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A study of fungal presentations at sea [1]

by
B.T. Fitzgerald, R.B. Schedlich [2]

Abstract
A study was conducted into the incidence of fungal presentations in an Australian warship at sea under hot and humid conditions. It had been hypothesised that there was medical value in changing clothing of an evening. It was suggested that this change could contribute to an increase in hygiene and a decrease in the risk of fungal skin infections. Personnel with presumed fungal presentations to the Sick Bay in HMAS Melbourne (an Australian frigate) were registered in two surveys during Cruising Watches (when night clothing was worn from 18:00). This was compared with two surveys when the ship's company were in Defence Watches, wearing combat coveralls (Proban® overalls) and safety boots throughout the day. Data were also collected during Cruising Watches when night clothing was not permitted and all had to remain in combat coveralls and protective footwear. It was found that presentation rates were statistically significantly lower during periods when a change of clothing was required.

Introduction
A preliminary study previously published assessed the value of changing to night clothing in an Australian warship under hot and humid conditions.[1] It had been argued that changing into night clothing was beneficial from a medical perspective due to a perceived increase in hygiene and the anecdotal evidence that most personnel would shower before changing. It was hypothesised that this would result in a lower risk of fungal skin infections. The initial study showed that there was a statistically significant difference between the presentations of the two groups ($p<0.01$), supporting the hypothesis that changing uniforms was beneficial.'

There were flaws in the initial study. The risk of infection increases the longer that personnel are exposed to adverse conditions.[2,3] The Defence Watches component of the survey was conducted after Cruising Watches. The higher number seen during Defence Watches may have reflected this increased risk. The numbers seen were small, as was the time frame of the study (constrained by the operational role of the ship). In Cruising Watches, some personnel wore shorts and sandals as part of daytime uniform, decreasing the risk of development further. None of these factors was accounted for in the first study.

This second study continued the comparison of presentation rates during Defence Watches followed by a period in Cruising Watches. The ship's routine meant that a third arm was able to be evaluated: a period when the ship's company were in Cruising Watches, but had to wear protective coveralls and safety boots throughout their day; no other uniforms were permitted to be worn (i.e. there was no change tonight clothing). However, in Cruising Watches personnel generally, work fewer hours than during Defence Watches, and their activity rates are consequently less arduous.

Subjects
Subjects were the members of HMAS Melbourne's ship's company. The complement for the deployment was 224, five of whom were female. Personnel were aged from 18 to 43.

Cases were those who presented to the Sick Bay with skin lesions which were clinically diagnosed by the author as having a fungal aetiology.

Methods
Five surveys were conducted over two study periods as shown in Table 1.

During Defence Watches, personnel are required to remain in protective overalls and safety boots. In Cruising Watches, the ship's company are required to change into night clothing at 18:00.

All surveys were conducted prospectively and recorded presentations of clinically diagnosed fungal infections on all body locations.

In the first study, two prospective surveys were undertaken - during an 18-day period in Cruising Watches (1CW) and during another 18-day period in Defence Watches (1DW).

The second study involved three surveys. The first was during Defence Watches, for 15 days (2DW). The second was 65 days of Cruising Watches during which period, personnel were required to remain in protective clothing at all times(2CW-NNC). The last phase was 19 days during Cruising Watches (2CW). In this phase, personnel were permitted to wear uniforms other than overalls and boots and were expected to change into night clothing after 18:00.

Table I. Study periods and surveys showing duration.

Code	Days	Night Clothing
First Study		
1CW	18	Yes
1DW	18	No
Second Study		
2DW	15	No
2CW – NNC	65	No
2CW	19	Yes

Codes:
CW – Cruising Watches
DW – Defence Watches

The five periods under observation included the entire period the ship was in tropical regions. The irregular duration of each period was a result of the operational requirements of the deployment. The two "Night Clothing" surveys occurred at the commencement and completion of the deployment, with the three "Non- Night Clothing" surveys being contiguous periods in the middle of the deployment.

Since the hypothesis under investigation was that changing into night clothing reduced the incidence of fungal infections, it was considered appropriate to test the validity of combining the surveys into two broad groups - Night Clothing (NC) and Non-Night Clothing (NNC) and testing the comparison between them. Table 2 shows the proposed combination.

Table 2. Proposal data combination

Group	Survey	Period	Days
NC	1CW	1st	18
	2CW	2nd	19
		Total	37
NNC	1DW	1st	18
	2DW	2nd	15
	2CW - NNC	2nd	65
		Total	98

Because of the low number of cases observed, data were analysed using the Poisson method.[4] In each case, the variation for 95% Confidence Intervals (lower - A.l, and upper - A.r) around the observed number of cases were taken from a Poisson table.[5]

Incidence rates (IR) for each group were determined in the usual way and expressed as cases presenting per day (the population was fixed throughout the deployment). Poisson 95% Confidence Intervals around the IRs were calculated using A.l and A.r.

All comparisons between groups were undertaken using Standardised Rate Ratios (SRR) calculated as

$$SRR = \frac{O}{E}$$

where 0 is the number of cases observed, and E is the number of cases that would be expected if the observed group had the same IR as the total of the combined groups.

Poisson Confidence Intervals around the SRR were calculated using A.l and A.r for the observed cases divided by the expected number of cases to give the 95% Upper and Lower Confidence Limits (UCL and LCL) around the SRR.

The groupings at Table 2 were validated by determining whether the 95% Confidence Intervals of the SRR for each survey, standardised to the grouping, showed a statistically significant difference (i.e., the null hypothesis of SRR = 1 was not within the CLs).

Once the two combined study groups, NC and NNC, had been validated, comparison between them was undertaken to determine the presence of a statistically significant difference.

Analysis of rates in different accommodation areas, and by work Department was also undertaken.

Results

A total of 72 cases presented during the study period. Table 3 summarises the data by survey period, giving IRs and 95% UCLs and LCLs of the IRs.

Table 3. Night Clothing Group and Surveys: Cases, Incidence Rates (cases per day), Upper and Lower Confidence Limits.

	Cases	IR	LCL	UCL
1CW	2	0.11	0.01	0.40
1DW	17	0.94	0.55	1.51
2DW	10	0.67	0.32	1.23
2CW-NNC	40	0.62	0.44	1.84
2CW	3	0.16	0.03	0.46
Total	72	0.53	0.42	0.67

The overall incidence rate for the whole period (135 days, 72 cases) was 0.53 cases per day. The IR per 1,000 population per day was 2.38.

Analysis of Surveys

Table 4 shows SRRs, standardised against the whole study group and period, and 95% Upper and Lower Confidence Limits for each of the surveys.

Table 4. Standardised Rate Ratios and 95% Upper and Lower Confidence Limits for all study Surveys (standardised to the whole period).

	SRR	LCL	UCL
1CW	0.21*	0.03	0.75

1DW	1.77*	1.03	2.84
2DW	1.25	0.60	2.30
2CW – NNC	1.15	0.82	1.57
2CW	0.30*	0.06	0.87

*****Indicates statistical significance at the 95% level.

Both the periods in Cruising Watches where night clothing could be worn 1CW and 2CW), have SRRs statistically significantly lower than unity. The other three Surveys (where night clothing could not be worn), all have SRRs greater than one, and in the first of these periods, 1DW, the difference is statistically significant (SRR 1.77, 95% CLs 1.03-2.84).

Validation of Groups

Table 5 shows the SRRs, 95% UCLs and LCLs for the two-night clothing surveys (1CW and 2CW), standardised to the IR for the combined periods (Night Clothing Group).

Table 5. Night Clothing Surveys- Standardised Rate Ratios,Upper and Lower Confidence Limits (standardised to the combined Night Clothing Group).

Period	SRR	LCL	UCL
1CW	0.82	0.10	2.97
2CW	1.77	0.24	3.41

Table 6 shows the SRRs, 95% UCLs and LCLs for the three non-night clothing surveys (1DW, 2DW, and 2CW-NNC), standardised to the IR for the combined periods (Non-Night Clothing Group).

Table 6. Non-Night Clothing Surveys - Standardised Rate Ratios, Upper and Lower Confidence Limits (standardised to the combined Non- Night Clothing Group).

Period	SRR	LCL	UCL
1CW	1.38	0.80	2.21
2DW	0.98	0.47	1.79
2CW - NNC	0.90	0.64	1.23

Tables 5 and 6 show that in each of the two groups, the upper and lower confidence intervals of the surveys span the null hypothesis of unity (SRR = 1). It can thus be concluded that there are no statistically significant differences between the surveys within the groups, and accordingly, the groupings are valid.

Night Clothing vs Non-Night Clothing

The IR for the NC Group was 0.14 (0.04-0.32), and that for the NNC Group 0.68 (0.53-0.87). Table 7 shows the standardised rate ratio and upper and lower confidence limits for each of these groups, standardised against the whole period.

Table 7. Night Clothing vs Non-Night Clothing Groups - Standardised Rate Ratios 95% Upper and Lower Confidence Limits (standardised to the whole period).

Group	SRR	LCL	UCL
Night Clothing	0.25*	0.08	0.59
Non-Night Clothing	1.28	0.99	1.63

*Indicates statistical significance at the 95% level.

The results of indirect standardisation of the incidence rates show that the SRR for the Night Clothing Group is statistically significantly less than for the whole period (SRR 0.25, 95% CI 0.08- 0. 59). Conversely, there is no statistically significant difference between the Non-Night Clothing Group and the whole.

Proportions by Accommodation

Table 8 presents the breakdown of presentations according to accommodation areas. These data were collected in the second study period (99 days). The Mess with the highest rate was the Petty Officers' Mess (IR = 3.79, SRR = 1.59), and that with the lowest 2 Mess (junior sailors) (IR = 1.68, SRR = 0.70)

Table 8. Incidence Rates (per 1,000 per day), Standardised Rate Ratios, Upper and Lower Confidence Limits by accommodation area (mess).

Mess	Cases	IR	SRR	LCL	UCL
Officers (82)	6	2.16	0.90	0.33	1.97
CPOs (16)	3	1.89	0.78	0.23	3.69
Pos (24)	9	3.79	1.59	0.73	3.01
2 Mess (JS – 30)	5	1.68	0.70	0.23	1.64
3F Mess (JS – 66)	13	1.99	0.83	0.44	1.42
3A Mess (JS – 60)	16	2.69	1.13	0.65	1.83
Not Recorded					
Total (224)	53	2.39			

Proportions by Department

Table 9 divides the presentations according to work groups. These data were also collected only during the second study period (99 days). The Department with the highest rate of infection were the aviators (IR = 3.19, SRR = 1.33), and that with the lowest Supply (IR = 1.80, SRR = 0.75) closely followed by the Marine Engineering Department (IR = 0.76, SRR = 0. 76). None showed any statistically significant difference.

Table 9. Incidence Rates (per 1,000 per day), Standardised Rate Ratios, Upper and Lower Confidence Limits by Department.

Department	Cases	IR	SRR	LCL	UCL
Seaman (95)	24	2.55	1.07	0.69	1.59
Marine Engineering (39)	7	1.81	0.76	0.30	1.56
Electrical Engineering (36)	9	2.53	1.06	0.48	2.01
Supply (28)	5	1.80	0.75	0.24	1.76
Aviation (19)	6	3.19	1.33	0.49	2.91
Not Recorded (7)	2				
Total (224)	53	2.39			

Discussion

Fungi are ubiquitous and are routinely found as part of the normal flora of human skin. Certain factors promote the overgrowth and subsequent clinical signs and symptoms. Warm, moist conditions are most favourable. Infections tend to be more common in summer. Clothing further enhances conditions especially when fitted tightly. The length of time that these conditions persist for is another significant factor. Trauma provides a portal of entry. Obesity and many medical diseases and treatments (especially antibiotics) also predispose to mycotic clonisation.[2,3] These last factors are less likely in sailors at sea, who are required to be fit for sea posting.

In Defence Watches, personnel were required to wear protective S18 uniforms (Pro- ban® overalls and safety boots). The watch system for most was a rotating five hours on, seven hours off, then seven hours on and five hours off. Engineering personnel worked four hours on and eight hours off, whether in Defence Watches or not.

In Cruising Watches, personnel were permitted to wear overalls or shorts and short sleeved shirts with shoes or sandals. Most personnel anecdotally had more spare time, and showering and changing was more common-place. Duty engineering sailors do not change to night clothing due to the need to be able to respond to emergencies in the engine rooms and work spaces at all times. Most in that department were said to shower and change rig (either to night attire for sleep, or to a new set of overalls) at the end of a watch. This replicated the hygiene effect of a change to night clothing, but meant that they continued to wear more constrictive and tight fitting attire.

This study has shown that there was a statistically significant difference (at the 95% level). In presentation rates of presumed fungal infections between the periods where night attire was permitted to be worn and when it was not. When the change in outfit was required, the presentation rate was one quarter (SRR = 0.25, 0.08 to 0.59) that of the overall presentation rate, and less than one-fifth that when night clothing was not permitted.

There was no consistent effect of duration of the exposure to tropical conditions. Al- though the second survey where night clothing was permitted (2CW) had an IR less than the first survey (1CW), the three surveys in the middle of the deployment where night clothing was not permitted (1DW, 2DW and 2CW-NNC), showed a gradual reduction of IR. This latter trend, although not statistically significant, does suggest a protective acclimatisation. The IR in 2CW is likely to include a 'carry over' of infections from the immediately preceding survey (2CW-NNC), and this may explain the higher figure compared to 1CW.

There are no obvious epidemic-like trends within accommodation areas. On the other hand, both the Marine Engineering and Supply Departments had a lower IR, although these were not statistically significant. In the latter case, this may be due to the generally less physically demanding and more environmentally favourable work patterns for Supply personnel. Marine Engineering personnel, however, consistently work in hot, humid conditions, of- ten at high levels of physical activity a situation conducive to sweating and skin maceration. The lower numbers of presentations in this group could be associated with the common practice of showering and changing clothes after work periods, although in this Department the duration of each work period is generally less than for other Departments.

Conclusions

There are several conclusions that can be drawn from these results.

Changing attire during the day appears to decrease the risk of attaining a fungal infection by reducing favourable conditions for their development. This assumption would favour the policy of changing outfits at the end of a working day.

Another possibility is that environmental conditions during the surveys were different. All data were collected during hot and humid conditions. Recording and analysis of daily temperatures and humidity would have permitted more scientific comparisons to be made and could have strengthened this study.

Similar presentation rates during both periods where night clothing was worn suggest that the conditions in each of those periods were similar. Presentation rates in each period where night clothing was not permitted were also comparable, again suggesting that each of those surveys were conducted under similar environmental conditions. This would strengthen the argument that the difference in presentation rates was due to the change in attire rather than due to different climates.

It is interesting to note that the Marine Engineering department had the second lowest IR of any group. This group did not change into night clothing. They did tend to change out of their overalls at the end of each watch, as the overalls would be saturated with sweat and/or filthy. This suggests that the act of changing was more important than the type of clothing personnel changed into. It also reinforces the concept that changing clothing during the day reduces the risk of presenting with a fungal infection.

This study would suggest that medical teams substantially increase stores of antifungal medications in preparation for situations where prolonged periods of hot and humid climates are likely to be experienced. For Navy medical teams this could also be advised when lengthy intervals of Defence Watches are program or possible. Preventative programs aimed at increasing awareness of fungal problems, improving personal hygiene and recommending a regular change of outfits would help to reduce this problem.

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