Heat Illness in the Services

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SUMMARY: In spite of considerable progress in prevention, heat illness remains a significant occupational risk in the Services. A retrospective analysis of cases reported through the Defence Analytical Services Agency for the years 1981-91 shows higher numbers in the second part of this period, though this may be due to reporting differences. Overall, there was an average of 135 servicemen and women admitted to hospital each year for heat-related conditions though only 15.5 of them required sick leave for more than a week. Annual incidence was higher in the Army (73 per 100,000) than in the RN (14) and the RAF (5). Tri-service incidence was 42 per 100,000 for males and 11 for females. There were 11 deaths, all in the Army, but only 5 servicemen were discharged because of heat illness. Although the largest number of cases was reported from Great Britain, the incidence of cases in troops in Hong Kong and Cyprus was greater. In all locations, cases occurred in the coldest part of the year, but were commoner in the warmer months. Heat exhaustion (73.6%) seems more frequent than heat stroke (13%), but there are problems with definition and reporting. Current preventive measures are outlined and suggestions are made for more accurate monitoring of heat illness in the future. In the light of recent literature, recommendations are made for the grading and management of servicemen following heat illness.

Introduction

"The notion that courage and esprit de corps can somehow defeat the principles of physiology is not only wrong but dangerously wrong; lives can be quite needlessly lost and survivors may suffer permanent brain damage". Few would dispute Sir Roger Bannister's view, expressed in a letter on heat exhaustion to the Times in 1989. Yet the Services have attracted vitriolic criticism on the subject in both the medical and popular press (1,2).

Such criticism is understandable; the lives lost are those of young people, generally in routine training and sporting activities. However it must be pointed out that such disasters occur also in the sporting world and that, with increasing knowledge of risk factors, great progress has been made in prevention. Servicemen are rightly required to be physically fit and not all their activities can be supervised. The knowledge is there and has been disseminated; accidents occur through occasional stupidity, over-motivation to succeed, freak conditions and, perhaps, occasional individual idiosyncratic sensitivity to heat.

Method:

This paper analyses heat illness in the Services using listings provided by the Defence Analytical Services Agency. This approach has severe limitations; it is necessarily retrospective, listings are available only for Servicemen admitted to hospital and diagnosis and classification are based only on the subjective opinion of the doctor or clerk who completes the ICD coding on the medical record after the discharge of the patient.

Further difficulty arises from the interpretation of the relevant ICD codes, which are shown as part of Table 1. There is no code that distinguishes exertional heat stroke, which occurs in young, exercising people, from classical heat stroke which occurs in the very young and the elderly

Table 1
Tri Service Heat Related Admissions 1981-91
By Diagnosis

	ICD 9920 Heat Stroke	ICD 9921 Heat Syncope	ICD 9922 Heat Cramps	ICD 9923-5 Heat Exhaustion	ICD 9928-9 Other/ unspecified	All codes
RN	21	4	0	58	18	101
Army	153	93	6	983	61	1296
RAF	14	12	0	25	0	51
All	188	109	6	1066	79	1448
Per cent	13%	7.5%	0.4%	73.6%	5.5%	100%

and infirm whilst sedentary. This is of little importance for the present purposes as we can assume that Service cases are exertional. More serious is the difficulty in distinguishing heat stroke from heat exhaustion. Heat stroke is often defined by an arbitrary core temperature, often 41°C, but difficulties arise from problems of measuring core temperature in the field or extrapolating backwards from rectal temperature recorded in hospital. Heat exhaustion is usually recognised from dehydration and hypovolaemia, with only minor rise in temperature, but we can expect that all exertional heat stroke patients will have at least some degree of dehydration. Heat exhaustion predisposes to heat stroke and vice versa. There is much to be said for the view that these conditions should be regarded as lying on a spectrum of heat illness rather than insisting on rigid definitions (3,4).

Results:

In spite of these reservations, Table 1 probably gives a true representation of the total numbers of serious heat ill-

Table 2

Incidence of Heat Illness by Sex and Service

Service	Cases 1981-91	Average Strength	Incidence per 100,000 per year
Male			
RN	99	64,100	14.04
Army	1283	160,100	72.85
RAF	45	85,600	4.78
Tri-service	1427	309,800	41.87
Female			
RN	2	3,700	4.91
Army	13	6,700	17.64
RAF	6	6,300	8.66
Tri-service	21	16,700	11.43
All			
RN	101	67,800	13.54
Army	1296	166,800	70.63
RAF	51	91,900	5.05
Tri-service	1448	326,500	40.32

ness cases in the three Services over the period 1981 to 1991. There were listings of only 32 cases of heat illness codes as secondary diagnoses for the whole period, and adding these gives a total of 1484 cases or an average of 135 cases per year. There will certainly be a number of additional cases that did not reach hospital, being managed solely in the field or in Medical Centres, but these were probably minor cases.

Table 2 gives the incidence per 100,000 of heat illness in the three Services, broken down by sex. It is apparent that the Army has a considerably higher incidence than the other two Services for both males and females. This is readily accounted for by the greater requirement for physical training. Overall, the incidence in females is only 28% of that in males, though it is actually higher than in males in the RAF. This may simply be a function of the small numbers involved.

It would be nice to think that occurrences of heat illness are decreasing. Figure 1 illustrates that there is considerable year-to-year variation and that there is a tendency for episodes in the second half of the period to be more frequent than in the first. However, there seems to be a downward trend following the peak in 1989. We should also note that trends in reporting may be as important as changing incidence in producing these effects.

Three analyses were made in order to obtain an impression of the seriousness of the listed cases. The deaths over the period, analysed in Table 3, totalled 11, an average of one per year. All were in Army personnel. Heat stroke was given as the cause of 7 of them. Heat syncope seems an unlikely cause, reflecting the confusion there has been over differential diagnosis and coding. NATO "Cause of Illness" coding gives "excessive heat" for 9 of the victims and codes indicating running and exercise for the other two. It is, of course, difficult to be sure of the relative con-

tributions of environmental heat stress and the endogenous heat of exertion.

Fig 1. Admissions for Heat Illness: Army Main Locations by Year

Table 3

Heat Related Deaths 1981-91

Army:	Heat stroke	7
	Heat exhaustion	2
	Heat syncope	1
	Other heat-related	1
	Total	11
Royal Navy and Royal Air Force: No deaths		

Secondly, the discharges from the Services because of heat illness were counted. Surprisingly, there were only 32 soldiers discharged for this reason in the 11 years. There were no such discharges in the RN or RAF. In any case, a discharge is likely to indicate unsuitability to serve in a hot climate rather than persisting disability.

Thirdly, the listing for the Army was analysed for time off duty as the result of an episode of heat illness. As detailed in Table 4, nearly 83% were back on duty within a week and, indeed, many of these were simply observed overnight. A further calculation tells us that an average of only 15.5 soldiers per year required more than one week off duty because of heat illness. However, a small number had long periods off duty, the maximum being 153 days, or about three months.

It seems reasonable to suppose that heat illness occurs in hot climates. Numerically, however, by far the greatest number of Army cases is found in UK (668) and Germany (230). This is because of the much larger numbers of troops in those areas. It was therefore necessary to attempt to reach incidence figures for some of the important locations; the results appear in Table 5. As indicated in the footnotes to the table, there were some difficulties in matching manpower deployment figures and medical statistics, but the results are not likely to be far from the

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truth. These incidence figures exclude 1990 because comparable denominators were not available. Compared with the overall incidence of 73 per 100,000, they reveal the expected higher incidences in Hong Kong (233), Cyprus (193) and, to some extent, Gibraltar (93).

Table 4

Length of Time off Duty (Army)

	Less than 1 week	1-2 weeks	2-3 weeks	More than 3 weeks
Number	1073	77	72	74
Percent	82.8%	5.9%	5.6%	5.7%

Table 5

Incidence of Heat Illness in Certain Locations

Location	Total Cases	Average Incidence per 100,000 per year
United Kingdom (including NI)	584	66
Germany	203	36
Cyprus	57	193
Hong Kong	168	233
Gibraltar	5	93

Notes:

1. Incidences are calculated from Medical Statistics and from Tri-service Manpower Statistics.
2. There are slight differences in the ways these are presented, which make for problems in ensuring that nominators match denominators.
3. Thus manpower figures are given for Europe as a whole, whereas Med Stats are for Germany. The difference is small.
4. UK manpower figures are somewhat inflated by including those in transit and those not included elsewhere.
5. Figures for "locally enlisted males" are included in denominators. Most of these are Gurkha soldiers. Med Stats include Gurkhas, and mark them as such.
6. This table covers the period 1981-91, but excludes data for 1990 as the Manpower Statistics were not produced in the usual way for that year.

It is sometimes said that "the Gurkhas are always getting heat stroke in Hong Kong" and, indeed they represent about 53% of the Army cases there. However it was possible to compare the incidence of heat illness in Gurkhas with that in British-based male soldiers in Hong Kong. This showed a lower incidence, 195 per 100,000, in the Gurkhas compared with 460 per 100,000 in the British-based group. There was only one report of a Gurkha sol-

dier admitted for heat illness in the UK over the period of 11 years, in spite of the presence of a battalion of infantry plus some Signals and Engineers. There is nothing here to indicate increased susceptibility; in fact they may be less susceptible.

Continuing to attempt to relate the incidence of heat illness with environmental temperature, Figures 2 and 3 show the pattern of heat illness through the year in four main locations. It will be seen that there is a rather longer "heat illness season" in Hong Kong and Cyprus, but that episodes can occur in all months in all countries considered. Returning to Table 1, it appears that Heat Exhaustion (74%) was far more common than Heat Stroke (13%). However, difficulties in measuring core temperature in the field and with coding and reporting may make this unreliable.

Fig 2. Admissions for Heat Illness: Army By Month, 1981-91

Fig 3. Admissions for Heat Illness: Army By Month, 1981-91

Table 6
Cases of Heat Illness Below 21°

Authors and Reference	Air Temp °C (Method)	Humidity %	Initial Body Temp °C (Method)	Dress	Outcome
Carson & Webb (8) (1973)	10.2 (DB)		40.4 (R)	Full military kit	Recovery
Sutton (9) (1984)	12.0 (WBGT)		42.0 (R)	Running kit	Recovery
			35.5 (O)		
Dickinson (10) (1989)	12.0 (DB)	88	40.5 (A)	Tropical combat kit	Death
Richards & Richards (11) (1984)	15.0 (DB)	82	40.0 (R)	Running kit	Recovery
Hanson & Zimmerman (12) (1979)	16.0 (DB)	60	42.5	Running kit	Recovery
Carson & Webb (8) (1973)	16.6 (DB)		39.4 (R)	Full military kit	Recovery
Parnell & Restall (13) (1986)	16.7 (DB)	87	40.0 (R)	Light clothing	Death
			42.8 (Oes)		
Whitworth & Wolfman (14) (1983)	19.0 (DB)	30	40.0 (R)	Running kit	Death
Sutton (9) (1984)	21.0 (DB)		41.5 (R)	Running kit	Recovery

**** = female patient. All others male

Key to methods of temperature measurement:
Air temperature:
DB = Dry Bulb or not defined WBGT = Wet Bulb Globe Temperature
Body Temperature:
R = Rectal A = Axillary O = Oral Oes = Oesophageal

Discussion and Conclusions

Considerable numbers of cases of heat illness occur in the Services and especially in the Army. Though relatively few of them are serious, an average of one death per year renders complacency impossible. Typical exertional heat stroke can occur at moderate environmental temperatures as shown by the cases summarised in Table 6, which are culled from military and civilian reports. Military cases of heat illness represent mainly heat exhaustion and exertional heat stroke, many showing fea-

tures of both these conditions. As shown by the "low temperature cases", endogenous heat is of greater importance than environmental, though of course high ambient temperature and humidity render the heat induced by muscular exercise harder to dissipate. Medical officers and commanders need to be aware of the possibility of heat illness in moderate conditions.
It is clear that a retrospective analysis such as this leaves many uncertainties. To establish a more accurate picture it would be necessary to mount a Tri-service

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prospective study. Instead of relying upon ICD codes, dedicated proformas should be completed in all cases of heat illness. These should show full details of environmental temperature (with humidity where possible), clothing, the level of exercise involved, measurements of core or other temperature (with elapsed time from the collapse), state of hydration and complications present. Outcome, medical grading and time off duty would all add to the picture. Questions relating to first aid management would be helpful in assessing the extent to which training in such management is effective. Such a co-operative project would require central co-ordination.

Much has already been done to control exercise in hot conditions; commanders are issued with tables recommending water requirements and work/rest ratios at different temperatures and in different forms of dress, including IPE. "Water discipline" no longer means learning to do without it! There is a recommended period of three weeks' acclimatization to heat for troops arriving in a hot climate. A chart based on Wet Bulb Globe Temperature is used to control physical exercise in conditions of high temperature and humidity.

These measures were successful in preventing serious problems during Operation Granby, during which there were only 8 cases in British Forces.

In spite of education in first aid management, patients with heat illness are still sometimes brought to casualty dressed in full combat clothing, especially in the UK where such problems are not expected. The process of education is unceasing. From the point of view of epidemiology as well as hospital management of cases, it would be helpful if field medical personnel were equipped and trained to measure rectal temperatures. Medical officers might consider screening for predisposing conditions before declaring servicemen fit for particularly energetic activities. However "unfit for running because of heavy drinking" is unlikely to be satisfactory to commanders!

There has been much uncertainty about the disposal of servicemen who have been admitted with heat illness. On the one hand, servicemen rightly feel aggrieved if their careers are limited as a result of an episode of heat illness, especially as some of them are highly motivated and athletic individuals. On the other hand, the Services are liable to public criticism if servicemen have second episodes leading to disability or death.

There are limited data to help resolve this problem. An influential Israeli study (5) published in 1979 found that, of a group of soldiers who had suffered heat stroke 2-5 years previously, all 9 showed impaired heat tolerance and inability to complete a laboratory test. However a study of 10 previous victims in the USA, published in 1990, showed that 9 of them had regained heat tolerance within 68 days and the other did so after 11 months (6). A recent Israeli review (7) suggests that in most cases of recurrent heat stroke the susceptibility pre-dates the first episode rather than being caused by it. It also suggests that the majority of cases are predictable because of the

presence of predisposing factors, such as obesity, infection, dehydration, skin disorders and lack of fitness.

In the testing of heat tolerance, the former victim must be allowed to achieve both fitness and heat acclimatization before testing in order to perform a valid test.

The following is recommended as a reasonable policy for medical grading and follow up of heat illness victims. Special note should be taken of the circumstances of the episode; the environmental conditions, whether others were affected at the same time and whether there had been previous episodes. All should be down graded and permitted only mild exercise for 3 months. Those with obvious predisposing circumstances (but not on-going diseases) and those who succumbed only under markedly adverse conditions or in company with others should be counselled and allowed to resume physical training under observation. If this is satisfactory, they may be upgraded.

Those who succumbed to mild conditions and those with previous heat illness should be allowed to regain a reasonable state of physical fitness and heat acclimatization and then undergo physiological testing, including measurement of sweat rates. Those remaining apparently heat intolerant may be re-tested for up to a year, but may require permanent down grading if results remain unsatisfactory or if a disability such as hypohidrosis is found. Finally, those with predisposing diseases, such as thyrotoxicosis or diabetes, need treatment, advice and grading appropriate to their condition.

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REFERENCES

1. BRAHAMS D. Death of a soldier: accident or neglect? *Lancet* 1988; **1**: 485.
2. LINSELL W D. Heat illness in servicemen. *Lancet* 1989; **2**: 803.
3. LIND A R. Pathophysiology of heat exhaustion and heat stroke. In Heat stroke and temperature regulation, ed M Khogali, & J R S Halse 1983; Sydney, Academic Press, 179-88.
4. SHAPIRO Y, SEIDMAN D S. Field and clinical observations of exertional heat stroke patients. *Med Sci Sports Exerc* 1990; **22** (1): 6-14.
5. SHAPIRO Y, MAGAZINK A, UDASSIN R, *et al.* Heat intolerance in former heat stroke patients. *Ann Intern Med* 1979; **90**: 913-16.

6. ARMSTRONG L È J, DE LUCA J P, HUBBARD R W. Time course of recovery and heat acclimation ability of prior exertional heatstroke patients. *Med Sci Sports Exerc* 1990; **22** (1): 36-48.
7. EPSTEIN Y. Heat intolerance: predisposing factor or residual injury? *Med Sci Sports Exerc* 1990; **22** (1): 29-35.
8. CARSON J, WEBB J F. Heat illness in England. *J R Army Med Corps* 1973; **119**: 145-53.
9. SUTTON J. Not so fun run. *Med J Aust* 1984; **141**: 782-83.
10. DICKINSON J G. Heat-exercise hyperpyrexia. *J R Army Med Corps* 1989; **135**: 27-29.
11. RICHARDS R, RICHARDS D. Exertion-induced heat exhaustion and other medical aspects of the City to Surf fun runs, 1978-84. *Med J Aust* 1984; **141**: 799-805.
12. HANSON G, ZIMMERMAN S W. Exertional Heat stroke in novice runners. *J Am Med Assoc* 1979; **242**: 151-57.
13. PARNELL C J, RESTALL J. Heat stroke: a fatal case. *Arch Emerg Med* 1986; **3**: 111-14.
14. WHITWORTH J A G, WOLFMAN M J. Fatal heat stroke in a long distance runner. *Br Med J* 1983; **287**: 948.