

Burkholderia pseudomallei Infection in the Singapore Armed Forces from 1987 to 1994—An Epidemiological Review

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Abstract

Between 1987 and 1994, twenty-three cases of *Burkholderia pseudomallei* infection (melioidosis) were diagnosed in persons serving in the Singapore Armed Forces. There were four deaths resulting from complications of the infection. Unlike the situation in the general population, where the affected are mainly the elderly with underlying illness, the majority of cases in the Singapore Armed Forces were otherwise fit and healthy young servicemen. Serological surveys have shown the prevalence of the infection in Singapore to be 0.2% in the military as well as civilian population. As physical contact with soil is an unavoidable part of military training, military personnel continue to be at risk of exposure to this soil-related disease.

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Introduction

Melioidosis is an infectious disease affecting both man and animals, caused by the Gram-negative bacteria *Burkholderia pseudomallei* which is endemic in South-east Asia. The organism is found in abundance in damp or waterlogged soil, e.g. rice fields, rubber plantations and excavation sites. It causes purulent infections of the lungs and skin. Recrudescences are common. In its septicaemic form, the infection is largely fatal.

There has been an increased awareness of the infection in Singapore in recent years.^{1,2} Between 1987 and 1994, the Singapore Armed Forces (SAF) experienced four deaths from the infection. The steady number of cases being diagnosed in SAF servicemen-representing an attack rate of four times that of the general population (Table I)-underscore the fact that melioidosis, as has been noted by Moore,³ is a military service-related disease.

Materials and Methods

No cases were diagnosed in the SAF prior to 1988. But since 1988, there have been a total of 23 cases of *Burkholderia pseudomallei* infection diagnosed in the SAF, accounting for 7.8% of the national total (Table II). A summary of the cases is shown in Table III.

TABLE I: CHARACTERISTICS OF MELIOIDOSIS CASES IN THE SINGAPORE ARMED FORCES AND SINGAPORE

	SAF Cases	Singapore Cases
Incidence per 100 000	4.36	1.60
Median Age-Group	15-24 years	>65 years
Sex	Males mainly Ratio M:F 1.3:1	Males mainly Ratio M:F 4.5 to 5.5:1
Ethnic Group	Indians and Malays more susceptible than Chinese	Indians more susceptible than Malays and Chinese
Medical History	Mainly healthy with no underlying disease	Mainly with predisposing debility and underlying illness

The incidence rate of melioidosis in the SAF (Table II) over the review period was 4.36 per 100 000 persons compared with the national incidence rate of 1.60 per 100 000 persons, based on the 1990 mid-year population.¹

The male to female ratio was 22:1. The relative risk was however smaller, at 1.3:1 (Table IV).

The median age group for the SAF cases was 15-24

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TABLE II: INCIDENCE OF *BURKHOLDERIA PSEUDOMALLEI* INFECTION IN THE SINGAPORE ARMED FORCES AND SINGAPORE FROM 1987 TO 1994

Year	No. of diagnosed cases		% of National
	SAF	National*	
1987	0	5	
1988	2	40	5.0
1989	6	37	16.2
1990	1	26	3.8
1991	6	43	14.0
1992	4	46	8.7
1993	2	56	3.6
1994	2	40	5.0
Total	23	293	7.8

Incidence rate per 100 000 (based on 1990 population) 4.36 1.60

*Source: Communicable Disease Surveillance in Singapore 1989 to 1994 and Quarantine and Epidemiology Department, Ministry of the Environment.

years (20 out of the 23 cases) compared with a median of 65 years for cases in the general population.

The distribution by ethnic group was 69.6% Chinese (16 cases), 17.4% Indians (4 cases), 8.6% Malays (2 cases)

and 4.3% Others (1 case). The ethnic-specific rate (Table V) was higher in the Indian and Malay groups. The ethnic-specific rate of Indians was 2.6 times that of the Chinese and the ethnic specific rate of Malays was 2.1 times that of the Chinese. While the ethnic-specific incidence rates for Indians and Malays in the SAF were roughly similar, the rate for Indians was much higher than for the Malays in the general population.'

The majority of the SAF cases were otherwise healthy young servicemen with no underlying predisposing illness. Of the two cases with known underlying conditions, one had non-insulin dependent diabetes mellitus with hypertension (Case No.8) while the other had hypertension (Case No.9). In contrast, the majority of the cases in the general population had predisposing medical conditions-including diabetes mellitus, liver cirrhosis, malignancies and renal failure.

The contrasting characteristics of the cases in the SAF and the general population are summarised in Table I.

Clinical Presentation

The breakdown of cases by clinical presentation is shown in Table III. Eight of the cases were diagnosed by serological tests (indirect haemagglutination or IHA)

TABLE III: CASES OF *BURKHOLDERIA PSEUDOMALLEI* INFECTION IN THE SINGAPORE ARMED FORCES FROM 1988 TO 1994

Year	No	Sex	Age	Race	Clinical Presentation	Diagnosis	Outcome
1988	1.	M	22	C	Buttock abscess	Culture	Well
	2.	M	21	M	Lung abscess	Culture	Well
1989	3.	M	20	I	Inguinal abscess	Culture	Well
	4.	M	19	C	Pneumonia	Culture	Died
	5.	M	19	C	Pneumonia	Culture	Died
	6.	M	21	C	Pneumonia	Serology	Died
	7.	M	20	C	Inguinal abscess	Serology	Well
	8.	M	40	I	Pneumonia	Serology	Well
1990	9.	M	40	I	Pneumonia	Culture	Died
1991	10.	M	19	O	Pneumonia	Serology	Well
	11.	M	19	I	URTI	Serology*	Well
	12.	M	21	C	URTI/Pneumonia	Serology	Well
	13.	M	22	C	URTI/Skin rash	Serology	Well
	14.	F	18	C	URTI/Skin rash	Serology	Well
	15.	M	20	C	Finger abscess	Culture	Well
1992	16.	M	27	C	Calf ulcer/abscess	Culture	Well
	17.	M	19	M	Pneumonia	Culture	Well
	18.	M	20	C	Abdominal wall abscess	Culture	Well
	19.	M	21	C	Buttock abscess	Culture	Well
1993	20.	M	21	C	Sacral abscess	Culture	Well
	21.	M	22	C	Right arm abscess	Culture	Well
1994	22.	M	21	C	Buttock abscess	Culture	Well
	23.	M	19	C	Right arm abscess	Culture	Well

*Diagnosed by serological surveys and tests

C: Chinese; M: Malay; I: Indian; O: Others; URTI: upper respiratory tract infection

TABLE IV: AGE AND SEX DISTRIBUTION AND AGE-SPECIFIC MORBIDITY RATES OF MELIOIDOSIS IN THE SAF FROM 1987 TO 1994

Age group	Male	Female	Both sexes	Morbidity rate per 100 000
0-4	0	0	0	0
5-14	0	0	0	0
15-24	19	1	20	6.60
25-34	2	0	2	3.33
35-44	1	0	1	3.47
45-54	0	0	0	0
55-65	0	0	0	0
65+	0	0	0	0
Total	22	1	23	4.36
Sex-specific morbidity rate				Male 4.45 Female 3.40
Relative risk				1.3:1

Based on the 1990 SAF population

and 15 by bacteriological culture. Table VI summarises the clinical presentations of the SAF cases.

Results

Serology-Positive Cases

Of the 8 serologically positive cases, 2 were diagnosed as a result of serological surveys or tests while 6 were diagnosed as a result of clinical suspicion.

Of the 2 cases picked up by serological surveys and tests, one had recent history of an inguinal abscess (Case No. 7—no culture obtained) and the other had respiratory tract infection (Case No. 11). Both their IHA titres were found to be 1:128

Of the 6 cases diagnosed serologically following clinical suspicion of the infection, 4 cases had pneumonia (including 1 death—Case No.6) and 2 cases had persistent upper respiratory symptoms and purulent skin rash (Cases No. 13 and 14).

The single fatal case whose diagnosis was based not on positive bacteriology but serology (Case No. 6) was a 21-year-old male recruit undergoing Basic Military Training (BMT). He presented with pneumonia following upper respiratory tract infection and subsequently developed myocardial abscesses and disseminated intravascular coagulation (DIVC). All cultures proved negative. He was maintained under intensive care until he eventually succumbed, some 22 months after the onset of symptoms.

Culture Positive Cases

Of the 15 cases diagnosed by bacteriological culture, 10 had abscesses involving the skin and soft tissues while 5 had respiratory infections. Three of the 5 cases with respiratory disease had fatal outcomes.

TABLE V: ETHNIC DISTRIBUTION AND ETHNIC-SPECIFIC MORBIDITY RATES OF MELIOIDOSIS IN THE SAF FROM 1987 TO 1994

Ethnic group	No. of cases	Morbidity rate per 100 000
Chinese	16	4.67
Malay	2	9.80
Indian	4	12.12
Others	1	
Total	23	4.36

Based on the 1990 SAF population

TABLE VI: CLINICAL PRESENTATION OF MELIOIDOSIS CASES IN THE SINGAPORE ARMED FORCES

Clinical presentation	No. of cases	%	Remarks
Serology Positive			
Symptomatic cases	8	34.8	1 death
Culture Positive			
Skin infection	10	43.5	
Respiratory infection	5	21.7	3 deaths
Total	23	100	4 deaths

The first case (Case No.4) was a 19-year old male recruit undergoing BMT who presented with upper respiratory tract infection which progressed to pneumonia. While in hospital, he developed Type I respiratory failure from fulminant bronchopneumonia and septicaemia. He succumbed 11 days after the onset of symptoms. The diagnosis was made by culture at post-mortem.

The second case (Case No. 5) was also a 19-year-old male recruit undergoing BMT who presented with upper respiratory tract infection and pneumonia. While in hospital he developed pleural effusion, disseminated intravascular coagulation and septicaemia. The infection was complicated by a bronchopleural fistula, pyopneumothorax with superinfection by methicillin-resistant *Staphylococcus aureus* (MRSA) and *Pseudomonas aeruginosa*. He succumbed 43 days after the onset of symptoms.

The third case (Case No. 9) was a 40-year-old male driving instructor who had a history of hypertension. He presented with cough and fever which progressed to pneumonia and was hospitalised. Within 6 days, he succumbed to septicaemia, acute renal failure and adult respiratory distress syndrome (ARDS).

There were two non-fatal cases with culture-positive respiratory disease. The first was a 21-year-old male (Case No.2) with lung abscess which was successfully treated with surgical drainage and systemic antibiotics. The second was a 19-year-old male (Case No. 17) with pneumonia and pyopneumothorax who was treated with systemic antibiotics and surgical decortication of loculated pleural effusion.

The 10 cases with skin and soft tissue involvement manifested as abscesses of the buttock, inguinal region, upper limb, finger, calf and abdominal wall.

Mortality

A summary of fatal cases from melioidosis in the SAF is shown in Table VII. All four cases had respiratory involvement, leading to systemic involvement and complications, leading to eventual demise. The overall mortality rate was 17.4%. The mortality rates for those with respiratory manifestations and systemic complications were 33.3% and 100% respectively. There was no mortality among the cases with only skin and soft tissue infections.

Discussion

Melioidosis in Singapore appears to affect two distinct groups—the elderly with underlying illness and young SAF servicemen without underlying illness. In the former, poor health and immuno-compromised states predispose to the infection which is endemic in the region. In the latter, the nature of military training, especially in the BMT phase, increases the exposure of healthy, young individuals to the bacterium.

Serological surveys in Singapore generally show a very low endemicity. Several small-scale serological surveys were conducted on a total of 916 SAF servicemen between 1989 and 1991. The prevalence rates ranged from 0% to 2%, with an overall prevalence rate of 0.2%. A study of 1854 blood specimens collected from selected population groups in Singapore also showed an overall serological prevalence rate of 0.2%.²

The low endemicity in Singapore may be explained by the high level of urbanisation and low level of exposure to soil among the general population. In contrast, figures from neighbouring countries show much higher prevalence rates.

In Thailand, where the infection is hyperendemic, serological (IHA) titre of >1:40 have been reported in 29.5% to 47.1% of selected study populations.⁴ In a study of Malaysian Armed Forces personnel, 10.1% of recruits tested positive serologically, with an increased rate of 20% in recruits from paddy-planting states. Ground-keepers at army camps and army engineers had rates of 13.4% and 11.2% respectively.⁵ United States Marine Corps personnel returning from Vietnam had a prevalence rate of 8.9% in a sample population of 414 compared with 2.9% in a control group.⁶ A survey on Commonwealth troops in Malaysia revealed a 1.99% prevalence rate.⁷

While the endemicity of *Burkholderia pseudomallei* infection is low in Singapore, the risk of infection exists for the ill and debilitated and for Armed Forces personnel. As close contact with soil is an obligatory factor in military training, especially in the Army, melioidosis is an unavoidable military service-related risk. In the absence of effective means of active immunisation, there is a need for increased vigilance on the part of medical practitioners treating servicemen with skin abrasions and lacerations (vigorous cleansing is recommended) and to consider melioidosis in the differential diagnosis of febrile illness affecting soldiers, especially if the presenting features are respiratory in nature or associated with skin lesions.⁸

TABLE VII: MORTALITY DUE TO MELIOIDOSIS IN THE SAF-SUMMARY OF FOUR CASES

No.	Sex/Age/Race			Clinical presentation	Complications developed	Diagnosis	Time onset until death
1	M	19	Chinese	URTI/ Right basal Pneumonia	Type I respiratory failure DIVC Septicaemia	Blood culture at post-mortem	11 days
2	M	19	Chinese	URTI/ Left basal Pneumonia	Pleural effusion pyopneumothorax with infection Bronchopleural fistula Acute renal failure Septicaemia	Sputum culture Culture of pleural fluid	43 days
3	M	19	Chinese	URTI/ Right upper lobe Pneumonia	Type I respiratory failure DIVC Myocardial abscesses Hypoxic brain damage	Serology All cultures negative	22 months
4	M	19	Chinese	URTI/ Left lobar Pneumonia	Septicaemia Acute renal failure DIVC ARDS	Blood culture	6 days

URTI: upper respiratory tract infection; DIVC: disseminated intravascular coagulopathy; ARDS: adult respiratory distress syndrome

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