HEAT STRESS MANAGEMENT: AN INDUSTRIAL PERSPECTIVE

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INTRODUCTION

In South African gold and platinum mines nearly 270 000 workers are exposed on a daily basis to working conditions potentially conducive to the development of a variety of heat disorders, notably heat stroke. Because of both technological and economical constraints, the ergonomically acceptable (engineering) strategies are of limited value and, as an adjunct a strategy based on personal protection, entitled Heat Stress Management (HSM), has been developed.

HSM is based on a two-fold approach, namely (a) the detection of gross or permanent heat intolerance and (b) promoting the progression of natural physiological acclimatization to heat during normal work routines. The purpose of this paper is to review the relevant research and development and, on the basis of the aetiology of heat stroke, to extend these findings to a more general industrial application and guideline.

METHOD

The research and development programme comprised three distinct phases, namely (a) the development of a heat tolerance screening (HTS) procedure under controlled laboratory conditions, (b) an estimation of the efficacy of natural acclimatization relative to artificial climatic chamber methods (acclimation), and (c) an analysis of the aetiology of heat stroke in the South african mining industry.

The HTS test was developed using mineworkers (n = 304), who volunteered on the basis of informed consent. Various environmental heat load and metabolic rate combinations were examined and, in terms of practical parameters of heat stress (oral temperature, rectal temperature and heart rate) related to a standard heat tolerance test.[1]

The degree of natural acclimatization achieved after a 12-shift period of underground work (dry-bulb = 33°C; wet-bulb = 31,7°C, air movement = 0,4 m.sec^{-1}) was related to that achieved following a conventional five-day climatic chamber regimen[2] Ambulatory electrocardiography was used on selected mineworkers to establish full-shift heart rate profiles.

RESULTS AND DISCUSSION

The degree of heat tolerance required for sustained work in the hot and humid South African gold mines is defined in terms of the risk of developing core (rectal) temperatures in excess of 40°C.[2] If this risk exceeds 10^{-6}, i.e. 99,9999 per cent confidence limits, the combination of metabolic rate, exposure time and environmental heat load is regarded as unacceptable. In this context an appropriate screening test for gross or inherent heat intolerance would constitute an external work rate of 80 W (positive component only of a bench stepping regimen) maintained for 30 minutes in a hot humid environment (28,0°C wet-bulb; 29,5°C dry-bulb; air movement 0,4 m.sec^{-1}).[3] Heat intolerance can then be expressed in terms of oral temperature (≥ 37,7°C) rectal temperature (≥ 39,0°C) or heart rate (≥ 162 beats.min^{-1}). The importance of an HTS device can be gauged from the fact that at present more than 9 000 workers are identified as inherently heat intolerant and therefore unfit for work in South African gold mines[4]

Provided that selection is based on HTS, an adequate degree of heat acclimatization can be achieved while

workers are engaged on normal routines. Heat stroke statistics (121 cases including 40 fatalities over the period 1980 - 1991 inclusive) identify, in descending order of occurrence, strenuous work (85% of incidents), dehydration (50%) and excessive environmental heat loads (28%) as the major causal factors4 The obvious precautions are therefore related to work-rest cycles and/or self-paciog, the availability of water, worker education to prevent alcohol-induced dehydration and observing prescribed thermal limits. It is also obvious that heat stroke is multifactorial in origin (major factors total 163 percentage points) and ongoing management commitment is therefore of overriding importance.

HSM has been implemented on South African mines3 It is suggested that although developed for a mining application, the essential elements can be extended to any industry where heat presents a health hazard.

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