Tropical Diseases of Military Importance: A Centennial Perspective

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Abstract

Vector-borne diseases stand out as major concerns for military deployments. Of particular concern are malaria, arboviral diseases and, more recently, leishmaniasis. Vaccine preventable diseases also remain important globally. Other common problems, for example diarrhoeal disease and non-infectious hazards, such as trauma, also need to be addressed.

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Figure 1. Dr Anton Breinl
Photo courtesy of the Anton Breinl Centre, James Cook University

Introduction

Despite a century of formal research in tropical medicine, tropical diseases remain a significant threat for many military deployments. Since the arrival of Dr Anton Breinl to head Australia's first medical research institute on 1 January 1910, the Australian Institute of Tropical Medicine (see Figures 1 and 2), there have been many institutional milestones and advances in tropical medicine, some of which are recorded in Table 1. During this time, military forces from the region have frequently deployed to areas that have been characterised by extremes of environment, endemic disease, poverty, and inadequate public health resources. Tropical diseases have remained one of the greatest challenges to defence health services in the region. Historically, tropical diseases have been regarded as a significant factor influencing the outcome of major military campaigns, including the Second World War.[1] It was one of Australia's most highly regarded tropical medicine specialists and military physicians, Neil Hamilton Fairly, for example during the Second World War that raised the importance of addressing tropical diseases such as malaria with the force commanders.[2]

Vector-borne tropical diseases

Vector-borne tropical diseases remain amongst the great problems for operational deployment of military personnel. Table 2 summarises potential tropical disease risks during deployment and some of the preventive measures. Some vector-borne diseases also represent a potential public health problem when returning home. Malaria remains the single most important vector-borne disease problem of the military worldwide.

Malaria

Malaria is a serious disease caused by a protozoan parasite largely confined to the tropics. Most life-threatening cases and deaths occur due to infection with *Plasmodium falciparum* malaria.[4] However, infection due to *P. vivax* also remains important, especially as dormant liver stages can cause relapses, sometimes several, for months after returning home.[4] Standard malaria countermeasures will be considered as part of planning for operational deployment based on current policy and disease patterns in the area of operations. Current countermeasures against malaria include the use of malarial chemoprophylaxis, personal protective measures, environmental health measures

Figure 2. Australian Institute of Tropical Medicine, Townsville, Australia, 1916

Photo courtesy of the Anton Breinl Centre, James Cook University

against disease vectors, early detection and treatment, and malaria eradication treatment.[4] These measures are detailed in Australian Defence Force (ADF) Health Directives, e.g. HD215 on Malaria.

Arboviral diseases

There are many arboviral diseases, which have the potential to impact on military deployments. In Asia, dengue fever and Japanese encephalitis are major concern for deployments; however in Africa Yellow fever is also a concern.

Yellow fever

Military personnel are one of the high-risk groups for yellow fever.[5] The WHO requires yellow fever vaccination for those travelling to endemic regions, including west and central Africa as well as a number of areas in south and central America. Vaccination with the attenuated live viral vaccine (17D) confers protective immunity for about 10 years.[4] Yellow fever vaccination should be appropriately documented and a booster should be considered after about 10 years. Military personnel should also be fully briefed on personal protective measures to avoid bites from infected mosquitoes.

Dengue

Dengue is a viral illness transmitted by various species of *Aedes* mosquitoes and is a major global public health problem. Infection may range from subclinical disease to fever, arthralgia and rash, or be complicated by haemorrhagic diatheses or shock syndromes. Treatment is supportive, while management of the problem is directed towards preventing transmission upon return home, which is a small potential risk in southern Africa. Numerous outbreaks of dengue can be attributed to travellers returning with the disease

Table 1. Some key institutional events in the past 100 years of tropical medicine in Australia

Year	Event
1909	The Australian Institute of Tropical Medicine (AITM) founded in 1909 as Australia's first medical research institute
1910	Anton Breinl arrived in Townsville to take up role as the Inaugural Director, AITM; AITM commences operations
1913	New AITM building officially opened in Townsville
1915	Walter and Eliza Hall Institute of Medical Research became Australia's second medical research institute after AITM
1926	First students graduate from Diploma of Tropical Medicine and Hygiene from the AITM in Townsville1 University of Sydney records first award of the Graduate Diploma in Tropical Medicine (DTM)
1928	University of Sydney records first award of DTM&H
1930	The School of Public Health, University of Sydney, assumes the role of research and teaching in tropical medicine; AITM closes.
1950	Sir Neil Fairley receives a Knighthood for services to tropical medicine
1967	Establishment of the 1 Malaria Research Laboratory at the School of Public Health, University of Sydney
1973	1 Malaria Research Laboratory moved to the Ingleburn Military Camp; changed name to Army Malaria Research Institute
1987	Kerr White Review of Public Health recommends Commonwealth fund public health research and training (now Public Health Education and Research Program) Establishment of what is now the Anton Breinl Cenre for Public Health and Tropical Medicine, James Cook University Establishment of what is now the Australian Centre for International and Tropical Health and Nutrition, University of Queensland
1991	Foundation of The Australasian College of Tropical Medicine (ACTM) in Townsville; Associate Profesor Rick Speare is the Inaugural President
1993	Re-establishment of a DTM&H in Townsville at James Cook University Master of Public Health and Tropical Medicine offered for the first time at James Cook University
1996	Army Malaria Research Institute relocated to the Gallipoli Barracks, Brisbane, and renamed Australian Army Malaria Institute
2004	Commencement of the Centre for Military and Veterans' Health – University of Queensland and University of Adelaide nodes
2006	Commencement of the Centre for Military and Veterans' Health – Charles Darwin University node
2007	Foundation of the Marshall Centre for Infectious Diseases Research and Training, University of Western Australia, and establishment of a Tropical Infectious Diseases stream within a Master of Infectious Diseases

from Southeast Asia. Until a vaccination becomes available, the mainstays of dengue prevention are personal protective measures and environmental health measures against disease vectors.[4] Further information can be found in Health Bulletins, e.g. HB No. 6/2000 Dengue. A useful update on Dengue can be found elsewhere.[6]

Japanese encephalitis

JE, transmitted by infective mosquitoes, is the leading cause of viral encephalitis in Asia. Up to a third of clinical cases die and about one half of clinical cases of JE have permanent residual neurological sequelae.[7] The recent development and release of safer and more immunogenic second-generation JE vaccines have been a useful advance for military deployments in JE endemic areas.[7] Some of the background for the ADF's involvement in JE vaccine research is given elsewhere.[8]

Filariasis

In Africa, soldiers may encounter several forms of filariasis, including lymphatic filariasis (LF), onchocerciasis and loiasis. In Asia, lymphatic filariasis is the predominant concern. LF is caused by three species of nematode parasites, which can be spread by a wide range of mosquito species.[9] It has a widespread geographic distribution mainly in the tropical regions of the world. Wuchereria bancrofti is the most common and accounts for around 90% of cases.[9] Brugia malayi is confined to east and southeast Asia and Brugia timori is found only in Timor and nearby islands.[9] From World War II, there have been numerous outbreaks and reports of LF documented amongst troops deployed in southeast Asia and the western Pacific region.[10] Countermeasures for filariasis include personal protective measures and eradication treatment.[4] Further information for ADF personnel can be found in Health Bulletins, e.g. HB No. 4/2002 Lymphatic Filariasis.

Rickettsial diseases

A number of rickettsial diseases have a significant potential to impact on military deployments.[11] Scrub typhus is widely endemic, particularly in a wide area of southeast Asia, Australia and the western Pacific region.[11] In Africa, ticks are important vectors of a number of diseases, including rickettsial diseases, such as African tick bite fever. There are no vaccinations for rickettsial diseases and prevention hinges on the use of personal protective measures by military personnel.[12] Weekly doses of 200 mg doxycycline can prevent scrub typhus, but the efficacy of daily doxycycline for malaria chemoprophylaxis as used against Orientia tsutsugamushi is unknown.[12]

Leishmaniasis

Leishmaniasis should be considered in those travelling to and returning from endemic areas. Leishmaniasis is caused by a protozoan parasite transmitted by the bite of infected female phlebotomine sandflies. There are several different forms, but the most common is cutaneous leishmaniasis (CL). CL is increasing being reported in travellers as they venture into endemic areas,[13] in about 90 countries.[14] Adventure travellers, humanitarian aid workers, military personnel and long term travellers may be at particular risk.[14]

Cutaneous Leishmaniasis

CL presents with skin sores, usually one or more chronic skin lesions where sandflies have fed. It has been coined the "Baghdad boil" reflecting the areas of operation where it is currently being encountered, including southwest and central Asia,[15] although leishmaniasis is widely distributed in other locations around India, the Mediterranean basin, central Africa and South America. Skin lesions usually develop within a few weeks of being bitten and are unresponsive to antibiotics or steroids. Lesions commence as a papule then often enlarge and then ulcerate. They can be painless or painful, especially if secondarily infected. The peak sandfly period is April to November, peaking in September/October in the northern hemisphere.

Diagnosis of CL is normally through a biopsy or skin scraping. Treatment is available, including sodium stibogluconate,[14,16] but prevention is the best option. The following preventive measures may be useful and are mostly directed at reducing contact with sandflies: stay in air conditioned buildings, where possible; spray out the accommodation area; permethrin impregnated clothing to cover as much of the body as possible; diethyl methyl- toluamide (or DEET) repellents; control of vermin and stray animals; and fine mesh bed net soaked in permethrin. Sandflies are most active from dusk to dawn.[14]

Other Forms

Other forms of leishmaniasis include the potentially disfiguring mucocutaneous or mucosal leishmaniasis and diffuse cutaneous leishmaniasis, primarily found in tropical South America, as well as visceral leishmaniasis (VL). Leishmaniases are regarded as a fairly heterogenous collection of clinical diseases caused by many different species of Leishmania, each with its own unique properties, including a fairly specific geographical location.[15] VL is the most serious form of leishmaniasis and affects some of the body's internal organs, most commonly the spleen, liver and bone marrow. It usually takes several months to years develop and may present with fever, weight loss, hepatomegaly and significant splenomegaly.[14] VL is

Table 2. Some tropical disease risks during military deployment

Risk category	Risk identity	Risk reduction or prevention strategy
Vector-borne disease	Malaria	Personal protective measures; chemoprophylaxis; sometimes field diagnosis and standby treatment may be appropriate – see main article
	Trypanosomiasis[3]	Tsetse flies are aggressive daytime biters and little can be done to prevent bites
	Leishmaniasis	DEET-containing repellents; permethrin impregnation of clothes and bednets; residual insecticide spraying of limited use
	Filariasis	Measures to prevent biting flies and mosquitoes (barriers, insecticides, repellents, bednets etc)
	Scrub typhus	Body surface should be checked for eschars; personal protective measures, including permethrin impregnated uniforms; periodic prophylaxis or treatment may help
	Dengue	Control peridomestic breeding of main mosquito vector, *Aedes aegypti*; personal protective measures
	Japanese encephalitis	Vaccination; personal protective measure
Water-related disease	Schistosomiasis	Avoid unnecessary exposure of skin to water
	Leptospirosis	Avoid unnecessary contact with likely animal urine-contaminated water; periodic prophylaxis/treatment may help
Water-borne infection	Hepatitis A and E	Hepatitis A is vaccine-preventable; effective water treatment
Enteric infection	Typhoid and paratyphoid fevers	Typhoid vaccine; food/water risk education
	Cholera	Oral vaccines preferable to older, killed vaccines; provide good short-term protection
	Poliomyelitis	Polio immunization booster
Blood-borne infection	Hepatitis B, HIV, malaria	Minimise transfusion of locally-donated blood; hepatitis B immunisation; behaviour risk modification; post-exposure prophylaxis for HIV
Animal-related disease	Envenomation	Ensure appropriate antivenom is available in major centres, where applicable
	Rabies	Consider pre-exposure vaccination; postexposure prophylaxis
	Anthrax	Avoid contact with or ingestion of meat from animals that have died of unknown causes
	Q fever	Avoid unnecessary contact with domestic stock and their aerosols
	Brucellosis	Avoid raw milk from any domestic animal
	Meningococcal meningitis	Various vaccines available; currently the quadrivalent polysaccharide A,C,Y,W-135 vaccine is appropriate for military personnel deployed in Africa
Other infections/ infestations	Myiasis (fly larva)	Wash laundry well; do not dry it on the ground; ironing will kill eggs and larvae laid in washing

not common in travellers,[14] but it has been reported amongst soldiers deployed to Iraq and Afghanistan.[17] Severe cases of VL are typically fatal, if untreated.[14] Health Bulletins provide further information for ADF personnel, e.g. HB No. 6/2003 Leishmaniasis.

Vaccine preventable diseases

Many infectious diseases of military personnel can be prevented by immunisation (see Table 2). There are few mandatory vaccines, for which certification is necessary. These include yellow fever and meningococcal meningitis.[4] Meningococcal meningitis is of concern across the meningitis belt of sub-Saharan Africa, particularly in west Africa, and vaccination is warranted for deployment to these areas and other areas where the vaccine preventable strains of the disease are endemic.[4,5] In addition to routine and national schedule vaccinations, there are a variety of vaccinations, which may be required for particular destinations. Influenza A and B are now considered major threats to military personnel in barracks as well as on deployment and influenza vaccination is starting to become more widely recommended.[18]

Zoonotic diseases

Zoonotic diseases may present a hazard for military deployments in rural Africa as well as many other parts of the world. Zoonotic diseases of concern

include rabies, leptospirosis, bovine tuberculosis, anthrax, plague, and even certain viral haemorrhagic fevers.[5] Rabies is amongst the most important of the zoonotic diseases. It is widely endemic in Africa and many other parts of the world and is an almost invariably fatal illness, spread by the bite of an infected animal. Military personnel are considered amongst the high-risk groups for rabies,[5] and pre-exposure vaccination is indicated for troops deploying to rural Africa or other parts of the world where the disease is endemic and access to rabies immune globulin and post-exposure prophylaxis may be variable. Military personnel should be cautioned against approaching potentially infected animals and taught about first aid treatment of wounds caused by animal bites, including post-exposure prophylaxis. Leptospirosis is a widespread concern and is transmitted by infected domestic and wild animals, especially rodents. Military personnel coming into contact with urine-contaminated water may be infected. Rodent control measures need to be instituted in the field, as well as consideration of antibiotic chemoprophylaxis or eradication treatment. In Australia, doxycycline has been widely used to assist in prevention of leptospirosis and has been demonstrated to be both an effective chemoprophylactic and therapeutic agent.[19] Further information for ADF personnel can be found in Health Directives, i.e. HD272. Leptospirosis.

Sexually transmitted diseases

Military personnel are often considered a risk group for sexually transmitted infections. In much of Africa and Asia, human immunodeficiency virus and hepatitis B and C virus are widespread.[4] Pre-deployment, hepatitis B vaccination is important, as is hepatitis B and C and HIV serology, as baseline measures.[5] Troops should be counselled on safe sex practices and preventing and managing percutaneous exposures to blood and bodily fluid.[4]

Schistosomiasis

Schistosomiasis remains one of the most important tropical diseases with a widespread distribution in more than 70 countries throughout parts of Africa, Asia and South America.[4] Schistosomiasis is an important health risk for military deployments to rural Africa, where it causes chronic gastrointestinal schistosomiasis *(Schistosoma mansoni)* and genitourinary schistosomiasis *(Schistosoma haematobium)*. Apart from avoidance of potentially infected water bodies or using protective clothing when fording streams, screening serology could be offered pre-deployment and post-deployment.[5] Soldiers who seroconvert should be investigated and treated appropriately, usually with praziquantel. Alternatively, stool and urine examination for parasite eggs may be indicated for soldiers where infection is suspected, where serology is not available or not useful due to previous exposure.[5]

Other infectious diseases

Other tropical diseases may affect military personnel on deployment. Prevention of diseases may require the use of personal protective measures by military personnel. Tuberculosis (TB) screening should also be considered for troops deploying from non-endemic regions to endemic regions. Active TB should be excluded in those exposed to TB or who are symptomatic.[5] The importance of travellers' diarrhoea should also not be underestimated in military deployments,[20] and is an important part of pre-deployment health briefing. Skin infections can also common problems of deployments.[5]

Infectious disease risks posed by bioterrorism and emerging infections

The identification of the most likely and threatening of the potential biological weapons remains a joint effort of civilian and military public health and medical experts, informed also by law enforcement and intelligence.[21] The development of public health and medical preparedness measures must then be instituted or developed against those threats that merit special concern. Some of the important criteria for this determination should include feasibility of aerosol dissemination, high case-fatality rates, potential for secondary spread, and the availability of protective vaccines or antimicrobial agents.[21,22] Among some of the major causes of concern in recent years have been smallpox and anthrax, for which vaccines and/or prophylaxis are available; however a range of viral and bacterial agents have been identified and classified according to the threat that they pose.[20,22] There is also widespread stockpiling of antiviral treatment countermeasures to the Avian influenza and other potential pandemic influenza viruses, such as the recent pandemic (H1N1) 2009, particularly for use by health and military personnel, who may be called out to assist in disease control of any outbreak of the disease in human populations. There is however no substantial evidence for the effectiveness of these drugs in Avian influenza.[23] Further information on Pandemic (H1N1) 2009 for ADF personnel can be found in Health Bulletins, e.g. HB No. 8/2009.

Non-infectious hazards of deployment

Sun exposure and heat illness remain a problem for soldiers, particularly on training exercises and military deployments. A US study by Carter et al showed that the diagnosis of the most serious form

of heat illness, heat stroke, is actually increasing in terms of hospitalisation, although overall heat illness admissions reduced over the period 1980-2002.[24] The complications of heat stroke, which can be life threatening -37 US soldiers died during 1980-2002 - may include dehydration (17%), rhabdomyolysis (25%) and acute renal failure (13%).[24] Injuries and accidents, especially fatal motor vehicle accidents and training injuries,[25, 26] represent a significant problem for military personnel on deployments. Other common problems include skin diseases, and field conditions during deployment, such as cold, sun exposure, heat, humidity and poor hygiene, can exacerbate skin disorders.[27]

Conclusion

Military deployments represent a significant risk of tropical diseases. In the past 100 years, there have been significant advances in countermeasures for many of these tropical diseases. In terms of infectious disease, vector-borne diseases, in particular malaria and the arboviruses, stand out as major concerns for military deployments. However, other common problems, for example diarrhoeal disease and non-infectious hazards, such as trauma, also need to be addressed.

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