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KEYNOTE ADDRESS

RECENT TRENDS IN CLOTHING PHYSIOLOGY

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The last decade have seen an increasing interest in research on clothing comfort and function. The demand of high-performance clothing systems in space, polar and underwater operations is one explanation. Others are the increased number of industrial operations requiring protective clothing and a growing interest among outdoor people for functional clothing. Another presumption for this development has been the use of more sophisticated methods for the analysis of e.g. thermal function. Several international conferences have dealt particularly with problems of protective clothing. This review deals with some recent trends in clothing physiology research, with particular emphasis on thermal function.

The function of a clothing system may be assessed in terms of its ability to give protection, ***maintain efficient operator performance***, and provlde ***thermal*** *comfort*.The first function depends *to* a great extent upon material properties. Research in this field covers numerous investigations of fiber and fabric properties such as permeability to gases, vapors, aerosols, and liquids, flame resistance and flame retardance, thermal insulation and radiation emissivity. The second function has to **do** with the impact of clothing on vision, hearing, limb and body movements. and mental performance. Improperly designed clothing may restrict muscular operations, reduce muscular power and increase muscular strain. Protective clothing increases the overall cost of work in proportion to e.g. its total weight, distribution of weight, number of layers and their material (internal friction). Clothing is our most important means of adjusting to the thermal environment and creating a comforlable or acceptable microclimate at the skin surface. Heat exchange through clothing takes place by conduction and evaporation and the determinant clothing properties are ***thermal Insulation*** and ***evaporative resistance***.

Measurements **of clothing** thermal properties. Thermal insulation of a garment or a garment ensemble (I_{cl}) is measured with a thermal manikin. This method is now being standardized (ISO DP9920). Evaporative resistance (R_T) is more difficult to measure. It may be calculated as function of I_{cl} or determined on the basis of the permeability index (i_m). Direct measurements can be made with a "skinwetted" manikin. A "sweating' manikin is being developed within the framwork of a joint nordic research project. Measurements with manikins are standardized in the sense that ambient temperature is constant, air velocity is minimal, and the manikin is standing and static. Measurements of I_{cl} and R_T can also be made *on* subjects. Such measurements are time-consuming, costly, less reproducible due to great variation between individuals. On the other hand, these measurements are required as complement to manikin measurements in order to (1) validate manikin data, (2) give information about individual variability, and **(3)** obtain information about thermal properties under clothing, climate and activity conditions encountered in the field.

Thermal ***function of clothing***. Both insulation and evaporalive resistance are dynamic properties and vary with factors such as wind, body posture, body motion, and moisture absorption. Much of the recent research has addressed these problems. Under most practical conditions I_{cl} and R_T do not accurately describe the heat transer processes in clothing. The resultant insulation ($I_{cl,r}$) of a garment assembly may be up to 20% lower in the seated position and **up** to 50% lower during bicycling or walking. Methods for measurement of the clothing microclimate volume and the air exchange rate in a clothing system have .been improved. The magnitude of ventilation in various types of garments (the pumping effect) has been determined. Evaporative heat exchange, moisture transporl and moisture absorption become a problem with most clothing under extreme conditions.These factors have been studied from both theoretical and practical points of view. Very few data have been published on resultant evaporative resistance ($R_{T,r}$) of clothing, particularly lor protective purposes. A number of studies focusing on the physiological strain associated with wearing different types of protective equipment have been carried. Some of this studies show that this is a new work environment problem in many industrial processes. In addition it has become a problem of great concern in many developing countries with tropical climates as well. Predictive models of climate stress and strain have been further developed and include. in most cases, the available information about clothing.