Heat sensitivity and exercise for people with MS

1. Andrea T White

1. University of Utah, Salt Lake City, UT, USA

- Andrea T. White, Research Associate Professor, University of Utah, 250 S. 1850 E, Rm 241, Salt Lake City, UT 84112, USA. Email: andrea.white@health.utah.edu

Thermal sensitivity in multiple sclerosis (MS) has been reported as early as 1824 by Charles Prosper Ollivier d'Angers, who observed that a hot bath induced leg numbness and reduced feeling and dexterity in the hands of a patient with MS.[1] However, Wilhelm Uhthoff's 1890 report, in which exercise-induced amblyopia was observed in four patients with MS, is often cited as the earliest observation of heating reactions in MS, referred to as "Uhthoff's symptom."[2] Since then, heating reactions in MS have been reported in dozens of studies [for a review, see Guthrie and Nelson[3]]. Further, work in the mid-20th century demonstrated that MS symptom exacerbation was proportional to the degree of temperature elevation, with initial neurological signs appearing after 8 minutes of heating, when body temperature increased by 0.8°C, and maximal signs appearing at temperatures 1.7°C above normal.[4] Symptoms resolved an average of 15 minutes after heating ended.[4]

In this issue of the *Multiple Sclerosis Journal*, a paper by Skjerbaek et al. demonstrates that heat-related symptom increases in MS are significantly greater following 30 minutes of endurance exercise (EE) compared to a 30-minute session of resistance exercise (RE), results that are consistent with the above-cited work. The purpose of this editorial is to underscore the idea that the inherent difference in EE and RE with respect to heat stress is metabolic heat production, and the selection of one exercise mode over another should be based on fitness and/or rehabilitation goals.

Heat accumulation is quantifiable through use of a simple heat balance equation:[5]

$$M \pm R \pm C - E = 0$$

In which M = metabolic heat production, R = radiant heat exchange, C = convective heat exchange, and E = evaporative heat loss. Obviously, environmental factors play a major role in heat accumulation and dissipation, influencing R, C, and E, and a large body of research has been devoted to quantification of these factors in order to optimize physical performance in a variety of environmental conditions. Additionally, evaporative heat loss is dependent on environmental and intrinsic factors such as fitness level, hydration status, and autonomic function. These intrinsic factors have been investigated in MS, and it is evident that, in at least a portion of MS patients, heat dissipation mechanisms may not function optimally.[6] Nevertheless, the factor that is most easily manipulated in the heat balance equation is metabolic heat production.

The magnitude of heat production is a function of metabolic work and is directly proportional to oxygen uptake. One liter of oxygen consumed corresponds to ~20 kJ or 4.8 kcal. If direct measurement of oxygen consumption is not available, it is possible to estimate the metabolic cost of exercise or other activities using the Compendium of Physical Activities, which provides metabolic equivalents (METS) of a wide range of activities.[7] One MET is equivalent to 1 kcal/kg/hr. To demonstrate the utility of this tool, we can estimate the metabolic cost of the activities used in

Skjerbaek's study: EE (cycling exercise at 60% VO_{2max}) and RE (two sets of six exercises at 12 RM, plus a warm-up set). The EE intensity corresponds to six to eight METS (average seven METS) and when performed for 30 minutes totals 246 kcal (for a 150-pound person). For RE, if we estimate that the concentric and eccentric movement of each weight-lifting task takes 2 seconds (4 seconds total for each repetition), the total work time is approximately 15 minutes (three sets of six exercises each performed 12 times). The RE intensity is 5.5 METS, resulting in a total energy expenditure of approximately 96 kcal. Interestingly, these numbers correspond well with Skjerbaek's results, with EE producing an approximate three-fold greater increase in core temperature, symptom number, and symptom intensity, illustrating that the primary difference in exercise modes was heat production.

The question that remains is, What do we do with this information? People with MS make activity choices based on the demands of their occupation, their daily obligations to family and home, and recreational preferences. Rehabilitation specialists utilize strategies to improve or maintain important physical functions based on individual characteristics, including functional consequences of MS and other health or wellness goals. While it is important to be cognizant of factors that may produce core temperature increases, such as environmental factors and metabolic characteristics of physical activities, it is critical that MS patients be encouraged to physically participate in activities that would maximize functional benefits. This means that they will be faced with situations that could increase body temperature and produce heat reactions.

MS patients and rehabilitation professionals should be aware of countermeasures to improve function during thermal stress, many of which involve manipulation of environmental factors. These countermeasures are reviewed by Davis et al.[8] Briefly, strategies include precooling, microclimate cooling, and potential pharmacologic treatment.[8] In addition, exercise may be performed during cooler times of day or in controlled environments, such as air-conditioned health clubs. Because water dissipates heat ~25 times faster than air, water exercise is a viable option for heat-sensitive MS patients, provided the water temperature is not too warm. It is also important that people with MS be aware that symptom exacerbation during heat stress resolves when body temperature returns to normal, and the process can be accelerated with post-exercise cooling techniques like cool baths, showers, or application of cold packs or water mist to enhance radiant, convective, and evaporative heat loss.