analysed from patients treated with artesunate. This artemisinin derivative is rapidly and completely hydrolysed to DHA after artesunate administration. In a collaborative project between the University of Western Australia and the Cho Rai

Hospital in Ho Chi Minh City, blood samples had been collected from Vietnamese malaria patients after treatment with artesunate and subjected to chemical analysis. Although specific chemical analysis had been problematical previously, it was now possible to assay the parent compound and its metabolite using a newly-developed High Performance Liquid Chromatographic (HPLC) method.[14] After completing drug analysis in Western Australia, plasma samples were forwarded to AMI for bioassay analysis. Overall, bioassay of artesunate/DHA in plasma correlated very well with HPLC analysis, and the results appeared to indicate that the combined effect of the parent compound and DHA was responsible for the antimalarial activity observed in plasma specimens after artesunate administration.[15] These findings demonstrated once again that the bioassay could be used as a convenient and sensitive means of assessing the antimalarial activity of drugs and any identified or unidentified metabolites which might not be measurable by chemical assays. Since *P. falciparum* can be cultured in basic field laboratories, the bioassay could be used to assist medical personnel in evaluating the response to treatment, either to one of the artemisinins or to a number of other antimalarial drugs.

Molecular markers for chloroquine resistance

With the establishment of a molecular parasitology laboratory at AMI, investigations were carried out to determine whether molecular markers carrying genetic mutations could be used to determine the presence of drug resistance. Using polymerase chain reaction (PCR)-based methods, a chloroquine resistance transporter gene (*pfcrt*) had recently been identified that correlated perfectly with chloroquine resistance phenotype in culture-adapted parasites originating from Southeast Asia, Africa and South America. To validate this candidate marker for chloroquine resistance in the South Pacific region, 33 parasitised blood samples, collected in Bougainville (see above), were analysed at AMI. All parasite isolates determined to be sensitive to chloroquine by the microtest had the wild type *pfcrt*, while all those determined to be resistant had a mutated *pfcrt* or a mixture of wild type and mutated *pfcrt*.[16] The study also showed that 87% of *P. falciparum* parasites were resistant to chloroquine and had mutation patterns that were similar to those observed in chloroquine-resistant parasites from PNG.[16] This PCR-based method, requiring only finger-tip specimens of blood, could thus be used as a convenient surveillance tool for monitoring the prevalence or spread of chloroquine resistance in local communities. However, the degree of chloroquine resistance was likely to be modulated by mechanisms on genetic loci other than just *pfcrt*.[17]

Using PCR-based genotyping, DNA fingerprinting of malaria parasites also made it possible to determine whether parasites recurring after chloroquine treatment were different from those before treatment. If they were different, a recurrence of parasitaemia was obviously due to a new infection and not due to treatment failure of the original infection. During the ADF deployment to Timor Leste, AMI collaborated with the Merlin/WHO Roll Back Malaria group in assessing the response of 48 malaria patients to chloroquine treatment over a period of 4 weeks. Although 32 patients had a recurrence of parasitaemia (uncorrected failure rate of 66.6%), all 48 patients were infected with parasites carrying mutant *pfcrt* gene. Presumably the patients who were cured had a significant degree of partial immunity and/or a low level of resistance to chloroquine. Interestingly, the mutation pattern in Timor Leste parasites was identical to that seen in Bougainville and PNG, indicating a common origin for chloroquine-resistant parasites in these countries.[18] In determining how many of these treatment failures were caused by the original infection, genotyping revealed that re-infection had occurred in only 4 of the patients.[19] With such a poor response to chloroquine treatment, national malaria treatment policy was changed, and pyrimethamine/sulfadoxine replaced chloroquine as standard treatment for uncomplicated falciparum malaria.

Identification of molecular markers for atovaquone resistance

Atovaquone was being increasingly recognised as a potential antimalarial drug, but many treatment failures were observed unless it was combined with other drugs, such as proguanil.[5] Given the widespread interest in the further development of atovaquone, studies were undertaken to elucidate the mechanism by which parasites became resistant to it and to identify molecular markers for atovaquone resistance. After producing 5 atovaquone-resistant parasite lines in the laboratory, a single (M133I) and several double amino acid substitutions (M133I+P275T, M133I+G280D, M133I+K272R and L283I+V284K) were identified in cytochrome *b* of parasites' mitochondrial electron transport chain. In addition, a single amino acid substitution (Y268S) was identified in the cytochrome *b* of parasites obtained from a patient who had failed atovaquone treatment. Significant correlation was observed between these substitutions and *in vitro* susceptibility to atovaquone, with Y268S conferring the highest degree of resistance (>9000-fold increase in IC50 value), followed by L283I+V284K (76-fold increase in the IC50 value).

In order to better understand how these amino acid changes affected atovaquone binding to parasites, a *P. falciparum* cytochrome *b* model was constructed with a view to predicting atovaquone binding site by using molecular modeling technology. These investigations predicted that amino acid changes such as Y286S, M133I and V284K resulted in changes to contact residuals responsible for atovaquone binding to parasite cytochrome *bc*1. This, in turn, reduced the binding of atovaquone to parasites and resulted in resistance to atovaquone.[20] The estimated parasite mutation rate was 1 in $5x10^8$ parasites per generation. Such a high mutation rate explained the rapid development of resistance observed in clinical trials and emphasised the importance of always using atovaquone in combination with other antimalarial drugs. Since then, these mutations and resistant parasite lines have been used as molecular markers for atovaquone resistance and in the development and evaluation of new drugs, respectively.

Non-microscopic malaria diagnosis

Examination of blood films by competent microscopists is the definitive way to establish malaria diagnosis. Because this is not always possible, a novel non- microscopic test was developed by ICT Diagnostics, Sydney. Earlier field evaluation of the ICT Malaria Pf test card had indicated that it could be used as a rapid diagnostic test (RDT) for falciparum malaria when microscopic examination of blood films was impractical.[5] During the field deployments in Bougainville and Timor Leste, another RDT incorporating both *P. falciparum* and *P. vivax* antigens - AMRAD/ICT Pf/Pv test – correlated well with microscopic findings for *P. falciparum* (even at low parasite densities). However, the sensitivity of the test was less than optimum for *P. vivax*, with many infections being missed at densities below 500 parasites/μL of blood. As most primary vivax infections in non-immune individuals present with parasite densities below this level, it was decided to recommend the use of the Pf test card in preference to the Pf/Pv card.

Could the Pf test card, based on detecting *P. falciparum* histidine rich protein 2 - PfHRP2, be used to verify cure of a malaria infection following treatment? This was answered by a soldier who had developed falciparum malaria shortly after returning from the Solomon Islands. Microscopic examination of thick blood films detected no parasites within 3 days after starting treatment with quinine and doxycycline nor in follow-up blood films examined weekly for 4 weeks. However, RDTs remained positive up to 2 weeks after treatment, probably because residual malaria antigen continued to circulate in the blood stream after parasites in red blood cells had been destroyed. Similar findings observed in other patients established the fact that this RDT could not be used to monitor the response to treatment. Conversely, this test might be very useful for confirming a malaria diagnosis in patients who may have been treated presumptively before a definitive diagnosis was able to be established.

In addition to RDTs, novel, highly-sensitive DNA-based methods could now also be used by AMI for estimating the incidence of different malaria species during field surveys. In a collaborative study with AFRIMS, PCR analysis of 230 blood samples from Thai soldiers detected 26 *P. falciparum*, 39 *P. vivax* and 1 *P. malariae* infections. This represented a 100% specificity and sensitivity for *P. falciparum* and a 100% specificity and 89% sensitivity for *P. vivax*, with PCR analysis being accomplished in a fraction of the time required for microscopic examination.[7]

2. DRUG DEVELOPMENT AND EVALUATION

Efforts were continued to ensure that ADF personnel were provided with the best possible protection against malaria. The three most commonly used drugs – doxycycline, primaquine and mefloquine – were not ideal because 1) they all had side-effects that limited or precluded their use by some individuals; 2) the frequency of drug intake and/or duration of prophylaxis did not encourage compliance; 3) malaria parasites were becoming increasingly resistant or tolerant to mefloquine and primaquine. As a possible alternative to doxycycline, further studies were conducted with atovaquone/proguanil

Figure 3: Dr Qin Cheng and MAJGEN Bui Dai during visit to AMI in 1998.

(Malarone®), including a field study in Bougainville. Following earlier investigations with tafenoquine (WR238605; Etaquine),[5] clinical/pharmacological studies were conducted in Thailand, Bougainville and Timor Leste to determine whether this drug might be a suitable replacement for primaquine. In addition, non-clinical investigations were continued with third-generation antifolates, Mannich bases, and artemisinin compounds.

Doxycycline concentrations to validate drug compliance

Since doxycycline was the main prophylactic drug used by the ADF, AMI collaborated with the United States Army Malaria Research Unit (USAMRU) in Kenya to validate drug compliance in 30 volunteers taking 100 mg doxycycline daily for malaria prophylaxis. Analysis of plasma samples for doxycycline revealed mean trough concentrations of 660 ± 339 ng/mL in 26 samples. No measurable doxycycline was detected in the 4 'prophylaxis failures'. These observations provided useful baseline data for monitoring the prophylactic efficacy of doxycycline and confirming drug ingestion.

Atovaquone/proguanil (Malarone®) given in combination with artesunate for malaria treatment

Earlier studies by AMI had provided a good deal of evidence supporting the efficacy of atovaquone/proguanil against falciparum malaria.[5] In May 1998, Malarone® was included in the Australian Register of Therapeutic Goods (ARTG) for the treatment of malaria. In all likelihood, the potential value of this drug combination for treating multidrug-resistant malaria would be increased even further by the addition of an artemisinin derivative as it would enhance rapid clearance of symptoms and prevent/delay the development of parasite resistance. But would there be a drug-drug interaction between artesunate and atovaquone/proguanil? In collaboration with the Wellcome Mahidol University Oxford Tropical Medicine Research Programme in Bangkok, healthy Karen adults on the Thai-Cambodian border participated in a randomised, two-period crossover study during which they received atovaquone/proguanil (1000/400 mg) with or without artesunate (250 mg).[21] The results of this WHO-sponsored study revealed that the triple drug combination was well tolerated and that the pharmacokinetic properties of atovaquone/proguanil and artesunate were comparable to those reported previously for the individual drugs, suggesting a lack of drug-drug interaction.

Atovaquone/proguanil (Malarone®) compared to doxycycline for malaria prophylaxis

In view of the efficacy of atovaquone/proguanil for treating drug-resistant falciparum malaria, could this drug combination also be used as an alternative to doxycycline for malaria protection? This was investigated during the deployment of 148 ADF personnel to Bougainville (see above) when half of them volunteered to receive a daily dose of one tablet of Malarone® (atovaquone 250mg; proguanil 100mg) and the other half, the standard one tablet of doxycycline 100mg.[22] Weekly examination of blood films indicated that both drug regimens suppressed malaria completely. No significant haematological or biochemical changes were observed, and side-effects were comparable and relatively minor in both groups. Gastrointestinal complaints were reported slightly more frequently in the doxycycline group, whereas headaches were more common in the Malarone group. Photosensitivity was reported by only the odd soldier in the doxycycline group. The findings indicated that Malarone® could potentially be used as an alternative to doxycycline for malaria prophylaxis. Health Policy Directive HPD 215 was subsequently amended to reflect the fact that Malarone® could be used as an alternative antimalarial drug for ADF personnel who were intolerant to doxycycline.

Effectiveness of a higher dose of primaquine against vivax malaria

The southwest Pacific area had long been considered to harbour liver stages (hypnozoites) of *P. vivax* that were more difficult to eradicate by standard courses of primaquine (15 mg base/day for 14 days) than in other parts of the world. This led to a higher total daily dose of primaquine – 22.5 mg (7.5 mg thrice a day) - being used for post-exposure prophylaxis.[23] Despite this, an increasing number of soldiers deployed to PNG in 1988[24] and in 1998 (see above) were experiencing relapses of vivax malaria after return to Australia. Following the outbreak of malaria among ADF personnel during the InterFET operation in Timor Leste, 267 vivax malaria cases and relapses were reported to the Central Malaria Register within six months after completion of the operation.[10] Might a higher total daily dose of primaquine 30 mg/day (15 mg twice a day for 14 days), given in combination with a standard course of chloroquine (1500 mg over 3 days), be more effective than primaquine 22.5 mg/day in curing these infections? Retrospective cohort analysis of cases receiving one or other of these treatments indicated a relapse rate of 7% in 71 patients receiving the higher primaquine dose, whereas 47% of 75 patients receiving the lower dose experienced a relapse (RR 6.63; CI 2.75-15.96).[25]

These findings indicated that primaquine-tolerant strains of *P. vivax* were present in Timor Leste and provided further support to the view that higher doses of primaquine should be used for the prevention and cure of vivax malaria.[23]

Potential replacement of primaquine by tafenoquine (also known as Etaquine; WR238605)

Earlier studies with tafenoquine at AMRU had shown it to have greater *in vitro* and *in vivo* antimalarial activity than primaquine.[5] Since this 8-aminoquinoline drug is eliminated from the body much more slowly than primaquine (half-life of 14 days vs 6 hours),[26] patient compliance with taking a short treatment course of tafenoquine for vivax malaria would be expected to be much better than was currently the case with the 14-day primaquine eradication course. Tafenoquine administration at regular intervals might also protect military personnel and travellers against vivax and falciparum malaria during their stay in malarious areas. As it killed gametocytes of *P. falciparum*, tafenoquine might eventually also be used to limit the spread of drug-resistant malaria and to eliminate malaria from epidemiologically isolated communities.[27]

Tafenoquine prophylaxis during deployment to malarious areas

Between April and November 1998, several AMI staff members participated in a joint clinical field trial with Thai and US Components of the Armed Forces Research Institute of Medical Sciences (AFRIMS). The purpose of the trial was to evaluate the effectiveness of tafenoquine in Thai Marine soldiers stationed in a malarious area along the Thai-Cambodian border. Loading doses of 400 mg base tafenoquine daily for 3 days, followed by single monthly doses of 400 mg tafenoquine, were given to over 200 non-glucose 6 phosphate dehydrogenase (G6PD) deficient Thai soldiers for 6 months. This prophylactic regimen was effective in preventing both vivax malaria and multiple-drug resistant falciparum malaria.[28-30] It was also well tolerated, with only mild and transient side effects (headache and diarrhoea) being reported. Using a simple, rapid and accurate HPLC method developed at AMI,[31] plasma tafenoquine concentrations indicated that trough concentrations of 80-100 ng/mL suppressed both vivax and falciparum malaria, whereas concentrations of <40 ng/mL were unable to do so.[32] The findings suggested that tafenoquine needed to be taken only once a month to prevent malaria. Although good compliance with this dosing interval might provide adequate protection against malaria, weekly prophylaxis with lower tafenoquine doses is expected to reduce the risk of 'breakthroughs' from 'missed doses' or of possible adverse drug reactions.

Tafenoquine post-exposure prophylaxis after return from malarious areas

In military personnel returning to a malaria-free area (e.g. Australia), might it be possible to replace the 14-day post-exposure primaquine eradication course with a less cumbersome 3-day course of tafenoquine? This was investigated in 1989/1999 when 592 Australian soldiers volunteered to take either a 14-day primaquine course of 7.5 mg base thrice daily or a 3-day tafenoquine course (400 mg daily or 200 mg twice daily) after the end of their deployment to Bougainville (see above).[33] About 7 hours after the last dose of tafenoquine, their mean plasma tafenoquine concentrations (584ng/mL) were substantially lower (730 ng/mL) than had been observed in the prophylactic study involving Thai soldiers.[32] Apart from Australian soldiers weighing more than Thai Marines (mean body weight 77 kg vs 60 kg), ethnic differences in the metabolic disposition of tafenoquine could also have contributed to these findings. Within 12 months after post-exposure prophylaxis, acute attacks of vivax malaria were observed in 6 of the 214 Australian volunteers who received primaquine and in 7 of the 378 volunteers who received tafenoquine.[33] Mean plasma tafenoquine concentrations were comparable in soldiers who developed and did not develop malaria. Relatively more gastrointestinal disturbances, such as nausea and abdominal cramps, were observed in the tafenoquine groups (single or split dose) than in the primaquine group, and these symptoms tended to be more common in female volunteers than in their male counterparts. However, these adverse events were transient in nature and generally not sufficiently troubling to interfere with performance of daily activities.

The deployment of the ADF to Timor Leste (see above), commencing in September 1999, provided a further opportunity to assess the value of tafenoquine in another area with falciparum and vivax malaria. Volunteers from the Third Battalion, Royal Australian Regiment preparing to return to Australia following InterFET service in February 2000, were randomly allocated to receive a 3-day tafenoquine course (either 400mg or 200mg daily) or the standard 14-day primaquine course. As observed in Bougainville, comparable episodes of vivax malaria were documented over the ensuing 12 months in the 3 groups of volunteers.[34] Soldiers preferred the 3-day tafenoquine course to the longer 14-day primaquine course. In an unsupervised setting, this shorter post-exposure prophylaxis would have the advantage of improving drug compliance, thereby reducing the

number of vivax infections after return to Australia. In contrast to the lengthy primaquine course, it might be operationally feasible to administer the short tafenoquine course under direct supervision before the departure of personnel from a malarious area, with an even better outcome for returning ADF personnel.

Search for alternative third-generation antifolate compounds

After demonstrating the remarkable antimalarial activity of PS-15 and its metabolite - WR99210,[5] further studies were carried out to identify other possible antimalarial agents in this class of third-generation antifolate compounds.[35] Results obtained after administration of 4 analogues to *Saimiri sciureus* monkeys showed that their *ex vivo* antimalarial activities were similar or lower than those observed with PS-15. When the *in vitro* antimalarial activities of 26 analogues of WR99210 were compared with one another, 11 of them were slightly more active than WR99210, 8 were slightly less active, and 2 showed very poor activity. These findings indicated that alternative antifolate compounds were available as possible candidates for further development.

Influence of parasite stages and densities on activity of Mannich base compounds

Earlier *in vitro* and *ex vivo* antimalarial studies with various Mannich bases had indicated that these compounds had greater antimalarial activity than standard antimalarials such as chloroquine, amodiaquine and pyronaridine.[5,36] Further observations highlighted the importance of parasite developmental stages and parasite densities when assessing the *in vitro* activity of antimalarial drugs.[7]

Using tightly synchronised *in vitro* cultures, the blood stage-specific sensitivity of drug-resistant parasites to four of the most potent quinoline Mannich bases changed markedly during parasite maturation, with the highest inhibitory effect being observed against young ring stages. Asynchronous cultures, in which the proportion of different parasite stages varied at the start of culture, not only yielded variable results from one experiment to another, but also failed to provide vital information regarding selective drug action against different parasite stages. In view of the stage-specific sensitivity of Mannich bases, combining them with companion drugs having different blood stage sensitivity patterns might improve the treatment response and delay the onset of drug resistance.

The *in vitro* studies also showed that increased concentrations of normal and infected erythrocytes were associated with a reduction in parasite growth and that the inhibitory effects of Mannich bases (including amodiaquine and pyronaridine) were reduced at higher parasite densities. These findings indicated that (a) *in vitro* concentrations of normal and infected erythrocytes must be carefully controlled during further studies with Mannich base compounds; (b) increased drug activity at lower parasite densities may be related to selective concentration in parasitized cells by this group of antimalarials; (c) malaria patients may respond poorly to standard chemotherapy due to elevated parasite densities and not due to suboptimum drug concentrations or drug-resistant parasites.

Artemisone - a new artemisinin compound

The artemisinin compounds were becoming increasingly important in countering the global threat of multidrug-resistant malaria (see above).[5] However, there was some concern about the safety of these compounds because some artemisinins, particularly DHA, had exhibited neurotoxicity in animal models. In the meantime, a new semi-synthetic more water soluble artemisinin compound – artemisone – had been synthesised which displayed low lipophilicity and negligible neuro- and cyto-toxicity in *in vitro* and *in vivo* assays.[37] With the support of Medicines for Malaria Venture (MMV), Switzerland, and Bayer AG, Germany, *in vitro* studies at AMI during 1999 showed that artemisone was more active than artesunate against a number of multidrug-resistant strains of *P. falciparum*. These studies were followed up by oral administration of a single dose of 30mg/kg of artemisone or artesunate to non-infected *Saimiri sciureus* monkeys, the collection of blood samples over a period of 6 hours, and determining the *ex vivo* serum activity[5] of both compounds against drug-resistant isolates of *P. falciparum in vitro*. The results clearly indicated that the efficacy and duration of activity was significantly greater for artemisone than for artesunate.[37] These findings suggested that further studies should be carried out to determine the efficacy of artemisone in *Aotus griseimembra* monkeys infected with drug-resistant *P. falciparum* malaria.

3. VECTOR CONTROL, BIOLOGY AND GEOGRAPHICAL DISTRIBUTION

Insect repellents

Deet (diethylmethylbenzamide; diethyltoluamide), first released in 1954, soon became the main chemical component in topical applications used to repel biting insects. Although Deet preparations were quite effective, efforts were continued to improve personal protection measures for soldiers in the field.[4] Previous collaborative studies with

AFRIMS in Thailand had indicated that two novel chemicals – the piperidine AI3-37220 and the lactone CIC-4 – were equivalent or superior to Deet against anopheline mosquitoes. Following the return of Major Frances to Australia in 1995, further tests were carried out to compare the effectiveness of these repellents against *Anopheles farauti*, the main malaria vector in Australia and the southwest Pacific region. In laboratory tests with insectary-reared mosquitoes, all three repellents exhibited activity, with AI3-37220 being slightly less protective than the other two repellents. Since results obtained in the laboratory may differ from those subsequently observed in the field, tests were conducted at Brown Range, Cowley Beach Training Area, northern Queensland during 1996. At a concentration of 25% (in ethanol), Deet and CIC-4 provided substantial protection against *An. farauti* for 7 hours after skin application, and AI3-37220 continued to provide greater than 95% protection up to the last observation at 9 hours. As observed in Thailand, AI3-37220 showed greater protection when tested under field conditions, highlighting the importance of assessing repellent efficacy in volunteers exposed to natural populations of mosquitoes.[38] Additional tests, conducted in the Morobe and Central Provinces of PNG during Operation Anopheles 1998, showed repellents provided a greater than 95% protection for only 3 hours. This was probably due to the very high anopheline densities encountered in these areas. Furthermore, unlike earlier studies in Thailand and Australia, AI3-37220 was not uniformly more effective than the other two repellents.[39-41] In summary, these studies showed that these repellents were generally not superior to the standard ADF repellent formulation, containing 35% Deet in a gel, which was introduced in 1992.[42]

Self-erecting, low profile bednet

The effectiveness of a new self-erecting, low profile bednet was assessed in March 1999 during the ADF deployment to Bougainville. The primary aim of the study was to compare the effectiveness of this US Army prototype bednet with the current ADF bednet and to assess permethrin impregnation under field conditions. The prototype net was more effective in preventing the entry of mosquitoes during the night because, unlike the ADF net, it has a taffeta floor with a zippered opening on the side. After impregnation with permethrin, both types of nets provided >97% protection, although some mosquitoes were able to obtain a blood meal biting through the nets.[43]

Distribution and speciation of anopheline mosquitoes in Papua New Guinea (1996-1999)

Studies on the identification, distribution and speciation of malaria vectors in PNG, started in1992,[5] were continued during this quinquennium. Jointly conducted with the PNG Defence Force, Operation Anopheles was extended to Morobe

Table. Anopheles species collected in Papua New Guinea and their vector status

Species	Distribution and abundance	Vector status	No. positive for CS protein/no. tested
Anopheles koliensis	widespread/common	major	41/8600
Anopheles punctulatus	widespread/common	major	3/245
Anopheles farauti	widespread/common	major	41/9692
Anopheles farauti 2	widespread/common	major	10/1189
Anopheles farauti 4	limited/common	major	15/1535
Anopheles longirostris	widespread/uncommon	minor	62/793
Anopheles farauti 8	limited/uncommon	minor	2/308
Anopheles bancroftii	widespread/uncommon	minor	1/476
Anopheles farauti 6	limited/common >1500m	minor	0/180
Anopheles subpictus s.l.	limited/uncommon	minor	0/116
Anopheles karwari	limited/uncommon	minor	0/13
Anopheles meraukensis	limited/uncommon	none	0
Anopheles novaguinensis	limited/uncommon	none	0
Anopheles farauti 3	limited/uncommon	none	0
Anopheles sp near punctulatus	limited/uncommon	none	0

Province (1996), Central Province (1997), Gulf, Milne Bay and Northern Provinces (1998). These activities were supported by rotary wing aircraft from 162 Reconnaissance Squadron and fixed wing aircraft from 173 Surveillance Squadron. Information obtained from these surveys would enhance our knowledge of the epidemiology of malaria in PNG and assist in its control.

During these operations, over 25,000 anopheline specimens were collected from larval breeding sites, CO2-baited light traps and adult biting catches. By using morphological and DNA techniques,[4] 18 anopheline species were identified from these collections (Table).[44-47] In addition, specimens were examined for their vectorial capacity by employing species-specific monoclonal antibodies and ELISA to detect circumsporozoite (CS) protein of human malaria parasites.[48] Based on field observations on the distribution and abundance of these species, and their ability to develop human malaria parasites, 5 species were considered to be major vectors of malaria, 7 minor vectors of malaria, while 7 were considered as unimportant with regards to malaria transmission (Table).[48] *An. farauti* 2 and *An. farauti* 8 (a newly recognised species) were both incriminated here for the first time as malaria vectors.

Further entomological investigations were carried out in PNG during 1999 in 90 different sites located in Buka Island, and the Arawa/Kieta and Tonu areas of Bougainville. Preliminary observations revealed both *An. farauti* and *An. farauti* 2 to be present on the main island of Bougainville whereas *An. punctulatus* could only be found on Buka Island.[49] The apparent absence of *An. punctulatus* in typical breeding sites around Tonu was surprising, given its proximity to the Solomon Islands were *An. punctulatus* was found to be quite common. The other interesting finding was that *An. farauti* 2 was not observed biting humans on Buka and Bougainville Island, despite the abundance of its larval stages on Buka Island.[49] This suggested that this species may play no role in malaria transmission on this island which is in marked contrast to previous observations on this species in PNG.[48] *An. koliensis*, a common malaria vector in PNG, was not observed during the survey. It was reported to be present the last time a comprehensive survey of Buka Island was carried out in 1960, and its absence 40 years later could possibly be due to the widespread spraying of residual insecticides during the early 1960s.

In 1998 an anopheline faunal survey was conducted on the north coast of Guadalcanal in the Solomon Islands. Although this region has the highest malaria transmission rates in the country, the identity and distribution of the anopheles species was poorly understood. *An. farauti* was the most widespread and abundant species in the area, with *An. farauti* 2 and *An. farauti* 7 being commonly collected as larvae but not found biting humans and unlikely to play a role in malaria transmission. Similar findings were made for *An. farauti* 2 on Buka and Bougainville Islands which lie in the same archipelago. Unlike the findings on Bougainville, *An. punctulatus* was fairly common in the inland coastal plain of Guadalcanal.[50]

Commencing in 1997, material collected from PNG and earlier surveys in northern Australia[4,5] was examined using a range of molecular tools made available as a result of recent advances in DNA-based technologies. In collaboration with Dr Nigel Beebe of the University of Technology, Sydney, both internal transcribed spacer regions (ITS2 and ITS1) of the ribosomal DNA gene were characterised and found to be suitable for studying the inter-phylogenetic relationships of these species and their population genetics.[51-55] This work revealed that several genotypes within the *An. farauti* taxon occur in discrete isolated independently evolving populations separated by overt physical and climatic barriers, such as the mountains of the Central Range in PNG, the arid region of the Gulf of Carpentaria and the sea gaps between PNG and the Solomon Islands.[52,56] Several genotypes also exist within the *An. farauti* 2 taxon; of epidemiological interest is the fact that the genotype which occurs in mainland PNG (and is a vector of malaria feeding on humans) is different from the one found in Buka, Bougainville and the Solomon Islands which does not feed on humans.[53] Molecular analysis of the ITS2 and ITS1 regions of *An. bancroftii* and *An. longirostris*, both of which are minor malaria vectors in PNG, revealed four cryptic species in the *An. bancroftii* taxon occupying discrete areas across northern Australia and PNG, and 9 cryptic species in the *An. longirostris* taxon spread across PNG.[57,58]

4. ARBOVIRAL DISEASES

Ross River virus and Barmah Forest virus

In 1995 several ADF personnel developed Ross River (RR) and Barmah Forest (BF) virus infections during Exercise Ready Soldier at the Shoalwater Bay Training Area (SWBTA) in Queensland. The following year there were further infections in both Australian and US soldiers following Exercise Tandem Thrust at SWBTA. Moreover, the likelihood of soldiers being exposed to these viruses was highlighted in the Environmental Impact Statement on the recently-established Bradshaw Training Area in the Northern Territory. In view of these threats to the health of ADF and other personnel, Brigadier Paul Buckley, the Director General of Defence Health Services

(DGDHS), encouraged AMI to conduct investigations relating to the epidemiology and control of mosquito-borne infections not transmitted by anopheline mosquitoes.

In March 1998 a longitudinal mosquito survey of the SWBTA was started to assess the potential threat of arboviruses to the combat readiness and efficiency of ADF personnel. With the logistical support and technical assistance of 4th Preventive Medicine Company, the main aim of the survey was to monitor the distribution, seasonal prevalence, densities and larval habitats of mosquito vectors and determine the activity of RR and BF viruses. This information would clarify the current and potential threats to the health of ADF personnel and enable the implementation of effective and sustainable control measures. Monthly collections from 15 sites for 2 years revealed that the predominant species were the saltmarsh mosquitoes *Aedes vigilax* (36%), *Culex sitiens* (17%) and the freshwater species *Culex annulirostris* (30%). After homogenising 1350 lots of mosquitoes (25 mosquitoes per lot, pooled by species and sex), each lot was screened for the presence of the RNA of RR and BF viruses using a highly sensitive and specific PCR technique established and optimised at AMI. With the ability to detect a single virus-infected mosquito per lot, a number of *Ae. vigilax* lots were found to be positive for RR virus.[59,60]

The importance of RR virus at SWBTA was documented during 1999 when 3 out of 169 mixed military and civilian personnel developed a debilitating illness and were IgM positive for RR virus after participating in a 10-day exercise. Subsequent investigations highlighted various problems in obtaining meaningful information about the local epidemiology of RR virus disease. Single serum specimens for IgG and IgM analysis proved to be of limited value, and it drew attention to the importance of collecting specimens both during the acute and convalescent phases of the illness. Only by instituting this procedure for all symptomatic cases reported during post-exercise surveillance would it be possible to identify the RR virus disease risks of training in this area.[61]

Dengue virus

Dengue is an important mosquito-transmitted infection prevalent in areas to the north of Australia, such as Timor Leste. During the period of the INTERFET Operation from September 1999 to February 2000, AMI confirmed 160 cases of dengue among ADF personnel.[62] The outbreak peaked in January 2000, with the risk of exposure to the virus being particularly high in the area around the Dili airfield. Although the likelihood of acquiring dengue was increased by the proximity of internally displaced (and infected) local people to ADF personnel, the epidemic could have been prevented by better application of personal protection (bednet usage, etc.) and vector control measures.

All 4 serotypes of dengue were identified, but serotype 3 was responsible for most of the infections. During its serosurveillance studies AMI successfully field-tested a new IgM ELISA card. Most ADF personnel were found to have no immunity to dengue before their deployment to Timor Leste, despite many of them having undergone prior training in dengue-endemic north Queensland. In the minority of soldiers with some pre-existing immunity acquired after a previous dengue infection, there was of course always the risk that some of them might experience serious clinical complications following exposure to a different serotype of the virus.[63]

Medical personnel were also aware of the possibility that soldiers returning to northern Australia might introduce the dengue virus into the local population of *Aedes spp.* – an efficient mosquito vector of the dengue virus. In 2000, AMI successfully managed virus containment when 9 soldiers infected with dengue serotypes 2 and 3 were medically evacuated to Lavarack Barracks, Townsville.[64] No cases of dengue were reported during the four months following their arrival in Townsville.

In addition to defining the epidemiology and managing the outbreak of dengue, work began on identifying potential vaccine candidates. AMI's involvement in the Australian development of quadrivalent dengue vaccine candidates was facilitated by its close collaboration with the US component of AFRIMS, Bangkok, and Aventis Pasteur.

Japanese encephalitis

Mosquito-borne Japanese encephalitis (JE) is the leading cause of viral encephalitis in Asia, but there has been a progressive eastward movement of the virus crossing the Wallace line into the Western Province of PNG. It was first reported in the Torres Strait islands in 1995 and then in the mainland of Australia in 1998. Due to the shortage and cost of JE vaccine (Biken) in Australia, the first of a series of studies was undertaken in 1998 using one tenth or one fifth the volume of the vaccine administered intradermally.[65] As preparations for deployment to East Timor escalated in 1999, the high cost of the limited supply of [then] CSL JE vaccine consumed half the ADF vaccine budget. A second proof of concept study was conducted in 2000 comparing the safety and efficacy of subcutaneous and intradermal vaccination in soldiers of the Sixth Battalion RAR.[66] This confirmed the dual intradermal method of

vaccination (0.1 ml in two injections) to be effective and well tolerated. By using less vaccine, it was possible to extend the vaccine stockpile life. The requirement for a replacement JE vaccine was to become a key research interest of the Institute during the next 5 years.

5. TECHNICAL ADVICE AND TRAINING

AMI provided the DGDHS with information regarding the latest laboratory, clinical and field investigations to assist his staff in updating health strategies and policies to prevent/treat malaria and other VBDs. Various publications and instructions on malaria and other VBDs were drafted and reviewed by AMI staff, such as Health Policy Directive 215 on Malaria and ADFP 705, Pesticides Manual guidelines for the use of Deet and permethrin by the ADF. As might be expected, health personnel at various command levels frequently (often several times a week) sought advice regarding personal protection measures, prophylaxis and treatment. In addition, AMI assisted ADF personnel in PNG and the Solomon Islands when problems arose regarding correct diagnosis and appropriate treatment of malaria.

AMI continued to conduct several malaria training courses for ADF personnel in laboratory and field methods and procedures. It also continued to train foreign military and civilian health personnel in malaria and other VBDs. Sponsored by IPDiv, WHO or AusAID, more than a dozen professional and technical personnel spent between 1 to 6 months at AMI; many of them subsequently occupied leading positions in PNG, Solomon Islands, Thailand, Vanuatu and Vietnam.

6. COLLABORATION AND ENGAGEMENT WITH MILITARY AND CIVILIAN ORGANISATIONS

Collaboration with military and civilian organisations, both in Australia and overseas, continued to be promoted during this quinquennium. This was considered to be the most efficient way to successfully develop and evaluate effective measures and tools to control malaria and other VBDs in the ADF. Apart from advantages derived from being a WHO Collaborating Centre for Malaria, AMI benefited from its association with many institutions identified previously.[5] Additional institutions with whom collaboration was established during this quinquennium included the University of Queensland, the Queensland Institute of Medical Research, the University of Technology Sydney, the University of Western Australia, the Papua New Guinea Defence Force, Bayer AG, Germany, and the Secretariat of the Pacific Community.

Further research activities were also being planned in collaboration with Vietnam. As early as 1986, the Australian Development Assistance Bureau (ADAB) had sponsored Professor Rieckmann as WHO Malaria Consultant to Vietnam to review the current malaria situation and identify potential areas of cooperation in field research, particularly with regard to drug-resistant malaria. Subsequent visits by various teams, including AMRU staff members, led to the establishment of the Vietnam Malaria Control Project in 1994. This project was funded by the Australian International Development Assistance Bureau (AIDAB) which replaced ADAB and subsequently became AusAID in 1995. Although information about various aspects of the epidemiology and control of malaria was mutually beneficial to Vietnamese public health research personnel and AMI, only relatively minor cooperative research projects were established.

In September 1991, Professor Bui Dai, a malaria specialist from Vietnam in the Ministries of Health and Defence, had visited AMRU for 2 weeks on a WHO Fellowship. Further consultation between him and Professor Rieckmann eventually led to a proposal for cooperative studies on malaria between the Vietnam People's Army (VPA) and the ADF. In April 1996, ministerial endorsement for the proposal was obtained by the International Policy Division (IPDiv) of the Department of Defence. After further planning and consultation, an official invitation was received by IPDiv from the Ministry of Defence in Hanoi to discuss possible collaborative activities on malaria of mutual interest to both armies.

In March 1998, Professor Rieckmann and Lieutenant Colonel Edstein had a series of meetings with senior medical personnel led by Major General (Professor) Bui Dai. They also included a meeting with the Vice Minister for Defence who expressed the view that cooperation in the field of medicine was an effective way of initiating a defence relationship between Vietnam and Australia. At the conclusion of the 4-day visit, the Australian Embassy commented that "The visit by the Australian delegation has successfully achieved real progress for the first time in our efforts to enhance direct cooperation between the defence forces of Australia and Vietnam". Following several meetings of a joint steering committee in Vietnam and Australia, a Memorandum of Understanding (MoU) was signed in Hanoi on 22 March 2000 for a 5-year collaborative project on malaria control – the Vietnam Australia Defence Malaria Project (VADMP). Funded by IPDiv, its main purpose was to improve malaria control measures in the military forces of both countries through various training and research activities.

Figure 4: The Vietnam Australia Defence Malaria Project initiated at Hanoi on 22 March 2000 by signing of Memorandum of Understanding between MAJGEN Nguen Van Thuong (Director of Military Medicine,Vietnam People's Army) and BRIG Wayne Ramsey (Director General Defence Health Services, Australian Defence Force).

Conclusions

The first half of the fourth decade (1995-2000) was characterised by many significant events and achievements which included:

1) Re-location of the Army Malaria Research Unit from Sydney to Brisbane and its re-designation as the Australian Army Malaria Institute (AMI).
2) Establishment of a molecular parasitology laboratory at AMI to address issues relating to drug resistance, including identification of a molecular marker for parasite resistance to atovaquone, a new antimalarial drug.
3) Deployment of AMI field teams to monitor local malaria situations and to assess effectiveness of various antimalarial measures during large-scale ADF peace-keeping operations in Bougainville and Timor Leste.
4) Demonstration of the continuing efficacy of doxycycline for malaria prevention and of the potential value of atovaquone/proguanil (Malarone®) for back-up prophylaxis during deployment to malarious areas.
5) Field investigations with tafenoquine indicating that it might not only replace primaquine to prevent vivax malaria after return to Australia but also be used for prophylaxis while in malaria-endemic areas.
6) Further laboratory-based evidence of the potential value of Mannich bases, artemisinins, and third-generation antifolate compounds for treatment/prevention of drug-resistant malaria.
7) Completion of mosquito surveys in PNG, with ongoing analysis of population genetics using DNA-based technology.
8) Commencement of investigations to provide better protection of ADF personnel against arboviral infections.
9) Consolidation and extension of collaboration with other institutions to maximise AMI achievements.
10) Initiation of the Vietnam Australia Defence Malaria Project.

Highlights

1996

- Standardisation of *in vitro* assays to determine susceptibility of *P. falciparum* to the artemisinins
- Several third-generation antifolates active *in vitro* and *ex vivo* against multidrug- resistant falciparum malaria
- Activity of Mannich base compounds greater against ring stages and lower densities of *P. falciparum*
- Non-microscopic rapid diagnostic test (based on PfHRP2) unsuitable for monitoring drug resistance
- Two new skin repellents not uniformly more effective than Deet for mosquito protection
- Mosquito survey in Morobe Province, PNG

1997

- AMI re-located from Sydney to purpose-built facility at Enoggera Barracks, Brisbane.
- Lieutenant Colonel Michael Edstein appointed as Commanding Officer following retirement of Lieutenant Colonel Tony Sweeney.
- Major (Dr) Peter Nasveld joins AMI as team leader for clinical studies
- Atovaquone / proguanil (Malarone®) pharmacokinetics not altered by administration of artesunate
- Mosquito survey in Central Province, PNG

1998

- Dr Qin Cheng joins AMI and establishes molecular parasitology laboratory
- Monthly doses of tafenoquine protect against malaria in Thailand
- AMI field team deployed to Bougainville Province, PNG
- Major (Dr) Scott Kitchener joins clinical studies team
- Non-microscopic test more useful for diagnosis of *P. falciparum* than *P. vivax*
- Molecular markers and DNA fingerprinting used to assess chloroquine resistance
- Bioassay used successfully to determine pharmacokinetics of artesunate
- Mosquito surveys in Gulf, Northern and Milne Bay Provinces, PNG

1999

- Atovaquone/proguanil (Malarone®) prophylaxis as effective as doxycycline in Bougainville, PNG
- Molecular markers identified for atovaquone resistance
- Tafenoquine post-exposure prophylaxis at least as effective as primaquine in Bougainville, PNG
- Artemisone, a new artemisinin compound, has greater *ex vivo* activity than artesunate
- Prototype of a low-profile, self-erecting bednet more effective than ADF bednet
- Mosquito survey in Bougainville Province, PNG

2000

- AMI field team deployed to Timor Leste to carry out risk assessment of VBDs
- Doxycycline prophylaxis prevents large-scale outbreak of malaria in Timor Leste
- Tafenoquine 3-day course preferred to 14-day primaquine eradication course in Timor Leste
- Vietnam Australia Defence Malaria Project established

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The Evolution and Role Changes of The Australian Military Medic: A Review of The Literature

Kristina Griffin

Abstract

Many ancient armies tried to reduce morbidity and mortality on the battlefield through the provision of first aid, the objective of this aid being to prevent further injury and relieve pain until medical help arrived, with the foundation of organised and trained first aid having its origins in this military environment[1]. The most successful were the Romans, under Emperor Augustus (63BC-18AD), who developed advanced military medical services to support their legions[2]. Included in these services were bandagers called Capsarii. These men, who wore the same combat gear as their fellow soldiers, were essentially combat medics, effective in providing prompt first aid due to their positioning in battle. Thus the origin of military combat medics, known also as medical technicians or medical assistants, begins[3].

These soldiers, also known as milites medici, had additional training in the art of medicine and were exempt from other duties as their priority was the care of the wounded and sick both on the march and in temporary hospitals[2]. The tradition stands true today with the military combat medic who goes into battle alongside soldiers of their company aiming to stabilise, give comfort and help evacuate[4]. The availability of persons skilled in the treatment of wounds improves the morale of fighting men, giving rise to a more efficient and motivated fighting force[2], thus the tradition of the military medics begins and continues today.

Key Words: Combat military medic, medical technicians, medical assistants, roles, history

Introduction

This paper, through a review of the literature, searches the history of the combat military medical assistant (medic). It seeks to trace the origins of this specialised branch of military service to determine what is known about the history of this corps and how its development and training has been adapted, and continues to adapt, to meet the medical needs of a constantly evolving Defence Forces both in Australia and overseas. It will also highlight gaps in this knowledge and how, by a better understanding the history of the health services in the Australian Defence Force (ADF), plans for future development of medical services can be made. To ignore history is "to risk errors based on ignorance of mistakes already made and solutions already devised"[5].

It becomes apparent that the development of the role of the military medic has varied greatly with the needs of the Defence Force in times of war and peace and the focus of government[6]. In war approximately 90% of combat deaths occur on the battlefield, forward of any type of aid station, thus medics must be ready to render care at a moment's notice as they are the medical corps first responders[6]. Their role is to maintain combat readiness and preserve manpower, bolstering morale and helping troops face danger whilst having a military focused tactical role in preventing deaths that could undermine support for a campaign[7]. As such they assume two sets of responsibilities: one to an organisation designed to inflict casualties, the other to a profession focused on prevention and alleviation of suffering[7], causing in some individuals conflicting feelings regarding their role as a soldier medic[8]. There is conflict at times as to which responsibility is paramount.

Roles and Responsibilities

The role of the medic in times of war is a unique one for whilst they are a part of the company with whom they enter fields of war, they are, as health care providers, non-combatant according to the Geneva convention of 1949 and as such must not carry weapons except for small arms to be used in self-defence and defence of patients[9]. This dichotomy between the caring, healing role and membership in an organisation associated with conflict can be challenging[8,10]. This is especially evident in conflicts that have both a peacekeeping and humanitarian aid role.

Whilst the primary care role of the military medic is the provision of medical support to Defence Force members to preserve the fighting force[11], the

concomitant difficulties of also providing medical care to civilian populations in places where civil infrastructure has broken down creates tension between the primary military mission and medical duty of care, especially when subject to resource and capability constraints[12]. These tensions are mentioned in various sources, but what training or strategies used to overcome them is not outlined in the literature. There is conflict in the reviewed literature as to how this symbiotic role of carer and warrior is managed, with only one study by Griffiths and Jasper[10] delving into how the challenges of this dual role are handled by those attempting this integration.

According to Butler[13], sourced from the Australian War Memorial, military medical services in Australia have existed since the arrival of the first colonists in 1788, initially formed by drafts of British troops, then establishing in New South Wales in 1888 the first official medical staff corps, a voluntary group. It is from this group that permanent members of the corps were recruited, these services evolving differently in each colony and varying considerably in pay, conditions of service and responsibilities. Commandant reports from 1901 make reference to the recruitment of combatant regimental stretcher bearers during this time. These men trained in stretcher drill and first aid are considered to be the origins of the current military medical assistant[2]. In the United States the modern combat medic trace their origins back to the American Civil War when in 1887 the Hospital Corps were developed with enlisted soldiers serving as hospital stewards[8,14].

Training

There is a gap in available literature with minimal reference to military medics from this date until the Second World War. Reference is made both to stretcher bearers, who removed wounded men from conflict, and orderlies, who assisted in the field hospitals with basic hygiene and cleaning tasks with neither group receiving what would be considered medical training[15]. The Second World War saw the implementation of basic training courses for Australian hospital orderlies, but much of their training occurred "on the job" and was provided by registered nurses[15] and it appears that it is around this time that the term medic appears. Walker[16] refers to difficulties of training hospital orderlies under wartime conditions that required rapid expansion of medical services and, whilst it was acknowledged that nurses could help with the training, this took them away from their primary role of providing a high standard of nursing care to troops. To solve this, tutor sisters were appointed to set up on-site training of nursing orderlies during campaigns in World War 2 to overcome the documented knowledge and training deficits of orderlies, or medics, sent to work in these environments[16].

Whilst this need for pre-hospital care by trained military personnel was recognised both in World War 1 and World War 2, the vital role played by military medics in saving lives did not become truly apparent until the Vietnam War[8,17]. According to Tyquin[15] the most challenging issue in the development of the military medic's role has been the training inconsistencies that have failed to prepare them for war-time demands.

The build-up of forces in Vietnam during the late 1960s required considerable medical support[18], but the training format of the time consisted of too much advanced theory without basis to build up practical knowledge and no casualty training. This meant that the medics were not meeting the needs of these forces[15] and resulted in medics arriving in Vietnam having to be "trained up" in emergency and evacuation medicine in the field before they could adequately support the allied forces. These deficiencies in training programs[15,19] resulted in a deficit in medical support for fighting troops[1].

This, in turn, led to an overhaul of the role of the military medic and their training emphasis which remains relevant today. Combat medics were incorporated into fighting units, administering immediate medical care in the field whilst under fire[19]. This immediacy of care is vital in saving lives as it became apparent that in modern day warfare the most common cause of death is haemorrhage and that survival is dependent upon appropriate first aid provision in the first five minutes[20]. As emergence of the understanding of the critical link between the timing of casualty evacuation and mortality rates occurred, with aero medical evacuation first used in the Vietnam conflict being one of the most significant developments in 20th Century military medicine[19], training in this speciality became a vital component of the medic program[1,20].

Thus the reality of multi-faceted training requirements for the role of military medics that included not only emergency care but also treatment under hostile fire, extreme environments, resource limitations and casualty transportation issues as well as in hospital care created a dilemma for education program development[8] and a re-examination of the training of combat medics[21,22].

One recent examination of the training requirements, role and responsibilities of Australian military medics came about in 1997, with the Australian National Office Performance Audit of the Defence Health Services examining the full range of health service

support and identifying areas for improvement in efficiency and management[23]. The result, according to Gill , is the battlefield medic having more complete training and emergency care capability than ever before, culminating in "the best trained Army medics the ADF has ever had"[24] with training across all services designed to meet capability requirements both overseas and in Australia.

For this to occur, and be maintained, the ADF has implemented dual strategies. Since 1988, military medics had lost any civilian accreditation standing for their qualifications as their training was not considered sufficient by any Australian nursing board[15]. To ensure maintenance of competency standards training and accreditation of military medics to the level of an Endorsed Enrolled Nurse, as per the Australian Nursing and Midwifery Accreditation Council, training is now done with a combination of in-house courses and through programs run by external accredited educational institutions[25]. This linkage with external agencies and accreditation bodies ensures skills proficiency is maintained through yearly accreditation processes as well as standardisation of training programs[26]. This standardisation and linkage is vital in basic skills development of military medics, but it does not give the medic the trauma experience of looking after critically injured patients that is required during overseas operations[27].

However, the emphasis on civil accreditation of the military medic is felt, by some, to have taken their training away from the vital war-time role of the medic in an attempt to adapt training of military personnel to meet civilian accreditation standards[19]. Whilst these training standards are well suited to the medics peacetime role of working in Defence hospitals and clinics providing medical care to Defence personnel[25], it does not prepare them to take care of critically ill patients or expose them to multi-trauma situations[27]. Reports dating back to the 1880's detail the importance of a military component of the training of a medic, but relevant medical training up to civilian standards is vital in their training regime to ensure adequate preparation for their complex role[15]. To overcome perceived deficits in training and to help bridge the gap between peacetime medic and combat medic, the use of medical simulation training environments[28] has now been introduced.

Training of military personnel to manage military casualties is difficult, as opportunities for medical teams to obtain realistic trauma experience is limited when traditional methods of training are perceived to lack realism[29] and the type of ballistic injuries and penetrating trauma injury experienced in operational activity differs greatly from that found in Australian emergency environments[7,25]. To overcome this, the use of full-scale simulation environments are recognised as enhancing the quality of training[29] together with the ability to create team-based realistic battlefield scenarios which have been proven to provide specialist health teams with a chance to practice their skills[28]. These scenarios become a vital part of training to prepare medics to make fast, accurate lifesaving decisions under severe stress and threat of gunfire in hostile conditions[30].

Evolution

The literature found and reviewed demonstrates how the role and scope of practice of the military medic continues to evolve and change. According to Tyquin[15] this evolution is influenced by changes in Government focus and funding and the never-ending array of reviews, reports, and policy shifts that these changes create. As Defence's strategic focus and objectives are redefined and economic pressure is felt, corps such as medical with high cost technology and consumables come under budget driven pressure to be cost effective[24]. This becomes almost impossible in an environment where the competing needs of peacekeeping, humanitarian missions and beneficiary care places great demands on the military medical system and requires training and support to be provided to ensure the military medic is as well trained and experienced as possible[26].

Conclusion

This paper focuses on a review of the literature that traces the transformation from the stretcher bearer of the 1900s to the highly qualified 21st century military medical assistant, or medic, and how this literature demonstrates that this evolution has occurred to meet the needs of the Defence Force but has been impacted by policy change and funding constraints. It focuses largely on this role as it pertains to the Australian Army, but also includes reference to both British and American corps due to the limited availability of information. Much of the literature reviewed is sourced from military journals as these are the only available sources of information, other than a limited number of books, on the selected topic.

The demonstration in the literature of role adaptation and development of the military medic identifies and helps to understand the history of health services in the Australian Defence Force, and the future path of this Australia-wide health service. Whilst history is often considered merely a narrative of past events, the purpose of history is to explain reasons and links between events, not only to record their sequence, in an attempt to learn lessons and provide insight into current circumstances[5]. Although this review

has a specific military focus, all health professionals confront daily social, biological and ethical issues that are complex and an understanding of historical problems and solutions could lead to better judgement and practice[31].

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Legal Medicine Aspects of Practising Medicine in the ADF
A Personal Perspective

Douglas McKenzie, RAN, Health Services

Introduction

The practice of medicine in the ADF is becoming increasingly complicated by administrative requirements, Health Directives and Instructions, with better informed patients and by an increasing doctor liability for medical outcomes. Patients and lawyers perceive modern medicine to be an exact science and, consequently, expect positive outcomes and have reduced tolerance for adverse events. Mother Nature can be cruel but she is not often held accountable for a poor outcome if a suitable human can be implicated. It is also considered disrespectful to blame the dead and injured for their misfortune, even if they were contributory to the outcome. Finding a 'guilty party' will appease complainants and their relatives and enable closure of the episode with resultant compensation. This outcome is often more preferable to finding systemic deficiencies or management failings. The long duration and exorbitant cost of Inquiries (often over $1m) necessitates a definite, if expedient, outcome.

In 32 years as an ADF medical officer I have observed increasing risks in practising ADF medicine. Having been a defendant in a military medical matter before a civilian medical board and an observer of several military Inquiries, I have observed a pattern of behaviour by lawyers appointed to such Inquiries. Natural justice with an equitable finding, from a common sense appraisal of the facts, does not always appear to be the main priority of a Commission of Inquiry into an adverse medical outcome.

Background

To a medical officer appearing before an Inquiry, it seems that a presumption of guilt usually prevails as opposed to the presumption of innocence. In the contrived atmosphere of an Inquiry, lawyers can become specialists in the practise of retrospective medicine where medical evidence is presented in chronological order (often selectively) with diagnoses appearing obvious so that any previous misjudgement, by a doctor, is viewed as a mistake by a lawyer. Despite lawyers insisting that Inquiries are inquisitorial this is not the impression of those under cross-examination on the witness stand, who consider that the atmosphere is adversarial.

An interesting example, demonstrating the often inherent anti-doctor sentiment at these Inquiries, involved a colleague of mine who was the Senior Medical Officer (SMO) in the case of an officer's death at sea in August 2006. The Inquiry's barristers ridiculed the SMO and witnesses in a private email (which I read after a copy was discretely delivered to my colleague's house one evening) and which prompted him to seek an injunction through the Federal Court. The Inquiry was dismissed and a judge was appointed to review the evidence and to make a finding that absolved the SMO of any blame in the death, concluding that the officer was the architect of his own demise.

The 2010 Inquiry into the APC rollover death at Puckapunyal, in 2009, is significant in that it was dismissed by a Federal Court judge after he found that the President of the Inquiry had shown bias against the psychiatrist in the case. The working assumption of the Inquiry appeared to have been that doctors contributed to the death of the crew commander. Subsequently, Victoria Police charged the driver with dangerous driving causing death and in March 2013 the Victorian County Court found him not guilty. The pragmatic approach by professional VicPol accident investigators is in stark contrast to the six weeks of cross-examination conducted by the Inquiry's lawyers, attempting to incriminate the doctors (SMO and psychiatrist) in the death of the crew commander. A senior counsel (Reserve lawyer) remarked, at an ADF medico-legal lecture I attended in Apr 2011, that he was bewildered as to how this matter could occupy twelve lawyers for six weeks.

I will discuss some legal aspects relevant to the practice of military medicine, gained from my experience as an ADF general clinician, noting some areas of concern for new doctors in the ADF. Junior medical officers are generally not aware of the potential traps awaiting them.

Medical Indemnity cover in the ADF - vicarious protection

ADF medical officers are medically indemnified under the terms of 'vicarious liability', a somewhat vague term whereby the employer will provide medical indemnity cover. The financial extent of this cover, when appearing before a civilian medical board, is unpredictable in that it is determined by the Defence Legal Service (DLS) and is dependent on the findings. Consequently, any adverse findings made against the medical officer could reduce full financial cover. In my particular case, costs for my legal team of $200,000 were 95 per cent covered by DLS such that I paid $10,000 of the legal costs, but only after the vigorous entreaties of a previous Director General of Defence Health Services (DGDHS). It was fortuitous that the DGDHS suspected that my case was not related to medical mismanagement, as alleged by the complainants counsel, but appeared more to do with a quest for compensation (reputedly being paid over $100,000 ex gratia). I received several convictions for administrative improper conduct, but none for incompetence or negligence, and personally paid fines of $10,000. My barrister stated in his final report, inter alia, that "I am absolutely flabbergasted at the findings made against you". There was no adverse medical outcome for the complainant but eventually a career truncation due to workplace issues. My private medical defence organization, which did not represent me, considered that the adverse findings set an undesirable precedent for the ADF in that a civilian medical board made an uncontested judgement while ignoring the obligations and peculiarities of military service, thereby demonstrating an anti-ADF bias. During the hearing, the board's presiding lawyer had referred to official defence regulations as "folklore" which elicited a vigorous response from my barrister in an attempt to explain the purpose of defence regulations in the Defence Force.

In the civilian domain, all doctors subscribe to their own private medical defence organization (MDO) which will provide dedicated medico-legal cover for the doctor, with his or her personal protection being paramount irrespective of the priorities of the employer. All legal costs are covered by the MDO but any fines imposed are paid by the doctor and are not a tax deductible expense.

It is essential to comply with all Health Instructions and Directives as failure to do so could potentially result in the medical officer being liable for legal costs if using vicarious liability cover. It is important to note that some of these documents are not consistent with current clinical practice and strict compliance could incur criticism by a civilian medical board (now AHPRA).

Patient Notes

Accurate contemporaneous medical notes are critical in establishing a good defence, as the legal assumption is that if it's not recorded in the notes then it didn't happen. Traditionally, medical notes have been hand written in the Unit Medical Record, but presently we are in a transitional phase where computer typed notes are superseding hand notes. My preference is to write hand written notes in addition to computer entries as I can write more detail and use diagrams.

When managing a mental health patient the notes should be comprehensive, since managing these patients has the highest chance of provoking a complaint, especially if self-harm occurred. The primary health care physician is the Clinical Case Manager for mental health patients and becomes the primary target at an Inquiry. It is interesting to observe how rarely psychiatrists and psychologists are implicated in an adverse medical outcome.

In my experience, the use of a personal defence diary (a private ADF note book admissible as evidence) is essential. It can be used for writing unflattering notes and observations about problematic patients or staff (non-compliant or insubordinate), for retaining disturbing emails and recording meetings and conversations with colleagues who may provide corroborating statements at a later stage. It is also wise to retain your own copy of particular notes about a patient if there has been a potentially litigious interaction. Although good medical notes are critical to establishing a defence case, it is still possible for a legal team to ignore significant entries in medical notes to the detriment of the case.

Appearing before an Inquiry

It is important to meet your legal team well before the Inquiry so as to assess their interest and understanding of your predicament and if they are able (especially counsel) to represent you. A campaign strategy will be discussed and if you have any doubts, these should be clarified early or else a second opinion obtained from ADF orientated lawyers (ADF Reserve lawyers). It is important to understand that despite your case being paramount to you, your lawyers are dealing with many other clients simultaneously and you might not rate highly on their radar.

For a medical officer being cross-examined before an Inquiry (being a potentially affected person against whom adverse findings may be brought) for an adverse medical outcome there is often the inference

of guilt which sets the scene for a potentially hostile interaction. The main tactic of Counsel Assisting (the cross-examining lawyer) is to discredit the doctor which, if achieved, will invalidate most of his/her evidence. The initial line of questioning may seem benign, as in detecting errors in notes such as spelling, dates of events so as to show sloppiness and erode confidence with the aim of getting the doctor to doubt or contradict him-or herself. Questions should be answered with a clear, concise and unemotional voice and with carefully considered explanations, as excessive talking or embellishment may give Counsel Assisting the opportunity to expose any weakness or contradictions in your evidence. It is very important not to reveal any emotion (anger, frustration, tears) as this is construed as weakness and will intensify cross-examination. Despite an initial appearance of respectful affability, Counsel Assisting is not your friend.

Witnesses before an Inquiry

The more supportive and credible witnesses you call, the better your position, though not necessarily. Some of your most valuable witnesses may have convenient memory lapses and not be as supportive as anticipated, especially if their own professionalism may be called into question. This memory affliction appears more likely to affect senior officers who may wish to avoid potential controversy associated with an adverse outcome.

It is interesting to reflect upon the witness who is a "cross-examiner's nightmare", as described by Geoffrey Robertson QC in his book "The Justice Game" (p 334), being a "skilled witness adept at turning your every question to your client's disadvantage". A skilled witness or defendant will make a cross-examiner work hard for his $4000 in fees per day.

For those civilian witnesses who may risk serious professional consequences as a result of appearing before an Inquiry there is an evasive tactic whereby a statement can be given 'de bene esse' – good for the time being. This enables a witness to submit their deposition before an Inquiry starts and not be available for further cross-examination during the course of the Inquiry, since they are intentionally absent. Traditionally, this option has been reserved, in good faith, for those who might not survive an Inquiry e.g. asbestosis victims, but I have observed it used by a local civilian doctor trying to avoid questions about his notes, which included a backdated medical certificate which used fictitious consults for a military person. (The doctor had gone overseas incommunicado to avoid the possibility of facing accusations himself).

Advice

To those junior medical officers who have not yet had the dubious honour of appearing before an Inquiry investigating a complaint or an adverse medical outcome, I make the following comments:

1. Subscribe to a private medical defence organization so as not to rely upon vicarious liability protection from the employer, as 'he who pays the piper calls the tune'.
2. Make careful and concise medical notes, as they are now medico-legal notes which will be critically examined at an Inquiry.
3. Keep a personal defence diary for private notes which can be used as evidence at an Inquiry.
4. Comply with relevant Health Directives and Instructions and, if unable to do so, then justify your non-compliance in writing. Non-compliance can amount to medical negligence.
5. Consult senior colleagues for advice sooner rather than later.
6. Keep a close watch over your legal team and retain copies of all your instructions to them and request perusal of all relevant correspondence from them to the opposing lawyers.
7. Do not expect your lawyers to have any understanding of the practise of clinical medicine as what may be highly significant to you will not necessarily be obvious to them.
8. Take a notebook into the Inquiry and record verbatim lawyers' comments that may suggest bias (apprehended or real) against you, which could justify seeking an injunction.
9. Having an adverse finding made against you is an undesirable outcome as it exposes you to the risk of civil legal proceedings being commenced by the complainant or their relatives. I am not aware of any process whereby an adverse finding can be appealed.

I believe that to restore confidence, fairness and integrity in ADF Commissions of Inquiry into adverse medical outcomes, there should be appointed a medical co-chairman who is an experienced independent, general clinician. This would enable a balanced assessment of the various aspects of medical management involved in a case, as opposed to lawyers making possibly biased and unchallenged findings. In conclusion, a self-protective and wary approach should be pursued when interacting with lawyers at a Commission of Inquiry.

Caveat Medicus

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Delivering CT Capability to the Battlefield

John Abbott

John Abbott is a former British Army Officer who served in REME for 30 years. He spent the last 5 years of his Army career working in Defence Procurement on a variety of projects including some military medical systems. One key project was to procure the UK's first deployable CT scanner. John retired from the Army in 2012 and now works for Marshall Land Systems, a leading supplier of deployable military medical infrastructure.

CT imagery is a routine diagnostic tool in the treatment of trauma patients. Extensive military trauma experience gained in Iraq, Afghanistan and elsewhere has proved that CT imagery is also an essential element of the modern military medical capability needs. The UK's most recent experience comes from the extensive use of CT imagery for trauma cases in the hospital at Camp Bastion, Afghanistan, where two multi-slice CTs have been installed for a number of years. The Role 3 facility at Camp Bastion is in a conventional building where the installation and operation of scanners presents little additional challenge than that found in any other hospital around the globe other than, perhaps, the distance from the home base that makes technical support a little more challenging. Such is the value of CT scanners that the challenge now is to provide CT capability in a deployable format. As military capability planners turn their thoughts to contingency operations and early entry into new theatres of operation, attention returns to the need for deployable medical capability, including CT capability in the field. Meeting these needs presents different challenges in contrast to those arising from the enduring nature of the campaigns in Iraq and Afghanistan.

CT technology is highly advanced and it use in civilian medicine is routine. However, the design and development of CT Scanners has been in the context of modern, static and highly controlled environments. Indeed, there are stringent temperature and humidity operating envelopes for the operation of a CT. Also, there are demanding limits on shock and vibration during transportation and installation. Providing the correct operating environment for a modern multi-slice CT in a hospital with all the modern facilities and utilities delivered with total reliability is relative undemanding. Transportation from the factory to the CT room for a once only installation and set-up can be done slowly and carefully with all necessary precautions to protect the scanner. Regulation, such as FDA approval, demands that the controlled environment must be provided for the safe operation of a CT scanner – even on the battlefield. The challenge of replicating this environment for the deployable military use of CT is great. Providing that controlled environment when deployed in extremes of climatic conditions from arctic cold to desert heat presents many technical difficulties. The requirement for both strategic and tactical movement by air, sea and land presents its own challenges not least in protect the scanner from shock and vibration. Deployment timelines means that any military CT capability must be made ready for use within a few hours of arrival in location rather than the days or weeks available for installation and set-up in a conventional hospital.

This presentation sets out the technical and operational challenges of delivering military deployable CT capability in the context of contemporary operations. It then describes how these were overcome to guarantee the highest levels of availability, reliability and durability, even in the harshest of conditions, thus providing CT scanning capability wherever and whenever it is needed.

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The Veterans' MATES program: Using routinely collected administrative health claims data health outcomes for veterans

Chris Alderman

Objectives

To demonstrate how a health promotion based quality improvement program utilises administrative claims data to bridge the evidence-practice gap and improves use of medicines and health outcomes for veterans.

Methods

The Australian Government Department of Veterans' Affairs Veterans' MATES program joins health professionals and veterans in its interventions, which are delivered quarterly. Administrative claims data are used to provide direct patient-based feedback to medical practitioners. This is supported with educational material developed by a clinical panel, peer review and overseen by a national editorial committee. Veterans who meet target criteria are mailed educational brochures. The program is supported by a national call centre, ongoing consultation with stakeholder organisations and, veteran and practitioner reference groups. Topic development is informed by the prevalence of medicine-related problems identified using DVA administrative claims data, Australia's national

health priority areas, and the Quality Use of Medicines (QUM) policy framework. Evaluation includes surveys and observational studies.

Results

Thirty-four educational topics targeting 259,000 veterans, 30,000 doctors and 7,500 pharmacies and accredited pharmacists have been implemented. Over 80% of medical practitioners, 90% of pharmacists and 75% of veterans consistently reported the material was helpful. Of the twenty four topics for which evaluation is complete, twenty have improved medicine use, with the remaining four reinforcing existing messages. Health outcomes analysis shows a reduction in hospitalisations; a 45% reduction in time to next hospitalisation for heart failure was observed for those who received a home medicine review service. Other outcomes have included an increase in bone mineral density testing and use of osteoporosis medicines in men, and an increase in renal function monitoring amongst veterans dispensed medicines requiring renal function monitoring.

Conclusion

Veterans' MATES is a health promotion based quality improvement program that utilises administrative claims data to bridge the evidence-practice gap and improves use of medicines and health outcomes. Key factors contributing to the success of the program include its grounding in behavioural theory and strong stakeholder engagement. The program provides a model that could be replicated in other settings where bridging the evidence-practice gap is proving a challenge.

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Emotional fitness and focussed attention training for partners of Defence Force personnel

Dr Jill Beattie

Dr Jill Beattie is a senior research fellow at Monash University, Victoria, adjunct senior research fellow at Flinders University Human Behaviour and Health Research Unit, South Australia, and director and mindfulness consultant in her Performance Enhancement Consultancy, Victoria. Jill has a background in nursing, education, management, research and clinical practice, and among other studies, has managed a three year randomised controlled trial for Vietnam veterans implementing and evaluating the Flinders Program. She tutors in mindfulness to medical students at Monash University, runs group mindfulness programs for partners and children of Defence Force personnel, and with individual clients.

Background

Members of the Defence Force and their families have unique needs because of the nature of the work of the Defence Force member. Periods of absence and then return, changing roles within the household, and frequent change in postings impact on each family member in different ways.

We need to keep physically fit and well, and we also need to keep emotionally fit and well.

With busy lifestyles, it is often a challenge to balance family, work, leisure, and time for peace; this can result in feelings of anxiety, anger, loss of control, and dis-ease.

Aim

To provide a safe, relaxed and supportive space for partners of Defence Force personnel to connect and explore emotional fitness (emotional intelligence) using focussed attention training (mindfulness tools) for improving resilience and decreasing stress.

Objectives

Provision of support and tools to deal with life events and emotions; specifically those related to being associated with the Defence Force.

Facilitate partners learning tools to use in daily life.

Methods

An 8-week (2.5 hours each week) emotional fitness program, based on the mindfulness-based stress reduction work of Jon Kabat-Zinn1 and Craig Hassed2 was conducted. Areas and activities covered included:

- The body's short and long term stress response
- The meaning of Mindfulness
- Relaxation and meditation techniques to reduce stress
- Mindful movement
- Perception
- Letting go and acceptance
- Presence of mind
- Mindful eating
- Limitations and granting permissions
- Listening, language, and transforming moods and actions
- Self-discipline

- Forgiveness
- Expanding and connecting self and community
- Lending a hand for Defence Force families

As this was the first program of its kind to be conducted in this context, only a post-program evaluation with free text responses was conducted. Data was content analysed.

Results

Of the 10 partners who registered for the program, six attended 4 or more sessions. Not all sessions were attended due to deployment of the member and therefore childcare commitments; shift work of the member and the partner was needed for childcare; annual leave interstate for 4 weeks; heavy day at work; and competing commitments on the night. One partner attended only 1 session, considering that the program was of no added value in the current context.

Participants reported gaining the following:

- Increased self confidence
- Self-awareness and self-acceptance
- Recognizing and learning what do to with emotions
- Increased perception of how things are, rather than perception based on emotion
- Importance of breath in being present
- Tools to use when angry or stressed
- Opportunity to discuss life issues
- New network of friends
- A new way of thinking

Conclusions

This program was offered to identify its acceptance and feasibility with partners of Defence Force personnel and was a success, with participants gaining valuable insight, increased self-awareness, acceptance, confidence and releasing of stress and anger as well as a beginning mindfulness practice. An additional benefit was the engagement of some of the participants in further activities of the local base Community Centre and forging friendships and networks. This group continued to meet fortnightly for 6months until interrupted by the festive season.

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The Well-being of Australian Serving Mothers

Davy CP, Lorimer M, McFarlane A, Hodson S, Crompvoet S, Lawrence-Wood E, Neuhaus SJ

Purpose

Australian women have served overseas in support of conflict operations in many roles since World War I. In recent years the deployment of women in support of Australian Defence Force (ADF) operations has also included mothers with dependent children. A number of researchers in other countries have suggested that service mothers are particularly vulnerable to mental health problems post deployment because of their additional family responsibilities. One of the few studies which has focused on servicewomen in an operational situation found that single mothers, in particular, were at most risk of developing high levels of depressive symptomotology post deployment. Disruptions to the mother/child relationships, in turn, may have a lasting effect on the mental health of their children.

This three part study aims to better understand this unique social change and the implications of deployment on the health of these women and their families. This is the first study of its kind into the effect of deployment on Australian servicewomen with dependent children.

Method

Part one of this study compared self-report mental and physical health data from a total of 196 servicewomen with dependent children who deployed to the Middle East Area of Operations, with service women who were not mothers at the time of their last deployment (n=567).

Building upon the findings from part one, parts two and three aim to gather qualitative data which will provide a more in-depth understanding of the psychosocial factors experienced by service mothers. Approximately 100 of the servicewomen with dependent children will be re-contacted and invited to participate in an in-depth telephone interview in order to explore factors that affect relationships with their child/children during and immediately after their last deployment. Participants will also be asked to describe the types of personal, social and/or organisational supports which were, or would have helped to maintain the mother/child relationship whilst deployed.

In addition, servicewomen with dependent children will be invited to document their experiences in the form of a social diary and/or provide examples of the type of communication methods used to maintain

relationships between themselves and their children whilst on deployment.

Results

Results from part one of the study, a quantitative analyses of non-specific psychological stress, post-traumatic stress symptoms, alcohol misuse, as well as somatic symptoms such as headaches, fatigue and sleep difficulties, are presented and discussed.

Conclusion

Deployment of servicewomen with dependent children to conflict zones represents a significant social change in Australia, and the implications of deployment on these women and their families is not fully understood. Findings from part one, together with qualitative data from parts two and three will ensure a more mature and developed understanding of the types of issues confronting deployed servicewomen.

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How changes in the control of DNA determine if someone develops chronic pain

A/Prof RV Haberberger

Rainer Haberberger is the convenor of the Centre for Neuroscience, Flinders Medical Science & Technology cluster and head of the pulmonary neurobiology lab Flinders. He studied Human Biology (Medical Research) at the Philipps-University in Marburg, Germany and has been a senior scientist and lecturer at the Institute for Anatomy and Cell Biology, Justus-Liebig University Giessen, Germany until 2005. He then was awarded the Mary Overton Neuroscience Fellowship and started to set up the Pulmonary Neurobiology Lab. Since 2009 he is Associate Professor for Neuroscience and in addition to his research also senior lecturer and course coordinator of the Medical Course at Flinders. His research areas of interest are the understanding of peripheral nociception and the control of peripheral airway function. He received the Collaborative Research Grant of the International Society for the Study of Pain 2006 & 2010, the Decima Strachan and Claire Lilia Wooton Estates Spinal Cord Research Award of the Australian Brain Foundation 2008 and the Australian Lung Foundation Ludwig Engel Grant-in-Aid for Physiological Research 2011.

Pain and chronic pain after injury and nerve damage are major health problems for society but in particular for the Defence community. New therapies are urgently needed and new diagnostic tools and targets for therapy will provide better treatment. Pain is very individual, one person experiences more pain than another to the same stimulus. Moreover, one person may develop chronic pain while another with the same injury does not. The reasons for these differences are unknown.

The overall aim was to discover the mechanisms which explain the differences in pain perception between individuals. We looked at the amount of messenger RNA for enzymes which had been shown to regulate the accessibility of DNA thereby determining if DNA can be read and used. Mechanisms that change the readability & use of DNA without changing the "code" are named epigenetic mechanisms. In particular we measured the quantity of RNA in those nerve cells that are the first in the chain of three populations of nerve cells that deliver pain information to the brain. We used mice which are mammals like humans and are very similar in the structure of their peripheral nervous system, for example of spinal cord and the nerves in legs. We compared 84 different enzymes in DRG and parts of the spinal cord. We compared mouse strains that were different in their response to pain. Both are mice but they respond differently to pain and have a different expression of a particular mRNA coding, an enzyme which seems to be a target for pain treatment named Sphk2. We compared pain sensing nerve cells in mouse strains with differences in their pain perception with and without injury and inflammation at different time points.

We looked very carefully using the system with the highest accuracy and several layers of controls. We were able to discover for the first time that the enzymes which change the use of DNA in pain sensing cells change in response to inflammation and injury. Even if only one side was injured, pain conveying nerve cells of both sides responded to the inflammation. The response to injury and inflammation increased over time with increased number of mRNAs change after one week compared to 3 days. The sphingosine 1-phospahte system seems to play a role since we detected differences between C57/Bl6 mice and mice with deficiency in the enzyme Sphk2.

Even this is only a small step, we are excited about the results of their experiments suggest a new direction in pain research and will certainly lead to new strategies in the understanding and treatment of chronic pain.This is important since drugs that interact with certain gene-controlling molecules are already in use as anti-cancer drugs. This data will build the necessary basis for the specific use of these drugs for the treatment of chronic pain.

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Beyond Life and Death: Trauma Resuscitation in Afghanistan aiming at Long Term outcomes

Kylie Hall

The Kandahar Airfield NATO Role 3 Hospital boasted a 97% survival of patients who arrived with spontaneous cardiac output. The resuscitation aspect of care was rehearsed and polished, such that subsequent effort was focussed on improving quality of life for the injured and prevention of worsening outcomes.

Rapid control of bleeding, early resuscitation, analgesia and transport, prepared the patient well for definitive care at the Role 3. Trauma teams, each with well defined roles, conducted their assessments and performed central venous access; blood/product resuscitation, TXA infusions, antibiotics, change to pneumatic splints, analgesia and airway and injury management.

Rapid transfer to the operating theatre with damage control surgery, and continued resuscitation and provision of regional anaesthesia for post operative analgesia was paramount. Intensive Care post operatively maintained and restored physiological parameters, preparing for transport to Germany.

The excellent survival rates for these patients led a focus of care for the long term. Preservation of tissue where possible, meticulous care of neural structures to minimise pain, analgesia, emotional and social support.

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The Role of Erythropoietin and Intravenous Iron in Trauma management

Kylie Hall

Following serious trauma involving hypovolemia, patients often undergo multiple surgical procedures resulting in further blood loss and persisting anemia. These patients frequently receive multiple blood transfusions which are costly and can be associated with transfusion related complications. As a result, transfusions are avoided whenever possible and postoperative anemia is tolerated, until the next surgical procedure when more blood loss occurs and transfusion is required.

A combination of Erythropoietin and intravenous iron may prove useful in replacing the traditional transfusion, in restoring red cell volume in the hemodynamically stable patient. An analysis of the current literature was undertaken, with a trauma focus, examining the potential benefits of such strategies.

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Whether, Whither, Wither, or Without; the role of Consultant Physicians in ADF Operations

W Heddle

Consultant Physician since 1980; currently Associate Professor of Medicine at Flinders University and Senior Consultant in Cardiology, Flinders Medical Centre. Operational experience in East Timor.

Joined RANR in 1976 and currently active reservist with rank of Commander.

Over the last 200 years continual improvement has occurred in survival of casualties in conflict with very high mortality from battle wounds in the 19 th century to remarkably high survival in the 21st century, with much better control of associated infection, the leading cause of mortality. (However the use of peri-operative antibiotics has been associated with a rise in infections with Gram negative organisms, many resistant to multiple antibiotics.)

However, with rare exceptions, the numbers of non-battle casualties has continued to easily exceed the battle casualties. In Operation Enduring Freedom, between 2003 and 2007, the US armed forces noted that non-battle casualties (NBI) were 6X greater than battle casualties. Medical evacuations had the same ratio. NBI were a combination of orthopaedic injury, infectious disease, and other medical illness. On this background, in the ADF, the deployment of CPs on Operations has diminished. The skill set of CPs includes strong grounding in infectious disease, and skill in clarifying acute and chronic illness of uncertain cause.

If one looks at the composition of many “teams” for deployment, they will usually include Surgeons (general and orthopaedic), anaesthetists, intensive care physicians, and emergency physicians. Infectious disease and new, unrecognised illnesses or unexpected illnesses are often seen on operations; a good example of the latter is Leishmaniasis in Iraq; in the 1930s the UK forces had major disability from this; in Iraq in 2003 initially the US forces had similar problems, but were able to dramatically reduce his problem with basic public health measures

The perspective changes greatly if one considers Humanitarian relief operations, where infection is common, and young (often pregnant) women and children present with illness.

With the large burden of NBI in both Combat and Humanitarian Operations, there is a strong argument for maintenance of CPs in the deployed health care teams.

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Evaluation of alternate solutions for the reconstitution of cryopreserved platelets to improve post-thaw recovery

Lacey Johnson

Dr Lacey Johnson has been a Senior Research Fellow at the Australian Red Cross Blood Service for the past 5 years. Her research focuses on improving blood processing and component quality, with a focus on platelets. She has been particularly focused on setting up the methodology to enable platelet cryopreservation in Australia, for use by the Australian Defence Force. Further, her work examines the mechanistic affects of cryopreservation on platelet quality, with the aim to improve platelet quality.

Background

Platelets for transfusion are stored at 20-24 °C for up to 5 days, making them unsuitable for use in austere military environments. However, freezing platelets at -80 °C enables extension of the shelf-life to 2 years and facilitates transport and storage. Frozen platelets have been used in military applications for more than 30 years [1], with several production methods trialled during this time. The most widely used protocol requires the addition of 5-6% dimethylsulfoxide (DMSO), washing to remove excess DMSO and freezing of the hyperconcentrated product at -80°C [2]. Upon thawing, platelets are reconstituted in fluid, typically fresh frozen plasma (FFP). Although the use of FFP is attractive for several reasons, there are also obvious disadvantages. The major disadvantage of FFP is the significant time required for thawing prior to use, which is up to 30 minutes. Alternative solutions, such as platelet additive solutions (PAS) may be advantageous as they are stored at room temperature and can be ready for use in the time taken for a platelet unit to thaw (5 minutes). Further, PAS have been specifically formulated to optimise platelet metabolism and reduce activation, with new generation additives containing glucose and/or bicarbonate to further aid platelet recovery.

Study Design and Methods

DMSO (5% final concentration) was added to buffy coat-derived platelets, followed by centrifugation to concentrate and freezing at -80 °C. Cryopreserved platelets (n=12 per group) were thawed at 37 °C, reconstituted in either a unit of thawed FFP or glucose containing PAS (PAS-G). In vitro platelet quality was examined prior to freezing, immediately after thawing and 6 and 24 hours post-thawing.

Results

After thawing and reconstitution, recovery was similar for platelets in FFP and PAS-G (69% and 73% respectively). All platelets maintained an acceptable pH and metabolic activity during post-thaw storage. Frozen platelets were activated, although the extent differed depending on the reconstitution solution, with platelets in PAS-G retaining better aggregation responses than platelets in FFP. The absolute number of platelet microparticles was significantly higher immediately after thawing, but the reconstitution solution did not significantly influence microparticle generation. Despite this, the platelets resuspended in PAS-G had lower pro-coagulant activity (as measured by FXa-based clotting assay and TEG) than FFP-reconstituted platelets. This was likely due the absence of additional clotting factors present when platelets are reconstituted in FFP.

Conclusion

Thawing cryopreserved platelets in PAS-G, without plasma supplementation, resulted in platelets with similar recovery and in vitro quality indicators to those suspended in FFP. Importantly, using PAS-G enables the platelets to be ready for use significantly faster than when having to thaw FFP, which may be beneficial in trauma situations. This work demonstrates the potential to improve both the time at which platelets are available for transfusion and their recovery. As time and product efficacy are two critical factors affecting transfusion outcomes, these changes may result in improved trauma management, when used in the field.

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Pain-related musculoskeletal disorders, psychological comorbidity and wellbeing in Australian Gulf War veterans – 10 years after the Gulf War

Helen L Kelsall

Dr Helen Kelsall is a Senior Research Fellow at the Department of Epidemiology and Preventive Medicine, Monash University. She is an Investigator on the current follow up study of the health of Australian Gulf War veterans and military comparison group being undertaken by Monash University and was an Investigator and undertook her PhD on the 2000-

02 baseline study. Her research interests include physical health assessment in veterans and other occupational groups, musculoskeletal disorders in other occupational groups, and the relationship between physical health, psychological health and exposures in veteran and military populations. Other interests include professional public health education.

Introduction

Musculoskeletal disorders (MSD) encompass a range of conditions and are diverse in their pathophysiology. They have a capacity to cause severe, chronic pain and impaired physical function. While community studies have found MSD to be comorbid with psychological conditions such as depression and anxiety, evidence for a relationship between pain-related MSD and psychological disorders in representative veteran populations is limited.

Aim

This study aimed to: (i) compare the prevalence of MSD in Australian Gulf War veterans with a military comparison group, (ii) investigate comorbidity of MSD and psychological disorders, and (iii) examine associations between general physical and mental wellbeing and MSD in those with and without comorbid psychological disorders.

Methods

This cross-sectional study compared the prevalence of pain-related MSD, comorbidity of musculoskeletal and psychological disorders, and wellbeing between 1456 male Australian 1990-1991 Gulf War veterans (veterans) and a military comparison group (n=1588). At a medical assessment in 2000-2003, reported doctor diagnosed arthritis or rheumatism, back or neck problems, joint problems, and soft tissue disorders were rated by medical practitioners as non-medical, unlikely, possible or probable diagnoses. Only probable MSD were analysed. DSM-IV psychological disorders, including posttraumatic stress disorder (PTSD), depression, and alcohol use disorders, were measured using the Composite International Diagnostic Interview. The Short-Form Health Survey (SF-12) assessed physical and mental wellbeing, the lower the score the poorer the physical or mental health status.

Results

Almost one-quarter of veterans (24.5%) and the comparison group (22.4%) reported a MSD.

Overall, comorbidity of any MSD with any psychological disorder was more common in veterans than in the comparison group: a total of 102 participants (3.7%) (4.6% of veterans vs 2.8% of comparison group; OR 1.72: 95% CI 1.13-2.60) had comorbid any MSD and any psychological disorder (depression, PTSD or alcohol use disorder). In veterans, having any MSD or a specific type of MSD was associated with depression and PTSD, but not alcohol use disorders. Physical and mental wellbeing was poorer in those with a MSD compared to those without a MSD (e.g. in veterans with any MSD, the difference in SF-12 PCS medians = -10.49: 95% CI -12.40, -8.57), and in those with psychological comorbidity (e.g. in veterans with any MSD and depression or PTSD, the difference in SF-12 MCS medians = -20.74: 95% CI -24.3, -17.18). Similar patterns were found in the comparison group.

Conclusions

Comorbidity of any musculoskeletal and psychological disorder was more common in veterans, but MSD were associated with depression, PTSD and poorer wellbeing in both groups. Psychological comorbidity needs consideration in assessment and management of painful musculoskeletal conditions in Gulf War veterans and other military groups. The findings of this research will be used to inform the current follow-up study of the longer term health of Australian Gulf War veterans, which will look at the persistence or resolution of reported MSD and psychological comorbidity and health services use.

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Depression in Gulf War veterans: A systematic review and meta-analysis

Helen Kelsall

Helen Kelsall is a Senior Research Fellow in the Monash Centre for Occupational & Environmental Health, Monash University. She is a public health physician and undertook her PhD in the field of veteran health epidemiology. Helen has worked in the veteran health epidemiology field with the research team at Monash University since 2000; using a variety of methods including cross-sectional and longitudinal epidemiological health studies, analysis of existing datasets to answer further research questions, and systematic literature reviews and meta-analyses.

Background

Major Depressive Disorder (depression) is the second leading cause of disability worldwide, contributing 8% of all years lived with disability in 2010,1 compared with anxiety disorders which contribute 3.5% of all years lived with disability. Research has

demonstrated that military personnel deployed to war zones experience increased rates of psychological disorders,3 and exposure to stressful events, such as war, is a risk factor for depression.2 Although posttraumatic stress disorder (PTSD) has been a focus of attention in 1990/1991 Gulf War veterans, the excess risk of depression has not been clearly identified.

Aims

To conduct a systematic review and meta-analysis of studies which compared depression and dysthymia in Gulf War veterans and in a comparison group of non-deployed military personnel.

Method

Multiple electronic databases (Medline, Medline In Process, PsycINFO, Embase, Published International Literature on Traumatic Stress (PILOTS) and the Cochrane Library) and grey literature were searched from 1990-2012. Studies were assessed for eligibility and risk of bias according to established criteria. The prevalence of depression was assessed across studies and sources of variability were assessed by subgroup analysis. A random effects meta-analysis, stratified by sub-groups according to the outcome measure (diagnostic interview; screening tool; self-reported physician diagnosis), was conducted. We further reported separate meta-analyses stratified by risk of bias (high v low) and adjusted vs unadjusted odds ratios.

Results

Of 14,098 titles and abstracts assessed, 14 studies of depression met the inclusion criteria. The elevated odds of depression were statistically significant in 13 of the 14 studies that were included. Five of the studies had included dysthymia or chronic dysphoria, the odds of dysthymia were elevated in 2 of the 5 studies, and 2 of the studies related to chronic dysphoria. Gulf War veterans had over twice the odds of experiencing depression (odds ratio, OR = 2.28, 95% CI 1.88-2.76) and dysthymia or chronic dysphoria (OR = 2.39, 95% CI 2.0-2.86) compared to non-Gulf-deployed military personnel. This finding was robust in sensitivity analyses, including to differences in overall risk of bias and psychological measures used.

Conclusions

Despite different methodologies between studies, depression and dysthymia were twice as common in Gulf War veterans compared with military comparison groups, and are important medical conditions for clinicians and policymakers to be aware of in assessing and managing Gulf War veterans' health.

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WHO CARES FOR THE CARERS? – Compassion fatigue and burnout in uniformed care providers

LTCOL Kerry Clifford, RAANC

The author is currently serving his 31st year in the ADF; the most recent two decades as a nursing officer. He has worked predominantly for Joint Health Command since 1996, including as a project officer in 2009 for the garrison health reform program that arose from the Alexander Review. Following work to develop the original set of Regional Level Agreements in that year, LTCOL Clifford was posted in 2010-11 to Northern Queensland to take command of the Lavarack Barracks Medical Centre and as the Senior Health Officer for that region. On the 14th of February 2011, he became the first Commanding Officer anywhere in Australia to raise and take command of a Joint Health Unit under the reformed garrison health organisation. Personal experience of overwhelming organisational demands and workplace stress prompted a year out of uniform in 2012 to complete full-time study for a Postgraduate Diploma in Mental Health Nursing.

The Dunt Review into mental health services in the Australian Defence Force (ADF) enabled significant investment in programs and initiatives across the defence environment in Australia. The subsequent attention to long standing mental health issues for our veteran community is both timely and admirable, and has indeed begun to address mental health stigma, education and community support around this country. Arguably, the overwhelming focus of these programs has been on Post-Traumatic Stress Disorder as it relates to the physical and mental trauma of operational deployment. However, this paper will attempt to redirect at least some of this focus onto issues of compassion fatigue in uniformed health professionals arising from their care of traumatised (physical and/or psychological) clients. The paper will also raise burnout as a related consequence of stressful defence health work/life experience.

This literature review based paper identified myriad peer reviewed references relating to research and programs for international healthcare systems and overseas forces on these conditions. However, at least within the published

domain, very little can be identified for the Australian military context or in the ADF's current mental health

strategies to specifically address these mental health issues for our uniformed health professionals.

This paper introduces these relevant concerns for the broader military/veteran's health peer group, leadership and academic audience to consider as worthy of greater attention in Defence and Veteran's Affairs research and policy agendas.

The presentation will encompass:

1. An introduction, background and definitions of 'Compassion Fatigue', being vicarious traumatisation of clinicians as a consequence of caring for traumatised people.
2. A similar discussion of Burnout' as a wider but still significant workforce issue that reduces the quality of care provided to patients, and the morale, quality of life and physical and mental health of sufferers.
3. A brief outline of a 'Four Stages of Burnout' model, being (1) Physical, Mental and Emotional Exhaustion, (2) Shame and Doubt, (3) Cynicism and Callousness and finally (4) Failure, Helplessness and Crisis.
4. Identified issues for military health services from compassion fatigue and burnout as identified in the literature.
5. Recommendations that individual practitioners and the defence health organisation should consider to address issues identified.

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An Electrophysiological Investigation of mild Traumatic Brain Injury in a Prospective Study of Australian Military Personnel

A. C. McFarlane AO

Prof AC McFarlane AO (GPCapt RAAFSR) is the Director For The Centre For Traumatic Stress Studies at the University of Adelaide. He is an international expert in the longitudinal course of PTSD and its neurobiology. He has been investigating the neurocognitive abnormalities associated with exposure to traumatic stress for over two decades. He has been a member of the reserves for over 15 years as well as being a senior adviser to the Department of Veterans Affairs. He was the principal investigator for the 2010 ADF Mental-Health Prevalence And Well-Being Study. He has received a number of awards, including the Lifetime Achievement Award for making outstanding and fundamental contributions to the field of traumatic stress awarded by the International Society for Traumatic Stress Studies in 2012.

There is major concern about the long-term impact of head injuries at the lower level of severity. However, investigation of this problem is complex, because of the many shared symptoms between postconcussion syndrome and the psychiatric disorders that can also arise from the psychological stress of being exposed to a significant blast with the implicit risks of death and/or serious injury. Furthermore, mild traumatic brain injury (mTBI) increases the risk of developing PTSD following blast exposure. At present, there are no clinical investigations that distinguish PTSD from mTBI. The lack of objective investigations is a major challenge in clinical settings due to the significant co-occurrence of PTSD and mTBI, given the different clinical management required for these disorders.

Using data from the MEAO MilHOP prospective study this investigation compared XX participants who sustained an mTBI with XX participants matched on a range of demographic and combat related variables (3 per mTBI case). All participants were assessed prior to and following deployment on five neurophysiological tests: quantitative EEG, go no-go response inhibition, startle reflex response, a working memory task and a facial emotion processing paradigm. These tests were chosen from a suite of possible tasks that can be performed and scored using a reliable and standardized protocol that automatically scores the data.

A significant amount of literature has previously investigated abnormalities in PTSD and mTBI using these methods, however to date no study has examined the specificity of these measures of brain function in PTSD and mTBI. These data will be analysed, controlling for symptoms of PTSD prior to and following deployment, to ascertain the existence of markers for mTBI. The within subject change on deployment will be assessed to ascertain which of the paradigms differentially characterises the abnormalities arising from mTBI.

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Investigating a visual test for bipolar disorder (manic depression)

Dr Steven M. Miller

Steven Miller is a medical graduate (University of Qld) with a PhD in Neuroscience and Psychiatry (University of Qld), and a Masters in Occupational and Environmental Health (Monash University). He established the Perceptual and Clinical Neuroscience Group, based at Monash Alfred Psychiatry Research Centre. Dr Miller was previously awarded an NHMRC post-graduate research scholarship, a Victorian

Neurotrauma Initiative Early Career Practitioner Fellowship, equipment grants from NHMRC and an Establishment Grant from the Defence Health Foundation. He is a current recipient of a NARSAD Young Investigator Award from the Brain & Behavior Research Foundation (USA) for his work on binocular rivalry and bipolar disorder. Dr Miller has published research in some of the world's top ranking scientific journals and recently edited a book on binocular rivalry, with papers contributed by leading international researchers in the field. He regularly presents his research findings at national and international scientific conferences.

Bipolar disorder (manic depression) is a devastating mental illness characterised by periods of mania and depression. Well-known triggers for bipolar disorder include sleep deprivation and extreme stress, which are common experiences for serving Defence personnel. Bipolar disorder is a genetic condition and there are no diagnostic tests available. This project, funded by a Defence Health Foundation (DHF) Establishment Grant, aimed to equip and establish a national and international research consortium to characterise a visual test — binocular rivalry rate (BRR) — that appears to satisfy several criteria for being a risk indicator for bipolar disorder. The use of this test in psychiatric populations has been pioneered by the principal investigator, has attracted international attention, and has been published in high profile scientific journals (Miller et al., 2003, 2010, 2012; Ngo et al., 2011; Pettigrew & Miller, 1998).

For the Defence community, being able to identify individuals who are at genetic risk of developing bipolar disorder would be invaluable. At the pre-employment stage, prospective recruits could be screened with the test for their risk of developing the condition. Accurate identification would avoid exposing at-risk applicants to sleep deprivation and stress, thus preventing triggering of manic or depressive episodes. Furthermore, serving and discharged Defence personnel who have developed symptoms of mental illness would benefit from a test that assists diagnosis, i.e., distinguishing bipolar disorder from schizophrenia and from major depression. Misdiagnosis in these contexts is high, leading to inappropriate treatment choices.

This presentation will discuss the status of the research consortium that has been successfully established with DHF funds. Testing centres are operational in Melbourne, Sydney, Brisbane, Wales and Germany. Establishment of this consortium has enabled the attraction of international competitive funding for this work from the Brain & Behavior Research Foundation (USA), by way of a NARSAD Young Investigator Grant awarded to the principal investigator. In addition to discussing the status of the current research consortium, the presentation will outline future directions for this research.

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The prevalence and operational significance of low-back pain in ADF aircrew

Adrian Smith

Dr Adrian Smith is Head of Research at the RAAF Institute of Aviation Medicine. Barrett Jarrell is a final year medical student at Flinders University who undertook an elective rotation at AVMED under Dr Smith's supervision.

Low back pain is a perennial problem for military aircrew, especially helicopter pilots. The prevalence of back pain has been established many times in large surveys, but few researchers have defined the operational impact of back pain. Method: a survey was distributed to 150 aircrew who underwent aviation medicine refresher training through AVMED. 142 surveys were returned (95% response rate). Results: 67 % of pilots reported operationally significant back pain during their career, greatest amongst helicopter pilots (90%) than transport (65%) or fast jets (60%). 75% of these describe at least one episode within the last 12 months. Although only 18% have ever been grounded by the AVMO, up to 45% have self-imposed flying restrictions due to back pain, or have been managed 'in house' by their colleagues; 75% believe they often fly 'sub-optimally' because of pain. 88% of pilots with back pain admit to modifying their flying programme or activities to accommodate back pain, with half of these doing so 'frequently. Half of the pilots who report flying-related back pain describe it lasting for a day or more; 80% of pilots with back pain self-mange their symptoms, primarily by continuing exercises and stretches taught to them during physiotherapy treatments for a prior incidence of back pain. 53% of the pilots who responded to the survey admit to using a lumbar-support cushion during flight in an attempt to alleviate or offset back pain, with 60% of these describing significant benefit in their symptoms when using the cushion – in terms of reducing the degree of discomfort, delaying the onset of discomfort, or alleviating the discomfort altogether. Use was greatest amongst helicopter pilots (65%) than transport pilots (50%) or fast-jet pilots (40%). Overall, 80% of pilots would consider using a lumbar support if one was available to them through the system, although 67% would re-consider their willingness if it required a medical re-categorisation. Conclusion. Back pain

is an operationally-significant condition affect ADF aircrew. ADF aircrew are already using lumbar support cushions with apparent good effect. AVMED should explore ways to provide ADF aircrew with an approved lumbar support cushion without requiring medical re-categorisation.

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Australian Health Specialist Group 2 deployed to the NATO Role 3 Multinational Medical Unit in Kandahar Airfield in 2012

CMDR Ian James YOUNG

CMDR Ian Young joined the RAN in 1998 after serving with the Canadian Forces from 1990 to 1998. CMDR Young initially served as a Medical Officer prior to training as an Orthopaedic Surgeon under MOSTS. He has had operational deployments in the Indian Ocean, Indonesia and the Middle East. CMDR Young is currently posted to the Maritime Operational Health Unit working part-time leave without pay as a specialist at Frankston Hospital.

Australia provided two groups of health specialists in 2012 to work in the NATO Role 3 Multinational Medical Unit in Kandahar Airfield, Afghanistan. CMDR Ian Young deployed with the second group as Senior Health Officer and Orthopaedic Surgeon.

This presentation will provide an overview of the deployment from an Australian perspective and will highlight the clinical experience gained by the author. Further points of discussion will be the Clinical Practice Guidelines that were utilised in the facility and consideration for development of Australian guidelines in our Role 2E facilities.

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Do you have an article of interest to our readers?

Authors are invited to submit articles of relevance to the Editor for consideration for publication in the Journal of Military and Veterans' Health (JMVH)

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JOURNAL OF MILITARY AND VETERAN'S HEALTH

CALL TO AUTHORS

The Journal of Military and Veteran's Health is a peer reviewed quarterly publication published by the Australasian Military Medicine Association. Its Editorial Board has indentified the following themes for future editions:

Edition	Theme	Publication Date	Closure of article submission date
July 2014	Veterans Health	21 July 2014	26 May 2014
October 2014	Tropical Medicine	20 October 2014	25 August 2014
January 2015	Mental Health	19 January 2015	24 November 2014
April 2015	Trauma Management - Past & Present	20 April 2015	23 February 2015

Categories for the above include:

Original Research/Original Articles, Short Communication, Review Articles, Reprinted Articles, Case Studies, Abstracts from the Literature, Biographies, History, Book Reviews, Commentary and View from the Front.

The Editor would be delighted to receive articles for consideration on these themes. However, please note that although these are identified themes for 2014, we encourage authors to continue to submit articles on a range of topics on military medicine and veterans' health including operational articles.

Submission of articles should be done online via JMVH website www.jmvh.org where the Instructions to Authors can also be found.

Should you have any queries, in relation to JMVH, please do not hesitate to contact the Editor via the AMMA Secretariat on +61 3 6234 7844 or secretariat@amma.asn.au.

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