Military Medicine Capabilities in the Australian Defence Force

Commander N Westphalen

Introduction

This article is the latest of a series regarding the role of occupational and environmental medicine in the Australian Defence Force (ADF).[1,2,3,4,5,6,7]

These articles, as well as a recent Productivity Commission inquiry,[8] indicate that high workplace illness and injury rates confirm the need to improve the management of hazards associated with ADF workplaces with better emphasis on prevention. To this end, a submission by the Royal Australasian College of Physicians to the aforementioned inquiry advocated this would best be achieved by basing the ADF's health services on a systems-based occupational health strategic model.[9]

Doing so would have to entail reassessing the fundamental inputs to capability[10] for both Joint Health Command and Defence's Work Health and Safety Branch. The current state of the ADF's occupational and environmental health services, and the small number of specialist practitioners within the Australasian Faculty of Occupational and Environmental Medicine, suggest that a mature model would take 10–15 years' sustained effort.[11]

This article expands on these papers with respect to military medicine support for ADF operational capabilities, such as combat aircraft (including fixed-wing transport aircraft and helicopters), Joint Battlespace Aircraft Controllers (JBACs), military parachuting and diving and submarines. A previous paper has described the ADF's current military medicine capabilities to support operations in Chemical, Biological, Radiological and Nuclear (CBRN) environments.[12]

Overview

Table 1 lists the ADF populations that require dedicated health support, based on their medical Specialist Employment Classifications (SPECs).[13]

Table 1 indicates that:

- 12.1 per cent of all ADF members have a SPEC. This proportion is equivalent to half of all Navy and Air Force members (24.4 per cent each) and a quarter of all Army members (51.2 per cent).
- 38.4 per cent of all ADF SPEC personnel are Air Force and constitute 19.1 per cent of all Air Force members. Not surprisingly, 82.7 per cent of Air Force SPEC members are aircrew, which increases to 97.1 per cent if JBACs are included.
- 35.0 per cent of all ADF SPEC personnel are Navy and constitute 17.4 per cent of all Navy members. These are distributed mostly between aircrew (22.0 per cent), divers (31.1 per cent) and submariners (41.5 per cent).
- The remaining 26.7 per cent of the ADF's SPEC personnel are Army and constitute only 6.3 per cent of all Army members. Army SPEC members mostly comprise aircrew (35.1 per cent) and parachutists (33.7 per cent).

Table 1: ADF Population Requiring Dedicated Military Medicine Support as of 01 March 2019[1]

	Aircrew	JBACs	Divers2	Paras	SM'ers3	All SPEC Pers	Non-SPEC Pers	Total
Navy	553	123	781	11	1,042	2,510	11,946	14,456
Army	673	274	302	646	18	1,913	28,458	30,371
RAAF	2,279	397	9	69	1	2,755	11,696	14,451
Total	3,505	794	1,092	726	1,061	7,178	52,100	59,278

Health support for aviation operations

The Air Force's *Air Power Manual* indicates that ADF aviation capabilities include the following roles:

- Control of the air, through offensive and defensive counter-air operations.
- Strike operations, including strategic attack, close air support, air interdiction, maritime anti-surface warfare, anti-submarine warfare, electronic warfare and information operations.
- Air mobility operations, including air logistic support, airborne (including parachute) operations, air-to-air refuelling and aeromedical evacuation.
- Intelligence, surveillance and reconnaissance operations.[14]

All three Services contribute to these roles, using a combination of fixed (Air Force) and rotary-wing (Navy and Army) aircraft, including an increasing number of Unmanned Aerial Vehicles (UAVs).

It is a well-known adage that 'Aviation is not inherently dangerous. But to an even greater degree than the sea, it is terribly unforgiving of any carelessness, incapacity or neglect'.[15] This reflects the interactions between the personnel who fly and otherwise operate or maintain aircraft and the physical and physiological hazards of the aviation environment, such as:

- reduced barometric pressure
- hypoxia
- acceleration forces associated with aircraft manoeuvring ('pulling G'), ejection and ground impact
- noise and vibration
- temperature extremes
- human factors, including ergonomics, sleep and fatigue
- escape (including ejection, ditching and underwater escape), survival and evasion.[16]

To this end, aviation medicine has enhanced flying safety since WWI.[17,18] However, unlike civilian aviators, ADF aircrew have an operational imperative to function *at the edge of their physiological and other limits as a matter of routine*, for example, fast jet aircrew who can pull more 'g' than their opponents have a substantial dogfighting capability edge. The ensuing risks should not be underestimated.[19,20,21,22,23]

The scope of *military* aviation medicine, therefore, includes enabling, sustaining and enhancing the performance of personnel engaged in *combat-related* flight operations. Historical examples include the development of 'g' suits for fast jet aircrew,[24] night vision aids to enhance fixed- and rotary-wing combat capability[25] and 'piddle-packs' for female aircrew.[26]

ADF aircrew have specific health standards that reflect the demands of the military aviation environment, for example, the importance of visual tasks for aircrew means that, compared with other occupations, they require a higher visual standard.[27] Aircrew recruiting health assessments are therefore used to reduce the risk of wasting training resources on entrants who are not medically suitable, while annual aircrew health assessments are subsequently used to monitor their ongoing suitability for aviation duties.

Even in the civilian setting, the scope of aviation medicine extends to the health, safety and working environments of the ground and seagoing personnel who support aviation operations.[28] It therefore, directly and indirectly includes all Air Force personnel and all Navy and Army personnel engaged in aviation-related occupations, including JBACs and UAV operators. Its relevance to parachutists not only pertains to assessing their medical suitability, but also addressing the physiological hazards associated with High Altitude High Opening (HAHO) and High Altitude Low Opening (HALO) operations.

The personnel who operate and maintain Air Force aircraft are typically home-based at Pearce WA, Tindall NT, Amberley QLD, Williamtown NSW, Richmond NSW, East Sale VIC and Edinburgh SA. Those for Army aircraft are home-based at Holsworthy NSW, Townsville QLD and Oakey QLD. While those for Navy aircraft are home-based at Nowra NSW.

However, in practice, non-deployed personnel with an aviation-related SPEC may be found at many other ADF bases throughout Australia. This poses significant challenges regarding their 'garrison' health services, particularly at bases that are not located near major urban centres.

Furthermore, ADF aviation medicine officers are often required to deploy with the aircrew they support. This creates tensions with respect to maintaining 'garrison' health services for non-deployed aircrew, both for extended deployments that require multiple aviation medicine personnel rotations, as well as multiple concurrent aviation medicine personnel deployments.

The Institute of Aviation Medicine (IAM) at RAAF Base Edinburgh acts as the ADF's centre of aviation medicine expertise. It provides a range of courses for Service and civilian health staff, while more advanced training necessitates sending selected medical officers on overseas courses in the US and UK. IAM also supports ADF aviation operations via research and policy development, using a very small number of uniformed and civilian personnel with diverse skills in aviation medicine, human factors and life support.[29] However, as the scope of IAM is limited to aircrew, it does not include the *non*-SPEC ADF members who support aviation operations or give its personnel a broader clinical grounding or currency *beyond* aviation medicine.

The IAM's policy development role supports the aviation medicine guidance per the *Defence Health Manual* website and the *Aviation Medicine for ADF Aircrew* manual.[30] In addition, Navy[31,32] and Army[33] both have their own operational and aviation medicine instructions that reflect their respective operational environments.

Spatial Disorientation System trainer briefing, RAAF IAM, 2018[34]

The scope of military aviation medicine is therefore far broader than simply providing primary care services for aircrew, JBACs and parachutists. It is, however, entirely consistent with a systems-based occupational health model.

Health support for diving operations

Navy's diving capabilities are provided by Mine Clearance Divers (MCDs) and ship's divers. *Australian Maritime Doctrine* indicates that Navy Clearance Diving Teams (CDTs) assist with the identification and rendering safe of explosive devices, particularly in shallow water and in ports and harbours. They also conduct clandestine hydrographic surveys of beaches for amphibious operations and clear mines or obstacles. Other CDT elements conduct underwater battle damage repair and other support tasks involving the installation and repair of underwater fittings.[35]

Ship's divers provide part-time organic support for Fleet units with respect to hull searches, underwater engineering support and other tasks as required.[36] Army diving capabilities are provided by special forces divers and Army work divers. Special forces divers undertake a range of tactical operations, some of which can have strategic effects.[37] Army work divers *facilitate* tactical mobility for land operations, by reconnoitring wet gap crossings and bridges, clearing underwater obstacles and mines, supporting wet gap crossings and removing underwater battlefield hazards. They also *restrict* enemy mobility by emplacing underwater obstacles, enhancing natural obstacles and undertaking demolitions. They also provide diving support to emergency respondents for tasks such as firefighting and urban search and rescue. Other Army work diver tasks include underwater damage assessment, equipment searches and recovery, maintaining lines of communication and supporting engineering tasks.[38]

For the purpose of this article, the term 'diving medicine' refers to the aspect of military medicine that is concerned with the interactions between the personnel who dive (and those who support them) and the physical and physiological hazards of the diving environment, such as:

- increased barometric pressure
- abnormal gas pressures
- cold and hypothermia
- (near) drowning
- infections
- dangerous marine creatures
- human factors, including ergonomics, stress responses, panic and fatigue.

To this end, diving medicine has enabled diving safety for more than 150 years.[39,40] However, like aircrew, ADF divers also have an operational imperative to *function at the edge of their physiological and other limits as a matter of routine*, albeit on comparable terms as other occupational (as opposed to recreational) divers. For example, Navy's coastal minehunters can be equipped with recompression chambers for *operational* rather than therapeutic purposes, to extend diving durations and bottom times while preventing dysbaric diving illnesses such as decompression illness and barotrauma.[41] Even so, the risks should likewise not be underestimated.[42,43,44,45,46]

To this end, ADF divers have specific health standards that reflect the demands of the diving environment, in particular an absence of lung and ear abnormalities.[47] Unlike aircrew recruiting health assessments, the purpose of diver health assessments pertains less to enabling operational capability than to reduce the risk of death or serious injury for entrants who are not medically suitable. However, even despite these standards, diving medicine practitioners may still have to treat dysbaric diving illnesses, breathing gas toxicity and other diving-related clinical conditions.

The scope of diving medicine also comprises enabling, sustaining and enhancing the performance of personnel engaged in diving operations, such as developing or assessing the various types of open- and closed-circuit air, oxygen and mixed gas breathing sets. It also includes facilitating the health, safety and working environments of all ADF personnel who directly or indirectly undertake diving-related occupations, such as the medical and other personnel who undertake operational and/or therapeutic recompression chamber duties.

Navy's CDTs are based at HMAS *Waterhen* in Sydney NSW and HMAS *Stirling* in Perth WA, while the ADF Diving School is located at HMAS *Penguin* in Sydney. Ship's divers are assigned to all Fleet units, which are generally homeported at HMA Ships *Kuttabul* and *Waterhen* in Sydney, HMAS *Coonawarra* in Darwin NT, and HMA Ships *Cairns* and *Stirling*. Army divers are located at various special forces and engineering units based throughout Australia.

Like aircrew, however, non-deployed ADF divers can be found at many other bases Australia-wide. As Navy divers, in particular, may be posted to sea at short notice, those so liable are required to maintain their medical suitability for diving duties at all times. This likewise poses challenges with providing their 'garrison' health services, especially at bases that are not located near major urban centres. Key mitigation, however, is that unlike the aviation setting, health support for deployed and non-deployed ADF diving operations are usually conducted by specially trained diving medicine medics, albeit *without* direct medical officer supervision. Besides maintaining their clientele's medical suitability for deployed diving duties, these medics may also be required to provide emergency hyperbaric and other treatment for diving casualties.

The ADF's centre of diving medicine expertise is the Submarine and Underwater Medicine Unit–East (SUMU-E) at HMAS *Penguin* in Sydney NSW. Like IAM, it is staffed by a limited number of uniformed and civilian personnel with a diverse range of skills. Unlike IAM, which has no direct clinical role, SUMU-E also provides primary care services for the co-located ADF Diving School, in conjunction with recently co-located *Penguin* garrison health staff.

SUMU-E also provides diving medicine-related courses for all Navy medical officers and other ADF and civilian health staff. At present, there is no requirement for overseas diving medicine courses.

Finally, SUMU-E undertakes a range of research and policy development activities. The latter includes the diving medicine guidance in Australian Book of Reference (ABR) 155 *RAN Diving Manual*,[48] entry medical standards for divers and submariners per the *Defence Health Manual*[49] and ABR 1991 *RAN Health Service Manual* Chapter 7.[50] Army work divers and special forces divers also have their own references.[51,52]

Opening Ceremony, SUMU-E, HMAS Penguin, *09 Dec 13*[53]

The scope of military diving medicine, therefore, extends considerably beyond simply providing primary care services for ADF divers. Like aviation medicine, however, it is also consistent with a systems-based occupational health model.

Health support for submarine operations

Australian Maritime Doctrine states that, with their inherent stealth, long-range endurance, striking power and intelligence gathering capabilities, submarines can have a significant impact on high-level maritime warfare.[54] To this end, Navy presently operates six *Collins* class submarines,[55] to be replaced by 12 *Attack*-class submarines from the early 2030s.[56]

For the purpose of this article, the term 'submarine medicine' refers to that aspect of military medicine that is concerned with submarine operations. This includes (but is not limited to) those associated with:

- shipboard occupational and environmental hazards that are associated with surface vessels, as well as those that are intrinsic to submarines[57]
- shipboard emergencies, such as fire, flooding and toxic hazards. Limited buoyancy compared to surface ships and limitations on the crew's ability to abandon ship pose additional threats even when surfaced
- waiting for rescue in the event of a survivable submarine accident. These hazards include toxic and/or hyperbaric atmospheres, cold and hypothermia, and dehydration and hunger. Rescue can be achieved using a suitable rescue vehicle[58,59]
- diving hazards (in particular drowning, ear and lung trauma and exposure) in the event of having to escape from a disabled submarine, if survivors are unable to wait for rescue.

The risks posed by these hazards are substantial.[60,61,62,63,64,65,66] However, unlike aviation and diving medicine, the requirement for dedicated submarine medicine health support stems less from the risks of routinely operating non-nuclear submarines at their maximum level of performance, than from their limited organic health support, continuous exposure to a range of workplace health hazards for months at a time, and saving lives *in extremis* in the event of a survivable submarine accident.

The latter requirement drives the entry and periodic health standards for Navy submariners.[67,68] To this end, all RAN submariners undertook Pressurised Submarine Escape Training (PSET) in the UK from the mid-1960s until 1989, when it was repatriated to the Submarine Escape Training Facility (SETF) at HMAS *Stirling*, until its cessation in September 2018.[69] During that time, SETF medical staff treated more than 300 diving casualties (including 29 requiring recompression), from about 4000 students and staff who collectively performed over 140 000 ascents.[70]

An additional complication pertains to the requirement to provide health support for Navy's submarine abandonment, escape and rescue (SAER) capability, in the form of deployable on-scene emergency hyperbaric and trauma treatment services. This capability is required to be rapidly deployable to survivable depths anywhere within Australia's area of direct security interest, which encompasses up to 10 per cent (51 million km^2) of the Earth's surface.[71]

While Navy's SAER capability uses a combination of ADF and contract civilian assets, the deployed health support services themselves are almost exclusively a Navy responsibility. This is because the civilian health sector cannot deploy emergency hyperbaric and trauma treatment services that can treat up to 60 submarine accident survivors at an accident scene. While this capability has not yet deployed for an actual submarine accident, it is exercised annually.[72]

Submarine Intervention Gear Ship MV Besant[73] *and HMAS* Rankin,[74] *Exercise BLACK CARILLON, 2015*[75]

Unlike surface Fleet units, submarines do not have a medical officer embarked, relying instead on submariner-qualified medical sailors, whose primary role is to maintain operational capability by reducing the need to land sick or injured crewmembers while deployed. This means that although these sailors have the same medical training as their surface counterparts, workload considerations mean their duties as medics are normally secondary to those as submariners.

While all submarines are homeported at HMAS *Stirling*, submariners can be found at any Navy shore establishment and many other ADF bases throughout Australia. Like divers, those with a liability to go to sea at short notice again pose particular challenges with providing their 'garrison' health services, in particular ensuring their medical suitability for submarine duties among a plethora of other submariner personnel management issues.[76]

Until recently, the ADF's centre of submarine medicine expertise was provided by the Submarine and Underwater Medicine Unit–West (SUMU-W) at HMAS *Stirling*, which is subordinate to the Officer-In-Charge at SUMU-E. At present, at least one SUMU-W medical officer is required to have undertaken the Canadian Forces submarine medicine course.[77]

SUMU-W was established in 2000, to provide dedicated underwater medicine services for all

submariners and divers at *Stirling*. Besides giving SETF medical staff clinical work to do while covering PSET (thereby also reducing the *Stirling* sickbay workload), this replicated the dedicated submariner health services that had been provided at the submarine base at HMAS *Platypus* in Sydney, from 1967 until its closure in 1999.

Since the cessation of PSET, and of providing dedicated primary care services for submariners and divers, SUMU-W now only conducts *non*-pressurised submarine escape and rescue medical training, as well as a limited range of submarine-related research and policy development activities as directed by the Officer-In-Charge SUMU-E. Examples of the former include potable water contamination and submarine atmospheric standards; the latter includes providing medical advice regarding the aforementioned submarine recruiting medical standards,[78] as well as SAER medical guidance for Australian Fleet Tactical Publication 9(H) *Australian Submarine Search and Rescue Instructions*[79] and other related references.

Submarine Escape Training Facility (now the Submarine Escape and Rescue Centre), HMAS Stirling, *1998*[80]

Once again, the scope of submarine medicine is consistent with a systems-based occupational health model. The splitting of primary care from the other submarine medicine services at *Stirling*, therefore, constitutes a retrograde step, whose impact on submarine operational capability remains to be seen. Examples of the latter include ensuring submariner seagoing medical suitability *beyond* providing their primary health care[81,82] and identifying future submarine workplace health hazards.[83]

Implications

Some of the ADF's more specialised operational capabilities require over 7000 of its permanent members to have a SPEC. This number is surprisingly large — it is equivalent to *half* of all Navy and Air Force and a *quarter* of all Army members.

These members are not evenly distributed: 15–20 per cent of all Air Force and Navy members have a SPEC, compared to only about five per cent of Army members. Neither are these members evenly distributed: while the majority are aviation-related (if one adds JBACs and perhaps parachutists), about 75 per cent of Navy SPEC members are either divers or submariners.

These proportions are substantially increased by the *non*-SPEC ADF personnel who *indirectly* support the operations conducted by SPEC members. They include most if not all Air Force, a significant proportion of Navy and a smaller proportion of Army members. An added complication to providing health services for SPEC personnel is that they can all be found more-or-less at any ADF base within Australia.

These personnel require bespoke health services because what they need is not generally available in civilian medical practice in forms that meet ADF operational requirements. This particularly refers to (as examples):

- enabling their ability to function at their physiological limits to give them a capability edge (aircrew and divers)
- sustaining these capabilities via deployable health services (aircrew and divers). This also includes providing bespoke (hyperbaric) treatment services for single (diver) or multiple (submariner) casualties.

It is therefore unclear how the ADF's current health delivery model enables operational capabilities that require SPEC personnel. As the necessary skills are (by definition) not generally available in civilian practice, ab initio civilian 'garrison' health staff require additional training and mentoring support. However, their frequently itinerant employment as contractor employees either limits or precludes them from undertaking this training; alternatively, such training is lost if (or when) they move on from working for Defence. At the same time, uniformed medical officer recruiting and retention issues have led to hollowness and fragility in medical SPEC expertise — all three Services lack long-service uniformed aviation medicine practitioners, while only two Navy medical officers have remained in the Permanent Navy beyond their posting as OIC SUMU-East since 2006.[84]

Hence at present, clinical SPEC health services are generally provided by junior uniformed medical officers of high turnover and limited experience and a very small pool of typically ex-ADF civilian contract and APS staff. Besides the ensuing lack

of *clinical* SPEC medical experience, the inability to retain uniformed aviation and underwater medical officers is having adverse effects on ADF operational capability concerning its *non*-treatment-service-oriented military health functions of SPEC research, training, policy development, medical suitability assessments and (in particular) workplace health hazards.

Hence, the scope of SPEC health services *must* be far broader that simply providing primary care and other treatment services. In order to also address their *non*-clinical operational requirements, the health services for *each* of these SPECs can and should be considered bespoke exemplars of military occupational and environmental medicine.[85]

Yet, at the same time, the limited size of the SPEC health services precludes them from operating in isolation from the ADF's *non*-SPEC health services, especially regarding those members who *indirectly* support the ADF's SPEC capabilities. This limits (but does not exclude) proposals such a 'blended career model', whereby uniformed medical officers transition to APS/contracted positions while remaining reservists, so they can pursue a (typically clinical-only) specialisation in a particular SPEC. Although such a model may be attractive from an *individual career perspective*, it is unclear how it enables *actual ADF operational* capability, especially for bases that are not located near major urban centres.

Rather, the support required by the SPEC health services of the ADF's health services (and vice versa) can and should be achieved via a holistic, systems-based, occupational health strategic model.

Conclusion

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

This suggests the need for substantially revised fundamental inputs to ADF health capability to develop a genuinely holistic and sustainable systems-based occupational health strategic model. Among its other attributes, the proposed model would incorporate each of the bespoke health services for the ADF's SPEC personnel, as microcosms of a broader systems-based, occupational health strategic model that can enable overall ADF operational capability.

Author

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

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

Commander Westphalen transferred to the Active Reserve in 2016. Comments regarding this and previous articles are most welcome.

Disclaimer

The views expressed in this article are the author's and do not necessarily reflect those of the RAN, or any of the other organisations mentioned.

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

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Personnel;
Organisation;
Collective training;
Facilities;
Supplies;
Major systems;
Support, and
Command and management.

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