OCCUPATIONAL HEAT ILLNESS: AN INTERVENTIONAL STUDY

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INTRODUCTION

Australia is the world's hottest, driest continent. Ambient dry bulb temperatures exceeding 40^0 C are common for several months of the year in inland areas and, in the hot, humid, tropical regions, workplace temperatures exceeding 28^0 WB are also frequent.

The historical approach to controlling heat stress and heat illness in occupational settings has been to apply a shortened shift when certain thermal limits were exceeded.

One of Australia's most important industries is the minerals industry. For various reasons, more mines in Australia are developing as underground rather than surface operations. Moreover, mines are increasingly being based on 12 hour shifts and "fly in, fly out" rosters with 14 or more days on site before taking a break. Long term trends towards lower commodity prices are forcing mines to become more productive and to continually lower their operating costs.

Hot working conditions in mines are common. The reasons include the hot surface climate, "autocompression" of air as it enters deep mines, the very intense use of high-powered diesel equipment in confined spaces and the high moisture pick-up in the ventilating air, which increases the humidity and wet bulb temperature and consequently the heat stress on workers.

The changing business and social needs of mines, along with the increased heat stress, have raised a number of questions regarding working in hot environments:

- At sweat rates of one litre per hour, mine workers can "turn over" their entire body weight within seven days. What are the short and long-term consequences of this?
- What is the most appropriate hydration/fluid protocol?
- How should the issue of acclimatisation be addressed?
- What are the physiological limits with respect to work intensity/work duration?
- Should physiological criteria be used to reduce the risk of occupational heat illness?
- How should the working environment be measured in terms of the strain it imposes? For example, most current indices are based on a constant work intensity. We know that this key assumption is not correct for many workplaces, which makes current indices difficult if not impossible to implement.
- Is a reduced shift length the most appropriate way to manage thermal strain in workers?

METHOD

In the summers of 1996/7/8, a major program of study was conducted in Australia's largest, deepest and hottest underground mine. These tests included:

- Continuous measurements of "core" (deep body) temperatures during the working shift and in the recovery period between shifts,
- Continuous measurements of heart rate during the shift,
- Measurement of fatigue levels before, during and at the end of the shift,
- Measurements of hydration status before, during and at the end of the shift,

- Measurements of wet and dry bulb temperature and wind speed at the work place during the shift.

At the conclusion of the tests, some results became clear:

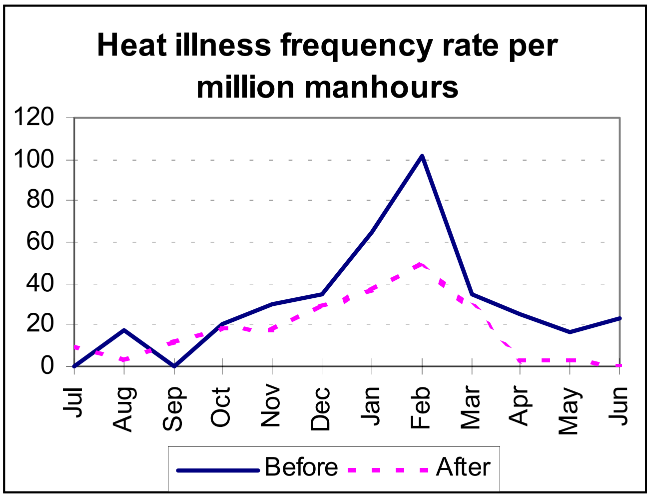
- If thermal stress was excessive, then an exposure of even two hours was not safe, and certainly six hours (the typical shortened shift length) was not safe,
- If thermal stress was not excessive, then there was no reason to shorten the shift length, providing self-paced workers were healthy and started their shift well-hydrated and remained well-hydrated during their shift,
- Most heat illness was occurring where the wind speed was low (less than 0.5 m/sec); wind speed was largely ignored in the existing protocols at this work site,
- Dehydration was by far the biggest cause of heat illness in the workplace. Some of this dehydration was occurring at work, but much was occurring before workers started their shift.
- No suitable instrument was available to measure all the environmental parameters needed to assess heat stress [1].

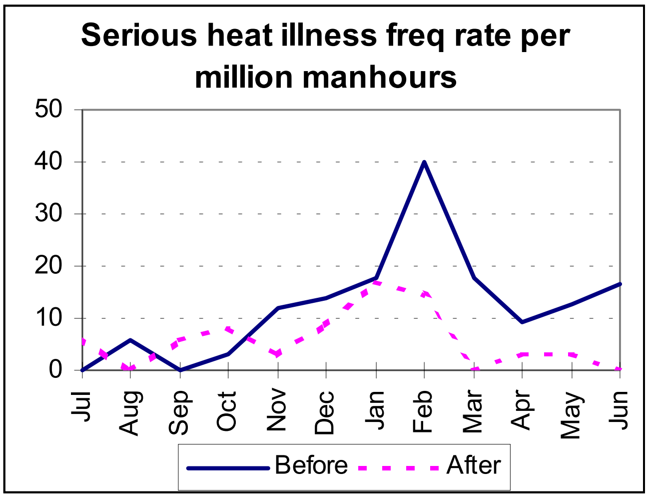
After carefully reviewing the current methods used to assess thermal strain in the workplace (e.g. WGBT and ISO7933), it was clear that these would be inappropriate for workers who were undertaking different tasks at different metabolic rates in different thermal environments on a daily and even hourly basis [2]. An index which took all the necessary environmental and clothing parameters into account, and which was designed for self-paced work, was therefore formulated [3].

Four management zones and a comprehensive management protocol [4] for working-in-heat were developed based on this new index and the recognised deficiencies in the existing protocols. These zones were:

Unrestricted	No restrictions due to thermal stress apply
Acclimatisation	Special precautions apply, but only for unacclimatised workers
Buffer	Restrictions apply for all workers and conditions are closely monitored.
Withdrawal	No work allowed except for a safety emergency. Where work is required, a formal permit to work in heat must be authorised in advance by the senior company officer, and this work permit requires, amongst other things, formal work-rest cycling.

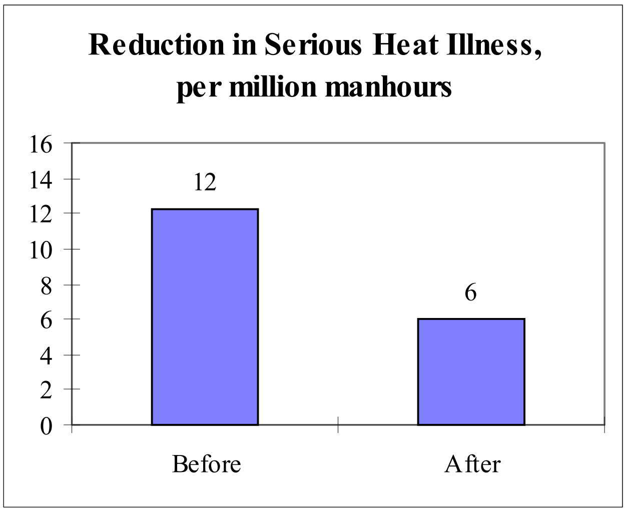
Over summer 1998/9, after the protocols had been implemented and the shortened shift removed, the test program was repeated and compared to the initial data.

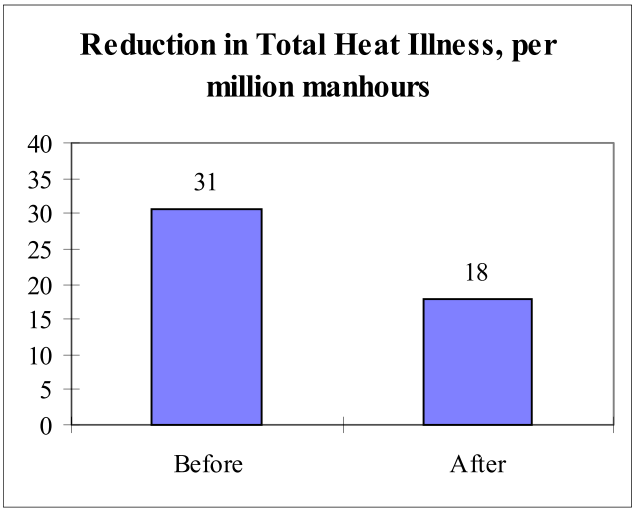




RESULTS

In summary, the total incidence of medically reported heat illness per million manhours worked has fallen from 31 under the old protocols to 18 under the new protocols, despite the abolition of the shortened shift. Likewise, the incidence of more serious episodes (based on symptoms and their severity) has fallen from 12 per million manhours to six.





DISCUSSION

Whilst these protocols have been developed in the context of a large underground mine, the underlying physiological principles are equally applicable in most occupational settings - mines, smelters, bakeries, foundries and even outdoor workers - and should have a similar effect in terms of reducing heat illness, with its commensurate improvement on safety, productivity, cost and morale.

CONCLUSIONS

Heat illness is now an acknowledged occupational condition [5] that traditionally may have been under-diagnosed and under-reported. The lack of practical and realistic protocols and suitable environmental measurement instruments has prevented this significant problem being adequately addressed in the past. This study has shown that correct interventions, including a practical heat stress index for occupational settings, can lead to a substantial reduction in occupational heat illness.

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