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Return to Activity Considerations in a Football Player Predisposed to Exertional Heat Illness: A Case Study

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Context: Heat illness is the third leading cause of death in athletics and a leading cause of morbidity and mortality in exercising athletes. Once faced with a case of heat related illness, severe or mild, the health care professional is often faced with the question of when to reactivate the athlete for competitive sport. Resuming activity without modifying risk factors could lead to recurrence of heat related illness of similar or greater severity. Also, having had heat illness in and of itself may be a risk factor for future heat related illness. The decision to return the athlete and the process of risk reduction is complex and requires input from all of the components of the team. Involving the entire sports medicine team often allows for the safest, most successful return to play strategy. Care must be taken once the athlete does begin to return to activity to allow for re-acclimatization to exercise in the heat prior to resumption particularly following a long convalescent period after more severe heat related illness. ***Keywords***: heat stroke, heat illness, heat cramps, heat exhaustion, athletics sports medicine, football

As the third leading cause of death in U.S. high school athletes,[1] exertional heat stroke is a significant concern for all individuals exercising in the heat.[2,3] Recent deaths of collegiate, high school, youth, and professional athletes have the sports medicine community in a state of "high alert," searching for the most efficacious methods of preventing these tragedies in athletes of all ages. The ever-increasing competitiveness of sport at youth and high school levels coupled with the unique physiology of children has also raised the level of concern regarding heat illness in the pediatric medical community.[4]

Of the five major forms of heat illness, only heat stroke is typically a medical emergency.[5,6] Risk factor awareness, early recognition, and effective treatment of the milder forms of heat illness (ie, heat cramps and heat exhaustion) may contribute to the prevention of exertional heat stroke and associated fatalities.[6-11]

Once faced with a case of heat related illness, severe or mild, the health care professional is often faced with the question of when to reactivate the athlete for competitive sport. Several works have explored the return to activity of athletes following exertional heat illness.[12-17] Clearly, there are numerous risk factors that

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must be attended to when returning athletes with a prior history of heat illness to previous activity levels. The risk factors, delineated more completely within our discussion section, may all have predisposed the athlete to one case of heat related illness.[9,11,15,16,18,19] Resuming activity without modifying these risk factors could lead to recurrence of heat related illness of similar or greater severity.[15,16,20-22] Also, having had heat illness in and of itself may be a risk factor for future heat related illness.[12,14,17]

A case of heat stroke results, in some cases, in a defined period of varying length of reduced heat tolerance.[9,12,14,16,17] Placing the athlete back in a hot, humid environment under exertional heat stress may significantly increase that athlete's risk of severe heat related illness.

Case

SC was a 20-year-old black male sophomore Division I football athlete (linebacker) with a history of recurrent heat cramps following exertion. The athlete had been identified as a "high risk" athlete for exertional heat cramps through the previous season of play due to frequent episodes of heat related cramping when exercising intensely under hot humid conditions. Heat tolerance testing during the off season (six months prior to the event outlined in this case) in our heat lab had allowed us to monitor the player's response to similar exertion in a controlled hot, humid climate to a point of heat cramps without demonstrating an inordinate core temperature response or heat intolerance.[17]

Despite extensive assessment of diet and hydration practices over the previous year of participation with daily weigh-ins, a food diary, urine color assessments, uniform changes, sodium supplementation, and nutrition consultation, the athlete continued to cramp often and in the early stage of practice during exertion in the heat and humidity.

On the first day of full contact practice during routine two-a-day drills, the athlete experienced an episode of heat exhaustion and heat cramps. During the afternoon practice, the player noted a gradual onset of fatigue and lower extremity cramps at approximately 90 minutes into practice with progression to significant fatigue, limiting further participation, slight dizziness, and intractable lower extremity cramps by two hours into practice. Protective gear was full pads, with 50% relative humidity and a wet bulb temperature of 82°F, dry bulb temp of 97°F (heat index = 110.2) at the start of practice, and 61% humidity with a dry bulb of 90°F and wet bulb temperature of 79°F (heat index = 100.2) at the conclusion of practice (Sling psychrometer, Bacharach, Inc., Pittsburgh, PA, 12-7022, accuracy to ± 5% relative humidity).

The player was removed from play, mental status remained normal, oral temperature was 98.6°F, and the player initially failed to respond to 500 cc of oral fluids with supplemental electrolytes as well as local ice rub (compressed 750 cc ice bags, gently suctioned for minimal insulating air) to the low back, bilateral quadriceps regions, and bilateral biceps regions. The oral temperature was clearly falsely depressed, and had there been concern for exertional heat stroke with mental status changes, rectal temperature would have been critical. Overall, in exercising athletes in particular, oral temperature is a poor predictor of true core temperature, and if significant concern exists for exertional heat stroke, rectal temperature should

be assessed. He then responded to 2L of IV 0.9% NaCl (normal saline) to the right antecubital fossa and ice bag massage of the tetanically contracting muscles in the quadriceps, abdominal, and lower back musculature. Cessation of cramping was noted within 15 minutes of starting intravenous fluids with improved dizziness and resolving fatigue.

Laboratory analysis was ordered the following day due to the more severe episode than typical and the recurrent nature of his cramping, represented in Table 1. The majority of the laboratory abnormalities exhibited in Table 1 (decreased glucose, elevated calcium, and decreased thyroid stimulating hormone) are likely a result of fluid and electrolyte shifts related to dehydration and rehydration and normalized in follow-up labs (Table 2). The significant elevation in the Creatine Kinase is likely related to the extensive muscle trauma involved in minutes of severe

Table 1 Laboratory Analysis (Abnormal Labs Bolded)

Test	Value	Normal
Sickle Cell	Negative	negative
Glucose	**61**	65 to 99 mg/dl
Sodium	140	135 to 146 mmol/l
Potassium	4.6	3.5 to 5.3 mmol/l
Chloride	103	3.5 to 5.3 mmol/l
Calcium	**10.5**	8.5 to 10.4 mmol/l
Creatinine	**1.5**	0.5 to 1.4 mg/dl
Creatinine Kinase	**2327**	0 to 200 u/l
Thyroid stimulating hormone	**.57**	.7-6.4 mIu/l
Urine specific gravity	1.016	1.001 to 1.035
Urine pH	6.0	5.0 to 8.0
Hematocrit	42.4	38.5% to 50%

Table 2 Immediate Post Practice Follow Up Labs, One Month Later (Abnormal Labs in Bold)

Test	Value	Normal
Aldolase	**8.3**	0-5.1 IU/l
Glucose	76	65-99 mg/dl
Sodium	139	135-146 mmol/l
Potassium	4.2	3.5-5.3 mmol/l
Chloride	100	3.5-5.3 mmol/l
Calcium	10.2	8.5-10.4 mmol/l
Creatinine	**1.5**	0.5-1.4 mg/dl
Creatinine Kinase	**528**	0-200 u/l
Thyroid stimulating hormone	1.29	.7-6.4 mIu/l

generalized muscle spasm as well as repetitive minor muscular trauma related to football participation.

The player was held from participation from the following practice and resumed limited participation the following day in the afternoon. He was carefully monitored during this practice by clinical evaluation, ambulatory gastrointestinal temperature (TGI) monitoring (via ingestible heat thermistors; HQ Inc., Palmetto, Fl), and a completed heat illness symptom index (HISI; Figure 2) post each practice.[23,24] The athlete's TGI ranged from 96.8°F to 100.6°F during practice. Peak TGI was 100.6°F, forty-five minutes into practice, and was 97.6°F at final cool down at the conclusion of practice, with frequent water and rest breaks. The player remained completely asymptomatic. His rating of perceived exertion during the practice of first return to sport was an 8 out of a possible 10 for intensity of exertion and he noted no symptoms on the Heat Illness Symptom Index (Figure 1).[23] The player had mild cases of heat cramps intermittently through the rest of "two a days," but had no further episodes of heat exhaustion. TGI ranged from a minimum of 96.8°F to a maximum of 101.3°F through the following five days of "two a days" without signs or symptoms of heat exhaustion or heat stroke.

Repeat labs, taken a month later immediately after a strenuous practice, are reported in Table 2. This post exertional laboratory assessment was done in order to exclude mild forms of myositis or muscle damage that might be seen immediately post exercise, indicative of an underlying genetic disorder of muscle metabolism such as McCardles disease, and might only be abnormal following exertion. The mild abnormalities in glucose, thyroid stimulating hormone, and calcium had normalized, likely due to the decrease in physiological stress, acclimatization to the activity level, and more adequate fluid and electrolyte replacement. The Creatine Kinase values had come down significantly, likely related to the previous significant muscle trauma from the generalized muscle cramping, but still were above normal on follow-up, likely related to the persistent intermittent muscle strain and trauma inherent to the sport of football. The elevated aldolase is also likely attributable to this recurrent microtrauma.

In this particular case, and in many cases of mild/moderate heat related illness, knowledge of a player's particular gastrointestinal temperature (TGI) response to exertion as well as close clinical monitoring in our extremely hot, humid climate has been instrumental in allowing our athletes to safely return to exercise soon after heat related pathology while closely monitoring their thermoregulatory response to such heat stress.[25-28] Careful attention to player symptoms, hydration practices, weight changes, sleep habits, medication use, risk factor modification, TGI monitoring, and possible heat tolerance testing will best allow a safe and effective return to play.[9,12,14,16-18,20,23,29,30]

Global Return-to-Play Recommendations

So how does one approach the return of a competitive athlete to participation in the heat? The return must be administered with significant investigative analysis of predisposing risk factors, consideration of laboratory and heat tolerance testing, a graded return, and close monitoring upon resumption.[9-15,17,21,30-32] Return must be initially very limited, following effective treatment and clearance, and accompanied by close daily supervision by the individuals' athletic training staff

Heat Illness Symptom Index

Name: _____

Date: _____ Practice Session: AM or PM

During the practice, you just finished, please indicate the greatest severity of the following symptoms or sensations.

Symptom or Sensation	None	Mild, did not interfere with practice	Moderate, slowed my practice down	Significant enough to take a break	Severe enough to stop practice
Tired					
Stomach Cramps					
Muscle Cramps					
Nausea					
Dizziness					
Thirst					
Goosebumps					
Vomiting					
Confusion					
Muscle Weakness					
Heat Sensation on Head or Neck					
Chills					
Irritable					
Lightheaded					

Did you stop sweating during the practice? Yes No

How hard did you work out today?

0	1	2	3	4	5	6	7	8	9	10
Minimal			Mild		Average		Very Hard			Hardest ever

Figure 1 — HISI—Heat Illness Symptom Index.

Name: Joe Bull **Date:** 8/20/06 **Sport:** Football **Age:** 19

Week of: *8/21/06*	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
Symptoms							
Headache	X	X	-				
Fatigue	X	X	-				
Nausea	X	-	-				
Confusion	X	-	-				
Dry mouth	X	-	-				
Dry skin	X	-	-				
Dizziness	X	-	-				
Visual	-	-	-				
Tachycardia	X	-	-				
Thirst	X	-	-				
Muscle Cramping	X	-	-				
Irritability	-	-	-				
	X	-	-				
Respirations							
Dysphagia	-	-	-				
Weight loss	221 = -7	224 = -4	228 = 0				
core temp.	101.5	99.0	98.6				
Sleep changes	-	-	-				
urination	-	-	-				
Initials of assessor	*JGK*	*JGK*	*JGK*				

Place an "X" in the box to represent the presence of a symptom.

Place a "-" in the box to represent the absence of a symptom.

Figure 2 — Sample checklist to assess return to play following heat illness.

and physician.[13,15,16,20,29] Continual reassessment as progress is made is important to evaluate any residual heat intolerance.[12,17] Though there is no uniformed or standard return-to-play criteria following heat illness, a documented, daily objective assessment can serve as an overview of one's progress toward a safe return (Figure 2).

Return to Play in Heat Exhaustion

One of the more severe forms of exertional heat related illness, heat exhaustion, typically warrants more concern and care when evaluating the athletic return to play compared to simple heat cramps or even heat syncope.[1,3,7,19,20] An extensive review of return to play in heat exhaustion is provided elsewhere in this special issue. Some relevant issues unique to this case in return to play are worthy of discussion. In the above case, a careful assessment of risk factors, with modification of those factors amenable to change was critical.[15,30] Particular attention to fluid practices, conditioning, acclimatization, and careful monitoring of return will often lead to a successful return to play.[11,18,33,34] In this case, particularly due to the more severe and recurrent nature of the muscle cramps, a more extensive evaluation was warranted. Laboratory analysis and heat tolerance testing will occasionally unveil an underlying heat intolerance due to organic disease.[17] In these cases a more careful return with graded resumption of activity under hydration monitoring, symptom monitoring, and, if available, T_{GI} monitoring will help assure a safe return.[12,14,16,17,22]

Risk Factor Modification

Extensive discussion of risk factor modification in heat related illness is outside the scope of this work; however, significant factors exist that may elevate a particular athlete's individual risk for heat exhaustion with exertion under heat stress, and these must be accounted for and minimized.[9,13,15,19,20,30.31,35] In this case, the athlete was already well acclimatized due to extensive off-season work in the Florida heat and was not on medications that would normally increase his risk of heat exhaustion. He did have a diet fairly low in sodium, which was adjusted, and his tendency to wear cotton shirts under his shoulder pads was corrected as well. For further review of risk factor modification, please see relevant discussion in other manuscripts in this issue.

Symptom Monitoring

Numerous questionnaires have been developed in the research environment for querying those exerting themselves under significant heat stress regarding symptoms suggestive of heat related illness.[23,36] In an attempt to customize input to exercising football athletes, the authors have also developed and validated a novel symptom based questionnaire, the Heat Illness Symptom Index, or HISI (Figure 1) that has proven useful in large population symptom monitoring (ie, football teams in August) for those that may be developing cumulative heat strain.[23] The questionnaire was particularly useful in monitoring this athlete's symptoms from

one practice to the next in assessing his risk of further heat exhaustion. None of these tools should be independently applied as a stand-alone tool for symptom based monitoring. They are, however, useful in adding additional data to the sports medicine team's attempt to monitor athletes for trouble. Typically, as the visual analogue type scores increase, cumulative heat stress is increasing.[23,24,36] Correlation of these rising values with elevated core temperatures, indicators of dehydration, and clinical evaluation can often provide additional safety to those returning to play after heat related illness.[23,36]

Hydration Monitoring

Perhaps one of the more critical components of return to play as well as general prevention of exertional heat exhaustion is the regular assessment of hydration status.[8,10,13,15,20,21,23,29,30,37-40] Daily pre and post practice weigh-ins with attention to replacement of losses prior to the next practice can add an additional degree of safety to the athlete exercising in the heat. Locker room hydration reminders as well as urine color charts are a simple tool that can educate as well as remind athletes to remain hydrated.[10,15,20,30,41] It is important, however, to have someone from the medical staff physically observe and record weigh-ins and urine samples so that self-reported athlete bias can be removed from the decision-making process. Urine specific gravity and osmolality can add an additional hydration assessment tool if available.[26]

Laboratory Analysis

In this particular case, laboratory analysis was performed due to recurrent severe heat related cramps. Typically, after 2 to 3 episodes of severe generalized muscle cramps, particularly those that don't respond to risk factor modification, basic laboratory analysis of electrolyte status, evidence of muscle injury, renal function assessment, and blood count assessment should be performed. Some medical conditions increase the risk of exertional heat related illness. For example, endocrine disorders such as hyperthyroidism, hypothyroidism, diabetes, and pheochromocytoma can in and of themselves present with side effects that either mimic or actually produce those related to exertional heat illness risk factors.[5,9,20,29,42] Furthermore, adrenal disorders as well as febrile illness, electrolyte abnormalities, renal disorders, and rhabdomyolysis are important to rule out in an athlete with recurrent heat related illness for similar reasons. Evaluation of these athletes by a sports medicine physician with experience in evaluating athletes with heat related illness may be critical in preventing more severe heat illness in the future.[17,30]

Simple laboratory analysis with a complete blood count, comprehensive metabolic panel, creatine phosphokinase, and thyroid stimulating hormone level will pick up many with an underlying medical condition. More extensive testing with sweat sodium analysis is often unavailable but may be very useful in assessing an athlete with recurrent disease as it may guide rehydration and electrolyte replacement practices. With results that are found to be within normal and acceptable ranges, the need for further laboratory testing is typically minimal.

Ambulatory Gastrointestinal Temperature (T_{GI}) Monitoring

One of the more significant developments recently has been the widespread availability of ambulatory T_{GI} monitoring, either through rectal probe, or more conveniently in team sports, the ingestible heat thermistor (HQ Inc., Palmetto Fl). Such devices have allowed minimally invasive monitoring of T_{GI} in exercising athletes without interfering with sports performance.[24, 25, 27,28] A simple vitamin-sized pill swallowed at least two hours prior to practice can then be monitored either continuously or intermittently through practice to evaluate a close approximation of core temperature. Such monitoring capability has been particularly useful in monitoring players returning after heat related illness for dangerous core temperature elevations suggestive of recurrent disease. The process of assessing one's T_{GI} using the ingestible heat thermistors is rather simple and can be performed by any member of the sports medicine staff with minimal training.

Currently, the cost of utilizing ingestible heat thermistors may serve as a deterrent to some organizations. The data recorder that interrogates the pill is approximately $2500, while the individual nonreusable pills are sold at a price of $40 each. Since the effectiveness of this technique has thus far been proven to be medically efficient, one should consider its implementation with high risk individuals operating in high risk environments despite the cost.

Acclimatization

Once the decision is made to allow an athlete to return to activity in the heat, particularly if there has been a significant hiatus in exercise in the heat, a graded return should be initiated that allows time for reacclimatization to exercise in the heat.[12,43] A minimum of 7 to 10 days of gradually increasing exercise in the hot environment is critical in risk reduction during return to activity. In the absence of sophisticated assessment tools, such as the ingestible heat thermistors, one should objectively monitor the myriad of symptoms that alert a medical staff to potential risk of heat illness.[13,29] Use of a symptom scale such as that in Figure 1, as well as a data organizer such as the chart demonstrated in Figure 2, can serve as additional safety tools.[23]

Conclusion

The return of an athlete post exertional heat illness is a common situation facing the sports medicine team. The decision to return the athlete and the process of risk reduction is complex and requires input from all of the components of the team. Involving the athletic trainer, the team physician, the strength and conditioning staff, exercise physiology, registered dietician, coaches, the athlete and their family, and administrative staff often allows for the safest, most successful return to play strategy. Care must be taken once the athlete does begin to return to activity to allow for reacclimatization to exercise in the heat prior to resumption particularly after a long convalescent period following more severe heat related illness.

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