METHODS OF MINIMISING HEAT STRESS DURING MILITARY OPERATIONS

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INTRODUCTION

Army personnel carry out many operations in hot climates which have high levels of solar radiation. Problems with heat stress may be encountered if personnel are wearing multiple layers of clothing, such as chemical and/or ballistic protection whilst carrying out tasks requiring a high oxygen consumption. This paper gives two examples of particularly stressful military tasks and describes investigations of ways of minimising the heat stress on the soldiers undertaking them: First: the members of a particular gun detachment, who lift and load 44 kg shells into the gun whilst wearing chemical and ballistic protective clothing. Second: munition disposal operatives, who may need to wear loose- fitting, heavy, impermeable gas-tight suits to which breathing air is supplied from either a self-contained breathing apparatus or from an airline (umbilical) attached to the suit. The air from the umbilical may also be circulated around the suit and vented.

METHODS

In both investigations various physiological measurements were made. However, rectal temperature will be discussed here as the main indicator of heat stress. The environmental conditions set in the hot chamber were designed to simulate the maximum which would be encountered operationally and were as follows: Dry bulb temperature 49°C; relative humidity 5 to 15%; radiant heat 1000 watts/m^2. The subjects carried out a series of tasks representative of their normal routine in the field.

The following methods of minimising heat stress of the members of the gun detachment were investigated

a. Shade - by working beneath a canopy made of opaque material the radiant heat load was reduced from 1000 watts/m^2 to 50 watts/m^2 .
b. Work/rest routines - grading the work in stages. This method may be used to reduce the overall rate of body heating and thus increase the overall time for which the detachment could work. The optimum duration of the work and rest periods were found by experimentation.
c. Wetting the protective clothing - the layers of clothing were wetted to increase the rate of evaporation and thus the rate of heat loss.

Of these, only shade was a practicable option for relieving heat stress of the munition disposal operatives, so the following additional methods were investigated:

a. Air flow - the air flow through the suit was increased to increase the rate of sweat evaporation.
b. Cooled air flow - the air flowing through the suit was cooled to approximately 10°C below ambient air temperature by the use of a vortex cooler.

RESULTS AND DISCUSSION

Gun detachment: The table shows that the maximum permissible rectal temperature (38.5°C) was reached in 22 minutes when working continuously. Introducing a 15 minute. work/30 minute rest routine caused a significantly lower rate of rise of rectal temperature. ($p<0.05$). Wetting the clothing caused a further reduction in the rate of rise of rectal temperature ($p<0.05$). Work endurance times increased about 10-fold and 15-fold respectively.

Mean (± 1 standard deviation) changes in deep body temperatures and endurance of the gun detachment

Activity	Change in rectal temperature °C/hr	Endurance minutes
Continuous shell loading	1.39 ± 1.16	22
15 min work/30 min rest	0.30 ± 0.05	230
15 min work/30 min rest with clothmg wetted	0.20 ± 0.09	330

Munitions disposal operatives: Figures 1 and 2 show an example of the effects of shade and of air flow through the impermeable suit on the rectal temperature of the munition disposal operatives. Figure 1 shows that working in the shade reduced the rate of rise of deep body temperature and increased endurance by 5 minutes. Figure 2 shows that as the air flow through the suit was increased from 35 to 75 litres per minute, the rate of increase in deep body temperature was reduced. The vortex cooler, used with the higher air flow, reduced the rate of rise of deep body temperature even further.

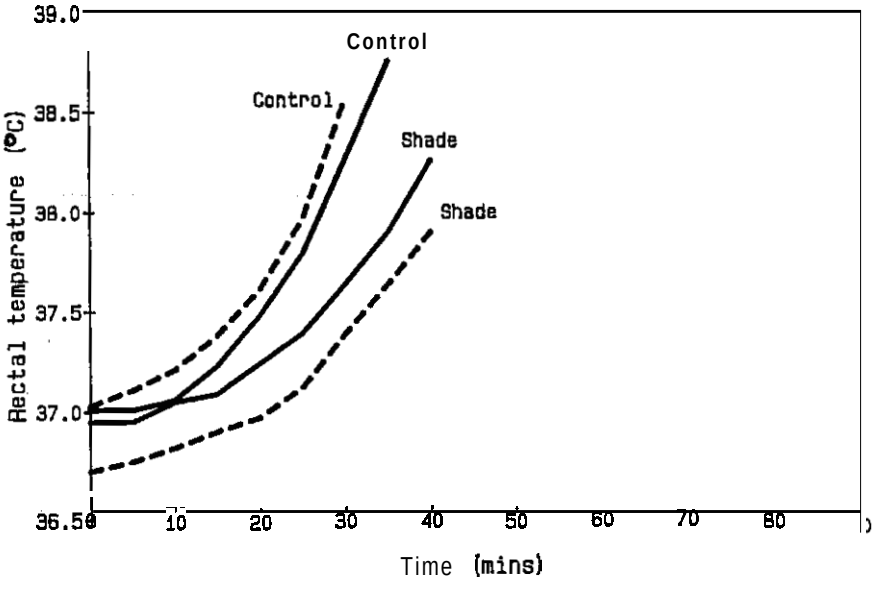

Figure 1. Rectal temperatures of two munition disposal operatives when unshaded (control) and shaded from the radiant heat load

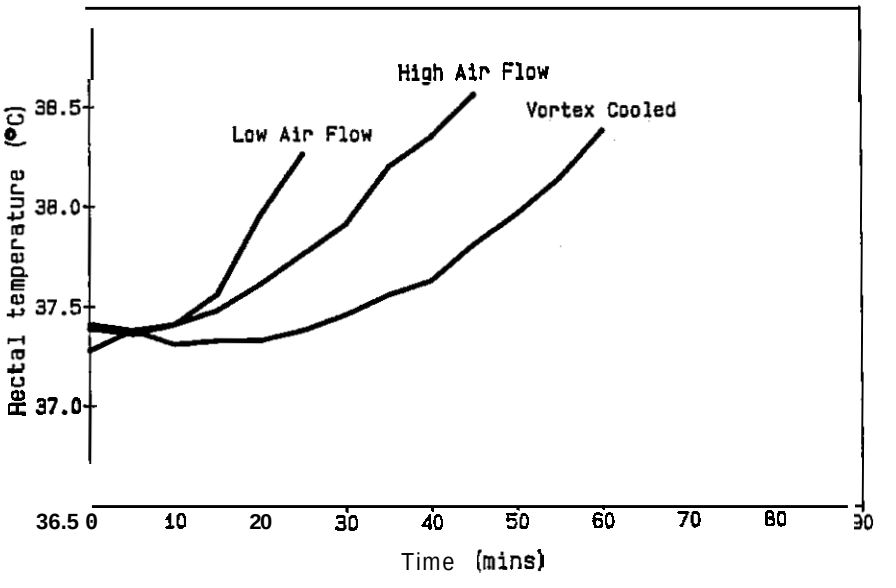

Figure 2. The effects of low, high and vortex-cooled airflow through the suit of a munition disposal operative

CONCLUSIONS

Shading, air cooling, work/rest routines and wetting the clothing reduced the rate of rise of deep body temperature and increased endurance of the individuals working in these hot environments. Many of these options are practicable in a variety of civilian as well as military activities.