LIGHT NBC PROTECTIVE COMBAT SUITS AND BODY HYDRATION DURING PHYSICAL ACTIVITIES UNDER TROPICAL CLIMATE

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INTRODUCTION

The improvements of nuclear, biological and chemical (NBC) protection have allowed development of light NBC protective suits that permit combat in conditions similar to that using standard battle dress. However, in full protection mode (gas mask, gloves, hood in place) body heat elimination is reduced and resulting dehydration can be very great. It has been shown that dehydration and resulting hypovolemia impair endurance capacity (1) and promote thermal injuries (2). In these conditions, rehydration is fundamental but the gas mask may constrain drink ingestion. The purpose of this investigation was to evaluate the effect of wearing different light NBC protective combat suits on body hydration during various physical activities in a hot country.

METHODS

Procedures. Six soldiers from an operational group participated in the experimental protocol in tropical country (Djibouti). Environmental conditions were as follows: dry bulb temperature, 30 to 34°C; field globe temperature, 44 to 48°C and wind speed, < 1 $m \cdot s^{-1}$. The relative humidity was higher in the morning (75%) than in the afternoon *(55%).* Each subject performed 5 moderate and *5* sustained physical activities at the same time of day with different combat suits: standard battle dress (SBD) and 4 light **NBC** protective combat suits in full protection mode (TcNBCO = charcoal impregnated compressed cells; TcNBCA = new charcoal impregnated compressed cells; TcNBCB = spherical particles; TcNBCC = activated charcoal cloth). The insulation values for the clothing ensembles, determined on a manikin, were SBD = 0.6, TcNBCO = 0.7, TcNBCA = 0.8, TcNBCB = 0.9 and TcNBCC = 0.7 clo.

Moderate exercise (approximately 30% of $\dot{V}O_{2max}$) consisted of walking at 4 $km \cdot h^{-1}$ for 30 min under the sun. Before and after the walk, subjects sat down under the shade of an open tent for 10 and 30 min (recovery), respectively. During the recovery, spontaneous rehydration with mineral water through the gas mask was allowed.

Sustained exercise (approximately 80% of $\dot{V}O_{2max}$) consisted of a training course run (500 m and 20 obstacles). A recovery period of about 85 min in com-

fortable conditions (under the shade and wearing light clothing) was provided between each run. Rehydration was provided using 2 modalities: imposed rehydration (maximal ingestion of water during 30 s through the gas mask) just after the run and rehydration ad libitum during the recovery.

Measurements. Before and after each test, subjects were weighed nude and a urine sample was collected and its volume, osmolality and density determined. A blood sample was obtained before and after each exercise and at the end of the recovery. Hematocrit was measured and used to estimate plasma volume (PV) variation. Heart rate (HR) and rectal and skin temperatures (T_{re} and T_{sk}, respectively) were continuously monitored.

RESULTS

During the moderate exercise tests, the sweat rates were higher ($P < 0.05$) for TcNBCA (991 ± 32 ml) and TcNBCB (895 ± 49 ml) than for the other suits: 815 ± 55 ml, 716 ± 65 ml and 768 ± 139 ml, for TcNBCO, TcNBCC and SBD, respectively. The time courses of T_{re} and T_{sk} confirmed previous findings for TcNBCO and TcNBCC (3). Tre and Tsk were always greater (from 0.3 to 0.5oC) than with the other NBC protective suits ($P < 0.05$). The time course of the HR response was similar for all suits. After exercise, the PV decrease was greater with NBC suits than with standard battle dress ($P < 0.05$, see Figure 1). During recovery, the amounts of ingested water were less with NBC protective suits (through the gas mask) than with the SBD ($P < 0.05$). As previously described (4), small amounts of ingested water are insufficient to correct the water losses and PV reductions. The urinary volume was also reduced with the NBC suits, and osmolality and density increased ($P < 0.05$).

The duration of the sustained exercise was similar for all suits (5 min 20 s to 5 min 50 s). Mean HR, recorded at the end of the exercise, was also similar for all suits (169 to 173 beats·min-1). Because of the short duration of the exercise, the increases in Tre and Tsk were small and did not differ significantly among suits. However, the sweat rates were twofold higher with NBC suits (mean ± SEM, 414 ± 27 ml to 507 ± 30 ml) than with standard battle dress (286 ± 27 ml, $P < 0.05$). The large PV decrease (about -6% with each suit), just after the run, could be due more to the intensity of exercise than the water losses (5). Maximal amounts of water ingested through the gas mask after the run were small (about 60 to 90 ml during 30 s) and insufficient to compensate for the fluid losses.

CONCLUSIONS

Our results have shown the importance of the fluid losses when wearing light NBC suits in full-protection mode during various exercises in hot country. Rehydration through the gas mask was difficult and did not allow effective compensation for the water losses.

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