Annals Physiol. Anthrop. Vol 5. No. 3 1986

57 Dynamic moisture transfer through clothing worn

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Complication of **the** evaporation process through clothing worn may be attributed to the effect of absorbency (Pratt et. al., 1956). **the** hygroscopic properties of clothing (Nelbace and Herrington, 1942) and ventilation in clothing microenvironment (Birnbaum and Crockford, 1978; Olesen et. al. 1982; Vogt et. al. 1984). The hygroscopic properties can be characterized by moisture gain and loss in varying relative humidity, which may cause imbalance between the rate 01 evaporation from the skin (Esk) ana that from the clothing sudace (Ecl). Similarly. considering that clothing insulation in warm environment and during exercise decreases due to increased ventilation. any change in ventilation may also lead to such disproportion in heat loss by evaporation. Thus. these implications appear to be of great importance in both sensible and insensible heat exchange through clothing. yet little word has investigated these significant effects on the evaporation process through clothing. In **this study**, using a new y developed device, changes :n **Esk** and Ecl were observed while ambient temperature was elevated.

The device was first developed by Lamke et al., (1977), and more recently Kakitsuba (1982) improved the system to allow measurement at multiple Sites simultaneously. However, the device used for this study has been further improved to minimize its size applicable for measurement underneath clothing. It consists of two relative humidity sensors coupled with thermistors so that absolute humidities at two points within boundary .layer can be determined. The rate of evaporation can then be derived by applying Fick's law of diffusion.

Four male subjects wore four different types of helicopter suits (Nomex, Goretex. Cotton ventile, Nomex/lnsulite) and sat in the middle pan of a box shaped frame enclosed with thick black drapery. Ambient temperature was elevated from 26^{o}C to 40^{o}C within 90 minutes and kept constant at 40^{o}C for 2.5 hr. The rates of local evaporation from the skin at three sites **(chest, arm** and thigh) and those from the clothing surface at corresponding sites were monitored throughout exposure. The **results** are **as f**ollows:

1) the average values of Esk and Ecl at three sites showed no significant difference in the initial stage until Esk abruptly increased;

2) following the sudden increase in Esk, Esk decreased exponentially but Ecl gradually increased over a period of **1** hr;

3) Esk returned to the initial levels, and Ecl remained in the range between 60 and 80 W/m^{2} during the last one-third of entire exposure.

These results may be associated with the onset of sweat secretion (sudden increase in Esk), the progress of saturation with water vapor in clothing microenvironment (exponential decay of Esk) and moisture and water gain in fabric (gradual increase in Ecl). In addition, substantial reduction of Esk in the heat indicated lack of ventilation as the obvious nature of protective clothing.

Acknowledgements
This work was supported by the Science Council of British Columbia and the Natural Sciences and Engineering Research Council of Canada.