The BASES Expert Statement on Athletic Recovery Strategies

Produced on behalf of the British Association of Sport and Exercise Sciences by Prof Glyn Howatson FBASES, Dr Jonathan Leeder and Dr Ken van Someren FBASES.

Introduction and background

Recovery is an established tenet of medicine to maintain physiological homeostasis that dates to Hippocrates (c.460 BC) and is based on the premise that rest is central to healing. The pursuit of gains in athletic performance has led to an interest in recovery following exercise. This is particularly pertinent when training and competition schedules are extremely demanding; therefore achieving an appropriate balance between physiological stress, recovery and subsequent adaptation is critical to optimise performance in training and competition by: 1) reducing exercise-induced stress; 2) accelerating recovery to allow for a greater training load; and 3) optimising preparation in times of competition congestion.

Athletes widely adopt recovery strategies such as compression garments, functional foods and cryotherapy. Despite their widespread use, the evidence-base on their efficacy is limited. However, any potential gains from an effective recovery strategy remain futile in the absence of getting the basic principles of training, nutrition, hydration, sleep hygiene and appropriate rest between exercise bouts correct - these are not however within the scope of this article. In this expert statement we provide recommendations and considerations on the use of recovery strategies. Specifically, we consolidate the evidence-base to provide recommendations based on literature and applied practice.

Principles and approach to recovery

Observations from athletic environments suggest an extensive use of recovery strategies without a clear need or rationale. When working with athletes, it is crucial to understand whether insufficient recovery is causing a reduction in the capacity to train or compete. With sufficient time, in most cases, the body will recover without the need for additional interventions.

Physiological stress induced by intense exercise, symptomatically manifests post-exercise as a decrease in neuromuscular function, increased muscle soreness, stiffness and swelling. Athletes completing exercise whilst experiencing these symptoms will likely perform below their potential and therefore the root causes should be reviewed because this might increase the risk of injury (Howatson & van Someren, 2008). On identification that inadequate recovery is causing a reduction in training or competition performance, it is essential to ascertain the aetiology of the performance decline. Many sports participants will be subject to a milieu of stressors, therefore a forensic understanding of the physiological challenges is required. These will be based upon: the exercise modality, frequency, duration and intensity; familiarisation to the exercise; environment; and in some cases the added complexity of collision or sub-clinical trauma.

If the aforementioned challenges are identified as the potential cause for inadequate recovery, strategies can be selected to minimise the deleterious effects on performance (see Table 1 for a summary of contemporary strategies). As illustrated in Figure 1, recovery selection should be influenced by: 1) the 'recovery window' determined by the requirement to next train or compete; and 2) identification of the causes that have the greatest negative effects on performance and their recovery time-course.

Recovery and adaptation

The chronic use of recovery strategies on long-term adaptation to training is of growing interest. Based on the premise that recovery strategies reduce the exercise-induced stress, they might also reduce the stimulus for adaptation. This presents a challenging dichotomy when developing a regimen to support long-term athlete development. Taking cold water immersion (CWI) as an example; there is evidence that adaptation is blunted to both resistance and endurance training and that anabolic signalling, satellite cell proliferation and strength gains are reduced (Roberts *et al.*, 2015). However, molecular responses indicative of mitochondrial biogenesis, have been associated with cold application (Ihsan *et al.*, 2014) together with modest improvements in endurance performance.

These equivocal findings are also seen in chronic high dose vitamin supplementation, showing a blunted increase in mitochondrial protein expression, but with no concomitant effect on physiological capacity or performance (Paulsen *et al.*, 2014). Similarly, the evidence-base to support the popular use of non-steroidal anti-inflammatory drugs (NSAIDs) to reduce indices of muscle damage is equivocal; so too the effects of long-term administration on adaptation to training (Urso *et al.*, 2013).

Table 1. A summary of contemporary recovery strategies

Recovery Modality	Expert Insight
Cold water immersion (CWI)	▪ Highly researched; meta-analyses suggest ↓delayed onset muscle soreness (DOMS), but questionable effect on muscle function recovery ▪ Probable mechanisms: ↓blood flow and tissue temperature ▪ Considerations: timing, duration, temperature, number of exposures and water depth - optimal protocol unclear ▪ Confounding factors: athlete anthropometry; tolerance to CWI
Whole body cyrotherapy (WBC)	▪ Growing area of research and practice ▪ Equivocal evidence on recovery of performance ▪ Logistics and cost limit the ability to research or apply
Compression garments	▪ Commonly researched; meta analyses suggests ↓DOMS, but recovery of muscle function is questionable ▪ Considerations: compression force and 'fit' of garment; clinical grade compression and custom fit measurements are preferable; timing and duration of post-exercise wear remain elusive ▪ Confounding factors: many garments do not exert the pressure they propose
Neuromuscular Electrical Stimulation (NMES)	▪ Use of NMES by elite athletes is increasing; however evidence is poor and inconclusive ▪ Equipment claim to ↑blood flow by stimulating smooth muscle and/or skeletal muscle ▪ Lessons from clinical use of NMES to reduce the incidence of DVT and inflammatory pathologies
Massage	▪ Popular intervention. Recent rise in self-myofascial release, through the use of foam rollers, etc ▪ Physiological effects remain equivocal. Some research and anecdotal reports suggest some efficacy in ↓DOMS ▪ Poorly timed massage can negatively impact on performance
Dietary polyphenols	▪ Growing popularity; demand for natural solutions, particularly in polyphenol-rich foods ▪ Optimum doses are yet to be elucidated, but strong emerging evidence showing efficacy in ↓inflammation, oxidative stress and ↑recovery of muscle function following mechanical and metabolic exercise stressors
Nonsteroidal anti-inflammatory drugs (NSAIDs)	▪ Popular use. Most popular in contact sports (taken orally and prophylactically). Chronic use is associated with side effects (gastro-intestinal distress, cardiovascular, musculoskeletal and renal complications) ▪ Data do not support their use in exercise recovery. When coupled with the potential complications, orally administered NSAIDs should not be recommended to enhance exercise recovery

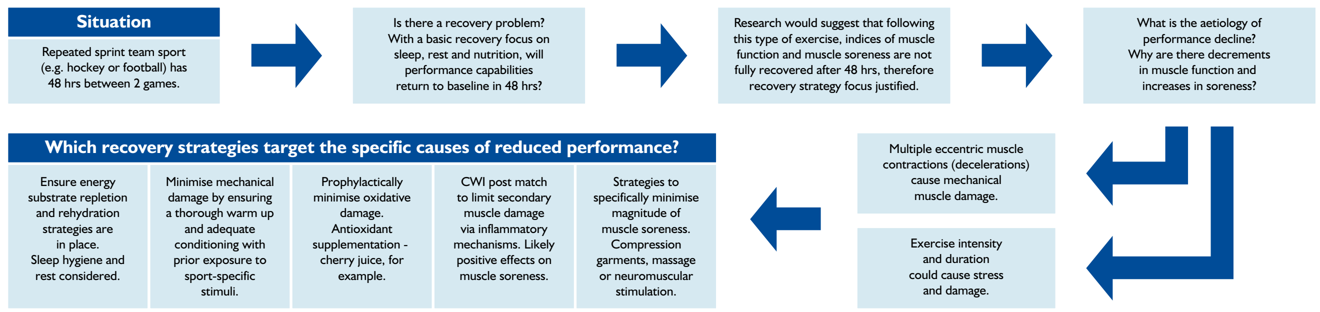

Figure 1. An example of how the principles of recovery could be applied in a hypothetical model

Hormesis

There is debate on the relative magnitude of the beneficial and detrimental effects of training-induced stress, and what the optimum level of this stress might be (Peake *et al.*, 2015). This hormetic paradigm (see Figure 2) describes the positive adaptive response to exercise-induced stress until a point is reached where an intervention may be required to ensure further stress does not cause deleterious effects. This may offer insights into why recovery strategies sometimes attenuate, and at other times augment adaptation. Of further interest is an emerging indication that recovery strategies might impact differently on adaptation to resistance and endurance training.

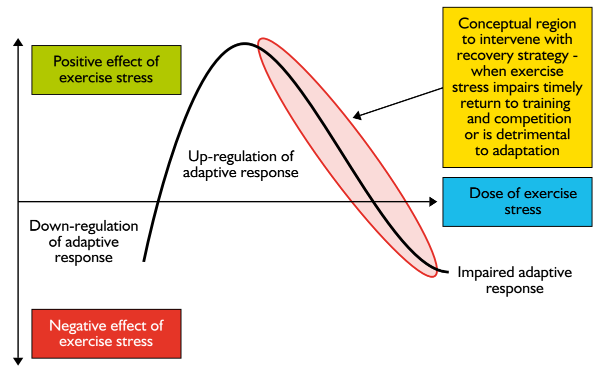

Figure 2. Adapted model of hormesis in exercise recovery

Belief and placebo effects

An important consideration in the application of interventions is athlete belief. This is particularly pertinent given that a growing body of evidence indicates that recovery is related to individual preference and perceptions of the intervention. Practitioners must recognise and manage the influence of the belief and placebo effects in the successful application of recovery strategies. Given the need to achieve coach and athlete buy-in to any intervention, there is an obvious challenge to balance an evidence-based approach with the beliefs and expectations of coaches and athletes (Halson & Martin, 2013). In cases where an athlete believes in a particular recovery strategy despite a lack of supporting scientific evidence, the demand on resource (financial, time, effort), the cost (i.e. what is sacrificed by engaging in a particular strategy) and critically, the potential for harm or a negative performance effect must be evaluated.

In light of the evidence in this nascent field, many practitioners currently implement recovery strategies during tournament situations or after specific training sessions when performance in the subsequent round of competition or training session is paramount. In contrast, the use of recovery strategies is often limited or avoided when long-term physiological adaptation to the training-induced stress is the priority. Future research must focus on the mechanistic and applied perspectives to elucidate the chronic use of recovery interventions on adaptation and performance. Finally, the study of recovery strategies in athletic populations may develop a greater understanding of the stress-repair-adaptation cycle that has translational benefits to promote health in clinical populations.

Recommendations

- Determine if a strategy is necessary or whether recovery can be attained without intervention
- Understand the training and competition stressors causing reductions in performance and delayed recovery before applying the intervention
- Determine the relative importance of short-term recovery and long-term adaptation; consider how the concept of hormesis could be applied
- The importance of athlete belief in the intervention should not be underestimated
- Research should combine multidisciplinary, mechanistic and performance approaches to elucidate the impact of recovery strategies on recovery and adaptation. ■

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