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Research Paper

Working Under Extreme Heat Conditions

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Abstract

In todays, complex work environments, occupation health, has become, more important, in safeguarding, the health and safety, of workers. Equipped with, scientific research, occupational health, is increasingly contributing, to the advancement, of industrial safety, right from the, management, to the individual levels. Environmental heat stress, has always, affected, the health and productivity, of workers. With more projects, requiring workers, to spend hours, under, the open sun, companies, need to device, more effective means, of protecting, their workers, from heat stress. This paper, provides, a methodical framework, as to, how, occupational health practitioners, along with HSE managers, can implement, effective, and safe, risk mitigation practices, based on, current scientific evidence. The author encourages stakeholders, to keep, up to date, with current research, and management protocols, to promote, the cause of, health and safety, for all.

Occupational Health: An introduction

Workers, in various, industrial sectors, are exposed to, myriad hazards, of the workplace. This often, leads to, accidents and ill health. To prevent, and mitigate, such incidents, the discipline of, Occupational Health(OH), was born, (Abrams 2001). As workplaces, became more complex, the scope, and complexity, of this discipline, saw an enhancement, in the roles, of its practitioners, (Frimat 2017). Various authorities, have tried to, define occupational health. An expanded definition, by WHO, (WHO, 2001), mentions risk mitigation, as a primary approach, to prevent ill health. It further emphasises, positive aspects, of a worker's existence, to promote, overall wellbeing. The importance, of research, in promoting, the causes, of occupational health, has been striking, in advanced countries, (Ashford and Caldart 1996). Health conditions, related to work, started, to be increasingly identified, and scientific methods, began to be used, for research and analyses. Engineering solutions, that were, able to address, specific concerns, and administrative controls, both contributed, towards greater safety, at the workplace. This, in turn, led to a reduction, in the morbidity, and mortality, from industrial, and occupational causes. The, leading causes of ill health, like lung diseases, musculoskeletal injuries, occupational cancers, neurotoxic disorders, began to impact, the workforce, to a lesser degree. Various industries, also began, to brace for, technological changes, that directly affected, work conditions, and the scope of, OH practitioners, kept including, newer, and unknown challenges. For, the developing world, it became apparent, that the full implementation, of these scientific protocols, (Nuwayhid 2004), will not be able, to match the success, seen in developed countries, because of certain barriers. Various practitioners, has identified, political will, lack of resources, and lax regulations, to be detrimental, to the causes, of OH. It has been, proposed, to include, other stakeholders, in a bid, to improve, the prospects of workers' health, in these economies. These, may include, social scientists, political scientists, economists, unionists, non-governmental organizations, and human rights activists. This will help, to address the, larger context, of social and political issues, that are most important, towards contributing to workers' health. Collaborative programs between these two disparate economies can shed more light on workplace hazards and risk mitigation. This will help to set up priorities in research, information gathering, technical methodologies, and training and intervention.

Because, of increased globalisation, there has been, awareness of challenges, that are global, in nature and may affect large swathes of population, in both developed and developing economies, (Lucchini and London 2014). One of the pressing issues, is of untrained migrant workers, which can lead, to conditions, becoming local, in a developed country. Sudden, infectious disease outbreaks, can affect, a population, that, was far removed, from the disease, before. It is suggested, that urgent remedial measures, are taken, to prevent, these issues, from having, devastating consequences. The following recommendations has been made:

1. Increased funding of regulatory and executive bodies (WHO, ILO, etc.).
2. Enhanced regulations.
3. Advocacy, awareness campaigns, technical guidelines.
4. Research, education, and training.
5. Consumer and public awareness.

Occupational heat exposure and its impact

Worldwide, workers often have to work directly under the sun for long periods of time, which can be detrimental to the health and safety of the workers, (Xiang et al. 2014), lead to increased injuries, (Varghese et al. 2018), and give rise to a cascade of medical problems, (Flouris et al. 2018). Certain regions of the world, experience extreme heat, and workers in these places face higher risk of heat stress, (Lucas, Epstein, and Kjellstrom 2014), and its ill effects. Because of climate change, there could be significant differences, as to how different regions are exposed to heat, in the near future, (Hyatt, Lemke, and Kjellstrom 2010). Construction workers are especially prone, to the ill effects of extreme heat, as their work also entails heavy physical exertion, (Al-Bouwarthan et al. 2019). Significant heat stress, not only affects the health, of the individual worker, but, undermines the safety, and productivity, at the workplace. Problems, can range, from mild, to most severe, and life threatening conditions,(Gauer and Meyers 2019). This, in turn, may hamper work, increase incidents, at worksite, and cause, more hospital referrals. To mitigate the risk of extreme heat at work areas, companies, need to take, various measures, to prevent, or reduce, the impact, of the hazard.

Working under extreme heat conditions

Working outdoors, under extreme heat, leads to, the body, to experience heat stress (HS). The most significant personal factors that contribute to heat stress are drinking patterns, age and work duration under the sun. Other factors include percentage of body fat, resting heart rate, air pollution index, heat indexes, chronic diseases etc, (Chan et al. 2012). The human body, can adapt, up to a certain limit, and after that, it begins, to experience, a continuum of conditions, known as Heat Related Illness(HRI), (Kovats and Hajat 2008). HRI, can be divided, into mild, moderate, and severe, (Anon n.d.). Mild symptoms, comprises of heat rash, muscle cramps, and swelling, of lower extremities. Muscle cramps occur when there is electrolyte depletion in the body. Moderate symptoms, includes, loss of consciousness (syncope), and heat exhaustion. Syncope occurs, during prolonged standing, aggravated by, vasodilatation, fluid loss, and decreased, venous return. This ultimately leads to decreased cardiac output and loss of cerebral perfusion pressure. In heat exhaustion, the person, begins to feel, fatigued or tired, accompanied by nausea and vomiting, headache and vertigo. There is no, mental signs or symptoms. Both water and electrolyte depletion, contributes to this. The most, severe form, of manifestation, is heat stroke, generally manifested when core body temperature exceeds 40 degrees centigrade. In this case, there is seizures, mental confusion, and agitation. Laboratory findings can include disseminated intravascular coagulation (DIC), rhabdomyolysis, and elevated transaminases. HRI management ranges from simple interventions to elaborate and swift measures to address the manifold risks. If, heat stroke, is left untreated, it may cause, permanent disability, or death. There are also, long term effects of heat stress. The most notable being urolithiasis. In certain areas of the world there has been manifold increase of this condition, in workers who have been exposed to the sun for several months. The incidence of skin cancer, cataracts, and endocrinal changes, will also increase, if proper precautions, are not taken, from the very beginning, of exposure.

Measuring the risk of heat stress and heat related illness.

Efforts to calculate heat stress has been ongoing for over a century, and various formulas and target parameters has been proposed to calculate heat loads, (EPSTEIN and MORAN 2006). These often combine ambient temperature, relative humidity and wind flow to create indices, to provide an objective view of the risk, (Acharya, Boggess, and Zhang 2018). Currently one of the most popular tools for risk assessment is the Wet Bulb Globe Temperature(WBGT), (Budd 2008). This generally incorporates the effects of sun and wind, along with temperature and humidity. Till date, WBGT remains one of the most sensitive indicators of heat stress, (Morris et al. 2019). Since it is the most commonly used tool at work locations worldwide, it’s important to know its limitations, (Budd 2008). Another popular index the Thermal Work Limit(TWL), (YANG and CHAN 2017), has been, implemented, in several projects, and, seems to be, very promising, in reducing the incidence of

HRI, (Brake and Bates 2002). In certain scenarios, alternative, or adjunctive heat index measurements, may be advisable. More elaborate heat indexes, (Rothfusz and Headquarters 1990), are also available, but have found limited acceptance worldwide. Needless to say, there is constant research, (Anderson, Bell, and Peng 2013), and some other formula, may gain acceptance in the near future. Another factor to keep in mind, is that with the availability of more advanced measuring instruments, automation, and computing power, it might be possible to use more complex heat index measurements at the workplace(Havenith and Fiala 2015).

Risk management

Various, engineering controls, and ancillary measures, can be implemented, to reduce, the risk of heat stress when working under extreme heat conditions. The methodology can be divided into several steps, (Ryan and Euler 2017):

1. Identifying the heat sources.

   One of the common sources is the sun itself, but in confined spaces there may be additional sources, that may generate heat.

2. Initiating a heat monitoring program.

   Environment heat, and accompanying weather conditions can be measured using the various instruments available, for monitoring outdoors. Additional hand held devices and probes can be used to measure heat generated by various construction activities, like drilling, etc.

3. Calculating heat loads.

This is, generally done, by calculating, heat indices, and other accepted formulas. The Predicted Heat Stress (PHS) model, is considered ideal for construction sites, but is limited by the expertise of the personnel, in charge of calculating heat loads, (Rowlinson and Jia 2014).

4. Implementing heat management strategies (administrative controls).

   Various administrative measures can be taken to reduce heat stress and its impact. Construction of shaded and well ventilated rest areas, provision of water and electrolytes, implementing acclimatization programs and work rest schedules, all can contribute to risk reduction.

5. Deciding on engineering controls.

   Use of heat shields, bulk air cooling, insulation, etc can be used along with administrative controls. Specific methodologies, and items used, will be limited, by available resources.

Reducing impact of Heat Stress and Heat Related Illness.

Managing the impact of heat stress and heat related illness in a construction project, subjected to extreme environmental heat:

A. Administrative measures

   1. Work acclimatization program

      All newly inducted personnel who will work in the sun for long hours, should be acclimatized using a predefined plan, (Li et al. 2016), . This has shown to increase resilience, prevent HRI, and allow for continued work.

2. A work rest schedule must also be in place for already inducted workers, (Yi and Chan 2013), (Hsie et al. 2009) . This will prevent excessive heat stress, allow workers to rehydrate with water and electrolytes, and provide necessary rest and cooling off period.
3. Work Supervisors must monitor the fluid and electrolyte intake of workers and encourage them to take frequent water and electrolyte breaks. The importance of hydration with both water and electroytes has to be emphasised. It must be understood only water replenishment, will not prevent HRI.
4. A buddy system is to be implemented, so that workers can monitor each other for early signs of heat stress and heat related illness.
5. Self monitoring for urine colour, etc. Workers should be trained as to how to estimate the level of hydration of the body, using simple techniques, so that they can take preventative actions.
6. Monthly awareness campaigns, toolbox talks and information sessions regarding heat stress, its ill effects and management. Preventative aspects of HRI needs to be stressed upon. Signage and information posters, needs to be placed at strategic locations, so that everyone is aware of the dangers of extreme environmental heat.
7. A heat alert program and flag system, is to be implemented, so that all personnel are aware, when it is too hot to work in the sun. This is generally guided by one of the accepted heat indices, or the WBGT values. Daily weather advisories, which is disseminated location wide, should be started.
8. Stakeholders, should also be, aware of the regulations, of the country, in which, the project, is going on. Some countries declare official hot season, allowed work timings and extra provisions, related to work safety, during this period.

9. Training sessions, regarding first aid, and further treatment for heat related illness. The management, can be categorised, according to, the severity, of the condition:
   A. Mild cases;
      1. Move the patient to a cool area, remove clothes, and give electrolyte water.
      2. Stretching and massaging for cramps and swelling.
      3. Rest for thirty minutes and then return to duty.
   B. Moderate cases:
      1. Lie the patient with legs elevated, and give electrolyte water.
      2. Remove the garments, and cool the body using fans, mist sprays and ice pack on the groin and axilla.
      3. Keep under observation and then return to work.
   C. Severe cases;
      1. Move the patient to an air-conditioned room.
      2. Cold water or ice water immersion for fifteen to twenty minutes.
      3. Wrap in cold towel and shift to the nearest health facility.

Certain, specialized programs, can be implemented, depending on, the severity of heat stress, and working conditions:

1. Establishing a health surveillance program, (Chirico and Magnavita 2019).
   This includes the monitoring of field workers, during their rest period, to ascertain vital parameters and any early signs of heat illness. Trained medical personnel will be required to randomly check workers at designated rest locations. This can provide the required feedback

regarding individual factors, efficacy of administrative and engineering controls, and make further risk management more tailored to site specific conditions.

2. Provision of specific resources targeted at reducing core body temperatures, rapidly, in case of any HRI incident in the field. This included but not limited to cold water mist sprays, provision for ice water immersion, phase change jackets, cold packs, body cooling units(BCU), fans, etc. The advantage of these additional resources, is that definitive management can start before the patient is shifted to specialised units, (Bouchama, Dehbi, and Chaves-Carballo 2007).

B. Engineering controls
    1. Construction of shaded rest areas, with increased airflow, and preferably air conditioning.
    2. Use of heat shields, insulation, reflective barriers.
    3. Prevent heat and steam leaks, wet floor, and high humidity in confined spaces.
    4. Providing heat stress related personal protective equipment to workers.

Conclusions

Heat stress is unavoidable in certain industrial projects. But the cost of heat related illness can be a major burden on the productivity of the workers, safety at worksite and viability of the project itself. It is imperative that stakeholders, understand the impact of environmental thermal stress, and endeavour to undertake measures based on current scientific evidence, to make the workplace more safe, and prevent any untoward incidents. A team approach and awareness of risk mitigation techniques, will go a long way in preserving the workers' health and long term viability of related industrial projects.

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