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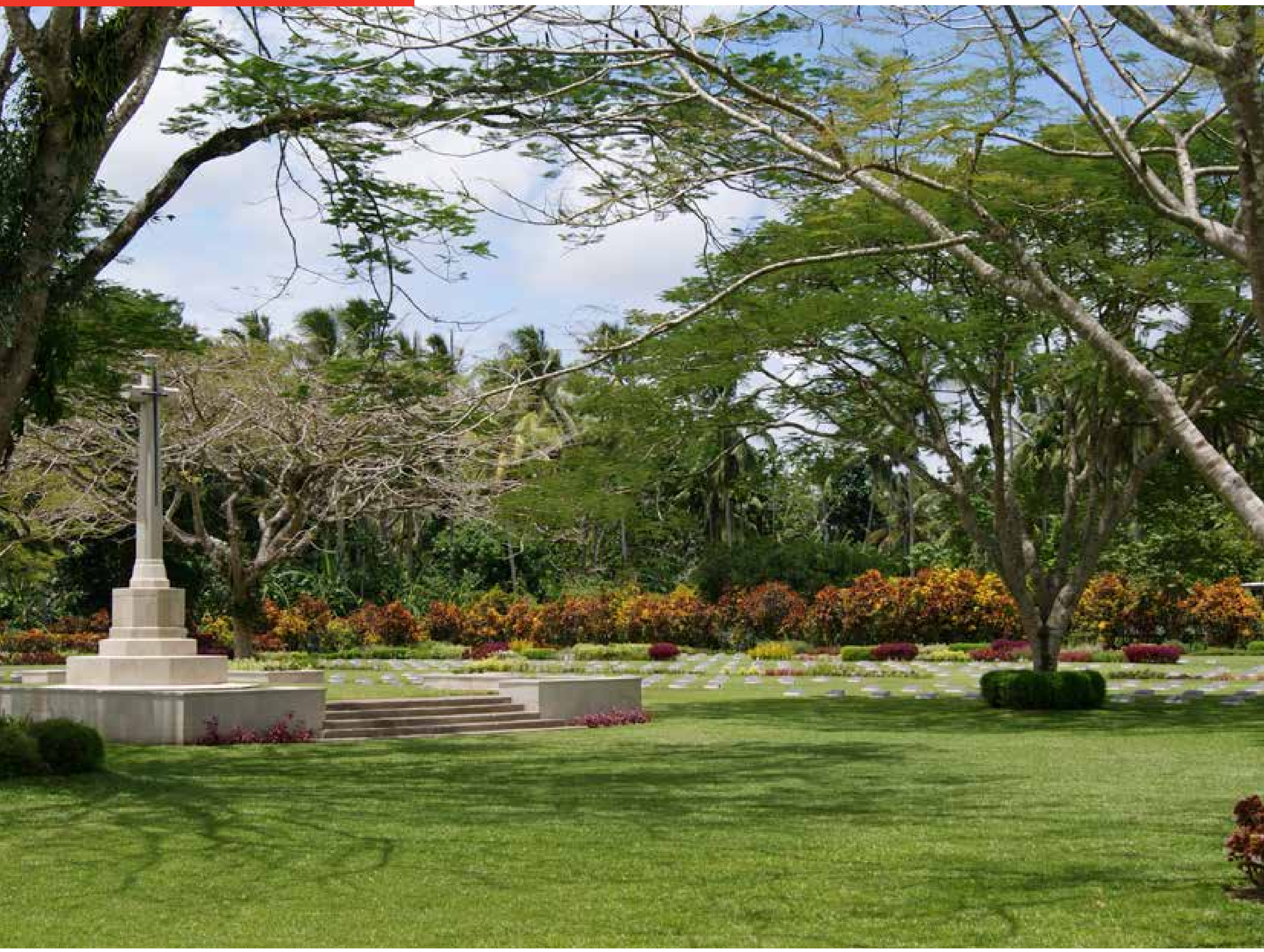

- Underestimating the burden for peacekeepers?
- The impact of a lengthened Australian Army recruit training course on recruit injuries
- Sydney Emden battle second instalment

The Journal of the Australasian Military Medicine Association

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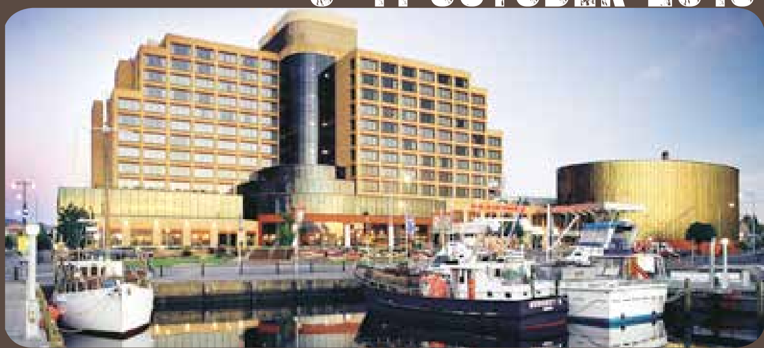

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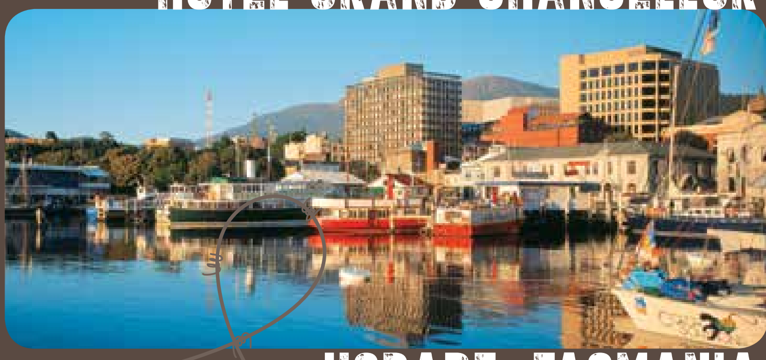

HOBART, TASMANIA

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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

This issue will probably be arriving in people's letter boxes just as we are preparing to commemorate the 100th Anniversary of the Gallipoli landings on 25 April 1914. The battles fought in Gallipoli, northern Africa and the Western Front, at sea and in the air, would cement the ANZACs reputation as a fighting force and would lead to the development of the Australian and New Zealand Defence Forces of today. They weren't saints, as the rioting in the Haret el Wassa on 02 April 1914 showed, albeit among troops bored by their current inaction, but these troops were to go on to fight bravely a little over three weeks later in some of the most brutal battles of the war. Roland Perry, in his book, "The Australian Light Horse", comprehensively chronicles the role of the Australian Light Horse at Gallipoli and subsequently in the Sinai, Palestine and Syria. Although Perry only briefly touches on the health challenges faced, from heatstroke, dehydration, malaria and scorpions to a range of battle injuries, the resilience the men of the Light Horse, and their subsequent victories at Beersheba, Gaza and Jerusalem, were truly remarkable.

In this issue, we have a range of excellent original articles, including articles on mental health among New Zealand peacekeepers, injuries in Army recruit training, the benefits of injury screening tools and an update on battlefield radiology. There is also a challenging review on changes to GP training and potential impacts on training ADF medical officers and some noteworthy book reviews. Finally, the second excerpt from the HMAS Sydney medical officers log for 10 November 1914 is reproduced. During the second day, HMAS Sydney surgeons and health crew, with assistance from the remaining German surgeon, managed the more than 70 SMS Emden casualties along with their remaining casualties. Despite very limited resources, both the health and other Sydney crew provided whatever care they could to the injured on both sides of the battle; a model that we need to continue to emulate in our modern military medicine roles.

AMMA recently ran its first health Symposium in Wellington on the health impacts of military trauma, which was well received, and we look forward to more papers from our New Zealand colleagues. We continue to get a good range of articles, but other military and veterans' health articles are always very welcome and we would encourage all our readers to consider writing on their areas of military or veterans' health interest. The theme of our next issue is trauma management (July 2015) with our October issue looking at mental health. If you have papers in these or other areas, we look forward to hearing from you.

Dr Andy Robertson, CSC

Editor-in-Chief

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1. Perry R. The Australian Light Horse. Hachette Australia; Sydney: 2009.

Pictured Left: Winning entry of the battlefield photo competition at the 2014 AMMA conference.

Photographer: Tim Adams

Photo title: "The First Casualties"

Photo description: Some seven months before storming the beaches of Gallipoli, Australian forces first went into battle in the jungles of Papua New Guinea. This memorial marks the site of that battle between Australian and German forces in September 1914, with the graves of Australia's first casualties of the Great War adjacent.

Tim Adams is a Canberra-based photographer, who bought his first digital camera 6 years ago as a means of managing depression. His interest in photography has grown and he now works as a semi-professional.

Tim has an ongoing love for Papua New Guinea, having been responsible for the maintenance of war graves and memorials there for four years.

Cover Image: "The First Battlefield" Also taken by photographer Tim Adams

Dear Editor

Recently, Clifford (2014) conducted a literature review of compassion fatigue and burnout in military health professionals. As noted by the author, the recent Dunt Review highlights the issue of Post-traumatic Stress Disorder (PTSD) has raised the awareness and public debate of this service related injury. Moreover, the authors focus of discussion in relation to health professionals is worthy of a broad review of the literature. Regrettably, the methodological rigour in which this review was conducted is not consistent with current best practice guidelines making interpretation of the conclusions difficult. Of significance is that only one database were used to search the literature, the findings of this search are not reported, no quality appraisal of the articles which were included in the review were detailed or process for analysis reported. I recommend that any author wishing to submit a literature review for publication consider undertaking an integrative review.

The integrative review has been identified as a robust tool for synthesizing available literature on a given topic (Williams, 2012). It is used as a tool of Evidence Based Practice (EBP) (de Souza et al., 2010) and allows for the combination of diverse methodologies (e.g. experimental and non-experimental research in order to fully understand the area of interest (Whittemore and Knafl, 2005). Assessing rigour is an important step in the integrative review process and should be addressed in a meaningful way (Whitemore and Knafl, 2005). While there exists no clear agreement on jointly appraising the methodological quality of diverse methods, recent guidance has been emerged: the Mixed Method Appraisal Tool (MMAT) (Pluye et al., 2009). A further tool to guide authors in reporting the findings of their review can be found via the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA).

My intention in outlining these points is not to detract from the significant work undertaken by Clifford (2014), but to offer future authors guidance in how to develop a review and have their work recognised as being trustworthy, rigorous and valid.

Regards,

Ben Mackie
Lecturer of Nursing, University of Southern Queensland

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07 March 2015

Dear Editor,

The article by Kristina Griffin regarding the evolution and role changes of Australian military medics[1] requires some amplification and clarification regarding its scope and conclusions:

- The content and referencing of the article is clearly limited to those ADF medics who provide health support for operations ashore. It is respectfully suggested that the term 'military medic' is too generic, if it excludes 'military medics' who provide health support for maritime operations.
- Furthermore, the scope of the article implies that the role of the aforementioned shore-based military medics is limited to providing health support for combat operations. It is also respectfully suggested that – like other ADF health personnel – all ADF medics (in particular those at the senior NCO level) facilitate ADF health capability, through their inimitable contributions to the following functions and roles:
  - Supporting the development of and implementing operational health support plans.
  - Supporting (and in some cases providing) forward, tactical and strategic aeromedical evacuation.
  - Supporting (and in some cases providing) humanitarian aid / disaster relief operations.
  - Supporting (and in some cases providing) military medicine capability, with particular reference to aviation, submarine and especially diving medicine.
  - Supporting the assessment of ADF personnel with respect to their health-related suitability for employment and deployment (typically via the ADF Medical Employment Classification System).
  - Supporting (and in some cases providing) occupational and environmental health services (in particular occupational hygiene and infectious disease preventive health).
  - Supporting (and in some cases providing) limited health promotion services.
  - Supporting (and in some cases providing) treatment services for operations, exercises and other deployments. These are typically) related (but by no means limited) to primary care, often with at times very limited remote supervision.

The importance of ADF medics with respect to preventive health and primary care treatment services to preserve the fighting force should not be under-estimated: the article's reference to 90% of combat deaths occurring on the battlefield fails to acknowledge that fact that even now, non-combat deaths and morbidity still significantly outnumber combat casualties[2].

It is also respectfully suggested that the role of ADF medics (particularly at the senior NCO level) also includes their participation in the following Fundamental Inputs to Capability (FiCs)[3] that makes the above functions and roles possible:

- Personnel management (including individual training);
- Supporting collective training.
- Facilitating and sustaining military health organisations.
- Managing and maintaining health facilities.
- Managing and maintaining health and other supplies.
- Managing and utilising major IT and other systems.
- Facilitating and sustaining military health command and management functions.
- Liaising with and coordinating support functions provided by non-health military organisations.

With specific reference to ADF medics who are primarily engaged in providing health support for maritime operations, it should be noted that:

- The article in correct in citing Butler[4], with respect to indicating that military medical services have existed in Australia since the commencement of white settlement in 1788. However these services were provided in the first instance, by Navy and ex-Navy medical personnel[5]: The first Army health personnel did not arrive in Australia until the NSW ('Rum') Corps took over garrison duties from the First Fleet Royal Marines from June 1790.
- The origins of the modern RAN medic are derived from the UK Royal Navy, which extends at least to the 1740s[6]. From the 18th century 'loblolly boys', through the 19th century 'sick berth stewards' and the 20th

century ‘sick berth attendants’ to the present day Navy medics, their role has always been far broader than caring for combat casualties, and includes supporting the provision of seagoing primary health care, and the inpatient care of non-combat casualties.

- The role of professionally qualified medical, nursing, dental, medical administration, and allied health personnel such as pharmacists, medical imagers and laboratory staff from all three Services are clearly evident and relevant to the provision of Maritime Role 2 health capability from the new *Canberra* class Landing Helicopter Dock (LHD) ships. The role of Navy medics with respect to supporting the professional health staff aboard these platforms can be considered generally comparable to that performed by their Army and Air Force counterparts ashore.
- However the role of Navy medics (and their part-time non-medical Minor War Vessel Medical Care Provider colleagues) is far less well understood, with respect to how they provide health support for maritime operations aboard Navy’s other 16 Major Fleet Units, as well as 23 Minor War Vessels and six submarines. As these platforms often have no medical officer on board, these health staff are often required to undertake the same functions and roles enumerated previously (albeit not always to the same depth), under far more limited and remote supervision compared to most medics from the other Services. These considerations mean that, rather than its professional health officers, it is Navy’s medics (in particular its clinical managers), who are the linchpin of both combat and non-combat health support for maritime operations.

I trust this letter will be considered a constructive elaboration of the issues raised in the article.

Yours sincerely,

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MBBS (Adel), Dip Av Med, MPH, FRACGP, FACAsM, FAFOEM (RACP) psc
Commander, RAN

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Underestimating the burden for peacekeepers? Difficulty in determining psychological well-being following operational deployment with low response rates from NZDF personnel

[1]Karen Brounéus, [2]Mariane Wray & [3]Peter Green

Abstract

Background: Since 2010, the New Zealand Defence Force (NZDF) have used post-deployment psychological screens with personnel returning from operational deployments to predict and support psychological ill-health in returning peacekeepers.

Aim: The objective of this article is to discuss the critical implications of low return rates in follow-up psychological health data in returning peacekeepers. Due to low response rates at the 4-6 month follow up screen, longitudinal analysis of mental health could not be conducted.

Methods: Two sets of responses were analysed using logistic regression from NZDF Post-Deployment screens with personnel who had served in Timor Leste and Afghanistan over the period 2010–2011. The total sample consisted of 695 cases.

Results: This study demonstrates that peacekeeping personnel with post-traumatic stress disorder (PTSD) scores above the cut-off at the initial screen returned the follow-up (FUP) screen to a significantly lower degree than their peers.

Conclusions: The results of this study suggest that among those who did not complete the FUP screen, there may be an over-representation of personnel with PTSD symptoms. If healthier subjects are more likely to return the FUP screen, post-deployment well-being may be skewed towards more positive mental health than is accurate, leading to an underestimation of the mental health burden for returning peacekeepers.

Keywords: Returning soldiers; Post-deployment psychological well-being; Post-deployment psychological screens; Mental health burden; International peacekeeping.

Conflict of interest: The authors declare no conflict of interest.

Introduction

In this article we analyse New Zealand Defence Force (NZDF) post-deployment well-being and psychological health data, collected from Service personnel returning from NZDF operational deployments in Afghanistan and Timor Leste during 2010 and 2011. Our initial aim was to enhance the NZDF's existing Psychological Deployment Support Programme (PDSP) by determining if differences in mental health over time existed amongst sub-sets of the deployment population. However, this aim was not achieved due to low response rates by NZDF Service personnel at the 4-6 month follow-up mark. This article will discuss the critical implications of low return rates of follow up psychological health data after deployment. Research suggests that those leaving Military Service following operational deployment may in fact be those who are struggling the most with psychological post-deployment issues.[1,2] Low responses at the 4-6 month follow up of psychological health data as seen in this study may therefore indicate that the mental health burden of peacekeepers is underestimated.

Ethics approval and funding

This project was ethically approved by the Assistant Chief of Personnel in the NZDF and the University of Otago Ethics Committee (ref. nr. 11/055). The NZDF had previously approved the collection of post-deployment survey data.

Methods

The data analysed in this study consisted of two sets of responses from the NZDF Post-Deployment screens over the period 2010–2011. The first screen, the Initial Return To New Zealand (RTNZ) screen, is administered to personnel in location or in the transition phase on exiting the operating environment. For this study, personnel deployed to Timor Leste completed their Initial RTNZ Screen in Timor Leste, and for those deployed to Afghanistan, they completed their screen during transition from Afghanistan in the United Arab Emirates (UAE). At the 4-6 month mark of personnel having returned to New Zealand, they are administered a second screen through the mail, the Follow Up Psychological (FUP) screen. The data set consisted of 1,000 personnel from two deployments within Afghanistan and one in Timor Leste; of these, all but a handful had completed the first post-deployment screen (Initial RTNZ), and 344 had also completed the FUPS. The matched survey data was received from the NZDF on January 19, 2012.

After initial analyses by the lead author, a statistician* from the University of Otago's Department of Mathematics and Statistics was contracted to explore the possibilities for analysing a data set with high numbers of missing data. A range of different methods were used† to investigate whether more information could be extracted from the data set despite the high proportion of missing data – most importantly, in identifying factors predicting psychological ill-health at the time of FUP screen completion – however, these advanced statistical techniques could not capture more information and did not change any of the conclusions. Therefore, simple descriptive statistics and logistic regression was used owing to their simplicity and ease of interpretation and understanding.

In the following sections, the findings and challenges of the data are reported and discussed. Some suggestions are made for addressing issues associated with the high percentage of missing data within screens and at follow up. The article will finish by identifying some pertinent areas for future research on the psychological well-being of peacekeepers.

Results

As mentioned, because of the large proportion of missing data from the FUP screen, a comprehensive analysis of matched data between the Initial RTNZ and FUP screen results was not possible. Therefore, the analyses reported here are a review of sub-sets of the sample population and the probability of non-responding to the FUP screen. This information is presented in order to begin thinking on the critical issue of how to develop screening procedures that may increase the response rate for the FUP screen. As mentioned, recent research suggests that the initial post-deployment screen may underestimate the mental health burden of returning soldiers,[2] which emphasises the significance of obtaining follow up data.

The original data set consisted of 1000 personnel. Of these, 980 personnel submitted the Initial RTNZ screen. However, nearly one third of these personnel did not fully complete the screen, which creates a selection bias in the Initial RTNZ results. This selection bias impacts upon the ability to gain information from the data, as it is unknown why approximately 30% of respondents chose not to answer certain items in the first screen, the Initial RTNZ. Those who had not completed the entire Initial RTNZ screen were eliminated from the study, in order to create a clean data set of complete case data.

In relation to the FUP screen, individual responses were included in the data set if any of the four scales included in the FUPs (PC-PTSD, K-10, AD and AUDIT‡ had been completed. Two rotations of personnel, one from Afghanistan and one from Timor (N=204), were excluded, as insufficient time had passed since their RTNZ, and they had not yet completed the FUP screen. Subjects without complete PC-PTSD, K10, or AD scores (scales included in both the Initial RTNZ screen and the FUP screen), as well as subjects with incomplete demographic information on the FUP screen were also excluded (N=106). This elimination of incomplete cases left a sample of 695 for inclusion in the analysis.

FUP screen response rates were very low; only 1/3 (approx 35%) of deployed personnel responded. Of the 980 who would have been sent the FUP screen for completion, only 334 had returned a completed screen. This is in contrast to the high response rate of the Initial RTNZ. This disparity in response rates is likely to be related to the administration processes associated with each screen. For those included in this data set, a NZDF psychologist provided them the Initial RTNZ screen on completion of a group psycho-education session on common transition issues. As mentioned above, the completion of this screen was

** Peter Green, co-author.*

† Such as Lasso and Elastic Net.

‡ PC-PTSD: Primary Care Post-Traumatic Stress Disorder screen; K10: the Kessler Psychological Distress Scale; AD: Adjustment Difficulties screen; AUDIT: Alcohol Use Disorders Identification Test.

Table 1. Complete case NZDF Post-deployment screen data, September 2013.

		Complete Case Analysis				
		Count	Any*	Followup	Reg.	Odds Ratio (CI)
Gender	Male	629	15.3%	35.5%		
	Female	66	31.8%	56.1%	15.2%	2.12 (1.10–4.07)
Ethnicity	NZ Euro	375	16.5%	45.9%		
	Asian	14	28.6%	14.3%		
	Maori	247	15.8%	27.5%	-11.1%	0.43 (0.28–0.65)
	Other Euro	28	14.3%	35.7%		
	Pacific Isl.	15	33.3%	20.0%		
	Other	16	18.8%	31.2%		
Age	16-19	70	18.6%	11.4%		
	20-24	239	19.7%	23.4%		
	25-29	163	18.4%	49.1%	31.5%	4.11 (1.66–11.14)
	30-34	92	10.9%	48.9%	27.4%	3.48 (1.23–10.54)
	35-39	63	11.1%	42.9%		
	40-44	34	8.8%	64.7%	32.5%	4.27 (1.15–16.90)
	45-49	16	18.8%	56.2%	41.9%	6.32 (1.35–31.87)
	50+	18	22.2%	72.2%	61.0%	17.22 (3.59–93.04)
Rank	Pte	236	18.6%	17.8%		
	JNCO	242	19.0%	36.0%	12.7%	1.90 (1.12–3.24)
	SNCO	99	8.1%	64.6%	38.0%	5.34 (2.54–11.48)
	WO	21	19.0%	52.4%		
	2Lt-Capt	59	13.6%	62.7%	31.5%	4.10 (1.93–8.87)
	Maj-Col	38	18.4%	50.0%		
Service	NZ ARMY	633	15.8%	34.4%		
	RNZN	33	24.2%	60.6%		
	RNZAF	29	31.0%	75.9%	40.6%	5.98 (2.18–18.52)
Relationship Status	Single	219	16.9%	29.2%		
	Girl/Boyfriend	148	19.6%	29.1%		
	Defacto	171	15.2%	34.5%		
	Spouse	157	15.9%	59.9%	14.5%	2.05 (1.08–3.95)
Mission	Afghan I	118	14.4%	54.2%		
	Afghan II	122	19.7%	41.0%		
	Timor Leste I	198	25.3%	30.8%	-11.1%	0.43 (0.24–0.77)
	Timor Leste II	67	7.5%	35.8%		
	Afghan III	126	11.9%	31.7%	-15.1%	0.25 (0.13–0.47)
	Afghan IV	2	50.0%	0.0%		
	Afghan V	62	8.1%	33.9%	-13.7%	0.31 (0.15–0.66)
PTSD		35			-14.6%	0.28 (0.10–0.68)
Kessler 10		90				
AD		19				

* Scoring above the prescribed cut-offs in any of the three psychological health measures: PC-PTSD, K-10, (A)AD.

conducted either in their deployment location (Timor Leste) or in a third location (UAE), prior to their home coming, and is a requirement of the NZDF post-deployment administrative procedures. On completion of the Initial RTNZ, the personnel return it to the administering psychologist. In contrast, the FUP screen is distributed by mail four–six months later, with an information sheet and a return-addressed envelope. At this time face-to-face contact with a psychologist was not required, and some of the cohort may have left the NZDF by then and/or moved from their last known address.

Table 1 shows the complete case data used in the analyses. The values for PC-PTSD, K-10, (A)AD, or scoring above the prescribed cut-offs on any (marked as 'Any') of these screens, are results taken from the Initial RTNZ screen using the NZDF cut-offs or those recommended from the literature[§]. The 'Follow-up' column demonstrates what percentage of the eligible 334 personnel completed the follow-up screen by category, but not what their scores were on the Follow Up Screen. This information was not included due to the low response rate in comparison to the Initial RTNZ, and the subsequent risk of possibly misinterpreting the results when compared to the Initial RTNZ. For example, Table 1 shows that 35.5% of men from the original sample also completed the FUP screen, compared to 56.1% of women; however due to the small number of women present in the sample (66 persons), this does not enhance the total FUPs response rate. By the same token, we can see in Table 1 that almost twice as many NZ Europeans/Pakeha completed the FUP screen (45.9%) in comparison to Maori (27.5%).

The column 'Reg' displays the results of logistic regression analysis (glm in R[**]) which was used to estimate the effect of demographic characteristics and postdeployment screens on the FUP screen response rate.[††] Results from this analysis are presented as percentage point departures from the baseline score, i.e. the change in the response rate as a percentage, if the responses to the variable in question have altered between response times (Initial RTNZ and FUP screen).

Based on this analysis methodology, the baseline probability for returning a completed FUP screen was 21.6%. This rate is substantially less than the mean response rate, and applies to a hypothetical baseline profile[‡‡]: a male, NZ European aged between 1619, a Private in the NZ Army, employed as a Regular Force Service member, who is single with no dependents, on his first deployment, which is Afghanistan[§§].

This profile was used as the standardised norm against which to compare other variables. For other categories of interest to the NZDF, the following differences can be noted:

Gender

Women were more likely than men to complete a FUP screen, by 15.2 percentage points.

Ethnicity

Maori personnel were less likely to complete the FUP screen by 11.1 percentage points compared to the baseline profile. There is insufficient data to estimate an effect for other ethnicities.

Age, Relationship Status & Family

Older personnel were more likely to return a FUP screen. Subjects aged 50 and over returned a completed FUP screen an estimated 61 percentage points over the baseline profile. However, this estimate is based on only 26 subjects, and conclusions are therefore somewhat imprecise. All respondents over the age of 25 had an estimated response rate at least 25 percentage points over the baseline profile, except those who were 3539. In summary, those aged 20 – 35, and 40 or older were more likely to return a completed FUP screen.

Married Service personnel were more likely to return a completed FUP screen by 14.5 percentage points compared to the baseline profile. No significant difference was found between Service personnel based upon the number of dependents.

Rank, Service, and Mission

Rank had different effects for Other Ranks and

§ The cut-offs used for analysis in this study were PC-PTSD: +1 (from literature), K10: 16+, and AD: 3+ (NZDF cut-offs). With the NZDF cut-off for PC-PTSD, only 1% were above cut-off – too few to get a good estimate of the effect on follow-up. With the standard, lower cut-off (used in other research) we get a significant predictor for nonresponse at follow-up. It may be worthwhile for the NZDF to lower the cut-off to the standard level in order to help identify those struggling with post-deployment.

*** Generalized Linear Models in 'R' – a programming language for statistical computing. †† For these analyses, the "Relationship Status Now" variable was removed from the analysis to avoid multicolinearity.‡‡ In line with praxis, the hypothetical baseline profile was chosen on the basis of the largest category; however, for ordered categories such as age, one end of the scale (e.g. youngest grouping) is chosen if the numbers are very similar. §§ The names of the NZDF rotations to Afghanistan and Timor are classified and therefore referred to simply as Afghanistan I, II, III, etc, and Timor Leste I and II.*

**** The rank abbreviations are as follows: JNCO (junior non-commissioned officer), SNCO (senior non-commissioned officer), 2Lt (second lieutenant, junior commissioned officer), Capt (Captain, commissioned officer), Maj (Major, commissioned officer), Col (colonel, senior commissioned officer).*

Officers.*** In comparison to the baseline profile, JNCOs (12.7 percentage points) and SNCOs (38 percentage points) were more likely to return a FUP screen. The sample size for Warrant Officers was too small to create definitive outcomes, and although no significant effect was found for this rank group, the estimated effect size was positive. For officers, personnel within the ranks of 2Lt to Capt returned a completed FUP screen 31.5 percentage points more often than the baseline profile, but no significant effect was found for those in the rank bracket between Maj and Col.

Personnel from the Royal New Zealand Air Force (RNZAF) were 40.6 percentage points more likely to return a FUP screen, but again this result is not definitive due to the small sample size. There was not enough data on Navy personnel to conduct an analysis on this group. The missions Afghanistan III (15.1 pp), Afghanistan V (13.7 pp), and Timor Leste I (11.1 pp) all had significantly lower response rates of the FUP screen in comparison to the baseline profile.

There was no significant effect on completion of the FUP screen in relation to the number of deployments.

PTSD

Personnel scoring above the cut-offs used in this analysis on the PC-PTSD screen had response rates 14.6 percentage points lower than the baseline profile. This would suggest that among those who did not complete the FUP screen, there may be an over-representation of personnel with PTSD symptoms. However, due to the high levels of missing data, analyses concerning what factors on the PC-PTSD predict ill-health at the time of the FUP screen cannot be achieved. In statistics, this high rate of missing data is called nonignorable nonresponse, and can be explained in the following way.

Suppose that we had a complete set of FUP screen responses which were able to be matched to the Initial RTNZ results from each respondent. If we shuffled the FUP screen responses, split them randomly into three piles, and discarded two of the three, this would be equivalent to having a smaller sample the same as the original sample. The result would be less precise estimates of effect sizes, but no additional bias would be introduced. At the other extreme, if we sorted the interviews into three piles according to one of the measures of illhealth as reported on the PC-PTSD (such as avoidance), and then discarded the two most negative piles, then any analysis of the remaining pile will give us effect size estimates biased towards a lack of avoidance amongst the sample. If healthier subjects are more likely to return the FUP screen, then the current NZDF sample may be skewed towards more positive mental health outcomes in the post-deployment period than is accurate. This would imply that the levels of mental health distress amongst those who have returned from deployment would be greater than that recorded by the NZDF. Any interpretation of results from the screens must carefully take this into account.

Discussion

Since 2010, the NZDF have trialled and implemented the use of post-deployment psychological screens with personnel returning from operational deployments. Little research on this data has yet been completed, and few studies have been conducted on the particular experience of New Zealand Service personnel on operational missions. Aside from psychological well-being, issues relating to adverse mental health outcomes which have occurred as a result of deployment are also likely to impact upon some individuals' decisions to remain in or leave the Service – the issue of retention has been of critical importance within the NZDF in recent years. Therefore, considering the importance of learning more about the relationship between deployment and retention, this survey data has the potential to provide critical information in a number of areas. This NZDF initiative is therefore of great significance.

The major finding from this study highlights the necessity to increase the response rate to the FUP screen so cases can be matched, and also to increase the response rate within each screen, ensuring all personnel complete all items within each screen. Recently, processes related to the administration of the FUP screen have been reviewed within the NZDF in an attempt to increase the response rate, and have proved to be successful in doing so. NZDF are also currently investigating the potential of running all future PDSPs with face-to-face contact with a psychologist, in order to ensure all personnel are provided with the best post-deployment psychological support as is possible.

However, the issue of low response is critical: mental health problems after deployment lead to severe difficulties such as decreased quality of life, psychosocial issues – often with dire consequences for families – or substance abuse. Further, mental health problems post-deployment have been found to be significantly associated with attrition from the military[3] and initial post-deployment screening may underestimate the mental health burden of returning soldiers[2]. Without more information, it is impossible to determine if those who do not complete the FUP screens are experiencing greater rates of post-deployment difficulties and mental health issues. As mentioned, recent studies call for more longitudinal data to determine the long-term implications of deployment[4]; without matching data we cannot know the long term effects of operational deployment for the personnel involved. Enhanced response rates would allow future research to investigate differences within the population and thus allow for targeted interventions and psychological support. Enhancement of the data set could be achieved in several ways, for example by emphasising the importance of answering all questions in the written information sheet attached to the screen, including verbal instruction provided by the administering psychologist and the completion of missing items during the face-to-face feedback with the NZDF psychologist, and a careful review on the layout and format of the screens in an attempt to reduce the likelihood of individuals 'not seeing' specific items.

Additional findings from this study relate to the profile of the non-respondent, and provide initial information on potential areas of risk for the NZDF. However, due to the issue associated with missing data, these findings are inconclusive and further research with a fuller data set is required to substantiate these results. Nevertheless, preliminary results from this study show that the possible areas of risk for psychological ill-health for members of the NZDF during the post-deployment period are associated with those who match the following criteria; male, Maori, aged under 20 or between 35–39, and single. Of interest, in the current study the number of deployments was not significant, although it is hypothesized that this would be a significant variable with regard to mental health outcomes should the data be complete.[5]

More substantially, a recent NZDF study demonstrated that Maori, to a greater extent than non-Maori, leave the NZDF after their first deployment. The reasons for this phenomenon are as yet unknown,[6] but may be correlated with the results from the present study, which highlighted that Maori are less likely to complete the FUP screen because they were more likely to leave the organization following completion of a deployment. However, another possible reason could be higher levels of psychological distress,[2] and less access to psychological support services in the post-deployment period. Such distress may impact upon the decision to leave the NZDF following deployment.

One pertinent question is whether returning Maori Service personnel suffer from greater psychological distress and mental health problems post-deployment than non-Maori, as has been observed in the wider New Zealand population.[7] In order to investigate this issue, we suggest that future research reviews the post-deployment data specifically in relation to ethnicity, mental health outcomes and post-deployment retention. This information would provide the NZDF with critical information regarding Maori and retention, and provide additional information on missing data by addressing the question of whether those who do not respond to the FUP screen are predominantly personnel who have discharged from Service. Addressing the proportionately low response of Maori to the FUP screen may also highlight specific needs of this group during the post-deployment period. Such research would need to examine quantitative results, but also utilise Kaupapa Maori research[†††] approaches in order to deepen the understanding of what specific issues Maori face post-deployment and how this impacts upon retention decisions.

Conclusion

In the present study, follow up response rates from returned NZDF personnel were too low to allow full analysis. However, the results of this study suggest that among those who did not complete the FUP screen, there may be an over-representation of personnel with PTSD symptoms. If healthier subjects are more likely to return the FUP screen, post-deployment well-being may be skewed towards more positive mental health than is accurate, leading to an underestimation of the mental health burden for returning peacekeepers. Recent research has demonstrated that initial post-deployment screens may underestimate psychological ill-health in returning peacekeepers. Hence, the major recommendation of this study is to urgently find ways to increase response rates in post-deployment psychological screens within the NZDF. Such an initiative can potentially both decrease attrition and support those struggling with traumatic experiences after peacekeeping – but who may currently be falling off the radar.

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††† Kaupapa Maori research is a framework or methodology for thinking about, approaching and conducting research, guided by the Maori philosophy and view of the world.

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The impact of a lengthened Australian Army recruit training course on recruit injuries

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Abstract

Background: An Army recruit is required to complete a variety of strenuous physical activities during their training. These activities have the potential to cause a range of injuries.

Purpose: The aim of this study was to determine if the length of a recruit-training program influenced injury rates.

Materials and Methods: Data were obtained from 267 Australian Regular Army recruits that attended basic recruit training, completing either the 80-day Australian Recruit Course (ARC) or the 100-day Australian Soldier Course (ASC). Injury prevalence and injury incidence were determined following analysis of reported injury data (Incident report form AC 563).

Results: Injury prevalence for ASC recruits was 17.8% and for ARC recruits 13.9%. Injury incidence for the ASC and ARC were 17.8 injuries/100 soldiers/100 days and 17.4 injuries/100 soldiers/100 days respectively. The majority of injuries for both courses were sprains and strains.

Discussion: ASC had a notably higher prevalence of injuries compared to ARC. However when considered against cohort size and exposure to training, both courses had similar injury incidence rates. This study found much lower prevalence and incidence rates than those reported in previous literature on basic recruit training. Injury types were however consistent with previous literature.

Conclusions: While potentially appearing to increase reported injuries, longer tactical recruit training programs may not influence the incidence of injuries when cohort size and length of training are considered. The types of injuries suffered by Australian Army recruits undergoing training are commensurate with those of foreign defence services.

Keywords: Recruit training, injury, military training, defence, army

Introduction

Prior to entry into military training courses, recruits must pass psychological, medical and physical screening assessments as well as physical fitness tests.[1] These physical fitness tests can differ between course types[2] and countries[2,3] as well as have different requirements according to gender.[2,3] Despite meeting the entry requirements, it has been found that many recruits may be required to participate in training that exceeds their previous training loads, resulting in injuries such as stress fractures, sprains and strains of joints and adjacent muscles.[4]

Recruit training courses typically include a variety of physical activities such as weight load marching, obstacle assault courses and general physical training.[1,5] In addition to planned physical training sessions, military recruits are required to briskly walk or march between sessions. In the United States, Naval recruits were found to move an additional 20-25 miles (34-40 km) per week marching around their training area.[6] In Australia, Army recruits have been found to march an average of 7.5 km per day (excluding physical training and parade drill.[7] Although it was found that this ‘incidental activity’ or ‘movement mileage’ was of benefit to recruits’ physical fitness levels,[6] no research into potential injuries this additional loading may cause has been found in the literature. Considering this, excessive loading has been found to have a negative impact on recruit health and lead to injury.[6]

One such type of injury is stress fractures. Studies of military programs in the United Kingdom, Israel, and the United States have found that stress fractures sustained during training are the leading form of injury to recruits, with two per cent of male recruits and 12 per cent of female recruits[8,9] and a gender-combined 7 per cent (approximately) of UK recruits sustaining at least one stress fracture in recent studies.[1] These studies identified that the incidence of stress fractures was directly proportional to the training load of recruits, which included the duration and intensity of training programs.[1] As a result of this, it was found that stress fracture rates would peak at the point of maximum training load.[1]

When encapsulated, the above discussions note relationships between recruit injuries and training loads, the physical requirements of recruit training courses and peak injury periods during recruit training. The aim of this paper was to investigate the potential impacts of changes in the length of army recruit training courses on recruit injury presentation.

Methods

Participants:

Participants were Australian Regular Army recruits that attended basic recruit training at the Army Recruit Training Centre (ARTC), Kapooka in 2013. Data were collected from a total of 267 participants from six platoons completing two training courses, the Australian Recruit Course (ARC), made up of four platoons (n=194 recruits), and the Australian Soldier Course (ASC) made up of two platoons (n=73 recruits). Table 1 illustrates the number of recruits and the gender distribution per course.

Table 1: Comparison of the number of male, female and total recruits in the ARC and ASC

Course	Number of Recruits	Male Recruits	Female Recruits
ASC	73	56	17
ARC	194	152	42
TOTAL	267	208	59

All participants were required by the Australian Defence Force to pass their physical fitness assessment prior to commencing their training course. This pre-enlistment assessment consisted of a 20-metre progressive shuttle run assessment (minimum score of level 7.5 for both genders), push-ups (minimum score of 15 repetitions for males and 8 repetitions for females), and sit-ups (minimum score of 25 repetitions for both genders).

Data Collection:

Data were recorded during the two different Army recruit training course types. ARC and ASC, over a one-year period. The ARC was a full time 80-day recruit training course which included basic military and weapons combat training, navigation, drill, advanced field craft and first aid, as well as physical training made up of weight load marching, circuits, obstacle courses, and strength and conditioning. The ASC was a full time 100-day recruit-training course, containing all aspects of the ARC but was designed to have a more gradual increase in load over the first four weeks. Furthermore, the ASC contained additional military field training and an extended field phase.

Recruits were randomly selected for each course with no differences in the recruiting process between the courses. The standards for recruits were the same for each course, with the pre-enlistment requirements for recruits unchanged, e.g. fitness requirements, aptitude and psychological profile. With power set at 0.8 and an alpha level at 0.05, the required number of recruits per group was 64 (total n=128).

Army Physical Training Instructors (PTI) captured the initial fitness assessment data, being push-ups, sit-ups and shuttle run results. However, at the time of the study, only pass or fail data were available to researchers as opposed to raw results (repetitions completed or run times). Injury data were collected by the 1 Recruit Training Battalion (RTB) Unit Safety Manager (USM) as part of the training management injury surveillance plan. This data, collected to inform the ADF Work Health, Safety and Compensation Analysis and Reporting process, was captured through the incidence report form (AC563). The incident report form was completed by the injured recruit or activity supervisor, and submitted to Defence Occupational Health and Safety representatives, in this case the USM. The report form data included the types of injuries sustained, how they were sustained, the bodily site of the injury, what activity was being conducted at the time of injury, and the week of training the injury occurred. Depending on the severity of the incident, legislated reporting time frames ranged from 1 to 28 days.[10] As more than 28 days had elapsed between completion of the selected courses and data collection, all data were considered to have been captured.

Data Extraction and Analysis:

Nominal rolls for each platoon completing the ARC and ASC were attained from the 1 RTB company clerks. The fitness data from PTIs and injury data from AC563s were then aligned to the nominal rolls. Any discrepancies between injury data and nominal roles (for example, a recruit listed in the injury data but not named in the nominal role) were excluded. Reasons for additional names in AC563 may be as a result of incorrect coding, or recruits who re-entered the training program following recovery from injury. Once all data types were aligned, the data were made non-identifiable and the results aggregated.

Injury prevalence represents the percentage of a population injured at a specific point in time.[11,12] For this study, injury prevalence was determined by the following formula:

Injury Prevalence = (number of reported injuries / number of personnel completing respective course) x 100

Injury incidence is defined as the number of injuries sustained during a specific time period within a given population.[11,12] This number may contain only new injuries,[13] may include a combination of both new and recurrent injuries,[12] or may represent the overall number of injuries sustained.[11] For this study the following formula was used to determine the injury incidence:

Injury Incidence = number of injuries / number of recruits completing the respective course / course length in days.

To provide context, these results were then multiplied by 100 to provide an injury incidence per 100 soldiers and then again by 100 to provide a course length of 100 days.

Ethics Approval:

Approval for this study was provided by the Commandant of ARTC with ethics approval provided by the Australian Defence Human Research Ethics Committee and the Bond University Human Research Ethics Committee.

Results

No recruits were excluded from the ASC data, while 23 recruit data sets were excluded from the ARC due to incomplete data entries and/or names not found in nominal rolls. It should be noted that no recruits were returned into the ASC course following injury, while some recruits may have been returned to training into the ARC course, and hence were excluded. During the ASC, a total of 13 recruits were injured (mean age = 26.23 ± 8.9 years). Female recruits comprised 38.5 per cent (n=5) of this injured group. In the ARC cohort, a total of 27 recruits were injured (mean age = 23.11 ± 6.1 years). Thirty three per cent (n=9) of the injured ARC recruits were female. The injury prevalence of each course was found to be 17.8 per cent for ASC recruits and 13.9 per cent for ARC recruits. The injury incidence of the ASC and ARC were 17.8 injuries per 100 soldiers per 100 days and 17.4 injuries per 100 soldiers per 100 days respectively.

Table 2 shows the mechanisms of injuries during both the ASC and ARC. When combining the results of both courses, the top three mechanisms of injury were: the unloading of a weapon due to repetitive biomechanical actions (27 per cent, n=11), running (8 per cent, n=5) and carrying equipment (8 per cent, n=5). The greatest number of injuries in the ASC were caused by unloading of weapons at 34 per cent (n=10) compared to the ARC, where carrying equipment resulted in the most injuries, at 31 per cent (n=4).

Table 2: Mechanisms of sustained injuries during ASC and ARC

	Course	
Mechanism of Injury	ASC	ARC
Unloading Weapon	1	10
Running	1	4
Non Specific	3	3
Falling	1	2
Marching	0	2
Walking	2	2
Carrying Equipment	4	1
Engaging Target	0	1
Making Bed	0	1
Swimming	0	1
Sit ups	1	0

As seen in Table 3, the most significant type of injury overall was strains and sprains, with a combined total of 15 injuries. Excluding those injuries that were unidentified or non-identified, the highest number of injuries were sprains and strains in the 80-day training course, with 33.3 per cent (n=9), followed by bone stress injuries/fractures, with 18.5 per cent (n=5). Likewise, the 100-day recruit-training course also found sprains/strains and stress fractures to be the highest form of injuries, with 46.2 per cent (n=6) and 23.1 per cent (n=3) respectively. The smallest number of sustained injuries within both training

Table 3: Types of injuries sustained during ARC and ASC

	Course	
Injury Type	ASC	ARC
ND / UD	1	11
Strain/Sprain	6	9
Stress Fracture	3	5
Soreness	2	1
Blisters	0	1
Dislocation	1	0

courses were a dislocation and a blister presenting in each course.

Although each Australian training course in the present study ran for different lengths of time, each course began on the Wednesday prior to week one, which was considered week zero, wherein introductory classes and physical training were initiated. As a consequence, injuries were first presented in week zero for the ARC and in week one for the ASC.

The weeks of training in which the reported recruit injuries were sustained are presented in Figure 1. Both courses sustained the most injuries in the final weeks of training and particularly in the last week of their respective course. The 80-day course, the ARC, sustained over half their injuries in the final two weeks (51.8 per cent, n=14), during a field training phase, with the majority of injuries occurring in the final week of training, Week 10 (33.3 per cent: n=9). This finding was similar to the 100-day course, with 38.5 per cent (n=5) of all injuries sustained in the final three weeks of training and the highest number of injuries sustained in the final week of training, Week 13 (23.1 per cent: n=3). It should be noted that the final week for both courses is the recruit's graduation week and loading is typically very low. As such, injury presentations during this period may be due to field injuries sustained the week prior.

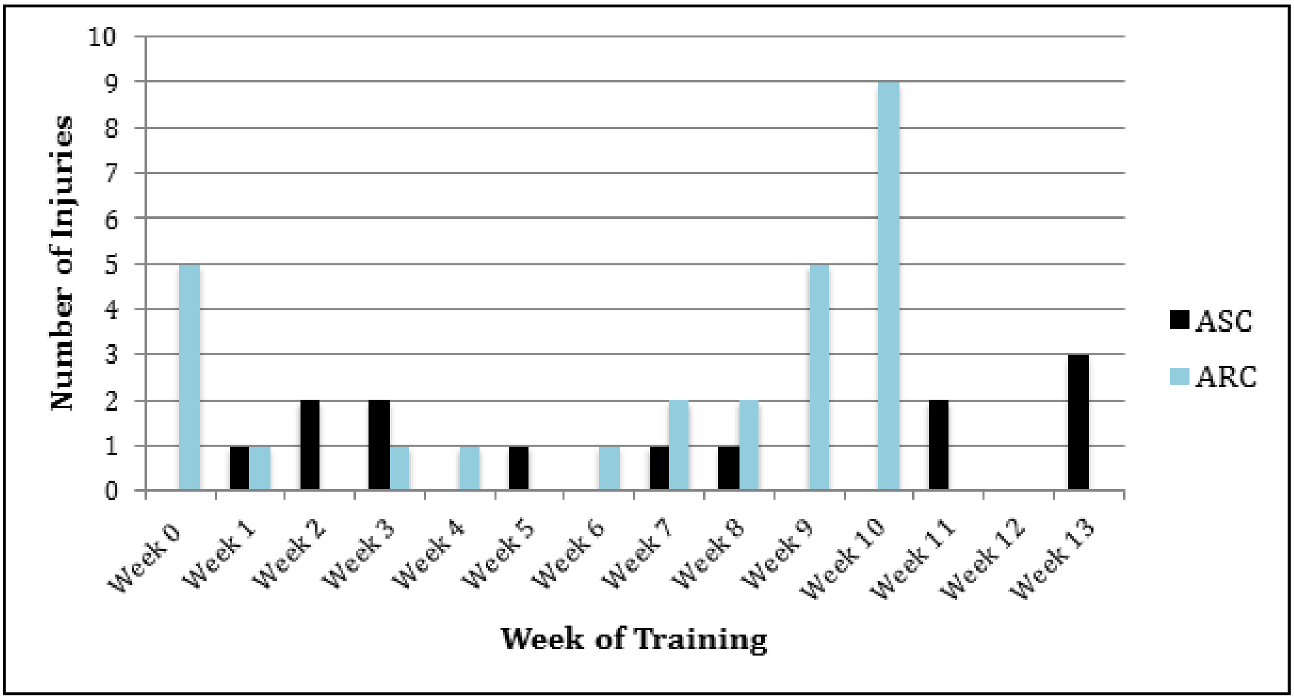
Collectively, the highest anatomical injury sites were the ankle/foot, at 20 per cent (n=8), the back/torso, 12.5 per cent (n=5), and the lower leg which made up 12.5 per cent (n=5) of overall injuries. The most common anatomical injury sites were back/torso (30.7 per cent), ankle/foot (15.4 per cent) and shoulder (15.4 per cent) for the ASC and ankle/foot (22.2 per cent) and lower leg (14.8 per cent) for the ARC.

Discussion

This study aimed to address whether differences in the length of recruit training courses affected the number of injuries that were sustained by recruits. In addition, this study intended to examine any differences between course lengths in injury types, anatomical sites of injuries and the times during the training courses that these injuries occurred.

The ASC course had a notably higher prevalence of injuries when compared to the ARC course (17.8 per cent versus 13.9 per cent). However, when viewed through the lens of cohort sizes and exposure to training, both courses had a similar incidence of injuries. In contrast to previous research, the current study revealed much lower injury prevalence rates than those reported by the Department of Defence,[14] Rudzki,[15] Havenetidis et al.[16] and O'Connor et al.[17] The Australian Defence Force Health Status Report[14] reported an injury incidence rate of 127 per 1000 soldiers per year for the Australian Army program for the financial year 1997/1998, which was found to be 14 per cent less than the average rate of 147 per 100 soldiers per year in 1987 to 1991 in the Australian Army.[15] Havenetidis et al.[16] reported a recruit injury prevalence of 28.3 per cent in 233 male Greek Army recruits over a 7-week time period of basic combat training. However, O'Connor et al.[17]

Figure 1: Injuries sustained in individual weeks of training



discovered an even higher injury incidence during a 6-week training period of 480 Marine Corp Officer candidates. The overall cumulative injury incidence in their study was 60.7 per cent, with male and female cumulative injury incidence of 59.5 and 80 per cent respectively.[17] In addition, O'Connor et al.[17] claimed injury rates of 3.9 injuries per 1,000 person hours of physical training.

Similarly, Havenetidis et al.[16] produced results in which the majority of injuries were reported in the initial two weeks (52 per cent combined) of training on a 7-week basic training course. However, in contrast to the present study, which showed increased injury rates in the final two to three weeks of training, Havenetidis et al.[16] reported a continuous and gradual decrease in injuries and injured recruits towards the final weeks of training.

During the final weeks of training, Australian recruits are sent out on a field exercise and are required to complete a dedicated military skills event in which all aspects of training, pack marching, obstacle and assault courses are completed within a small amount of time. Increased injury rates within the final weeks and particularly the final week of training may be a consequence of this increased training load[6] and increased fatigue levels of recruits.[18]

Conversely, O'Connor et al.[17] found their highest injury rates within the second (18.4 per cent) and third (27.3 per cent) week of training, without looking at hours of exposure to training and the third (6.66 per 1,000 person training hours) and final (sixth) (5.28 per 1,000 person training hours) weeks, when the hours of exposure to training were taken into account. Similarly, the present study found the majority of injuries occurred in the final week of training, 33.3 per cent for the ARC (Week 10) and 23.1 per cent for the ASC (Week 13).

The leading types of known injuries were sprains and strains followed by bone stress when injury data were aggregated. Sprains and strains represented 46 per cent (ASC) and 33.3 per cent (ARC) of reported injuries, and stress fractures represented 23.1 per cent (ASC) and 18.5 per cent (ARC) sustained over the data collection period. These injury types were also found to be the most common type in studies conducted by Havenetidis et al.[16] and O'Connor et al[17]. Furthermore, the Australian Department of Defence[14] reported 39 per cent of injuries in the financial year 1997/98 were sprains and strains of joints and adjacent muscles with fractures (10 per cent) the second leading injury/illness category.[14]

The distribution of injuries by anatomical site among injured recruits was similar but not equal to other military populations in previous studies. Similar to the study by O'Connor et al.[17] Havenetidis et al.[16] and the Australian Department of Defence[14] found the most common injury sites were to the ankle and foot. These sites of injury were also in the top three injury sites in studies by Knapik et al.[19] and Ross and Allsopp.[1] Other anatomical sites found to be of significance were the knee, tibia and lower limb in general,[1,19] all of which were also sites of injury in the present study.

Limitations:

Two key limitations were noted for this study; limited fitness data and lack of more detailed injury information. Due to data restrictions at the time of the study, only pass/fail data were available for physical fitness assessment results. However, as all recruits are required to pass this assessment, excessively low fitness levels should have minimal impact on the injuries sustained.[20] Additionally, the severity of recruit injuries in the study was unknown, including how much time the recruits required off training, or if indeed they had to be withdrawn from training altogether. As such, while both courses may have had a similar injury incidence, one course may have had injuries which were more severe in nature.

Conclusion

While the ASC had a higher prevalence of injury, when injuries took into account exposure, incidence rates between the courses were virtually identical. When considering the ASC against the ARC, recruits were no more likely to be injured on one course over the other. However due to limited data, any potential differences in injury severity between courses could not be determined. Future research examining injury differences between different course lengths would benefit from the inclusion of fitness data and the quantification of injury severity.

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Traumatic brain injury – A time to reappraise – a wake-up call

Roy G. Beran

Abstract

Mild traumatic brain injury (mTBI) is becoming topical with potential association with post-traumatic stress disorder (PTSD) and dementia and questions are being raised for the Defence Forces. Traumatic brain injury results from head trauma causing altered consciousness or post-trauma amnesia and may be categorised as mild, moderate or severe. It has been recognised since World War I and has re-emerged as a source of concern in sports men and women with potential litigation becoming a reality. Its association with PTSD, cognitive dysfunction, depression and other neurological symptoms is being increasingly recognised with new imaging techniques demonstrating pathology not identified in standard CT and MRI. In June 2012, a U.S. class action for 2.500 football players was initiated and has the potential to be the forerunner of similar actions within the Defence Forces.

Introduction

Issues related to mild traumatic brain injury (mTBI) barely raised a ripple on the surface a little more than a decade ago. Since then there has been a groundswell of interest and investigation which has the potential to become a veritable tidal wave, which may cause a tsunami, the impact of which will be felt for many decades to come.

The connection between mTBI and such conditions as post-traumatic stress disorder (PTSD) or Alzheimer's Disease (AD) are yet to be fully appreciated.[1-3] The legal medicine ramifications for organisations which hold vicarious liability for those working within them, or for them, has not yet fully bubbled to the surface.[4] When it does, it will create waves that most people in authority have chosen to ignore. There was a preliminary approach, by Joint Health Command (JHC), for the Australian Defence Forces (ADF), to create both a centre of excellence for the study of mTBI and to establish a legal medicine service operating within JHC but neither eventuated. The question arises, "Should they happen now or is it already too late?".

What follows is a very brief overview of some of the ramifications and consequences of mTBI which should act as a wake-up call, leaving it to the reader to decide the answers to the above questions.

Definition

Traumatic brain injury (TBI) is defined as head trauma resulting in altered or lost consciousness or the experience of post-traumatic amnesia.[5] Military personnel experience TBI with falls, motor vehicle accidents and blasts.[1] Blast-related TBI may be associated with barotrauma, consequent to dynamic changes in atmospheric pressure, or blast forces causing direct impact as a result of provoking the head to hit, or be hit by, foreign blunt or penetrating objects.[6] Blunt force TBI is classified by severity into mild, moderate or severe with mTBI being the most frequently encountered,[1] especially in serving military people.[7]

Some Historical Perspectives

Potential consequences of mTBI are not a new realisation, even within the modern era of medicine, with preliminary commentary dating back almost a century,[8] to World War I. The newer realisation that blast injuries are associated with serious consequences re-emerged after World War II[9-11] with a better appreciation of the neuronal consequences following rapidly from that knowledge.[12-14]

There has been a significant Australian connection providing a better delineation of the neuropathology associated with mTBI, through the contribution of Blumbergs and colleagues.[15-17)] His focus on amyloid precursor protein should have sent warning bells ringing for the later understanding of the degenerative consequences that are provoked by mTBI, as has emerged in sports men and women.[18-22] Again this has had a significant Australian connection, looking particularly at Australian football players and the consequences of concussive head injuries.[23-30] McCrory also examined the American Association of Neurologists (AAN) guideline,[21] related to head injuries and sport, and concluded there remains a paucity of scientifically evidence-based guidelines for sports people,[30] which bodes poorly for military personnel.

While military conflict is not the favoured weekend spectator activity, sport is! The realised serious consequences of mTBI in sport have triggered legal medicine ramifications with a class action against the National Football League (NFL) and the helmet manufacturers in the US.[4] The consequences of this, for the ADF, are yet to emerge.

In a critical review of the prognosis of mTBI, a decade ago, the authors wrote, "… For adults, cognitive deficits and symptoms are common in the acute stage, and the majority of studies report recovery for most within 3 - 12 months. Where symptoms persist, compensation/litigation is a factor …".[31]

It is argued that a decade later there continues to emerge epidemiological data attesting to the serious consequences of mTBI. There is evidence that mTBI independently increases the risk of ischaemic stroke by more than 30%, according to a study of over 1 million trauma patients.[32] With this type of evidence emerging, the time for cavalier disregard for the consequences of mTBI would seem quite inappropriate.

The same group who raised the spectre of "compensation/litigation", a decade ago,[31] have also examined the inherent costs, at that time, without definitive findings and concluded, "… The sparse scientific literature in these areas reflects both conceptual confusion and limited knowledge of the natural history of mild traumatic brain injury …"[33] While this may have been true a decade ago, the emerging data suggest one can no longer ignore what seem to be established sequelae of mTBI and what also appear to be unequivocal foreseeable risks, with definite implications for duty of care.

Overview of mTBI

As stated earlier, much of the current understanding of mTBI has emerged from investigation of sports-related concussion. Investigation of almost 3,000 US College footballers, between 1999 and 2001, covering ~ 4250 play-seasons, revealed 184 (6.3%) had concussion, of whom 12 (6.5%) had repeated concussion in the same season.[18] An association was found between reported number of previous concussions and the likelihood of the incident concussion, suggesting a subsequent predisposition.[18]

Players, with at least 3 previous concussive episodes, were three times more likely to have the incident concussion, provoking inclusion within the study.[18] Headache was the most common symptom with mean duration being 82 hours, with slow recovery following multiple concussions (30% who experienced at least 3 concussive episodes took more than one week).[18]

Major depression has been recognised in association with mTBI and may influence prognosis.[34] Seventy-four patients with TBI were assessed, of whom 21 (28%) met criteria for major depression, being older than those without (41 v 32 years; $p < 0.01$) and more likely to have a past history of depression (24% v 6%; $p < 0.05$).[34] There was no other difference regarding gender, educational status, marital status, employment, previous TBI, premorbid intelligence, family psychiatric history or past substance or alcohol use.[31] Mechanism of injury, other injuries, CT scanning, Glasgow Coma Scale scores and duration of post-traumatic amnesia were also similar between both groups.[34]

At six months post TBI, major depression was associated with worse performance on tests for attention, memory and executive function. While > 50% of those without depression had no impairment of cognition, this was only true of 15% of patients with major depression.[34]

There is further evidence for the association of mTBI and PTSD in ~30-40% of those with mTBI. Of more than 2,500 US troops returning from Iraq, ~ 5% reported loss of consciousness, of whom ~ 44% met criteria for PTSD.[35] Soldiers with mTBI, especially with loss of consciousness, had greater risk for poor general health, missed days from work, medical consultations and increased somatic and post-concussive symptoms, although adjusting for PTSD and depression resulted in removing these as significant factors[35] other than the presence of headaches.[35]

Taber et al[36] examined blast related TBI and noted the common occurrence of soldiers becoming dazed or unconscious following an explosion, which caused no external evidence of injury but provoked associated prograde or retrograde amnesia. Almost 60% of the "at risk" group of injured soldiers, returning from Iraq or Afghanistan, to the Walter Reid Centre (2003 - 4) had at least mTBI while in combat with TBI consequent to closed head injury occurring in ~ 90%.[36] More than 50% (665/1303) with only lower limb explosive injuries had neurological symptoms, including headache, insomnia, psychomotor agitation and vertigo, consistent with TBI.[36] Of these, a third (36%) showed electroencephalographic abnormalities with ongoing symptoms.[36] The TBI is thought to result from secondary and tertiary blast injuries.[36] Comparing blast and non-blast mTBI subjects, concussive symptoms, psychological symptoms and neurocognitive performance within 72 hours of exposure, showed no real differences.[34] Both groups showed clinically significant impairment of cognitive reaction time, thought to relate more to duration of loss of consciousness rather than injury mechanism.[37]

Among surviving soldiers, wounded in combat in Iraq and Afghanistan, TBI accounts for a greater proportion of casualties than was the case in previous conflicts.[38] While there appeared to be some remarkable recoveries in the relatively short term,[38] as reflected by return of function, the long-term consequences are extremely guarded when interpreted in the light of the evolving data related to mTBI in sports men and women.

Nature of Injury and Investigations

The recognition of axonal damage following head injury is not new[12] with techniques using magnetic resonance imaging (MRI) employing diffusion tensor imaging (DTI), are providing additional confirmation consistent with traumatic axonal injury.[39]

Not all those with mTBI show abnormality on DTI, thus confirming mTBI as a clinical diagnosis.[39] Bazarian et al[40] have explored the numerous investigative tools used to examine brain injury following concussion. These include sophisticated MRI with functional imaging or DTI (as cited above), single photon emission computer tomographic scanning, serum biomarkers, formal cognitive and balance tests and positron emission tomography.[40] Micro-structural white matter lesions are detectable by DTI and correlate with cognitive deficits identified in mTBI, when other techniques fail to do so.[41] A recent case, presented to the Australian Defence Force Reserves NSW Health Triumvirate[42] demonstrated convincing evidence of a soldier presenting with mTBI, complaining of headache, with normal CT scan of the brain and 1.5 Tesla MRI of the brain, who had clearly demonstrable evidence of an intracranial bleed using 3 Tesla MRI, with the addition of susceptibility weighted imaging.

It follows that the evolution of greater technology and the capacity for better imaging techniques must be considered when the clinical picture suggests mTBI. Without such an approach, it could be argued patients were provided suboptimal care within the context of current knowledge.

Legal Medicine Considerations

In June 2012, a class action for more than 2,500 football players was initiated against the US NFL and helmet manufacturer Riddell Inc. in the US District Court for the Eastern District of Pennsylvania.[4] Causes for damage included: wrongful death; several varieties of fraud; negligence – referenced over different periods (pre-1968, post-1968, 1987-93 and post-1994); plus negligent hiring and retention.[4] In addition, the plaintiffs alleged several strict product liability claims, including design and manufacturing defects, failure to warn and general negligence regarding Riddell Inc.[4] The plaintiffs also alleged a civil conspiracy jointly against both defendants.[4]

An underlying issue, in the NFL concussion litigation, is the notion that the NFL did not provide sufficient resources to accommodate the long-term health needs of its retired players.[4] In 2002, Bennet Omalu, a forensic pathologist, conducted autopsies on former NFL players and found evidence of chronic traumatic encephalopathy similar to that found in former boxers[4] and claimed that a single episode of mTBI could take months, rather than hours or days, to recover.[4] The role of amyloid precursors, in mTBI damage, has been reported almost 20 years ago[14] and these same precursors are recognised to be involved in so-called tau pathology thought to be a consequence of chronic traumatic encephalopathy.[4] There has been evidence,since 1980 that these proteins remain in the brain for at least 3 months, thereby suggesting that the paucity of symptoms, associated with post-concussive status, need not equate to the brain having recovered from a concussive episode.[4]

It is important, within the ADF, to appreciate that there are many more potential litigants re mTBI than might have been involved in the NFL, resulting in a class action. There is far more potential for serious and repeatedly significant exposure to blast and concussive head injury.

Conclusions

Appreciation of the consequences of mTBI is gaining momentum with sports people leading the charge. There is evolving litigation, especially in the U.S., and sporting clubs are considering the consequences of allowing those so exposed to continue participating within the sporting activities. This raises questions regarding a need to provide better 'duty of care'.

The history of mTBI is not new, within the military context, with very important publications dating back 100 years to World War I and re-emerging after World War II. It follows that no one could claim ignorance of what is gaining greater recognition.

Our understanding of mTBI is growing on a daily basis but still requires a real focus to better delineate what might be expected and what kind of services and intervention may be required to adequately meet the expectations of serving personnel, both within the present climate and into the future.

It is argued that the litigation being undertaken against the NFL and helmet manufacturers is only the tip of an iceberg, and is reflective of U.S.

experience which may not directly translate to Australia. Despite this disclaimer, such litigation may have far greater ramifications for the military environment than it does in sport. This realisation should cause those in authority to reflect upon what is happening and what may happen into the future.

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Changes to the landscape of GP training, but some aspects stay the same. Should we expect further delays to medical officer training progression?

Scott Kitchener

Abstract

ADF medical officers must complete military, military health and civilian GP training to progress to the independently deployable status of Medical Level 3. (ML3). Changes to administration of the Australian General Practice Training program (AGPT) is making recruitment more challenging for medical officers. Budget changes have removed the prevocational GP placement program that supported progression to Medical Level 2 (ML2) when medical officers are deployable under supervision. Regional training providers [of the AGPT] still experience difficulty finding GP training placements and integrating GP training with military and military health professional development, and the regional nature of these providers does not serve the national mobility of ADF registrars. AGPT Policies for ADF GP training are outdated. As a result ADF registrar training continues to be delayed compared to that of civilian registrars.

Changes to the AGPT Program and continuing issues in the efficiency of civilian GP training for ADF medical officers will require reconsideration of coordination of this element of training to avoid restricted availability of deployable medical officers.

Introduction

To progress from a newly graduated and registered medical practitioner to an independently functioning military medicine practitioner, Medical Officers (MO) and Medical Commanders need to consider new approaches to acquire civilian medical training. Securing civilian medical postgraduate training places for medical officers is becoming more competitive, associated with national medical workforce growth and changes to the civilian training support program in the Federal Budget 2014. Further delays in medical officer progression to ML3 may result without reconsideration of coordination of civilian GP training for medical officers.

Background

Along with military and military health training, MO must complete further medical training to achieve the standard of Medical Level 3 (ML3 - deployable unsupervised).[1] The majority of MO will be required to complete Primary Care postgraduate medical training to the standard of vocational registration with the Medical Board of Australia, usually by achieving Fellowship in either the Royal Australian College of General Practice (RACGP) or potentially in the Australian College of Rural and Remote Medicine (ACRRM). The latter has not been a commonly used pathway to date.

The current model of training for Medical Officers utilises the Commonwealth funded Australian General Practice Training (AGPT) program to support training requirements towards Fellowship.[2] The AGPT financially supports Regional Training Providers (RTP), which provide logistic and academic support to Registrars including those in the ADF.

Changes to the landscape of civilian training support will potentially compromise the progression of ADF Medical Officers towards ML3. Recruitment of MO to RTP has become more competitive and funding for ADF MO training by RTP has changed and may change further. Some things that have remained the same are the difficulty RTP experience in understanding and supporting ADF MO and the delays in the time taken for ADF MO to complete civilian training in General Practice.

This paper will detail these issues and open discussion on the potential impact.

Recruitment of ADF MO to RTP is becoming more competitive

Competitive selection to the AGPT is required for the limited places available and to satisfy College requirements for entry to training. Selection may occur during any postgraduate year, beginning with

Internship (postgraduate year 1) for commencement on the Program in the following January as an ADF registrar.

The Commonwealth has steadily increased the places available on the AGPT Program. From a modest program attracting 675 applicants for 600 positions in the 2005 entry,[3] the appeal of general practice training has grown. The AGPT attracted 2245 applicants sitting the entry examinations for 1500 positions beginning in 2015.[4,5]

With increasing numbers of applicants, ADF registrars, who were previously additional to the registrar numbers allocated to each RTP, are now included under the cap for each RTP. This increases the need for ADF applicants for AGPT to be competitive for these limited positions, in addition to being competitive to join a College training program.

Changes in funding for ADF MO civilian training

While an increase in registrar places available appears to be a positive for ADF MO, funding for these places has come from ceasing the Prevocational General Practice Placement Program [PGPPP]. This program served the ADF well, providing funded, supervised, civilian general practice exposure during postgraduate year 2 that has expedited progress to ML2. These terms could be recognised as meeting hospital training time (RACGP Hospital terms or ACRRM Core Clinical Training terms) for the purposes of the AGPT. Loss of this program will reduce such opportunities prior to medical officers beginning return of service obligations, so delaying progress to ML2.

Further significant changes in the Federal Budget 2014 reduced [AGPT] funding for State employed registrars in order to make savings to expand the program elsewhere. The focus of this direction is toward supporting more training in private general practice. This is entailed in the reformation of Federalism being undertaken by the Commonwealth Government in defining State sovereignty.[6] Risk exists for compromise to funding for GP training of ADF medical officers. Support for registrars not engaged in private general practice will need to be reviewed and negotiated with the Department of Health as funding for training is reformed.

RTP difficulties in supporting ADF MO

Regional Training Providers have gathered annually at the GPET (GP Education and Training) Convention to discuss [their] issues with ADF Registrar training. The themes remain constant.[7,8,9]

Issues include:

- Transfer of ADF Registrars between RTP, commonly required due to the regionalised nature of RTP and ADF MO required to choose a RTP long before they receive their posting for return of Service that will determine their training location.
- Limited harmonisation of policies between RTP regarding hospital terms, recognition of prior learning and release of ADF Registrars for civilian placements.
- Management policies of billings arising from civilian practice placements.
- Apparently inconsistent and variable availability of MO for civilian placements.
- ADF registrars without a civilian placement, or more commonly left with the placements remaining after civilian registrars have already chosen earlier in the academic year and before military and military health courses have been completed by ADF registrars. This is particularly a problem in RTP, when registrars must find their placement among the list of available training practices rather than actively choosing their position.

Some RTP have been critical of the medical training available to ADF MO, insisting on a further release of ADF registrars to civilian practices for training.[10] Concerns of the quality and adequacy of civilian supervision in the ADF have also been raised as limiting to the training of ADF registrars.[11]

In fairness, difficulties with managing the training of ADF registrars by civilian RTP do arise because of confusion about the requirements for civilian training. The AGPT policy guiding ADF Registrar training was last issued in 2008 as a “transition” policy.[12] It was recently updated as the sponsoring authority, [GPET], was being dissolved in December 2014. The policy will require further review since it is exclusively related to RACGP involvement and silent on ACRRM training, and still refers to the now non-existent PGPPP. This will leave further uncertainty regarding policy.

Nevertheless, AGPT Guideline s3.1.2.5 clarifies that ADF registrars require six months full time equivalent in civilian general practice and this is a requirement for both RACGP and ACRRM training. Both this guideline and the new AGPT policy for ADF registrars recommended GP terms be completed during hospital rotations in postgraduate year 2. Of course, with the demise of the PGPPP also in December 2014, this will be difficult and potentially cause a resurrection of RTP advising ADF Registrars to acquire this placement by resigning their hospital post before completing two years of hospital rotations and consequently the College-required exposure to hospital rotations.

Beyond this issue, with the increasing number of registrars seeking private practice placements, the opportunities for ADF registrars to secure such placements to meet College requirements will become more difficult. Rather than having to accept placements left over after civilian registrar placements, ADF registrars may be left with no civilian training placement options as training capacity is reached.

Notwithstanding the inherent difficulty in integrating GP training by a civilian organisation with military and military health training by each of the three uniformed Health Services, shifting and uncertain policies make efficient coordination of a training program for a registrar by a RTP almost unachievable.

Training transit time for ADF registrars

The ease of fit of civilian coordinated GP training with military and military health training during the early years of medical officer service in uniform has been previously discussed in this Journal.[13] Analysis of training time of registrars on the AGPT Program in 2011 found there were training delays of ADF compared to civilian registrars.[14] At the time, 51 ADF registrars had completed FRACGP through the AGPT Program, taking an average of 4.42 years including 48 weeks recognition of prior learning [RPL]. This was 0.4 years longer than 2226 civilian registrars who had similarly completed training. At this time, few if any military health and military training courses were recognised for the value they provided in preparing an ADF registrar for practice in the military cultural environment. With the annual intake of ADF registrars, this delay translates into several full time equivalent independently deployable medical officers per year not available to the ADF. Central coordination of ADF registrars, rather than regionalised training provision, and understanding of military health training and experience were recommended.

In 2014, several military health training courses have been recognised for College training. Repeating this analysis in 2014, it is found that registrars now join the AGPT earlier, evidenced by much smaller claims of RPL with time credit [6.08 weeks, SD: 16.76 weeks], than civilian registrars who claimed a mean of 18.10 weeks [SD: 25.51 weeks]. However, mean time from AGPT start to FRACGP for 208 ADF registrars was 4.34 years [SD: 1.28]. In this period 6785 civilian registrars took on average 3.46 years [SD: 1.38] to FRACGP. Accounting for differences in RPL, ADF registrars averaged total time to completion of FRACGP on AGPT of 4.48 years [SD: 1.32] which remains longer than the 3.81 years [SD:1.46] taken by civilian registrars. These are overlapping distributions, but they appear to be diverging. The delay in ADF registrar training remains the same.

Conclusions

ADF medical officers will find it more challenging to secure positions on the AGPT should the current arrangements of recruitment to RTP for access to the AGPT Program continue.

The loss of funded prevocational general practice placements as part of hospital rotations during postgraduate year 2 and difficulties in securing any private practice training placement will cause delays in progression to ML2 and potentially compromising progress to ML3, depending on how RTP manage acquisition of civilian GP training placements.

Uncertainty exists with potential changes to funding of RTP for registrars not engaged in private general practice. These may further reduce the desirability of ADF applicants to RTP, when these Providers continue to find their management difficult.

The civilian-coordinated regionalised approach to support general practice training of the national ADF medical officer workforce hasn't been as efficient as it is for civilian GP registrars. A more standardised approach to ADF registrar training needs to reflect the national and international mobility of Defence registrars and the imperative to integrate and recognise military health training and experiences.

An updated AGPT approach to ADF registrar training is well overdue. This should proceed in partnership with the Health Services responsible for medical officer training. Recognition of the changing landscape of GP training and the more intractable issues now well known to current and past ADF registrars should permit a new training coordination solution to arise. A dedicated national ADF training provider partnership, preferred regional providers with focus on ADF training needs, or an integral training capability for GP training are such solutions. As highlighted in 2011, central coordination and better understanding of military and military health training integration should be re-considered.

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Excerpt from HMAS Sydney I medical officer's log during action with SMS Emden 09 November 1914[1]

Action with S.M.S. Emden off Cocos Island – 9th November 1914

Surgeon Leonard Darby

10 November 1914 (Excerpt 2)

Early next morning we arrived off Cocos Island, near the cable station, and having ascertained the damage done we took off the Eastern Extension Telegraph Co's Surgeon, Dr. H.S. Ollerhead, to help us with the German wounded. We then steamed back to North Keeling Island to the Emden. We now had the sick bay rigged up as a theatre, having unshipped the beds and made as much room as possible. Our great difficulty was lack of space and trained assistance. We had used up all the sterile towels on the previous day and had no chance of getting more.

The shortage of trained theatre staff, with lack of conveniences, caused much delay in the preparation of the theatre between each case, and the actual operations were delayed for the same reason. There was also much delay in getting instruments sterilised, and one could not get what was required in good time. Consequently, the asepsis was not what it might have been. Later in the day we organised a theatre staff from volunteers. They helped to clear up, held basins and receptacles and got things for one, and did remarkably useful work with composure that was astonishing, since they were present at many bloody operations and gazed upon some sights to which none of them had been previously accustomed. Surgeon Todd acted ably as anaesthetist and Dr. Ollerhead assisted me with the operations.

The first case we took was "B", A.B. He had had a restless night, and from his dyspnoea and the oozing of blood it was obvious that there was much blood in his pleural cavity. His colour was bad, likewise his pulse. Chloroform was administered. Examination showed that a fragment the size of sixpence had entered his chest in the right axilla and had tracked downwards and forwards to the left, through the pleural cavities finally emerging through a large ragged hole just below the apex of the heart. In fact soon after the injury the apex of the heart could be seen emerging with each thrust. A piece of the sixth rib had been carried away leaving a gaping wound. This wound was enlarged, a piece of the rib removed, and a search was made for bleeding points. This search could not be prolonged owing to the patient's condition so I swabbed out the blood from the left pleural cavity, and a considerable amount of gauze was inserted therein and a tight bandage and pad then applied. The patient was removed to the only bed left in the sick bay, and saline given subcutaneously. The patient rallied considerably, but later on haemorrhage occurred, and he died two or three hours after operating.

The next case taken was "J". This case was shorter and less serious. He had been struck from behind by a bursting shell and obtained numerous wounds in both lower limbs. His left leg had been traversed by a fragment which left a jagged sinuous hole through the calf, just below the knee joint. His right calf was pierced, having a large ragged hole, charred at the edges, the fragment being deep in the muscles. There was another smaller deep hole in his right thigh on the inner surface, and numerous smaller wounds on buttocks and back. The patient had had considerable haemorrhage which was controlled by plugging and pressure. Search was made for fragments, but none could be felt with a probe, and it was decided not to cut down and look for them because more harm than good would have been done. The wounds were, therefore, thoroughly cleaned and syringed out with Hydrogen Peroxide and plugged with Iodoform gauze and with careful dressing they remained clean, and patient was doing well when he left the ship. There was a good deal of destruction of muscles and nervous tissue, but the main vessels and nerves had presumably escaped more or less. An X-Ray photograph, taken at Colombo Hospital, showed numerous pieces of shell in his right leg, none very large, and it was there decided that it would be unwise to remove them then.

1 *From translation held in Mitchell Library, State Library of NSW, with minor corrections from original hand-written document.*

By this time we had returned to the Emden which was flying distress signals, and arrangements had now to be made for the transhipping and receipt of about 80 German wounded. The figures are the estimates of the surviving German Surgeon, and there was never an opportunity of verifying them, but they are considered approximately correct. All available stretchers, hammocks, and cots were sent to the Emden with a party, under Dr. Ollerhead, who did not return until the last patient left the Emden some five hours later. Even then some Germans who had got ashore could not be brought off until the following day (Wednesday). The transhipping was an exceedingly difficult and painful undertaking, as there was a large surf running on the beach where the Emden went ashore, and she was so much of a shambles that the shifting, collecting and lowering of the wounded into the boats was necessarily rough. They were hoisted on board us in cots and stretchers by means of davits, but there were no such appliances on the Emden. One German Surgeon, Dr. Luther, was intact, but he had been unable to do much, and for a short time was a nervous wreck, having had 24 hours with so many wounded on a battered ship with none of his staff left and very few dressings, lotions and appliances. The state of things on board the Emden, according to Dr. Ollerhead was truly awful.

Men were lying killed and mutilated in heaps, with large blackened flesh wounds. One man had a horizontal section of the head taken off, exposing mangled brain tissue. The ship was riddled with gaping holes, and it was with difficulty one could walk about the decks, and she was gutted with fire. Some of the men who were brought off to the Sydney presented horrible sights, and by this time the wounds were practically all foul and stinking, and maggots ¼ inch long were crawling over them, i.e., only 24 hours to 30 hours after injury. Practically nothing had been done to the wounded sailors, and they were roughly attended by our party and despatched to us as quickly as possible. A Cook's mate, named Fulton, did some exceedingly disagreeable work with great credit to himself in connexion with this.

The best arrangements possible were made under the circumstances for the receipt and treatment of the wounded as they arrived. All blankets and beds available were drawn from the stores, and most of the officers went without them. Still we had nothing like enough, and the German Sailors had, in many cases, to put up with beds most unsuitable for wounded men. As they came on board they were taken down to the temporary hospital in the ward room, where Surgeon Todd and myself attended the more serious cases and directed the first aid party with the simpler ones. I tried hard to keep the sick bay clear and ready for operations later, but we were soon crowded out of the ward room and the sick bay had to be used as a dressing station, the wounded being placed along the neighbouring corridors and spaces adjacent and soon there was scarcely room to move there.

Besides the 70 wounded received that day, there were over 110 prisoners and 20 chinamen from the sunken collier, so the crowding can be imagined, seeing that we were a crowded ship before. Of necessity the work done now was only immediate and temporary till the cases could be sorted out and put under anaesthesia in a clear theatre. From 35 to 40 of the cases were serious, the rest being more or less slightly wounded, and they were able to help themselves somewhat and wait. The condition of many was pitiable, some had legs shattered and just hanging; others had shattered forearms; others were burnt from head to foot; others had large pieces of flesh torn out of limbs and body. One man was deaf and dumb, several were stone deaf in addition to other injuries.

The worst sight was a poor fellow who had his face literally blown away. His right eye, nose, and most of both cheeks were missing. His mouth and lips were unrecognisable, the tongue, pharynx, and nasal cavity were exposed, part of his lower jaw was left and the soft tissues were severed from the neck under his chin, so that the face really consisted of two curtains of soft tissue hanging loosely from the forehead, with a gap in the centre like an advanced case of rodent ulcer. In addition, the wound was stinking and foul with copious discharge. The case was so bad that I had no hesitation in giving a large dose of morphia immediately, and after cleaning the wound as well as possible, a large dressing was applied, and he was removed to the fresh air on deck. The odour was appalling and it was some time before the sick bay was clear of it. The patient lingered from four to six hours afterwards in spite of repeated liberal doses of morphia. Another face injury was nearly as bad. Practically the whole right side of the face was completely blown away. His temporal, pterygoid and maxillary regions were deeply exposed, and temporo-mandibular articulation was entirely removed. One had not time to examine these cases for minute details, but they were very instructive, and showed how hard it is to kill a man with face injury. In addition, the wound was septic and most offensive.

I had no hopes for his life when he arrived, but he seemed to struggle on and five days later on arrival at hospital at Colombo, it seemed likely that he would live. Later news tells us that the patient is doing well and they hope to fit him out with an artificial right half to his face.

There were four cases of fractured forearms two of which I amputated in the middle third of the arm – both did well. There were only two cases of fracture of the lower limb, both being the leg, which was in each case badly mutilated. One was amputated successfully in the middle third of the leg by the German Surgeon; in the other case I had to amputate through the lower third of the thigh. This case died.

Another face injury was rather severe. He had his right cheek turned down as a flap from the level of the upper lip, in addition the mandible was fractured and a piece of skin, fascia, and muscle the size of a large plate was blown out of the middle of the anterior surface of the left thigh. Later, when we were attending this case, it was suggested to me that the limb be removed. But though there was much destruction of tissue, and the wound was very foul, I refused to allow this to be done and after events proved the wisdom of this, as the wound cleaned up and the limb was saved.

There were many cases of severe burns, two of which had head injuries in addition and died on board. One of these was an engineer, who had suffered from pneumonia for six weeks on board the Emden. Altogether four deaths occurred on board us from among the German wounded. Most of the remaining cases had multiple lacerated shell wounds, with smaller or larger pieces of flesh blown away or penetrating tortuous holes, with metal buried in the tissue. Quite often this metal was found just under the skin on the opposite side of the limb. Most of the wounds were charred. In one case a large amount of gluteal tissue was taken out in the region of the right anterior superior iliac spine with fracture of the ileum. This man, in addition had a compound fracture of the right arm and numerous other wounds. A man was very lucky if he had less than 3 separate shell wounds. He was in a very low condition when we landed him, and it is doubtful if he will live.

In cases where large vessels of the leg or arm had been opened, we found tourniquets of pieces of spun yarn, or a handkerchief, or a piece of cloth bound round the limb above the injury. In some cases, I believe the majority, they had been put on by the patients themselves. One man told me he had put one on his arm himself. They were all in severe pain from the constriction and in all cases where amputation was required, the presence of these tourniquets made it necessary to amputate much higher than one would otherwise have done. But no doubt their lives had been saved by the tourniquets. There was very little evidence of any skilled treatment before they arrived on board. Naturally the German Surgeon had been very much shaken and handicapped. His station in action was the stokehold, which was uninjured. His Assistant Surgeon was less fortunate, his station being the tiller flat aft, and when they were badly struck aft, fire broke out above him, whereupon he went up and was blown overboard, slightly wounded. The steering party remained in the tiller flat and were unhurt. After being blown overboard the Surgeon managed to get ashore, and during the night he lay helpless and exhausted, dying of thirst, along with a few others who had also got ashore. After much persuasion he got a Sailor to bring him some salt water, of which he drank a large quantity, and straightway became raving mad and died.

Having now cleared up most of the immediate work we had the theatre straightened up once more and cleared, after the constant stream of filthy cases had left it in a pretty mess. Operations had had to be discontinued at noon, but we recommenced at about 6 p.m., and did not stop till 4.30 a.m., Wednesday morning. The first case taken was a German whose right leg had been almost severed just above the ankle. The German Surgeon, assisted by Dr. Ollerhead, with Dr. Todd as anaesthetist, amputated the leg successfully in the middle third. The case did very well.

We now gave our attention to our own wounded and after dinner started on “A”. This boy had over thirteen separate shell wounds, most of them very severe. They involved the right thigh, buttock, leg, and foot, both bones were fractured 2 inches above the ankle and, in addition there was a large area blown out of his left groin, exposing the femoral vessels and spermatic cord. It looked at first as though we would have to amputate, but we decided to give him a chance, and after cleaning up the wound with soap and water, hydrogen-peroxide, and iodine, and removing the metal accessible, Iodoform grains were inserted and the leg was put up in a back and side splints. It took Dr. Ollerhead and myself, working hard 2 solid hours to complete the case. Dr. Todd gave the anaesthetic, which the patient stood very well. This poor fellow had been in considerable pain. He was now put in charge of a special nurse in the Commander’s Cabin. All future dressings had to be done under anaesthesia for about fourteen days, but the latest report is that the leg has been saved.

After doing the operation mentioned above, the German Surgeon became more of a hindrance than a help. During the evening he broke 4 of our syringes without successfully giving an injection, and he was sent to take a rest which he needed badly. Next morning he had improved considerably and he was able to take the place of Dr. Ollerhead when the latter returned to Cocos Island.

The next case taken that night (Tuesday) was "M". He had a shell wound in his back the size of a half crown, just below the last rib on the left side. Earlier in the day he had retention of urine, and a catheter was passed, drawing off almost pure blood, so evidently the fragment had lodged in, or passed through, the kidney. The patient had had a good deal of pain and haemorrhage, but, apart from the pale colour, he was very fit. Under chloroform the wound was cleaned up and I traced the track of the fragment with a probe below the twelfth rib 3 inches from the middle line, but could feel nothing. The wound, which was foul, was enlarged with a scalpel and I tried to get my finger on to the metal, without success. Eventually, before doing too much cutting, and from fear of carrying in infection too deeply, I decided to wait, and contented myself with draining the wound. The blood in the urine was much less on the following day and the patient had no retention. He continued to improve, and within 2 days there was no trace of blood in his urine. He was landed in hospital very fit, but still with a fragment in his kidney, and some slight discharge from the wound. Later news says that he is convalescent. It was now about 12.30 a.m. and after a solid and anxious day, all were pretty well done up, especially the two sick berth ratings. They had worked wonderfully well and had now to be sent to bed thoroughly exhausted.

Use of the Functional Movement Screen in a Tactical Population: A Review

Clare Bock & Robin M. Orr

Abstract

Background: The Functional Movement Screen is a tool used in athletic populations for predicting injury potential by assessing movement dysfunction. This tool may be of use in tactical populations (police officers, firefighters and military personnel) who perform daily duties of a physical nature, often carrying loads that negatively affect their movement patterns and cause physical injury.

Purpose: This purpose of this review was to explore the literature on the use of the Functional Movement Screen in tactical populations.

Methods: Literature databases were searched using key search words and terms. Studies meeting the inclusion criteria were critically evaluated using the Downs and Black protocol. Inter-rater agreement was determined by Cohen's Kappa.

Results: Five articles were retained for evaluation with a mean Downs and Black score of 73%, (k=0.82). Studies included both genders from military and firefighting populations.

Conclusion: Research suggests that the Functional Movement Screen can be reliably applied to a tactical population and may be of use as a screening tool. A score of below 14 may indicate an increased risk of injury. Furthermore, the tool can be used to evaluate the effectiveness of tactical conditioning programs. Further research is required to confirm and advance these findings within this population.

Keywords: Functional Movement Screen, military, solider, tactical, injury

Introduction

Tactical personnel, who include police officers, firefighters and military personnel, are required to wear external loads while performing daily duties. These loads, which are determined by daily duty requirements, consist of items like protective body armour and personal weapons. For the general duties police officer these loads could equate to 10kg and for the specialist police up to 27kg,[1,2] while for the firefighter a standard load of protective clothing, breathing apparatus and specific tools can equate to 37kg.[3] For the average military rifleman a fighting load of around 29kg and marching order load of over 50kg is not uncommon.[4,5] The duties performed while bearing these loads can include tasks that require the performance of dynamic movements (running, jumping, crawling, balancing, climbing, lifting, carrying, pushing, pulling, fighting and dragging) over dynamic environments (rugged and harsh terrains).[1,4-6] As such, the addition of external loads can affect tactical personnel in a number of ways, from reducing their physiological function,[4] task performance[7] and ability to tolerate heat,[8] to increasing their energy expenditure while performing a given task.[9] In addition, carriage of external loads is known to impair balance,[6] change gait patterns (running and walking),[6,9,10] influence postural stability[4,6] and is associated with an earlier onset of muscle fatigue.[6,9]

Given the nature of their duties, which can impart significant physical stress over prolonged or repeated periods[1] and noting the influences of carrying external loads, it is not surprising that load carriage is associated with causing musculoskeletal injuries [acute and overuse injuries] to tactical personnel.[11-13] Musculoskeletal injuries cause a reduction in physical performance, training and duty time, morale and operational readiness while increasing medical and training costs.[12,14,15] Chronic conditions, which could present if musculoskeletal injuries are not identified early, can preclude soldiers from completing training[16] or returning to duty[17] and are associated with reductions in operational readiness.[12]

One means of identifying the potential risk of musculoskeletal injury is through the use of the Functional Movement Screen (FMS) tool. The FMS is an evaluation tool used to assess the fundamental movement patterns of an individual in a dynamic and functional capacity.[18] The FMS consists of seven movement patterns that include an overhead squat, hurdle step, lunge, shoulder mobility, active straight leg raise, push-up, and rotary stability test.[18] To successfully complete these movements, the participant requires elements of muscle strength, flexibility, range of motion, coordination, balance, and proprioception;[18] elements which, when lacking, are associated with an increased risk of musculoskeletal injury.[19] As such, the FMS assessment tool offers an approach to injury prevention by identifying an individual's functional limitations and / or asymmetries.[10,18,20,21] It is for this reason that the FMS is widely employed within athletic and physically active populations.[18]

With a total possible score of 21, previous studies have suggested that low FMS scores of <14 have an association with musculoskeletal injuries in athletic and general populations.[20-22] Kiesel et al.[21] concluded that NFL players with FMS scores <14 had an 11-fold increase in the chance of injury in comparison with players with scores >14. Chorba et al.[23] also concluded that female collegiate athletes who scored <14 had a four-fold increase in the risk of lower extremity injury when participating in autumn and winter sports. Schneiders et al.[22] and Perry et al.[10] both confirmed that a FMS score of <14 indicated an increased risk of injury within general populations.

With the widespread use of the FMS used within the athletic population as a predictor of injury,[21,23] proposing its use within a tactical population is a viable concept. If the FMS can be reliably and validly employed in the tactical population, its implementation could inform strategies to reduce musculoskeletal injuries (and their associated costs) to both the individual and their unit. The aim of this review was to critically explore the literature on the effectiveness of the FMS within a tactical population.

Methods

Keywords and terms were entered into the search engines of five literature databases and were manipulated to suit the search capabilities applicable of each database. The databases searched and keywords and terms used are outlined in Table 1.

Table 1: Details of literature search: database used, search terms and inclusion filters

Data Base	Search Term	Filter	Number after inclusion	Number after exclusion	Duplicate	New articles
CINAHL	Functional movement screen AND military OR soldiers Functional movement screen AND military Functional movement screen AND soldiers "Functional movement screen" AND military OR soldiers	2003-2013, English, Humans	8	2	1	1
PubMed	Functional movement screen AND military OR soldiers Functional movement screen AND soldiers Functional movement screen AND military "Functional movement screen" AND military OR soldiers "Functional movement screen" AND military	2003-2013, English, Humans, Adult 19+, core clinical journal articles	5	2	1	1
Pro Quest	Functional movement screen AND military OR soldiers Functional movement screen AND military Functional movement screen AND soldiers "Functional movement screen" AND military OR soldiers		0	0	0	0
Pro Quest (Military)	"Functional movement screen" AND military OR soldiers "Functional movement screen" AND tactical population		3	0	0	0
Medline	Functional movement screen AND military OR soldiers Functional movement screen AND military Functional movement screen AND soldiers "Functional movement screen" AND military OR soldiers		5	1	2	2

After collection of all preliminary articles, duplicates were excluded and abstracts were subjected to specific inclusion criteria. The inclusion criteria comprised of: a) the study being published in the English language, b) the study being published within the last decade, and c) the study involving both the FMS and human participants. Once identified, the collected articles were then subjected to specific exclusion criteria to remove literature not relevant to this paper. These exclusion criteria are shown in Table 2.

Table 2: Search exclusion criteria.

Studies were excluded if the they included;

a) the use of devices that alters movement (i.e. strapping tape);
b) populations did not include tactical personnel (i.e. solders, first responders, fire fighters police);
c) participants outside the age of typical tactical population service age (17-55yrs);
d) the use of supplements (vitamins);
e) a commercial interest (a certain brand of equipment); or focused on a specific piece of equipment (mountain carriage stretches);
f) medically unfit (soldiers with injuries or obese subjects);
g) literature not published in English and not able to be translated by software or linguistic support available to the researcher (Dutch, Spanish, French and German);
h) a psychology focus (i.e. trauma; PTS; traumatic brain injury);
i) only an abstract printed in journals without full text.

While excluded, some articles were used to enrich background information and context. Once all articles were appraised against inclusion and exclusion criteria, the reference list of these remaining articles were reviewed for further potential articles as part of a secondary search process.

The included articles were critically appraised to assess their quality through use of the Downs and Black protocol.[24] The protocol comprises of a checklist that permits evaluation of both randomised and non-randomised studies of health care interventions.[24] The checklist comprises of five subcategories: reporting quality, external validity, internal validity (bias), internal validity (confounding) and statistical power. There are 27 items on the checklist, for which each item is scored on a scale of 'yes' (one point), 'no' or 'unable to determine' (zero points). There are two additional questions with greater scoring power; Item 5 within the reporting subcategory can be scored from zero to two points, with one point given for 'partially' detailing confounds and two points for conclusively detailing confounds, and Item 27 within the power subcategory can be scored from zero to five points based on the sample size with a larger sample size awarded more points. The scores for each article were converted to a percentage by dividing each total score by 32 (total possible score) and then multiplying by 100. All studies were independently rated by the two authors (CB, RO) with the level of agreement measured using a Cohen's Kappa (k)

Figure 1

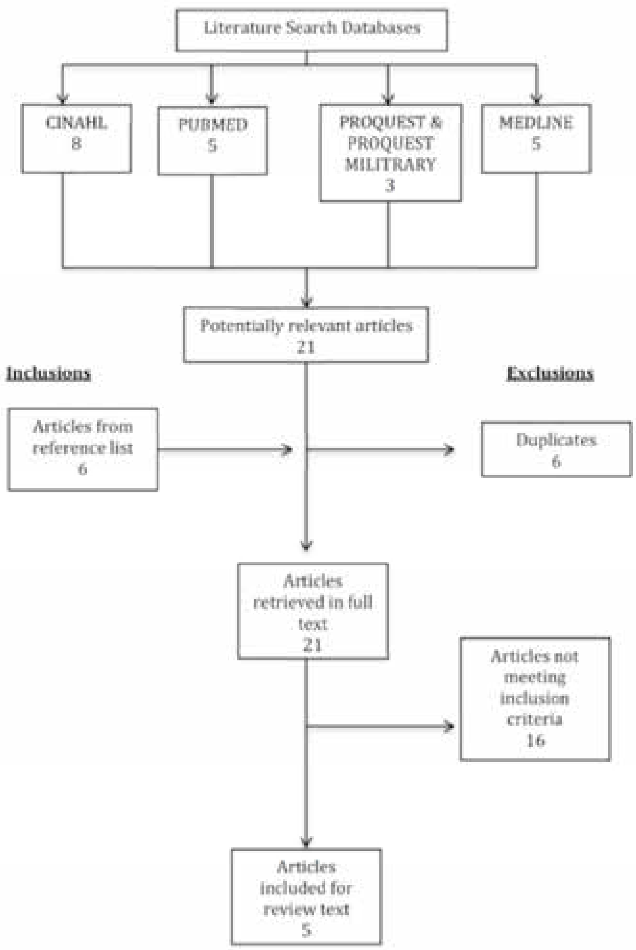

Table 3: Summary and critical appraisal of included articles in this review.

Author Year Title	Participants	Study Design	Outcome measure
Frost et al. 2012 "Using the Functional Movement Screen(TM) to Evaluate the Effectiveness of Training."	60 firefighters from Pensacola Fire Department volunteered to participate. Male only participants Participants were free of musculoskeletal injury or pain at the time of testing and were on full active duty. 3 groups.	Cohort study The participants were assigned to 1 of 3 groups: intervention 1, intervention 2, or control. The 2 intervention groups received three 1.5-hour training sessions each week and differed in the emphasis that was placed on movement quality.	FMS: - Individuals were graded on how they chose to perform rather than how they could perform. -Sagittal and frontal plane videos were used to grade the FMS with 3 methods -Baseline FMS above and below 13.
Goss et al. 2009 "Functional training program bridges rehabilitation and return to duty."	90 Special Operations Soldiers 80 males and 10 females. The mean age of participants was 35 yrs. 2 types of participants stated: (1) Participation is 100% voluntary, but patients who were about to be discharged from physical therapy following extensive rehabilitation are strongly encouraged to participate. (2) Other participants are healthy individuals who have not been patients in the clinic.	Cohort study Effectiveness of a Functional training program (FTP). (The FTP is designed to prepare them for returning to full duty, resuming airborne jump status, and deployment to combat zones.) Each FTP cohort meets 3 times per week for six weeks in duration. Classes are 75 minutes in duration to include warm-up and cool down.	FMS Other fitness test: -T-test (agility), 6 meter hop for time, single leg hop for distance, vertical jump, skin-fold body fat measure, balance test and core strength (kip-ups).
Lisman et al. 2013 "Functional Movement Screen and Aerobic Fitness Predict Injuries in Military Training."	874 Marine Officer Candidates Male only participants Age range = 18-30yr old 2 training groups: -6 wk (n = 447) -10 wk (n = 427)	Cohort study 2 training groups -6 wk -10 wk	-Exercise history questionnaire -FMS -Standardized Physical Fitness Test (PFT) (pull-ups, abdominal crunch, and 3-mile run) -Injury data were gathered
O'Connor et al. 2011 "Functional Movement Screen: Predicting Injuries in Officer Candidates."	874 Marine Officer Candidates Male only participants Age range = 18-30 years old 2 training groups: -6wk short cycle (n = 447) -10wk long cycle (n = 427)	Cohort study 2 training groups: -6wk short cycle -10wk long cycle *Both groups have comparable training intensities and volumes with Candidates expected to be extremely fit for successful participation.	-FMS -Physical Fitness score -Injuries Data collection -Questionnaire Data (Survey of age, tobacco use, exercise history and prior injury were incorporated into the medical screening).
Teyhen et al. 2012 "The Functional Movement Screen: A Reliability Study"	64 Army service members (53 males, 11 females) met the inclusion Participants age range = 18 - 35 years old Novice examiners participating in this study consisted of 8 physical therapy students	Cohort Study Four physical therapy students were randomly assigned to the participants to assess intra- rater test-retest reliability by assessing the FMS on day 1and day 2.Each rater measured between 14 and 18 participants. A second set of 4 physical therapy students were randomly assigned to view the participants' movement simultaneously with the first set of raters for the inter- rater reliability assessment on day 2	FMS

Measurement intervals	Results	Critical Appraisal Score
FMS scores were examined before and after 12 weeks of training.	The total number of asymmetries present before and after training was found to be just as variable as the individual screen scores, there were no differences between groups (p = 0.528). 85% of the participants in the control group actually changed irrespective of the baseline score. The distribution of total FMS score changes (e.g., number of increases) was dependent on the grade of the initial screen (p = 0.008). Seventeen of the 26 participants exhibiting an increase were given an initial grade <13, whereas 14 of the 17 who received a lower total post training score had a baseline FMS >13. There were no differences in the distribution of scores between groups (p = 0.653).	72%
Testing of the FMS, and fitness test conducted pre and post 6 weeks of training program.	Post functional training program FMS scores improved an average of 2.5 points. Fitness test: T-test improvement was 0.5 seconds. Single leg hop time improved 10%. Hop for distance improved approximately 10%. Body fat improvement was statistically significant. Kip-ups improved 32%. Vertical jump height improvement was statistically significant. All subjective fitness category self-evaluations demonstrated statistically significant improvements, except for pain.	65%
-Completed an exercise history questionnaire -Underwent FMS during medical in-processing -Standardized Physical Fitness Test (PFT) within 1 wk of training -Injury data were gathered throughout training from medical records and classified into overuse, traumatic, and any injury.	Three-mile run time (RT) was the only PFT component predictive of injury: candidates with RT >20.5 min were 1.7 times (95% confidence interval = 1.29–2.31, P G 0.001) more likely to experience an injury compared with those with RT <20.5 min. Combining slow RT (>20.5 min) and low FMS scores (<14) increased the predictive value across all injury classifications: candidates scoring poorly on both tests were 4.2 times more likely to experience an injury.	75%
-FMS -Fitness test within 1 week of starting the training program. -Data in injuries were collected daily during the training cycle.	Injury data: - Long cycle group had significant higher cumulative injury incidences for any, overuse, traumatic and serious injury -When the groups were compared as a function of injuries per 1000 person-days, the short cycle had higher incidence rates for any and traumatic injuries; the 2 groups did not differ in overuse or serious injury rates. FMS & injury: -Short cycle group, candidates with a FMS score of < 14 had a 1.91 times (95% confidence interval = 1.21-3.01, P=<0.01) higher incidence of injury compared to those scored >14. -Long cycle group, candidates with a FMS score of < 14 were 1.65 times more likely to sustain an injury (95% confidence interval = 1.05-2.59, P=0.03) compared to those scored >14. -45.8% of persons with scores <14 suffered an injury compared to 30.6% of those with scores of >14. Physical fitness scores: -Relationship between FMS scores and physical fitness. -Physical fitness scores <280 were 2.2 times more likely to have FMS scores of <14 and significantly more likely to sustain an injury.	75%
FMS tested day 1 with 48 to 72 hrs between and day 2 retest To minimise bias, raters were randomly assigned, raters for day 2 were kept blinded to day 1 raters' measurements, pairs of raters on day 2 were blinded to each other's analysis and scoring, and 48 to 72 hours of time elapsed between intra-rater test- retest reliability measurements.	The FMS has an adequate level of reliability when assessed in healthy service members by novice raters. The inter-rater agreement of the FMS component scores ranged from moderate to excellent, with 6 of the 7 tests categorized as having substantial agreement . The intra-rater and inter-rater point estimates of the FMS composite score reliability ranged from 0.74 to 0.76, with the 95% CIs suggestive of moderate to good reliability.	78%

analysis of all raw scores (27 scores per paper). For final scores, any disagreements in points awarded were settled by consensus.

The total raw scores of articles following the Downs and Black checklist[24] were compared to the graded system proposed by Kennelly[25] to provide further validation on the quality of the articles used for this review. Kennelly[25] proposed that a total Downs and Black score greater than or equal to 20 is considered a good study, between 15 and 19 is considered a fair study and scores of 14 and below is considered a poor quality study.

Results

The principal search identified a total of 21 potential articles for review (see Figure 1.). A further six articles were then identified after the secondary search, with a total of 27 articles identified for review. Subsequently 22 articles were excluded as duplications or based on the exclusion criteria. Consequently a total of five articles were retained for evaluation.[19,26-29]

Table 3 highlights the methods, main findings and critical appraisal quality scores for each included article. The methodological quality scores ranged from 65%[26] to 78%[27] with a mean score of 73%. The kappa statistic for inter-tester agreement of the methodological quality of the studies indicated an 'almost perfect' agreement (k=0.819).[30] Based on a mean total raw score of 23.4 points the articles are generally of a 'good' quality when viewed through the lens of the grading system proposed by Kennelly.[25] The most noted limitation of these studies based on the Downs and Black protocol[24] was the lack of methodological evidence regarding the blinding of participants and randomising of the groups with only one study[27] meeting these criteria.

Participants involved in the studies varied from male only,[19,28,29] to male and female participants,[26,27] from populations including firefighters,[19] Special Operation Soldiers,[26] Marine Officer Candidates.[28,29] and Army service members.[27] In all of the included articles the FMS was clearly defined and outlined. The use of the FMS throughout the studies varied slightly from confirming the reliability of the use of the FMS within the tactical population[27] to use of the tool as a means of predicting injury potential[28,29] and as a means of validating the effectiveness of training programs for tactical personnel.[19,26]

Only one study[27] was found to investigate the reliability of employing the FMS tool within the tactical population. The study by Teyhen et al.[27] was designed to determine the intra-rater and inter-rater reliability of the FMS when tested by a group of novice raters. In addition, the study also reported on the FMS component and composite scores of tactical population members.[27] Eight novice examiners, who were physical therapy students enrolled in their second and third semesters of a doctor of physical therapy training program, examined 64 Army service personnel with the FMS tool.[27] The examiners underwent 20 hours of FMS training conducted by four physical therapists and one research assistant. Four novice examiners were randomly assigned to the participants to assess intra-rater test-retest reliability by assessing the FMS on Day 1 and Day 2.[27] The four novice examiners measured between 14 and 18 participants with no differences in outcomes across examiners.[27] To mimic field conditions that often include mass screening and multiple examiners, the remaining four novice examiners were randomly assigned to interpret the participants' movement scores instantaneously with the first set of examiners on the second day of testing. To assess the intra-rater reliability, 48 to 72 hours of time elapsed between measurements.[27] To minimise bias for the inter- rater reliability assessment, examiners were blinded to any previous and ongoing results.

The researchers[27] considered the FMS to have a moderate to excellent inter-rater agreement of the seven component tests with an intra-class correlation coefficient (ICC) of 0.76 (95% CI: 0.63, 0.85). It was also ascertained that there were considerable intra-rater agreement scores at 48 to 72 hours, which resulted in an ICC of 0.74 (95% CI: 0.60, 0.83). Teyhen et al.[27] concluded that the FMS had an adequate level of inter–rater reliability within a group of novice examiners when assessing healthy service members and the inter-rater agreement of the FMS component scores were in substantial agreement.

Two studies[28,29] investigated the potential for the FMS to predict the risk of injury within tactical populations. The study by O'Conner et al.[29] was the first known large-scale study to be conducted within an active-duty military cohort. In this study, the researchers examined the utility of FMS during medical in-processing of 874 Marine Officer Candidates aged between 18 and 30 years of age.[29] All members of the research team were certified in the FMS to maximise inter-rater reliability.[29] The participants also completed a physical fitness test within the first week of starting their officer candidate training course.[29] These fitness tests consisted of pull-ups to exhaustion, two-minutes of abdominal crunches, and a three-mile (4.8km) run for time. Officer candidate training was divided into two groups; the first group completed a six-week training program and the second group completed a ten-week training program. During officer candidate training, injury data was captured daily in order to allow comparison of injuries to FMS prediction scores.[29] Physicians of the research team determined injury data by examining records of medical encounters of the subjects from external medical care providers. An injury was defined as physical damage to the body secondary to physical training with members seeking medical care one or more times during the study period.[29] Following the Marine Officer's training, it was observed that personnel with an FMS score of <14, were 1.91 times more likely to sustain an injury and personnel completing the ten-week-long cycle were 1.65 times more likely to sustain an injury when compared to personnel with scores higher than 14.[29]

In 2013, Lisman et al.[28] expanded on the findings of O'Connor et al.[29] Using the same data, Lisman et al.[28] investigated the associations between injuries and individual components of the Marine Corps physical fitness test, self-reported exercise participation and previous injury history, and FMS scores. Lisman et al.[28] observed that, when including the time to complete a three mile (4.8km) run with FMS scores, the injury predictive value increased with officer candidates who scored poorly in both tests (FMS scores <14 and running time > 20.5 minutes) being 4.2 times more likely to experience an injury during Marine Corps officer training.[28]

Rather than focusing on injury prediction, the two remaining studies[19,26] that met the inclusion criteria for this review focused on the ability of a physical training program to change FMS scores within their tactical populations. Frost et al.[19] noted no significant changes in the total FMS for any group post training, whereas Gross et al.[26] noted an improvement of FMS scores post training.

Frost et al.[19] considered the practical application of the FMS within a tactical population of 60 male firefighters. Their study design included three groups: one control group and two intervention groups. The FMS was implemented by a certified FMS instructor prior to and following a 12-week physical training intervention provided by strength and conditioning professionals.[19] The results obtained revealed that there were no significant differences between groups in total FMS score prior to the 12 weeks of training ($p = 0.838$) or following the intervention ($p > 0.176$).[19] While no significant differences were found between groups, the base- line scores of 17 out of 26 participants that received an initial FMS score of < 13 exhibited an increase in FMS scores post training. Conversely 14 of the 17 participants who received a lower total post training score had a baseline FMS score of >13.[19]

In a tactical population of Special Operations Forces (SOF) soldiers, Gross et al.[26] employed the FMS tool to validate the effectiveness of a functional physical training program designed to prepare SOF soldiers for return to duty through reducing the gap between rehabilitation and return to duty, by enhancing movement performance and preventing injuries.[26] The study was conducted with 90 participants who were about to be discharged from physical therapy following extensive rehabilitation and healthy individuals who had not had any physical therapy.[26] The composition of these two groups (following rehabilitation or healthy) was not provided. Four physical therapy staff members administered the testing of the FMS, and the fitness tests pre- and post-six weeks of a training program.[26] The fitness tests conducted included a T-test for agility, six metre hop for time, single leg hop for distance, vertical jump, skin-fold body fat measure, balance test and core strength (kip-ups).[26] Following the functional training program, FMS scores improved an average of 2.5 points, with improvements noted across all segments of the fitness tests. Gross et al.[26] concluded that functional training programs are beneficial for soldiers returning to duty based on these increases in FMS scores. The researchers[26] concluded that the FMS provided an effective tool for screening the tactical population and for validating the effectiveness of physical training programs.

Some constraints and variances were identified in the five studies employing the FMS in a tactical population. These included the availability of the participants to complete the study[26] and a potentially higher fitness level of tactical personnel when compared to the general population.[19,26] The use of the tactical population encounters some restrictions when it comes to the participant's availability that may limit their participation and completion of studies. Gross et al.[26] stated that within their study a number of participants were unable to participate in the follow-up due to a variety of reasons such as job requirements, time of day the research was conducted, and a lack of interest. Of the 155 participants that attempted the program, 65 (42%) participants dropped out of the training or were lost to follow-up.[26] Of the remaining 90 participants the mean number of intervention classes attended was 10 out of a possible 18 (56%).[26]

The fitness level of the tactical population may also need to be considered when comparing the data to current research findings of non-tactical populations. O'Connor et al.[29] and Lisman et al.[28] stated that their sample of participants, who had been previously challenged and screened in the Marine Corps, were highly fit in terms of muscular strength, muscular endurance and metabolic (anaerobic and aerobic) fitness. With metabolic fitness in particular associated with injury risk in tactical populations, the high fitness of personnel within these populations may influence the ability of the FMS to predict injury in a tactical population.[31-33]

Discussion

The aim of this review was to critically explore the literature on the potential use of the FMS tool within tactical populations given previous findings of its use in athletic[21,23] and general populations.[10,22] Unfortunately, while the research reviewed was of good quality, the use of the FMS within tactical populations was found to be limited. Considering this, five articles[19,26-29] were identified to examine the use of the FMS within tactical populations, with the focus of these articles being on reliability,[27] use as an injury prediction tool[28,29] and use as a tool to validate tactical conditioning programs.[19,26]

For a tool to be used effectively in any population, it must be reliable. On this basis, Teyhen et al.[27] investigated the reliability of the FMS within the tactical population. The results of their study suggested that raters (n=8) could, with moderate to excellent agreement, reliably employ the FMS tool in a tactical population (n=64 military personnel). Furthermore, their study results were comparable to the previous studies of Minick et al.[34] and Onate et al.[35] Minick et al.[34] considered their raters (n=4) to have 'excellent' to 'substantial' agreement when assessing the FMS scores of 40 male and female college students. Similarly, Onate et al.[35] considered their raters (n=2) to have a 'high' reliability in a similar University population of 17 male and female volunteers. On this basis, the FMS has the potential to be employed reliably within a tactical population.

O'Connor et al.[29] and Lisman et al.[28] both investigated the use of the FMS as an injury predictor within the tactical population through a large sample size of 874 participants. O'Connor et al.[29] considered a score of <14 to be a viable score to predict injury. Lisman et al.[28] expanded on this result to increase the predictive potential by including run times of > 20.5 minutes for a three mile (4.8 km) run. The result of these two studies, in regard to FMS scores, are consistent with current findings in other populations.[10,21-23] For example, Chorba et al.[23] found that female collegiate athletes (soccer, volleyball and basketball players) that obtained an FMS score of <14 had a four-fold increased risk of lower extremity injury when participating in autumn and winter sports. Likewise, Kiesel et al.[21] found the FMS to positively predict injury in male National Football League players who scored below 14. It should however be noted that not all studies have found a relationship between FMS scores of below 14 and injury.[36,37] In studies investigating the injury predictive ability of the FMS on recreational runners[36] and Basketball players,[37] no relationship between scores of below 14 and risk of injury were identified. Several potential reasons for these discrepancies in findings include; the variability between studies in regard to the definition of injury, previous injuries [e.g. history of ACL injury[23]] and differences in sporting populations and average FMS scores in these populations. As such, while there is some evidence supporting the potential of a score of <14 to predict injury, further research is needed. Considering this, the research of O'Connor et al.[29] did note that, while not as pronounced as scores <14, participants who scored >18 on the FMS had a higher risk of injury than those scoring between 15-17 points. These results suggest a potential bimodal distribution of injury risk in relation to FMS scores.

While two papers[19,26] investigating the use of the FMS to validate tactical conditioning programs were identified, no similar uses of the FMS in an athletic population could be found. One paper by Kiesel et al.[20] however, considered how a conditioning program could be used to specifically improve FMS scores. The study found that a 7-week off-season intervention program could improve FMS scores (three points, $p<0.01$) and reduce the number of asymmetries in the group (from 50% to 34%, $p=0.01$). Chapman et al.[38] conducted a similar study of 121 elite track and field athletes with corrective exercises prescribed following FMS screening. In addition, FMS scores were then compared to best performance results over two calendar years. While compliance with the corrective exercises were considered problematic and no results were provided, athletes with FMS scores of 14 or less did not improve in performance to the same extent that athletes with a score of higher than 14 (-2.3% versus 2.5% respectively). Similarly, subjects with an asymmetry had lower performance improvements than subjects with no asymmetry (2.10% versus 2.86%). These results suggest that for athletes with low initial FMS scores or an identified asymmetry, performance ability may be reduced.

As a final consideration, the study by O'Connor et al.[29] considered the practical application of the FMS within the tactical population by adding the FMS to the medical screening of a large tactical cohort of over 800 personnel. While the intent of their study was to determine whether FMS scores could predict injury in a large military cohort,[29] the study also concluded that the FMS can be used as part of medical processing within the tactical population. While this application may be superfluous in non-tactical populations, the ability of the tool to be applied in a large, often time-poor, population may be valuable for tactical populations.

Conclusion

Occupational injury risk is prevalent within tactical populations such as police officers, firefighters and military personnel, who are required to carry external loads while performing daily duties. These external loads can affect their movement patterns and in turn lead to injury. Previous research in athletic and general populations suggests that the FMS is a reliable tool that may be of value in predicting injuries and even athletic performance. Results of this review suggest that the FMS tool may also be of use in tactical populations, employed as a reliable screening tool for either predicting the potential for injury or to determine the effectiveness of conditioning programs. Further research, specifically within tactical populations, is required to confirm and advance the findings presented in this review.

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Battlefield Radiology: 2014 Update

Peter Duffy

Abstract

A "Military Medical Revolution – the Military Trauma System"[1] has revealed the developments during the Middle East Area of Operations (MEAO) wars over the last decade showing survival rates of up to 98% of trauma patients brought to hospital alive. This significant improvement is due to the "combat care revolution"[2,3] involving major multidisciplinary changes in health care with on site tourniquets and medic, rescue resuscitation teams, immediate aeromedical evacuation to a NATO Role 2E (basic field hospital with unspecified extra surgical and other capabilities) or Role 3 hospital (Role 2E with additional specialist tertiary level capabilities), improvements in blood product availability, Damage Control Resuscitation, Surgery and Radiology and later aeromedical removal to major hospitals. The changes in radiology have been the deployment of 64 slice CT (Computed Tomography) scanners situated adjacent to emergency casualty receiving areas, with clear access and space for the whole surgical /resuscitation team to work together with the radiologist and radiographer who can have the CT trauma examination completed in 2-3 minutes and have the interim CT report delivered verbally to the trauma team less than 2 minutes later. The final written report, including clearing of the spine, is usually available 60 minutes after the completion of all reconstructions and review thereof. Most patients who need immediate surgery for survival have a postoperative CT examination for completion of diagnosis and management planning.

The ADF (Australian Defence Force) has benefited from the NATO supply of radiology aspects of this service to provide best standard of care to its members. As the ADF regroups and plans for a new era, review of the decision to postpone acquiring the capability of its own deployable CT should be undertaken. The ADF should be able to provide current standards of care to members incurring ballistic and blast injuries on non-NATO or US supported deployments that may be required in Australia's interests.

Description

the last decade has seen major change in the contribution of radiology to the battlefield trauma team as part of the combat casualty care revolution, with survival rates of up to 98% of trauma patients brought to the hospital alive.[2,3]

This huge improvement in survival is due to major multidisciplinary evolution of health care, starting with self and "buddy" first aid, tourniquets, on site medics, use of rescue resuscitation teams, immediate aeromedical evacuation from the site of injury to NATO Role 2E or Role 3 Hospitals, improvements in blood product availability, damage control resuscitation and surgery and, later if necessary, aeromedical evacuation to major hospitals well outside the combat region for ongoing definitive care and rehabilitation.[4-11]

The changes in radiology, now being referred to as Damage Control Radiology,[12] have been deployment of 64 slice or more CT scanners situated adjacent to the emergency casualty receiving area, with clear access and space for the whole resuscitation team to work together with radiologists and radiographers who can have the CT trauma examination completed in 2-3 minutes and have the interim CT report delivered verbally to the trauma team by the radiologist less than 2 minutes later. The final written report, including clearing of the spine, is usually available by 60 minutes, after completion of all images reconstructions and radiologic review thereof. Any significant unexpected findings in the meantime are reported verbally to the trauma team. Back up teleradiology is available to assist with the workload if necessary, to audit the on site reports and to store the patients' images and reports for future access.[13-15]

This evolution is, perhaps, best reflected in the experience of the UK Defence Forces over the last decade.

The UK Defence Forces have a central DMS (Defence Medical Service) responsible for all health matters, with a subsidiary JMC (Joint Medical Command) specifically in charge of operational policy and support of single service health delivery in a tri-service fashion. These provided for a central tri-service integration of radiological examinations, unlike in the US Defence Forces, which have separate radiology services for Air Force, Army, Navy and Marines with incompatible separate Picture Archival Communication System (PACS) across the forces.

Before 2004, the UK Forces were providing the then standard operational radiology service in Iraq with mobile x-ray units, wet film processing and mobile FAST (Focused Abdominal Sonography in Trauma) ultrasound units. Shortly thereafter the Basra unit was re-equipped with direct digital X-ray units, bypassing wet film processing and CR (Computed Radiography), together with teleradiology and a PACS for timely image acquisition and reporting. A 16 slice CT unit was then deployed, again with teleradiology reporting back-up in the UK. A couple of years later in Afghanistan at Camp Bastion a pair of 64 slice CT units were installed with on site radiologist supervision, again with back-up teleradiology support.[14–20]

The same progression to deployment of radiologists and fast CT scanners occurred with US Forces in Iraq (Balad) and in Afghanistan (Kandahar), as has been noted by ADF surgeons and other deployed health team members and our ADF patients. Folio in his now classic text, Combat Radiology,[2] details the challenges and changes faced in Iraq and how they were dealt with using earlier 16 slice CT, including a detailed review of ballistic and blast injury, Traumatic Brain Injury and CT and plain X-ray examination of the chest abdomen, pelvis and extremities. A later review confirms progression to 64 slice CT with radiologists incorporated into the multidisciplinary trauma care team.[1,20-22]

Naval hospital ships from the US and the UK (USNS Mercy and RFA Argus) are equipped to function as Role 3 Hospitals which capability was in use during the Gulf War and Operations Desert Shield and Desert Storm. Both are equipped with CT but from that time of military involvement it was more that a decade later that the full impact of Damage Control Radiology became available as CT scanners became faster. These ships remain available to support military requirements but may be more active in their secondary functions of providing humanitarian care and disaster relief.

Damage Control Resuscitation and Surgery evolved from US urban civilian healthcare of multiple gunshot injuries associated with the increased availability of automatic pistols in the 1970s, together with the growing number of high speed motor vehicle accidents, leading to the ongoing development and spread of major Trauma Centres. As is usual under the pressure of war, military experience has led to better utilisation and outcomes compared to civilian trauma experience in many countries. Germany has also pioneered these principles together with Damage Control Radiology. In the UK, the Royal College of Radiologists has published Standards of Practice and Guidelines for Trauma Radiology in the Severely Injured Patient.[23-28] Radiologists have documented their trauma radiology responses to mass terrorism blast and penetrating injuries in Boston and Jerusalem.[29,30]

Currently in Australia a major trauma centre is generally closed to new admissions if the CT scanner is not operational.[31]

Reasons

Why has CT examination become a central component of the management of penetrating or blunt polytrauma patients over the last 7 years?

Before CT, radiology trauma examination generally comprised FAST ultrasound and supine X-ray examination of the chest, abdomen, pelvis and spine. Its problems are that FAST, while accurate for free fluid in the abdomen, pelvis, pleura and pericardium and also for pneumothorax, is not reliable for liver and spleen injury. Supine chest X-ray is not reliable for pneumothorax detection and supine X-ray examination of abdomen and pelvis is not reliable for soft tissue injury. X-ray examination of the spine, especially the cervical region, is no longer regarded as reliable.

Initially, CT was known as the “tunnel of death” where haemodynamically unstable patients could perish in association with a CT examination that could take 20 minutes and a journey from the resuscitation bay to CT scanner that could be 100 metres or more, plus or minus lift transport. But it was quite useful for diagnosis in haemodynamically stable patients.

Under current policy, fast CT scanners (64 slice or more) are sited adjacent to the resuscitation area, separate from a general radiology department if it is present, and staffed by dedicated radiographers and consultant radiologists who are an integral part of the trauma team and captained by the team leader. The CT scanner can now be regarded as a “circle of life”.

From the practical perspective, deployable CT scanners are supplied built into an expandable ISO (International Organisation for Standardisation) container / shelter, which is transportable by truck, C17 aircraft or by ship to the presumed tented hospital. Some units have been sited in hardstand deployed hospitals (Camp Bastion). An example of a deployable CT scanner is the Philips 64 unit adapted by Marshall.[32,33]

CT is very accurate in the positive identification of head, neck, chest, abdominal, pelvic and spine injuries as well providing an angiographic review of the arterial system from the brain down to the toes if necessary. Limb trauma is also definitively demonstrated with review in multiple planes and tissue levels. However formal definitive assessment of sensitivity, specificity and accuracy have not yet been reported.

CT is used to examine most polytrauma patients either immediately on arrival, or, if haemodynamically unstable, after Damage Control Resuscitation and Surgery in theatre so as to detect the full range of injury and exclude the presence of any unsuspected lesions.[34]

Integration of Damage Control Radiology CT findings with Damage Control Resuscitation and Surgery and all the other components of the retrieval and trauma management systems have lead to the current very major improvements in survival of injured service personnel.

Associated CT Utilisation

Apart from the use of CT for investigation of less severe injuries and for general medical and surgical indications that may come up in the military health care system on the deployment, a number of specific military areas of utilisation are current. These include:

General medical and surgical referrals, as above;

- Scout / scanogram views of patients or others to exclude the presence of hidden ordinance[34];
- CT ballistics calculations to determine from where the bullet was fired[2];
- Analysis of injury patterns for improvement of body armour and for aircraft incident assessment[2,35-37];
- Veterinary use for investigation of injury to and treatment of valuable working dogs[2,16];
- Post mortem forensic CT including for use by the Coroner[35,38];
- Post mortem injury assessment and for ongoing military review of causes and mechanisms of death.[2,36]

Overview of Operational Radiology in the ADF

Operational radiology includes all radiology undertaken outside the Garrison Area. It has a long history.

Shortly after Roentgen's publication on X-rays in 1895, X-ray examination was undertaken in the Graeco- Turkish War of 1897.[39] Madame Curie,40 better known for her work with radium, developed and equipped 18 mobile X-ray cars ("little Curies") for use by the French Army in World War 1.

The next 80 years has brought us to its more recent status, as noted above, in the UK Defence Forces prior to 2004.

In the ADF X-ray services are available for Role 2 military hospitals in the field for Army and Air Force and afloat for Navy for the ongoing health care of members as currently supplied in the ADF together with FAST diagnostic ultrasound. This capability may also be deployed for humanitarian or disaster relief missions.[41]

If required for military or other reasons, the capability of a Role 2 health facility can be upgraded to Role 2 E, but such has not been required by the ADF in the Middle Eastern Area of Operations over the last decade as ADF hospital requirements have been made available by our Coalition and NATO partners. The ADF does not have current capability to deploy a Role 3 Hospital.

At present, ADF operational equipment comprises now dated CR (Computed Radiography) units, replacing wet film technology with relatively old mobile X-ray units and a range of current and out-dated SonoSite mobile ultrasound units.

Enoggera Health Centre X-ray facility is staffed on an augmentation basis by ADF radiographers from 2GHB (Army) and Amberley Air Force base and provides the only ongoing "hands on" experience for ADF radiographers. At all other sites where deployable X-ray capability exists, radiographers require rostering to work in the civilian sector on a regular basis to maintain their professional skills and registration.

Navy: While awaiting the commissioning of its first LHD (Landing Helicopter Dock) with PCRF (Prime Casualty Reception Facility) capability, HMAS Canberra Navy has an operational capability for X-ray and FAST ultrasound examinations on HMAS Choules. Operational radiology arrangements for the HMAS Canberra are under review at the time of writing and include X-ray and theatre image intensifier capability. CT capability has been discussed previously without positive implementation.[42]

Currently, ADF operational service require physical transfer of the referral form and X-ray and ultrasound images acquired and recorded on optical disc or "thumb nail" drive to an Australian radiology practice site which is part of the group contracted to provide radiology services to the ADF for "untimely" reporting and incorporation into the medical record of the patient. Outside Australia, the delay is extended until the return to base of the deployed unit.

Teleradiology capability is under review so as to be able to supervise examinations and provide timely reporting of examinations as per the national guidelines for radiological services that apply to civilian services.[43-45]

ADF PACS: I-MED, Sonic and other contractors for the provision of radiology services to the ADF for its garrison members have commissioned the ADF PACS which is situated outside the IT (Information Technology) domain of the DRN (Defence Restricted Network) but is accessible both from within the DRN and from without at https://adfdirect.com.au and from without through the I-MED Intelerad / Comrad Network.[46]

Next Steps

As the ADF commenced its wind down from more than a decade of deployment and war, amongst the many lessons learnt is the "Military Medical Revolution"[1] in respect to the trauma treatment system for ballistic and blast injuries. The arrival of patients at hospital requires Damage Control Resuscitation, Radiology and Surgery as best triaged by the trauma team leader.

Among the future projections on what military problems the ADF may next face are those put forward by Kilcullen,[47] suggesting possible terrorist, insurgency, revolution and / or criminal paramilitary activity in coastal mega-cities, usually with poor governance. Kilcullen has updated his projections in light of the current ISIS and more formal military action in Syria and Iraq.[48,49] Favoured weapons are thought to include the usual high velocity ballistic types, relatively expensive RPGs and relatively inexpensive IEDs (Improvised Explosive Devices) and EFPs (Explosively Formed Projectiles). All of the above are causes of polytrauma with penetrating and blast injuries. Current civilian and military trauma management systems include CT and the radiologist as an essential component of the trauma team.

With the recent postponement of its deployable CT equipment order, the ADF is not capable of providing current military best practice standards of care to its members if it were to deploy without NATO or US forces. ADF radiographers and radiologists have undertaken the majority of preparation work to provide the manpower for deployed CT capability. ADF surgeons, anaesthetists and emergency physicians have deployed experience in working in the "Military Medical Revolution". In planning for the immediate future, the ADF should include deployable CT capability by air, land and sea, and CT capability with the PCRF functions of the LHD naval vessels.[40] In civilian Australian practice, it should be noted that a Trauma Centre without a functioning CT scanner is usually closed for further admissions. Those admissions are usually due to accidents rather than the planned or expected injuries of operational military service.[29] This highlights the lack of CT capability in military practice, when our members volunteer to take the risk of polytrauma in the service of our nation. At the same time, connection of current operational X-ray capability to the existing ADF PACS by teleradiology must proceed in order to get the standard of care up to community expectation.[41]

Conclusion

A Military Medical Revolution – the Military Trauma System – has been recognised to comprise developments during the MEAO wars over the last decade. A significant additional component to Damage Control Surgery and Resuscitation is Damage Control Radiology provided by onsite CT and radiologists. The ADF has benefited from the NATO supply of this service so as to provide the best standard of care to its members. As the ADF regroups and plans for a new era, including further operations in the Middle East, the recently postponed capability of having its own deployable CT requires implementation to provide current standards of care to members incurring ballistic and blast injuries on non-NATO or US supported deployments that may be required in Australia's interests.

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My predecessor radiology advisors to the Surgeon General ADF (SGADF), GPCAPT Bernie Raffles and RADM Graeme Shirtley, pioneered this concept of advice, and I have been ably supported by my successor, WGCDR John Magnussen, and by our recent ADF Chief Radiographer, SQNLDR Karen Thomas.

RADM Robyn Walker, CJHLTH (Commander Joint Health) & SGADF, and AVM Hugh Bartholomeusz, SGADFR supported my recent visit to UK Defence Radiology in concert with BRIG Tim Hodgetts, Medical Director, JMC, who authorised COL Iain Gibb, Defence Consultant Adviser in Radiology, MAJ Catriona Watson, Defence Specialist Adviser in Radiography and SURG CDR Richard Graham, Head RNR Medical Branch, kindly to give me hours of their time.

Disclosures

The views expressed in this review are my personal views as a military radiologist and do not represent the policy of the ADF. I have neither financial interests nor incentives regarding the above.

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Pioneers of Medicine without a Nobel Prize*

Gilbert Thompson (Editor)

*Thompson G (Ed). Pioneers of Medicine without a Nobel Prize. London: Imperial College Press, 2014. ISBN 978-1-78326-383-7. Hardback. 296 pp USD128 (also available as softcover and eBook)

The Nobel Prize was established in 1901 using a bequest from Alfred Nobel and is probably the most highly regarded international award. Nobel prizes are currently awarded annually in several categories, including Physiology or Medicine, and winners are termed Nobel Laureates.[1] The Nobel Prize for Physiology or Medicine is awarded for "discovery of major importance in life science or medicine. Discoveries that have changed the scientific paradigm and are of great benefit for mankind are awarded the prize, whereas life time achievements or scientific leadership cannot be considered for the Nobel Prize".[1] While many medical researchers have been recognised with the Nobel prize for Physiology or Medicine, many famous medical researchers over the years did not win a Nobel Prize. Pioneers of Medicine without a Nobel Prize brings together chapters describing discoveries which have had a major impact on medical science and the practice of medicine, but where the medical scientists involved did not win a Nobel Prize. Pioneers of Medicine without a Nobel Prize appears to be a companion volume to another title published by the same author, Nobel Prizes that Changed Medicine.[2]

Pioneers of Medicine without a Nobel Prize is presented as a 23.5 x 16 x 2 cm hardback publication. The front cover is simple in design with some basic graphic art work. The work contains a table of Contents, a Foreword by Sir Mark Walport, a Preface, an Acknowledgements section, a list of the details of the 21 Contributors, 15 Chapters and an Index, as well as a number of historically relevant figures, photographs and plates. There is no list of figures/plates or glossary. The chapters or essays (and the names of contributors) contained in Pioneers of Medicine without a Nobel Prize include "Ch. 1. Archibald E. Garrod: The Founding Father of Biochemical Genetics" (David J. Galton); "Ch. 2. Nikolai Anitschkow: The Birth of the Lipid Hypothesis of Atherosclerosis and Coronary Heart Disease" (Daniel Steinberg); "Ch. 3. Willem-Karel Dicke: The Role of Gluten in Coeliac Disease" (Chris J.J. Mulder and Karel A. Dicke); "Ch. 4. Richard Doll: The Link Between Smoking and Lung Cancer" (Tony Seed); "Ch.5. Albert Sabin: The Development of an Oral Poliovirus Vaccine" (Derek R. Smith and Peter A. Leggat); "Ch. 6. René Favaloro: Pioneer of Coronary Artery Surgery" (Stephen Westaby); "Ch. 7. Christiaan Barnard and Norman Shumway: The Heart Transplant Pioneers" (Stephen Westaby and David Marais); "Ch. 8. William Kouwenhoven and Paul Zoll: The Introduction of External Cardiac Massage, Defibrillators and Pacemakers" (Max Lab); "Ch. 9. Inge Edler and Carl Hellmuth Hertz: The Development of Ultrasound for Clinical Use" (Bhavna Batohi and Paul S. Sidhu); "Ch. 10. Cyril Clarke, Ronald Finn, John Gorman, Vincent Freda and William Pollack: The Prevention of Rh Haemolytic Disease of the Newborn" (David J. Weatherall); "Ch. 11. Herbert Boyer and Stanley Cohen: Recombinant DNA" (Anne Soutar); "Ch. 12. Harvey Alter and Michael Houghton: The Discovery of Hepatitis C and the Introduction of Screening to Prevent Its Transmission in Transfused Blood" (Leonard B. Seeff and Marc G. Ghany); "Ch. 13. Willem Kolff and Belding Scribner: The Development of Renal Haemodialysis" (John Turney); "Ch. 14. James Till and Ernest McCulloch: The Discovery of Stem Cells" (Joe Sornberger); and "Ch. 15. Akira Endo: The Discovery of Statins" (Gilbert Thompson and Hiroshi Mabuchi). The back cover of the book gives a brief description of the book and its publisher.

The searchable archives of the Nobel Prize organisation include information released after 50 years concerning nominators.[3] It is interesting that only one of the persons described in Pioneers of Medicine without a Nobel Prize was listed as the nominator for someone else who did go on to win a Nobel Prize up to the embargo period at least. Following a search of the Nomination Database for the Nobel Prize, only Albert Sabin acted as a Nominator and this was for the second of four nominations of Max Theiler, who did go on to win the Nobel Prize for Physiology or Medicine in 1951.[3] Otherwise the essays contained in this book describe some remarkable people and some extraordinary discoveries that were never recognised with a Nobel Prize. In many cases, the names of these people live on in major research institutes around the world, for example the Sabin Vaccine Institute in the USA, which was founded in honour of Albert Sabin (Ch. 5) in 1993.[4] It is curious that Austin Bradford Hill was not formally included in the biography related to Doll's discovery (Ch. 4) of the link between smoking and lung cancer,[5] but Hill was mentioned in the Chapter. It is significant that the discoveries described in Pioneers of Medicine without a Nobel Prize are still having considerable impact today.

The editor, Gilbert Thompson, is a former gastroenterologist and Emeritus Professor in Clinical Lipidology at the Hammersmith Campus of Imperial College London. He is a Past Chairman of the British Atherosclerosis Society, the British Hyperlipidaemia Association and the Forum on Lipids in Clinical Medicine of the Royal Society of Medicine. He is also a Distinguished Fellow of the International Atherosclerosis Society. He has published more than 300 papers and seven books. Most of his work has been in the field of lipoprotein metabolism and atherosclerosis.

Pioneers of Medicine without a Nobel Prize is the first compilation of essays on medical scientists and physicians, who, despite significant contributions to medicine and medical science, did not win a Nobel Prize. The concise style and interesting selection of subjects help to make the book easy to read. It will broadly appeal to all health professionals and medical scientists with an interest in some of the major discoveries that have shaped medicine and medical science, as well as medical historians. It is likely that this book is a one off edition, unless it is revised, reprinted or expanded in the future, so those wanting it for their medical history library in its current form are strongly encouraged to purchase a copy of Pioneers of Medicine without a Nobel Prize.

Declaration of Interests

The reviewer was the second contributor to one chapter to this book (Ch. 5. Albert Sabin: The Development of an Oral Poliovirus Vaccine).

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Textbook of Adult Emergency Medicine*

Peter Cameron, George Jelinek, Anne-Marie Kelly, Anthony F.T. Brown and Mark Little

*4th edn, 1104 pp, paperback with illustrations, ISBN: 978-0-7020-5335-1. Sydney, Churchill Livingstone (an imprint of Elsevier), RRP: $114.74, 2014.

The International Federation for Emergency Medicine definition of emergency medicine is provided in the Introduction of the Textbook of Adult Emergency Medicine, which defines the areas as:

> "a field of practice based on the knowledge and skills required for the prevention, diagnosis and management of acute and urgent aspects of illness and injury affecting patients of all age groups with a full spectrum of episodic undifferentiated physical and behavioural disorders; it further encompasses an understanding of the development of pre-hospital and in-hospital emergency medical systems and the skills necessary for this development." (p xxv).

This is an extremely broad brief for health professionals; although the availability today of a number of emergency medicine reference textbooks internationally has assisted greatly. There is no substitute for local relevance assisted by having a textbook, such as the Textbook of Adult Emergency Medicine, edited by Australian physicians. The textbook is now in its 4th edition and it has established itself as one of the leading reference textbooks in the field of adult emergency medicine in Australasia.

The 4th edition of the Textbook of Adult Emergency Medicine is presented as a formidable 3 kg, 1104 page, 27 x 21.6 x 4.8 cm softcover publication that would normally sit on the reference book shelf, although Kindle and eBook versions are available. The "no nonsense" front cover depicts a typical scene of a patient being wheeled to the emergency room using time-lapse photography to protect the identity of those in the photograph. The textbook contains a table of Contents, Preface, list of the 208 Contributors, List of the 6 members of the International Advisory Board, Introduction, 30 Sections, 91 Sub-Sections and a comprehensive Index. There is no bibliography, glossary, acknowledgments or list of abbreviations. It is now part of the "Expert Consult" series and has searchable full text online, which is activated via a "PIN code" provided in the inside cover of the textbook (scratch off panel). The eTG complete[1] would potentially be a useful adjunct to the textbook, as this provides a succinct listing of relevant therapeutic guidelines for busy health practitioners.

The Sections of the Textbook of Adult Emergency Medicine include "1. Resuscitation"; "2. Critical care"; "3. Trauma"; "4. Orthopaedic emergencies"; "5. Cardiovascular emergencies"; "6. Respiratory emergencies"; "7. Digestive emergencies"; "8. Neurology emergencies"; "9. Infectious disease emergencies"; "10. Genitourinary emergencies"; "11. Endocrine emergencies"; "12. Metabolic emergencies"; "13. Haematology emergencies"; "14. Rheumatology and musculoskeletal emergencies"; "15. Dermatology emergencies"; "16. Ocular emergencies"; "17. Dental emergencies"; "18. ENT emergencies"; "19. Obstetrics & gynaecology emergencies"; "20. Psychiatric emergencies"; "21. Challenging situations"; "22. Pain relief"; "23. Emergency imaging"; "24. Academic emergency medicine"; "25. Emergency medicine and the law"; "26. Emergency and medical systems"; "27. Administration"; "28. Environmental emergencies"; "29. Toxicology emergencies"; and "30. Toxinology emergencies". The publisher states that the 4th edition provides updates on the latest imaging in emergency medicine; organ donation; massive transfusion protocols; medico legal issues; and patient safety and quality measures. There is also a new electronic version, as previously alluded to, which includes emergency procedure videos and self-assessment materials to check understanding and would be a useful aid for exam preparation, which was not specifically reviewed here.

Details of the five authors of the Textbook of Adult Emergency Medicine are given in the textbook and they are well known in Australasia. Peter Cameron is Professor of Emergency Medicine, Department of Epidemiology and Preventive Medicine, Monash University, The Alfred Hospital, Melbourne, Australia. George Jelinek is based at the Department of Emergency Medicine, Sir Charles Gairdner Hospital, Nedlands, Western Australia, Australia. Anne-Maree Kelly is Academic Head of Emergency Medicine, Joseph Epstein Centre for Emergency Medicine

Research, Western Health, St Albans, Australia, and Professorial Fellow, Faculty of Medicine, Dentistry and Health Sciences, The University of Melbourne, Melbourne, Australia. Anthony F. T. Brown is Professor of Emergency Medicine, School of Medicine, University of Queensland, Queensland, Australia, and Senior Staff Specialist, Department of Emergency Medicine, Royal Brisbane and Women's Hospital, Brisbane, Australia. Mark Little is an Emergency Physician and Clinical Toxicologist, Cairns Base Hospital and Associate Professor, College of Public Health, Medical and Veterinary Sciences and the Queensland Tropical Health Alliance, James Cook University, Cairns, Queensland, Australia.

The consistent and concise style ensures that the 4th edition of the Textbook of Adult Emergency Medicine is easy to read. Given that this textbook is now in its 4th edition, it is now a mature reference textbook, which is a credit to the editors and the contributors. In addition to the more traditional areas for emergency medicine consumption, it was pleasing to see that Section level coverage given to each of Environmental Emergencies (S. 28), Toxicology Emergencies (S. 29) and Toxinology Emergencies (S. 30). Such Sections would also be useful reading for those involved with rural and remote medicine as well as expedition and wilderness medicine. The Sub-Section on Medical Issues in Disasters (S. 26.3) was also interesting reading. This provides some general principles in what is a very complex area. More coverage in this area would be welcome in dealing with specific issues, for example those ranging from talcum powder "biological" incidents through to pandemic management, which have a potential to impact severely on emergency departments.

The primary target audience of the 4th edition of the Textbook of Adult Emergency Medicine is stated to be "the trainee doctor in the emergency department". It is also on the list of Fellowship Exam Recommended References.[2] It is also mentioned that it would also be a useful resource for other professionals working in this setting, including nursed[nursing?] specialists and paramedics, as well as hospital doctors. Although not mentioned, the manual would also be a useful resource for general practice and other clinics that operate an on-call or after hours service, as well as medical and other students undertaking emergency department training rotations or training in rural and remote medicine or expedition and wilderness medicine, where emergency medicine is featured as a core area of the curriculum.[3] Of course a textbook is not a substitute for appropriate experience, but it does provide a useful framework for professional development. The cost is not prohibitive and there is little competition nationally. The 4th edition of the Textbook of Adult Emergency Medicine has become established as part of the portfolio of standard textbooks in emergency medicine in the Australasian region.

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