3M Transcript for the following interview: Ep 60 Managing Heat Stress - Part1

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Welcome to the 3M Science of Safety podcast presented by 3M Australia and New Zealand Personal Safety Division. This is a podcast that is curious about the signs and systems of all things work, health and safety, that keep workers safe and protect their health. I am Mark Reggers, an occupational hygienist, who likes to ask the questions Why, How, and Please Explain. Whether you are a safety professional, occupational hygienist, or someone with any level of WHS responsibility in the workplace, maybe you are a user of safety products or maybe you are a bit of a safety nerd who finds this stuff really interesting, then this is a podcast for you.

(R) Today, we're talking about managing heat stress with Dr Ross Di Corleto. Welcome, Dr Ross.

(D) Thank you, Mark.

(R) Now, we're going to do two episodes together because this is a fairly big subject. We want to make sure we cover all those key points, but can you please introduce yourself? Who are you, where are you from and maybe a little bit of your background, if that's okay?

(D) Thanks, Mark. Just a little bit on my background. I started in the industry, in the occupational and health area probably around about 1980s. I initially worked in the power industry in Victoria, in Australia, and then from there, progressed north to Queensland to the sunny climates. And there, I started working in the alumina refinery industry. From there, progressed into mining and general resources and worked there for another 20 odd years. So, all up, close to 40 years in occupational health. As mentioned, one of my primary interests is the thermal environment. It's something I've

always found fascinating. So, I did my thesis research in occupational exposures to heat in Northern Queensland, so that's where I developed that passion.

(R) Excellent stuff, so you are a great person to speak to. Now, heat stress, but I've also heard the term 'heat strain' in my travels, and I'm sure many of our listeners have as well. Is that the same thing, heat stress and heat strain? Is it a tomato-tomato situation, or are they two very different things?

(D) Actually, Mark, they're two quite different terms. Often, they are incorrectly transposed, and they use one for the other, but if you think about it, heat stress is the environment that the heat, the humidity, how hard the individual is working, what they're wearing, their clothing. Now, individually and combined, these things create a heat stress on the body. The body then reacts by creating certain responses such as sweating, increased heart rate, elevated core temperature. So, that's how the body responds to those stresses, and that's what the heat strain is. So, they're two quite different terms. So, heat stress results in heat strain.

(R) So, how does the body handle that heat strain to maintain that constant internal temperature of about 37 degrees that we're all familiar, when our mums put our thermometer in our ear or in our mouth? How does the body maintain that in those hot environments?

(D) Well, the body has got quite an interesting mechanism in the way it controls the internal temperature. So, we have what's call our thermoregulatory system and it's really quite a simple heat balance. So, the body needs to balance the heat coming in from the environment and from the work that the individual does, with the heat going out, so there has to be this net balance so the heat in equals the heat out. Now, the best way to explain it, I suppose, would be looking at the human body and car engine analogy and this is an example I often use. So, Mark, you can be my bouncing point on this one. In a car, what is a key coolant?

(R) You'd have the water, the radiators helping cool the car engine down.

(D) Yeah, so our key coolant in the car is the water, the water that circulates through the car engine. That takes the heat from the engine. What do you think would be the equivalent in the body?

(R) The blood?

(D) Very good. So, the blood and the water are our coolants and if you think about in the car, what circulates that water?

(R) The water pump?

(D) Very good. And the equivalent in the body would be?

(R) Our heart which is our pump in our body.

(D) Excellent, so we've got those two analogies there. How does the car get rid of that heat? Where does it pump the water to?

(R) The radiator sitting in the front?

(D) Very good, and what would be the equivalent in the body?

(R) I'm going to say the skin maybe?

(D) That's a very good guess. Well done. So, the skin is the human body's radiator and I won't hit you with the last one. So, in the car, to control the temperature, we have a thing, the thermostat. It maintains the temperature. In the body, at the base of the brain, we have a similar system called the hypothalamus. And that's the body's thermostat, so it's what controls. So, in the car, when the temperature goes up, the thermostat acknowledges that, pumps the water to the radiator which cools, and then pumps it back to the engine. The same thing happens in the body. The hypothalamus picks up an increase in temperature which sends a signal to the heart to increase the blood circulation to the skin. The blood vessels dilate or increase in surface area. Evaporation of sweat; we cool, and it pumps the blood back to the core of the body, which cools the body down. So, very similar systems.

(R) So, to try and summarise in my very simplistic approach of things, so the hypothalamus is monitoring whatever our body temperature is. As that temperature goes up, it says, "Hey, pump more blood to get that heat away from the body," or if it's going down, it does the opposite to try and tell you to shiver and to get your body moving. And obviously, it's that balance that we're trying to maintain to keep at 37 degrees. Would that be a simple summary of what you've described?

(D) Yeah, that would be a pretty good description. There's a lot more obviously involved, but that is a pretty good description, yes.

(R) So, when our body can't balance that heat and we can't maintain that 37 degrees, and maybe it's 39, maybe it's 40 degrees, what are some of those heat related illnesses or symptoms of these that

may be shown in the body, and how should a first aider react if they've got a worker that's responding or showing some of these symptoms?

(D) Well, it's an interesting area. I think most people, when they think about heat stress or heat illness, automatically think about cramps, collapsing, heat stroke, heat exhaustion; those sorts of things. And they obviously are the result of overexposure to heat. But the reaction actually starts much, much earlier. The initial symptoms of a heat illness are things like fatigue and lethargy. So, you know on those really hot and humid days, you just don't feel like doing anything. You just feel quite worn out and tired, they're the initial symptoms. If you continue to work or in some cases, at play, at sport, without making any adjustments, you'll tend to find that there is a decrease in performance. And things like cognitive function or being able to focus or fine motor skills, they start to deteriorate a little bit and in actual fact, there's been some very recent work done in Europe and these studies, been done by some leading researchers, and they're suggesting that for every degree centigrade above 25 degrees C in the workplace, employers are losing approximately 2% of productivity. So, if you've got a workplace operating at 35 degrees centigrade, we're talking about a loss of about 20% of their productivity. So, that's a really significant amount. So, whilst we do have the issue with the health impact, there's also quite a significant business case associated with it. If we go a little bit further with that; so, if we ignore the symptoms still, as I mentioned, we start to lose the cognitive functions and our focus, and concentration starts to deteriorate, and that's where we start to see an increase rate of mistakes and accidents. And if you look at the statistics, often you will find that safety incidents start to increase in the hotter months of the year, as this start to impact. So, it can be traced to a direct relationship as well. So, before we've even started cramping or any of those symptoms, we're already seeing some significant impacts on the individual. And obviously, if you ignore all those, so what happens then is we then start to see the traditional illnesses we normally associated with heat. And these are for example, heat cramps, heat rash also often known as prickly heat, dehydration, syncope, which is probably more commonly known as the fainting, heat exhaustion and ultimately heat stroke and fatalities, which obviously, the final point.

(R) So, for a workplace, so we're thinking about hot environments, what are other risk factors that go into maybe doing an assessment of a hot environment that workplaces should be aware of, to factor in, other than just it's hot and our guys are sweating a lot?

(D) Well, you need to really start to look also at the individual because there's considerable variations between people in the workplace. We're not all the same. So, things like general physical fitness, their

age, their dehydration state at the start of the shift or during the shift. Have they been consuming alcohol? Even the night before it can have a significant impact. What drugs are they taking? These could be not just the illicit drugs, but also prescribed medication. Are they acclimatised? Sometimes we see people coming up from the southern states into the northern states, trying to deal with the heat and the acclimatisation is quite important there. How hard are they working? Are they walking around with a clipboard ticking sheets, or are they swinging a pickaxe? Now, that generates a lot of heat. Environment obviously, and is PPE worn? Are they wearing a lot of PPE or are they wearing a hazmat suit for example, which significantly alters the risk associated with heat?

(R) Talking about some of those illnesses, about fainting and prickly rash, is it only short-term issues with heat? Obviously, they have an event or something, a heat-related illness on that day, or are there longer-term issues that we should be aware of with heat exposure as well?

(D) The key focus generally has been the acute illnesses, as you've just mentioned, but more and more as the research continues, we're seeing a lot of long-term effects, or what we call chronic heat illness. They're not as well understood, but we're starting to see things such an increase in hospital admissions for kidney complaints for example, kidney stones, impact on the liver, the heart, the digestive system, skin conditions, central nervous system, and the key one is the reproductive process, particular with pregnant ladies in their first trimester can be a very important factor.

(R) So, I think most people, whether in the health and safety game or not, understand that water and maintaining fluid intake is fairly important. So, how much fluid should a worker be taking in on a day? Should that be specified by a workplace?

(D) I tell you what, if I had a dollar for every time this question was asked, I'd be quite wealthy. It's a very complicated issue there. I thought about including hydration in the control section, in some of my early presentations when I spoke to groups. But the more I thought about it, the more I believed that this is not just a control; it's a must-have. It's really a no-brainer. With any workplace where there is a risk for heat exposures, you need to have in place some kind of a policy or process that allows the individual to rehydrate and to drink fluid as required. But there really isn't a set rule. It varies so much depending on the exposure of the individual, acclimatisation, the illness, how hard they're working. As these things vary, so does the fluid requirement. So, fluid replacement should try to approximate the sweat and urine losses. In athletes, for example, they try to ensure a dehydration level that's around about 2% of the bodyweight, and this generally requires about 200 to 300 mls every 10 to 20 minutes,

again, depending on the factors already mentioned. So, if you needed a rule of thumb, that would probably be the way to go; 200 to 300 mls every 10 to 20 minutes, but again, that will vary with the individual and the amount of sweat and work they're undertaking.

(R) As you say, it's that balance at the initial part, what's going out to then make sure it's being topped up by what's coming in as well. If you've got more going out than what's coming in, that's when you're going to start to see more of those issues.

(D) Exactly, and the body can only absorb a certain amount, so the body normally absorbs around about 1,200 mls an hour, so if you're putting out more than that, and some of the heavy labourer, that's done in the heat, will end up with a result of losses greater than that, then you will start to dehydrate.

(R) Often, you'll hear, recommendations about drinking electrolytes, and that's one of those common recommendations. What is that actually doing to the situation, having electrolytes in fluids?

(D) Well, when we sweat, we don't just lose fluids. If you think of days when you sweat quite a bit, and you will see a white deposit on the skin or on your shirt, they're actually the salts that we are losing as well as the fluid. So, those salts are also known as electrolytes, and they're important for the body's ability to move fluids in and out of our cells. So, when we lose excessive sweat, these electrolytes also need to be replaced along with the water. Now, at the moment, there are a variety of electrolyte products available on the market that can be used, so I won't specify any particular types, but one thing I would say is that they should be used in conjunction with plain water to maintain the correct balance in the high fluid loss scenario, so drink water and also you can drink electrolytes as well.

(R) So, we've established hydration as very important. When should workplaces consider doing hydration testing for their workers, because you mentioned before about turning up to work already dehydrated? How should workplaces approach that side of things and knowing what the hydration levels are and when?

(D) The approach to measuring hydration is actually quite a useful training tool. It can be used to help inform the workers of what their hydration statuses are. And often, the individuals don't know themselves that they're dehydrated at the start of the day. So, it's not unusual to see workers starting their shift already massively dehydrated from the previous day or night and they get worse each shift. Once you get behind, it's very difficult to catch up. So, it's a great education tool, to help the awareness of dehydration among workers and also it helps them to manage their intake.

(R) If they're turning up to the job behind the eight ball, they may never catch up during the course of the day, so as a workplace, you want to be aware if that is your situation, and to do something about it.

(D) Exactly and as I said, most of the tests are quite simple; specific gravity urine testing or just the old colour test. These things can help the individual identify that they are starting to dehydrate, or they're already dehydrated.

(R) What does legislation say about heat stress in the workplace? And we've got different states and territories in Australia, but generally, what obligations do workplaces need to meet? Are they quite specific?

(D) This probably varies on the jurisdiction. Some regulations tend to be very specific, and they give temperature limits such as in mining. They have very specific temperatures that they work to. But generally, you'll find the regulators try to steer away from being prescriptive, and that's for a good reason. It's normally very general, i.e., they say, "Workers exposed to extremes of heat or cold at the workplace are able to carry out work without risk to health and safety." Now, those general motherhood statements will manage the health and safety risk, and that is because, as we spoke about earlier, you've got a lot of variation. So, you've got three key areas of variation. You have variation in the environment, as we talked about before and the temperatures and humidity and the like. You have variation in the individual and then you have variation in the task, or the job being carried out. So, to try and pinpoint a specific temperature or whatever can be quite difficult.

(R) So, how then does a workplace go about actually risk assessing these situations and prioritising them so they can meet their obligations of managing health and safety risks?

(D) So, my preferred method is the three-stage approach, which is explained in the Australian Institute of Occupational Hygienist Guide for Managing Heat Stress. Level one is the basic thermal risk assessment. It is quite easy to use. It is based on a series of questions that the individual can check off. There is no technical requirements. It's available as a checklist. These days, it's even available as a phone app that an individual can do the assessment on sites. So, very simple, very straightforward and it provides some guidance and some control recommendations. If, after using that basic thermal risk assessment, the outcome is that you have a potential heat stress risk, then you move forward onto level two, which this is an assessment protocol that is what we call quantitative, so it requires some measurement. And this is a little bit more, slightly more complex, and we use what's known as rational indices. Now, a heat stress index is basically an equation or series of equations that when you input

the data into it, it mimics the body's response to the heat. In these level two indices, they're quite complex but again, readily available in phone apps and computer programs. They can be used on site and they take the measurements such as air temperature, globe temperature, humidity, air velocity and some other key components such as clothing and metabolic workload and come out with an estimated response or heat strain of the body. If after the level two assessment, we find we have a significant or a high risk, we would then move to level three, which is physiological monitoring. Now, this involves actually measuring the body's response to the environment, and these days, it can be done with a number of instruments, the most popular being the swallowing of a thermal transmitter which the individual would swallow, and it transmits a signal of the core temperature and the heartrate to a receiver, or there are some other types that you'll see. Often in athletes, you'll see them wearing a chest strap when they're doing the triathlons, which measures their heartrate, so you can have external measurements as well. So, there are a number of different ways of doing it. The actual interpretation of the data, though, requires some expertise, so it's not quite that straightforward.

(R) So, you said 'swallowing' there. I imagine that passes through the system. We're talking ingestion here?

(D) Yes, that's correct. So, the small pill is swallowed, and it passes right through the system. It's not recyclable. It disappears and it's a very accurate way of measuring the internal body core temperature and heart rate.

(R) So, while that pill is in the body, it's transmitting via Bluetooth or some wireless technology to outside the body, or do you pass it through and then you plug it into a computer to get the results? How does that work, because I didn't know this type of stuff exists, but it is obviously a very valuable tool when required?

(D) Yeah. Well, it is similar to a Bluetooth system. It sends to a receiver. Now, the receiver is normally worn on the belt or it can be worn on a harness on the body. And that signal goes directly to that receiver and that can be downloaded into a computer. Some of the more modern technology will actually send that signal through to a mobile phone and you can be monitored using the mobile phone.

(R) So, level one, we're talking qualitative, so we've got a fairly simple tool, looking at the work rate and environment and shade areas. Then we get to level two, that you mentioned. Is level two just measuring the temperature, or what other things are being measured because I'd imagine there's more things to do that more detailed assessment?

(D) Yeah, you're correct there. There is quite a bit more involved in there. It depends on the method used. In the early days, they looked only straight at the temperature. Some of them looked at the temperature and the humidity and these are what we would call the empirical indices. The more modern types are the rational indices, so if you were to look at some of the ones that you may hear being used, there's obviously WBGT, wet bulb globe temperature. This is probably the most popular and has been used since the '50s. So, this was used by the military as they were having some issues in their training, in the warmer climates. So, it was developed to help them manage that process. It's actually still quite a valuable index, but it's really best used as a first level assessment tool, and this is recommended by the ACGIH, and it gives you a very good indication of the heat risk. It's one of what we call the empirical or direct indices. If you look at something like the mining industry, the mining industry use basic effective temperature or the BET, and again, quite a simple, first level index developed in the early 20th century, very popular in underground mining, but it has limitations once you start to get up into the high temperatures. The more modern indices, the thermal work limit, which a number of Australians would be familiar with, and the ISO Standard, Predicted Heat Strain, these are more complex. They're what we call second level rational indices and they use quite a number of parameters in the heat balance equation. So, they use air temperature, air velocity, humidity, the globe temperature which gives you an indication for calculation of the radiant heat, the metabolic workload, the clothing they're wearing, the posture that they're working under and whether they're acclimatised, so all these factors are included in the series of equations. So, it can be quite complex, but as I mentioned earlier, with modern applications on phones and on laptops, it's not a big issue these days to calculate these things.

(R) With these level two assessments and these different indices, is it just a process of just determining how long a worker can work in a hot area? That's the objective of these things?

(D) No, it's not quite that simple. It's more than that. Unfortunately, I think in the past, that's how the processes have been used to determine what we called work-rest regimes; how long can I work before I stop and have a break. But these newer indices are far more flexible than that. So, when used correctly, the rational indices can be used to determine what is the key source of the heat issue and from there, potentially, the best engineering control to use. We'll actually cover a bit more of that in the next podcast on controls. So, stay tuned on that one. I can get a bit more involved in that.

(R) Nice plug there, Ross. So, with this level three assessment, we spoke about the pill being swallowed, but do you have examples of the type of work environments where that type of assessment is being used?

(D) It's probably more commonly used in the more aggressive high temperature areas, or when you're wearing high levels of PPE, so guys wearing hazmat suits for example. Now, when they're wearing these suits, they're actually creating their own microclimate for the wearer. So, measuring the external environment is not really representing what the individual is being exposed to inside that hazmat suit. So, we use the physiological monitoring to see what the direct impact is on the individual. And the two key parameters that we usually measure are core temperature and heartrate. The thing is, once you get into this area, you're going to need some specialist advice for interpretation. It's not quite as simple as it appears.

(R) And who would be the type of people that would be able that specialist advice?

(D) I think obviously you could talk to an occupational hygienist. The other people you could talk to; occupational physicians. And another group that people are not as well aware of are thermal physiologists. These are individuals that work specifically in the heat area. And if you're not sure, the Australian Institute of Occupational Hygienists list the consultants. If you go onto their website, you can actually track down people with expertise in this area.

(R) If you had to sum up the chat that we've had this morning about heat stress and heat strain and the assessment of these working environments, what would be a couple of key takeaway points you think would be great to summarise our chat.

(D) I think one of the most important ones is that it's not just about exposure to heat. It's about exposure to a number of variables. It's the heat, the humidity, the workload, the variation of the individual and variation of the task. So, it's not a simple, straightforward, "Give me a temperature." That's a key one. The other aspect too is to bear in mind that a lot of the impact of heat happens much earlier than when we start to see the clinical symptoms of cramps and exhaustion. We need to catch it a lot earlier than that stage. Once it reaches the heat illness stage, we have left it too long. The other aspect is don't forget about the business case. We always know it's important to look after the health of our workers and sportsmen and the like, but there is also a significant impact on productivity and it can be quite a significant business case. To protect the health of your worker is also protecting your business.

(R) This is a very big subject and we really have touched on a couple of these higher-level concepts. But for those that, at this point in time, would like to do a bit of research or reading before our next episode, where would be a couple of good places they could head?

(D) Some of the obvious ones are places like Safe Work Australia or WorkSafe New Zealand. As I've mentioned earlier, the Australian Institute of Occupational Hygienists have a guidance document that you can access, and I think the regulators in each of the states all have websites that you can access for information.

(R) So, for those people, Ross, that would like to get in contact with you to maybe discuss some specific situations in their workplace, what would be the best way to get in contact with yourself?

(D) I suppose the best way would be either via our website at www.monitorcs.com.au and that will give you a direct link through to our email and we'll be able to help you out.

(R) Excellent. Well, thank you so much for your time today, Ross. Yeah, looking forward to speaking with you in the episode about controls.

(D) Thank you, Mark. It's been a pleasure.

(R) Well, thanks for listening, everyone. You can get in contact with the show by sending an email to scienceofsafetyanz@mmm.com. If you have any questions, topic suggestions or would like some assistance in your workplace, 3M are certainly here to help. You can also visit our website, 3m.com.au/sospodcast for further resources on heat stress in the workplace and it will have a transcript of what we've spoken about today, as well as links to some of those resources that Ross did mention. Be sure to subscribe and share through Apple Podcasts, Spotify, Google Podcasts or wherever you get this podcast from and as Henry Ford said, "Whether you think you can or think you can't, you are right." Thanks for listening and have a safe day.