

***A survey to determine the recovery strategies that
medical support staff of rugby teams use to improve
recovery of the players***

In partial fulfillment of the MPhil Sports Physiotherapy degree

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Thesis Summary

Background: Following the introduction of professionalism to rugby in 1995, the physical demands on the players has increased significantly. It is known that a rugby match causes structural damage to muscles even in the "uninjured" players. Professional rugby players often have to play a match every 7 days. This imposes a serious physiological stress as the players have to train and compete while their muscles are in a state of disrepair. In an attempt to facilitate the recovery of the players, the support staff associated with teams have used a variety of techniques with the goal of ensuring that the muscles of the players have the best opportunity to repair before the next training session/match. Several different strategies are used by the support staff. These include cryotherapy, contrast baths, nutritional intervention, compression garments, massage, active recovery and non-steroidal anti-inflammatories. Ice/cold water immersion is a relatively new and popular recovery strategy derived from cryotherapy. Water is cooled either by adding ice cubes/ice blocks or simply by using refrigerated water cooled thermostatically. Practical recommendations for ice/cold water immersion vary according to body area immersed, individual toleration of ice water, and timing after event, frequency, and duration and water temperature and repeated, versus continuous application. All these recommendations are made based on personal experience and theory and data examining the validity of them are lacking. However, before recommendations can be made about recovery strategies it is important to know what practitioners are actually doing. At this stage this information is not available.

Thesis objective: To survey a representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) who are involved with rugby teams to determine which strategies they use to accelerate recovery of the players after training and matches and in particular to focus on the application details of ice/cold water immersion as recovery strategy.

Design: A questionnaire-based cross sectional descriptive survey was done on most (N=58) of the medical support staff of rugby teams (doctors, physiotherapist, biokineticists and fitness trainers) who attended the inaugural Rugby Medical Association conference linked to the South African Sports Medicine Association Conference in Pretoria (14-16th November, 2007) . **Results:** Generally the doctors were the eldest and fitness coaches the youngest subjects in the survey. The majority of subjects were between 25 and 30 years of age. Most of these subjects have been involved with sport teams and have been using recovery strategies for 4-6 years. Of all subjects 56% and 47% respectively agreed that their planning and executing of recovery is a multi-disciplinary approach. Of the 17 post-match and/or training recovery strategies proposed in the questionnaire, stretching and ice/cold water immersion was utilized the most (83%), followed by active recovery (74%) and massage (66%). More biokineticists and fitness trainers advocated the usage of stretching than their counterparts (medical doctors, physiotherapists). Hyperbaric oxygen, visualization and other strategies (including the use of powerplate (vibration training), controlled participation and immuno-nutrition) were utilized the least. Ice/cold water immersion achieved the highest efficacy rating among the recovery strategies. More doctors rated massage as an effective recovery strategy than the physiotherapists, biokineticists, and fitness coaches. Of the 17 strategies surveyed in this study ice/cold water immersion, active recovery, massage, extra carbohydrates, limiting/avoiding alcohol

use, extra protein, extra electrolytes and contrast temperature water immersion are utilized mostly after matches, followed by after every training session. Massage and additional sleep and rest (29%) were the strategies mostly used if a player was overtrained, where NSAIDS was mostly used for injured players (45%). The players' perception seems to be the most important influential factor forming the medical staff's perception about the use of ice/cold water immersion as recovery strategy. With regards to the protocols for ice/cold water immersion, the following protocols were the most popular: Ice/cold water immersion is utilized mostly after matches, followed by only if the training sessions were hard. The time to immersion after matches: 0-5 minutes; total duration of immersion session: 0-5 minutes; duration of single immersion: 0-2 minutes; number of single immersions per session: 1; immersion sessions per average training week: 2-3. Only 14% of subjects measure the temperature of water with immersion. Reasons for not measuring the water temperature include that the ice cubes in water are cold enough and logistical issues were also a reason. The average water temperature for immersion was 10 °C. Ice cubes are most frequently used to cool water, where plastic drums are mostly used as the container for the water. There is a difference between the protocols of ice/cold water immersion between home,-away matches and training. **Conclusion:** This survey of the representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) who are involved with rugby teams provided insight into which strategies are utilized in South African elite rugby teams to accelerate recovery of the players after training and/or matches. This information will therefore be useful for designing studies to investigate the efficacy and mechanism of actions of the various procedures and in particular ice/cold water immersion as the most popular recovery strategy.

KEYWORDS:

- RECOVERY STRATEGIES
- PROTOCOL
- QUANTITATIVE
- QUALITATIVE

Chapter 1

Introduction and scope of the thesis

Following the introduction of professionalism in rugby in 1995, the physical demands on the players has increased significantly (Garraway et al, 2000). It is known that a rugby match causes structural damage to muscles even in the "uninjured" players (Takarada, 2003). This conclusion was made by measuring plasma creatine kinase activity of rugby players before and after competitive matches and observing that the levels were elevated, indicative of soft tissue injury. The extent of the muscle damage in this study was highly dependant on the number of tackles made or received. The damage could also have arisen from the repetitive, eccentric muscle actions involved in the intermittent running/sprinting during rugby matches. This was confirmed in a study by Thompson et al (1999) who studied the effect of eccentric muscle actions during running in rugby, soccer, field hockey and basketball players.

The stressful components of training and competition may temporarily impair an athlete's performance (Barnett, 2006). This impairment may range from transitory (lasting minutes or hours after training or competition), to a longer period (several days). Short-term impairment results from metabolic disturbances following high-intensity exercise (Westerblad et al, 2002) whereas longer lasting impairment may be related to exercise-induced muscle injury and delayed onset muscle soreness (DOMS) (Cheung et al, 2003). Also, although the underlying mechanisms are not well understood, an imbalance between the stress of training and recovery over extended periods seemingly affects performance independently of the above. Such an imbalance can have potentially long-term debilitating effects in the form of overtraining (Barnett, 2006).

Laboratory studies show that the muscles take at least 5 days for the subtle muscle pain to subside and even longer before the functional aspects of the muscles are fully recovered (Cheung et al, 2003). However, professional rugby players often have to play a match every 7 days for several consecutive weeks. This imposes a serious physiological stress as the players have to train and compete while their muscles are in a state of disrepair. Lack of appropriate recovery may result in the player being unable to train at the required intensity or complete the required load at the next training session or match. This results in a decline in performance and increased risk of injury (Barnett, 2006).

It is generally accepted that inflammation is associated with DOMS (Cheung, 2003; MacIntyre et al, 1995; Pyne, 1994; Smith, 1991). While the exact mechanisms are still to be elucidated, post-exercise inflammatory responses appear to be involved in both damage and repair (Tidball, 2005). The muscles of elite athletes are subjected to different types and magnitudes of stress than untrained or moderately trained individuals, and their history of muscle use differs greatly (Barnett, 2006). Therefore, the magnitude of inflammatory processes after exercise between athletes of various

training backgrounds varies greatly. It follows that investigations are needed that examine the effect of recovery interventions on the inflammatory process in elite athletes.

Achieving an appropriate balance between training and competition stresses and recovery is important in maximizing the performance of athletes (Këntta et al, 1998; Lambert and Borresen, 2006). No matter how sophisticated and carefully planned a training program, without adequate recovery it will never be optimally effective. According to Jeffreys (2005) optimal recovery requires a multidimensional approach that addresses all aspects of the athletic lifestyle, such as sleep, nutrition and overall stress levels. An important element of this multidimensional recovery program is to develop a recovery ritual for use after matches and/or training (Jeffreys, 2005).

In an attempt to facilitate the recovery of the players, the support staff associated with teams have used a variety of techniques with the goal of ensuring that the muscles of the players have the best opportunity to repair before the next training session/match. These recovery sessions are designed to shift the stress-recovery balance away from the stresses induced by training and/or matches and towards recovery. The overall advantage of these recovery sessions allows the elite athlete to tolerate higher training loads (intensity, volume or frequency) and enhances the effect of a given training load (Barnett, 2006). Several different strategies, alone or in combination, are used by the support staff. These strategies include cryotherapy, contrast baths, nutritional intervention, hyperbaric oxygen therapy, electromyostimulation (EMS), compression garments, massage and stretching, active recovery and non-steroidal anti-inflammatories (Barnett, 2006).

Ice/cold water immersion is a relatively new and modern method of cryotherapy and based on anecdotal reports is a popular recovery strategy in rugby. To apply this treatment water is cooled by adding ice cubes/ice blocks. Refrigerated water which has been cooled thermostatically can also be used. The thermodynamics of ice water immersion is similar to "Wet-Ice" application, a commercially available fabric bag to which crushed ice is added (Merrick et al, 2003). One of the panels of this bag is made from terrycloth, allowing the water from the melted ice to soak through. This makes for a wet interface, which should allow for greater thermal conduction than would be seen with a dry interface, because water has a relatively large thermal conductivity (Lide, 1994). Ice water immersion thus absorbs heat through conduction and may also absorb heat through convection in the event that the water is moving, as with the movement when someone climbs into the ice bath. The application and dose of water immersion which occurs in practice differs from the theoretical approach. Theoretically, the most effective water immersion approach should be of a duration of anything between 5-15 minutes (Fu et al, 1997; Bailey et al, 2007; Burke et al, 2001; Eston et al, 1999). However the practical recommendations for ice/cold water immersion vary according to the body area immersed, water temperature, timing after event and the individual toleration of ice water which affects the duration. In many cases the practical recommendations are governed by logistical factors. It is sometimes difficult to establish a fixed immersion protocol due to changing event venues, traveling (unfamiliar conditions), equipment space and availability of ice. Therefore most of the practical recommendations are made

based on personal experience and preferences. As a result, each medical support group develops their own protocol which may consist of a specific technique or a combination of techniques. The strategies that are currently used usually vary between teams. The scientific evidence supporting each protocol is in many cases lacking or not applied according to the principles of best practice. However, before more general recommendations can be made about recovery strategies it is important to know what practitioners are actually doing. At this stage this information is not available. Whilst it may be concluded, based on anecdotal data, that ice/cold water immersion strategies are effective, there are insufficient data to support its effectiveness in an evidenced-based way.

Therefore the aim of this dissertation was to survey a representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) who are involved with professional rugby teams in South Africa to determine which strategies they use to accelerate recovery of the players after training and matches. In particular, details about ice/cold water immersion as a recovery strategy were investigated. Prior to the experimental phase of the dissertation, the literature on recovery strategies was reviewed (Chapter 2). Following the experimental phase (Chapter 3) there is a concluding section with recommendations on best practice (Chapter 4). This chapter also includes potential areas of research to investigate the efficacy and mechanism of actions of the various procedures.

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Chapter 2

Strategies used to improve recovery after exercise: A literature review

ABSTRACT

It is well understood that recovery forms an integral part of the whole training process. High volumes of training with insufficient recovery lead to symptoms of fatigue with an accompanying high risk of injury. Recovery after exercise can be passive or active. Passive recovery allows the body to recuperate without any the intervention. Active recovery, which can take many forms, attempts to accelerate the rate of recovery so that the player is better prepared for the next training session. A review of the literature on the popular strategies which are used to accelerate recovery in rugby (cryotherapy, massage, stretching, compression garments, active recovery, nutrition, sleep and non-steroidal anti-inflammatories) shows that there is not overwhelming evidence supporting any of these techniques. This can be attributed to the fact that many of the studies are laboratory based and the protocols which are used to simulate training or competition may lack specificity. Another potential problem is that the markers which are used to define the state of recovery are indirect and also lack specificity. Despite the lack of scientific support, there is fairly strong anecdotal evidence to suggest that "*something is better than nothing*". Furthermore, practical experience shows that once a recovery strategy is designed it should become ritualistic and habitual for the players within the team. They need to be educated about the importance of recovery and be expected to take some responsibility for their own recovery. With this as background some practical examples of various strategies are provided.

INTRODUCTION

Training for high performance sport involves a systematic application of a training load, followed by a period during which recovery and adaptation can occur. If there is any imbalance between training load and recovery, the athlete will either incur symptoms of overtraining or underperformance. It has been known for number of years now that each training session imposes a physiological stress which causes a disturbance of the intracellular homeostasis and transient physiological and metabolic changes (Coyle, 2000). The nature of these changes depends on the type, duration and intensity of exercise (American College of Sports Medicine, 1998). This is the primary signal for stimulating adaptation of the muscle and other organs in the body which are associated with improved performance.

For competitors at the elite level there is a fine line between doing too little or too much training (Kuipers et al, 1988; Lehmann et al, 1993; Morton, 1997). Insufficient training does not induce adequate adaptations and results in suboptimal performance. In contrast, too much training results in maladaptations or the failure to adapt, causing symptoms of chronic fatigue and poor performance (Budgett, 1990; Derman et al, 1997). Chronic fatigue can also be caused by inadequate recovery. In a review on the basic errors of training neglecting recovery was regarded as one of the main causes of chronic fatigue. The other factors listed in the review follow below (Smith, 2003):

- recovery is neglected
- demands on the athletes are made too quickly
- after a break in training because of illness or injury, the training load is increased too quickly
- high volume of maximal and submaximal training
- overall volume of intense training is too high when the athlete is training for endurance events
- excessive time is devoted to technical or mental aspects, without adequate recovery
- excessive number of competitions – this includes frequent disturbances of the daily routine and insufficient training time which accompanies competition
- bias of training methodology
- the athlete has a lack of trust of the coach because of inaccurate goal setting

Whilst recovery may be interpreted as a passive process, strategies have been developed which attempt to accelerate the rate of recovery. Data from studies on soccer players showed that optimising recovery after training and matches depend on a combination of factors that consider individual differences between players and lifestyle factors. The procedures to accelerate the recovery should start immediately after the end of the match or training session (Reilly et al, 2005). Without these procedures, it is unlikely that a player will be able to maintain a high level of performance throughout the season. This will result in a loss of form and confidence which will spiral out of control unless there is a positive intervention. Recovery should be viewed as an action orientated, multidimensional process involving a number of systems, all which might have a different time course (Jeffreys, 2005). Furthermore, recovery strategies can be discussed in the short-term, (i.e.

immediately after training and competition), and also in the long-term (i.e. throughout the season). Ensuring long-term recovery requires an ongoing monitoring programme to prevent the levels of fatigue from becoming unacceptably high. The short-term strategies for accelerating recovery between training sessions or after a match will be reviewed in this section.

THE PHYSIOLOGY OF RECOVERY

During exercise the metabolic rate increases. This is measured as an increased oxygen consumption. Immediately after exercise the oxygen consumption declines. First there is a rapid decline which lasts about five minutes, followed by a slower decline lasting for up to an hour. Circulating lactate, which may increase up to 10-fold during a rugby match (Duthie et al, 2003), takes about 60 minutes to return to pre-exercise concentrations (Brooks et al, 2005).

During a rugby match forward players lose between 1 and 4 kg and that the backline players lose about 0.8 kg of body mass (Meir et al, 2005). This is a transient change in body mass with a return to pre match weight soon after the game, providing there is adequate fluid ingestion.

Muscle glycogen concentrations decrease with exercise. The concentrations continue to decrease even after exercise has ended, particularly when muscle damage occurs. Glycogen levels returned to their pre-match level within 24 hours providing there is no muscle damage. In the presence of muscle damage glycogen restoration takes about 24 hours longer (Zehnder et al, 2004). The only study that has been done on muscle glycogen depletion in rugby players showed that a rugby match did not cause significant depletion of muscle glycogen (Jardine et al, 1988). However studies done on soccer players showed that glycogen stores were reduced to near depletion at the end of a soccer game (Reilly et al, 2005). An explanation for the differing results (soccer versus rugby) could be that the subjects were club rugby players whereas the soccer players completed at a higher level. It is reasonable to assume that had rugby players of a higher level been used that more glycogen depletion would have occurred, similar to the findings in soccer players.

Whilst the metabolic rate might decrease down to pre-match levels within an hour, the metabolism associated with muscle damage occurs for longer. There is convincing evidence, as shown by the increased levels of circulating creatine kinase activity, to show that rugby players incur muscle damage after a match, and also as a result of contact at practice (Suzuki et al, 2004; Takarada, 2003). The amount of muscle damage appears to be associated with tackling as the circulating creatine kinase activity increases in proportion to the number of tackles either delivered, or received (Takarada, 2003). The symptoms associated with muscle damage usually develop and reach a peak within 24 to 48 hours after the bout of exercise and then slowly subside, disappearing within five to seven days (Cheung et al, 2003). Other clinical symptoms associated with muscle damage are inflammation and muscle shortening. After all the symptoms disappear (usually within five to seven days), the muscle continues to regenerate with signs of regeneration still being present two weeks after the injury. After

severe muscle injury, such as occurs after a marathon, signs of muscle regeneration are still evident for up to 12 weeks (Warhol et al, 1985).

The goal of recovery is to restore cellular function to the pre-exercise levels, without bypassing any of the biological steps which are important for complete regeneration. By excluding or blocking these biological factors, there is a risk of compromising regeneration and the restoration of the cellular function.

Recovery after exercise, does not only involve muscle tissue. Following high-intensity exercise, there are aspects of elevated metabolism which have to recover. For many years a conventional understanding was that increases in muscle and blood lactate and the associated hydrogen ions was the cause of fatigue after high-intensity exercise (Cairns, 2006). This understanding arose from experiments which examined the decline of force during fatiguing exercise and blood lactate concentrations. The erroneous conclusions arising from these studies were that there was a cause-and-effect type relationship between the lactate and fatigue. This led to misplaced speculation that a reduction in circulating lactate would delay fatigue, and extending this argument, that clearing blood lactate after exercise would improve recovery. Therefore the studies which have used blood lactate as a marker of whether recovery has occurred or not, should be interpreted with caution.

A more contemporary understanding of fatigue arising from high-intensity exercise is that impaired muscle function is a consequence of down-regulation by the central nervous system, rather than fatigue caused by metabolites in the muscle. In particular, after exercise that has repetitive stretch-shortening cycle actions, the pre-activation of the muscle decreases resulting in impaired control of the stiffness of the muscle. This results in a reduced force output which is proportional to the degree of exercise-induced muscle damage (Gollhofer et al, 1987; Horita et al, 1999).

Recovery after exercise is dependent on the physical demands of the bout of exercise. It is unrealistic to expect all players to be affected similarly by a match. There are distinct differences in the physiological demands of playing rugby according to the playing positions (Duthie et al, 2003). Forwards spend more time competing for the ball and are involved in physical contact, whereas the backs spend more time running. A study on Vodacom Cup players show that there were 382 (range 306 – 535) impact contacts per match, with the forwards being involved in 68% of these (257 per match (range 199 – 389), while the backline players were involved in 125 (range 93 - 148) impact contacts per match (Thorsson et al, 1998). The evidence suggesting that rugby forwards have more physical demands placed on them compared to the backline players is supported by a study which showed that forwards had a marker of muscle damage (interstitial creatine kinase concentration) which was nearly threefold higher compared to the backline players (Scott et al, 2004). Studies have also shown, based on heart rate that the backs do less work during a match than the forwards. About 95% of the bouts of activity during a rugby match last less than 30 seconds. The rest periods in between these bouts are generally greater than the preceding bout of exercise (Duthie et al, 2003).

Muscle pain is a poor marker of the state of recovery after exercise that causes muscle damage (Nosaka et al, 2002). Also indirect markers of muscle damage such as circulating creatine kinase and inflammation are also not necessarily related to the amount of muscle damage. Some studies, which have examined the efficacy of modalities to accelerate recovery, have used pain and indirect markers of muscle damage as their main outcome measures. These studies may have come to the wrong conclusions because of the poor relationships between the "state of the muscle" and markers of muscle damage. This has unfortunately confounded the evidence-based approach to managing recovery, which will be discussed in more detail later.

In summary it may be concluded that rugby players have varying degrees of muscle damage after training and matches, ranging from very marginal (backline players) to the more serious damage (loose forwards). There will be accompanying symptoms such as inflammation and impaired muscle function with the more serious muscle damage. In most cases players will have lost intracellular fluid and muscle glycogen after a match. Recovery can be defined in many different ways, but from the perspective of a rugby player, recovery should be defined as the point at which the player is able to train without constraints of sore muscles or an increased risk of injury. This physiological definition does not exclude the fact that there are cognitive processes which also need to recover following a stressful match or period of travelling across time zones which interferes in sleep patterns. Optimal recovery requires a multidimensional approach that addresses all aspects of the rugby player's lifestyle, such as sleep, nutrition, overall stress exposure and physiological recovery (Jeffreys, 2007). The next section will examine the experimental evidence supporting or refuting the efficacy of the often used recovery strategies in rugby. This will be followed by guidelines which have been established using evidence-based principles (where available) and anecdotal experience.

TYPES OF RECOVERY TECHNIQUES

Recovery needs to be a proactive process and is an integral part of the entire training programme (Jeffreys, 2005). Whilst there are several laboratory studies which have attempted to provide evidence for the efficacy of these interventions many of these studies are limited because they either use untrained subjects, they use non specific modalities to induce fatigue/muscle damage or they define their outcome measures of recovery rather poorly. Taking all these factors into account there are only a few studies which can be used to make evidence-based decisions about techniques for accelerating recovery. The next section will include a discussion on cryotherapy (including cold water immersion and contrast temperature therapy), massage, stretching, compression, active recovery, nutrition, sleep, and non steroidal anti-inflammatory drugs, as these are the recovery modalities which are commonly used in rugby.

Cryotherapy

Cryotherapy is a term which describes a range of therapeutic treatments of cold aimed at lowering tissue temperature by the withdrawal of heat from the body (Chesterton et al, 2002). Treatment can be applied either in the form of ice packs, ice massage, ethyl chloride, cold air, cold water immersion (Mednick et al, 2002). These treatments have a long history in medicine, with their use ranging from the removal of warts, to more conventional applications aimed to reduce swelling after tissue trauma and the treatment of pain. More recently cryotherapy has been used as an ergogenic aid, as whole-body immersion in cold water before exercise in the heat has been associated with an improvement in performance (Booth et al, 1997; Marino, 2002).

Various forms of cryotherapy are used as an intervention for post exercise recovery, particularly after exercise which raises body temperature, and causes inflammation of muscles (Smith, 1991). The basis for using cryotherapy is on the assumption that it is effective for decreasing metabolic rate, inflammation, blood flow, and skin muscle and intra-articular temperatures (Merrick 1999). Cryotherapy increases pain threshold and pain tolerance possibly as a consequence of a significant decrease in nerve conduction velocity (Algafly et al, 2007). However, according to Meeusen et al (1986) prolonged exposure to cold may have negative effects, from a recovery perspective, because blood flow increases in the muscles when the muscle temperature reaches about 10° C. Furthermore, the permeability of the lymph vessels increases at prolonged low temperatures, resulting in increased subcutaneous swelling (Meeusen et al, 1986).

The wide range of cryotherapy modalities, differences in application, and duration of treatment all contribute to varied results of the treatment lowering skin temperature. Chesterton (2002) has summarised a range of studies which showed that the mean skin temperature reduction ranged from 7°C (15 seconds application of ice massage) to 26.6° C (10 minutes of ice massage) (Chesterton et al, 2002). Therefore to achieve the required clinical response, it is important that the modalities are clearly understood. For example, localised analgesia requires a skin temperature of below 13.6° C (Chesterton et al, 2002).

The amount of subcutaneous fat in the area being cooled influences the rate of intramuscular cooling degree with which cryotherapy has an affect. For example, a study was done on subjects who were assigned to groups dependent on their calf skinfold thicknesses (less than 8 mm, 10 to 18 mm, and greater than 20 mm) (Myrer et al, 2001). Intramuscular temperature was monitored every 10 seconds over a 20 minute treatment at 1 cm and 3 cm below the subcutaneous fat in the left medial calf during and after a 1.8 kg crushed-ice pack treatment and again 30 minutes after the treatment. The amount of adipose over the therapy site had a significant effect on the decrease in intramuscular temperature that occurs during and after cryotherapy. This study has practical applications for treating rugby players with cryotherapy, as the amount of subcutaneous fat will vary between players (Duthie et al, 2006).

Whether cryotherapy improves recovery remains open to debate. Relevant studies on cold-water immersion and contrast temperature therapy will be discussed below.

Cold-Water Immersion

A study reviewed the effectiveness of cold water immersion and active recovery in 10 well trained cyclists following high-intensity exercise conducted in hot conditions (34°C) (Vaile et al, 2008). The therapies consisted of either intermittent coldwater immersion for 15 minutes at either 10°C, 15°C, 20°C, or a 15 minute continuous immersion at 20°, or active recovery. Recovery was assessed as a function of the total work performed after the treatment. The cold water immersion protocols all reduced the thermal heat strain of the subjects after the high-intensity exercise, compared to the active recovery protocol. There were no differences in total work performed between any of the cold water immersion protocols. However, the subjects were able to maintain their repeat performance in the heat following all of these interventions in contrast to treatment with active recovery. The authors concluded that cold water immersion may be a useful strategy in sports when there is going to be two training sessions a day performed in hot conditions. This study was not designed to investigate the effect on inflammation and muscle damage. This question was examined in another study where healthy active subjects were exposed to exercise which caused severe muscle soreness and dysfunction and elevated serum markers of muscle damage (myoglobin and creatine kinase activity). Subjects were then assigned to treatment which consisted of 10 minutes of cold water immersion (10°C) (Bailey et al, 2007). Subjects had reduced muscle pain at 1, 24 and 48 hours after the exercise. The treatment had no effect on creatine kinase activity; however myoglobin was reduced one hour after the exercise. These results suggest that cold water immersion therapy reduces some of the symptoms of exercise-induced muscle damage. The authors postulated that the effect was manifested either through a decreasing intramuscular temperature with a reduced inflammatory response, or an alternative explanation for the findings is that immersion caused haemodynamic changes as a result of increased hydrostatic pressure.

In another study subjects stood in either cold water (8°C) or hot water (44°C) up to their gluteal folds for 10 minutes (Burke et al, 2001). All subjects (n = 45) exercised only the right lower limb using a modified proprioceptive neuromuscular facilitation flexibility protocol, consisting of 1 set of 4 repetitions. This procedure was followed for 5 consecutive days. The maximum active hip flexion was measured on the first and fifth days. Both groups had significant improvements in hamstring length (pretest to posttest), however, there were no significant differences between groups. The authors concluded that there was no advantage in using either hot or cold immersion to increase hamstring length in healthy subjects (Burke et al, 2001).

Regular exposure to cold therapy during training may compromise the adaptation of the muscle. This was shown in a study which examined the effects of regular cold application to exercised muscles

after training (Yamane et al, 2006). Training occurred either by a cycle ergometer or a handgrip dynamometer and cold therapy consisted of cold water immersion (5°C for 20 minutes, short rest and then repeated). After six weeks significant training effects were more frequent in the control than in the cold group, including increases in artery diameters in the control but not in the cold group. The authors concluded that training-induced molecular and humoral adjustments during the bout of exercise, including muscle hyperthermia are physiological signals which are important for inducing training effects (myofiber regeneration, muscle hypertrophy and improved blood supply). These data suggest that cooling generally reduces the signals associated with increased muscle temperature and which may have a negative effect on training adaptations. This however should not be confused with the potential benefit effect of cold therapy in the treatment of tissue trauma, i.e. as part of the RICE treatment (Yamane et al, 2006). The so-called "negative" effects of cryotherapy were also shown in a study which examined cold water immersion in 40 untrained subjects who performed eccentric loading on one leg to induce muscle soreness (Sellwood et al, 2007). Immediately after exercise subjects were randomly assigned to either a cold water immersion group (5°C) or tepid water (24°C) for three minutes. Response to these interventions was measured at 24, 48 and 72 hours after the exercise. There were no differences between treatments with regards to swelling, muscle function or circulating creatine kinase activity. However, at 24 hours the cold water immersion group had more pain when doing a specific movement compared to the control group. This was a paradoxical finding which argued against the use of cold water therapy as a recovery strategy. As mentioned earlier, a distinction should be drawn between the responses of untrained subjects versus trained subjects. As this study used untrained subjects it would be interesting to see whether similar findings were obtained with this protocol in a group of more highly trained subjects.

Several studies have used protocols consisting of predominantly eccentric actions to induce muscle damage to determine the efficacy of cryotherapy treatment. For example, Eston et al (1999) used an immersion protocol (15° C for 15 minutes after exercise and thereafter same treatment every 12 hours for seven sessions) following eccentric exercise which caused muscle damage. Although they showed that muscle stiffness was reduced, there were no other signs of enhanced muscle repair (Eston et al, 1999). Another laboratory study, which also used eccentric exercise as a way of inducing muscle damage, also showed that cold water immersion (20 minute immersions in a 5° water bath, interspersed by 60 minute rest periods was ineffective in reducing symptoms of muscle soreness (Paddon-Jones et al, 1997).

In another study with a similar design, a group of subjects completed 100 drop jumps to induce muscle soreness, followed by 12 minutes of cold water immersion (15°C). This treatment was repeated every 24 hours thereafter for three days. Although there were measurable symptoms of muscle damage after the drop jumps, the subjects who had the cold water therapy did not have any advantage over the control subjects (Goodall et al, 2008).

The data from these laboratory studies (Eston et al, 1999; Goodall et al, 2008; Paddon-Jones et al, 1997) should however be interpreted with caution because they used eccentric actions to induce muscle damage, and therefore the association with tissue trauma arising from this intervention compared to the physiological trauma of a rugby match/training may be limited. During a rugby match muscle damage is caused by direct trauma (tackles/contacts made and/or received) as shown by Takarada (2003), Suzuki et al (2004) and Scott et al (2004). For meaningful comparisons between studies a number of factors need to be controlled, such as the intervention causing the fatigue and muscle damage, the type of cold water immersion protocol, the duration of exposure, the body area immersed and the temperature of the water. Given these limitations, the available data are rather sparse making it difficult to formulate an evidence-based decision about the efficacy of cold water immersion after rugby. However, physiological evidence aside, there does seem to be anecdotal evidence for using cold water immersion after a match or hard training session. Perhaps the ritual of undergoing the cold water therapy focuses attention on recovery, and the increased attention indirectly enhances the recovery process? Further research is needed to answer this question.

Contrast Temperature Therapy

Contrast temperature therapy consists of alternative cold and hot treatment through contrast temperature baths or warm and cold packs (Cochrane, 2004). A reduction in oedema and bruising, vasodilation and vasoconstriction of blood vessels, blood flow changes, and influences on the inflammatory responses have been attributed to this modality (Higgins et al, 1998). The mechanism of action however is unclear as studies have shown that contrast therapy had little effect on deep muscle temperature (Higgins et al, 1998; Myrer et al, 1997). Therefore the theory that the effects of contrast therapy can be attributed to fluctuations in tissue temperature is not founded on experimental evidence.

The data supporting the efficacy of this therapy is equivocal. For example, 20 rugby players performed a repeated sprint test and then were either allocated to a contrast temperature water therapy or active recovery (Hamlin, 2007). The therapy consisted of three 1-minute immersion in cold water (8 - 10°C) up to hip height, alternated with three 1-minute hot water (38°C) showers. The active recovery consisted of six minutes of slow jogging. The contrast temperature group had a decrease in blood lactate concentration three minutes after the procedure and also had lower heart rates after the procedure and later when the subjects did a further set of exercise. There were no meaningful differences in sprinting performance one hour after either recovery treatment. Another study has also shown a reduction in plasma lactate after intense exercise, following contrast water immersion (Morton, 2007). In this study the lower body of the subjects was immersed in hot (36°C) and cold (12°C) water baths, after a bout of high-intensity exercise. On average the exposure time was four minutes hot, one-minute cold (5 repetitions). Although the subjects exposed to the contrast water immersion had a marginal decrease in lactate concentration, it is questionable whether this small difference had any practical significance.

Although recommendations have been made about the ratio of warm to cold exposure and duration of treatment, there is lack of scientific evidence to support the efficacy of any of these combinations (Cochrane, 2004). At best it can be said that any protocol involving contrast temperature therapy is based on anecdotal experience.

Massage

Massage is widely used by athletes to prepare for exercise and accelerate recovery from training and competition (Weerapong et al, 2005). Data collected from 12 major national and international athletic events between 1987 and 1998 showed that physiotherapists spend between 24 and 52% of their time using massage. The premise upon which massage treatment exerts its effects are thought to be through decreasing oedema and reducing pain, enhancing blood lactate removal and promoting healing by increasing muscle blood flow. These proposed mechanisms are not always supported by the scientific evidence (Hemmings et al, 2000; Ogai et al, 2008; Tiidus et al, 1995), suggesting that the effects may be psychological. Some studies have found that massage does not reduce symptoms of muscle pain (Hart et al, 2005). Other studies have found to the contrary. For example, ten healthy subjects performed eccentric exercise of the elbow flexors designed to induce muscle soreness (Zainudden et al, 2005). The arm which underwent exercise received 10 minutes of massage therapy three hours after the exercise. Massage was effective in reducing inflammation and the symptoms of pain by 30% but it had no effect on muscle function. These results show once again that pain and muscle function are disassociated and that muscle pain should be used with caution as a clinical marker of how a muscle has recovered.

It is understandable why the results of the studies that have used massage to alleviate symptoms of muscle damage are quite varied. This can be explained because there are many different types of massage therapy, duration and frequency which can all influence the results. Furthermore, it is quite difficult to do a completely blinded study using massage as an intervention therapy, making the results difficult to interpret.

A review of all the published studies on massage showed that most studies contain methodological limitations, including inadequate training of the massage therapists, insufficient duration of treatment, too few subjects in the experiment, or over or under working of muscles that limits the practical conclusions which can be derived (Mika et al, 2007). However, it may be concluded from all these studies that generally muscle soreness arising from DOMS is reduced with massage. Whether impaired muscle function also recovers after massage remains less clear. Furthermore, whether recovery is enhanced after massage is also unresolved. In conclusion, there are sufficient positive results from the peer-reviewed literature to support the application of massage as part of the recovery process; however there is need for further research to fully understand the mechanism of action.

Stretching

The main goal of stretching is to increase the range of motion about joints. The data showing that this indeed occurs is convincing (Beaulieu, 1991; Thacker et al, 2004). Stretching is commonly advocated as a technique for reducing the risk of injury (Hartig et al, 1999) although the research does not necessarily support this (Thacker et al, 2004; Anderson, 2005). The evidence supporting stretching as part of a recovery protocol is less convincing. While a mechanism by which stretching may enhance the recovery process has yet to be identified, it has been suggested that stretching may disperse oedema accumulated during tissue damage (Bobbert et al, 1986). This theory however has not been proved. Furthermore, there do not appear to be any studies that have investigated the effect of stretching between exercise sessions/matches on performance during post-recovery exercise/competition (Barnett, 2006). Stretching exercises have been shown to be ineffective in reducing the symptoms of muscle damage (Cheung et al, 2003; Connolly et al, 2003; Gulick et al, 1996; Mika et al, 2007). A comprehensive review of studies which had used stretching after exercise (total stretching time ranging from 300 to 600 seconds) with the goal of reducing muscle soreness, showed that 72 hours after exercise, pain had only reduced by 2% which was not regarded as meaningful (Anderson, 2005).

Compression

Compression is a therapeutic technique whereby external compression is applied following exercise or an injury. The theory behind this modality suggests that the external pressure reduces oedema by creating an external pressure gradient and reducing the efflux of fluid from capillaries. Furthermore, the space available for fluid leakage is reduced, minimising haemorrhage and haematoma formation. Certain types of compression treatments involve a dynamic immobilisation that reduces movement during the recovery process. Although the evidence for the efficacy of this treatment was largely anecdotal, recent studies suggest that compression can be effective in minimising swelling, improving the alignment and mobility of soft tissue and improving proprioception in an injured joint (Kraemer et al, 2001; Kraemer et al, 2004). The only study on compression garments and recovery from rugby showed that the players who wore lower body compression garments for 12 hours after the match showed similar signs of recovery (defined by clearance of creatine kinase from transdermal exudate) to players treated with active recovery and contrast temperature water immersion. All these treatments were better than no treatment at all (Gill et al, 2006).

Unlike cold therapy which should be applied intermittently, compression treatment should be applied constantly for at least 72 hours (Kraemer et al, 2004). Furthermore, it is important that the pressure of the compression garment does not exceed diastolic pressure which is about 40 to 60 mmHg for the upper limbs and 60 to 100 mmHg for the lower limbs. If the pressure exceeds these values blood flow will be impeded. Ideally the garment should create a distal to proximal pressure gradient to facilitate

the removal of metabolites from the periphery towards the central circulation. This encourages fluid to move away from the high-pressure areas (site of injury) to the lower pressure areas (Kraemer et al, 2004). The commercial production of garments with these characteristics, designed to fit both the upper and lower body, has popularised this form of recovery treatment among rugby players.

Active Recovery

Active recovery enhances the removal of high levels of circulating lactate (Brooks et al, 2005). However, as discussed previously, the link between high levels of circulating lactate and impaired muscle function is dubious. It follows then that if active recovery has beneficial effects, the mechanism of action is then through other mechanisms.

Despite the lack of understanding of the mechanisms of active recovery, there are several studies which show that this method has some positive effects. For example, a recent study on rugby players showed that recovery rates (using creatine kinase in transdermal exudate as a marker) were similar for active recovery, contrast temperature water immersion and wearing lower body compression garments and were significantly better than passive recovery (Gill et al, 2006). Another study also showed that after high-intensity training a 15 minute treatment of either (i) active recovery (cycling at 30% VO_2max), (ii) massage or (iii) cold water immersion (15°C) improved recovery (measured by work performed) in contrast to a group which did not use any of these strategies (Lane et al, 2004).

However not all studies show that active recovery has a beneficial physiological effect. Suzuki et al (2004) found that active recovery did not have any effect on recovery (measured by circulating creatine kinase and neutrophils) after a rugby match, although the players seemed to have better mental recovery after being exposed to an active recovery protocol consisting of low intensity exercise (Suzuki et al, 2004). Another study showed that low intensity exercise had a temporary analgesic effect on sore muscles, but no effect on recovery from muscle damage (Zainudden et al, 2006).

Active recovery needs to be an integral part of the training programme and implemented immediately after a training session (cool down), or after a match. Active recovery can also be structured into the programme on days of "easy" training. Active recovery needs to incorporate aerobic type activity with stretching exercises included (Jeffreys, 2005). The activity should be of a sufficiently low intensity not to induce further fatigue, and also to assist with a psychological recovery, particularly after a tense match. Active recovery should always be performed in a non-competitive environment. A popular form of active recovery, particularly the day after a match is a pool session (Jeffreys, 2005).

Nutrition

There are compelling reasons for embarking on a rehydration, and refuelling strategy immediately after a training session or match. The basis for this started over 40 years ago when it was shown that

exercise performance (moderate to high-intensity) is related to muscle glycogen availability (Bergstrom et al, 1967) and that fatigue during such an activity is often associated with a depletion of muscle glycogen. Furthermore, it is known that muscle glycogen decreases during a rugby match (Jardine et al, 1988), and that for complete recovery these stores need to be replenished.

There is evidence to suggest that ingesting carbohydrates and soon immediately after exercise results in higher glycogen levels six hours later compared to if the carbohydrate was only ingested two hours after exercise (Sawka et al, 2007). Muscles that are damaged from the exercise do not restore their glycogen as efficiently as undamaged muscles (Costill et al, 1990) possibly as a result of transient insulin resistance (Kirwan et al, 1992). In a study using magnetic resonance spectroscopy, two groups of subjects exercised and reduced their muscle glycogen by about 50% (Zehnder et al, 2004). One group of subjects incurred muscle damage whereas the other group did not. During the first two hours after exercise, glycogen concentrations decreased even further in the group that had damaged muscles whereas the glycogen concentrations increased in the group that did not have muscle damage. The group that incurred muscle damage needed more than one day to increase their glycogen stores to the pre-exercise levels, even though they ingested a diet high in carbohydrate. This was in contrast to the group that did not incur damage and who were able to restore their glycogen levels within 24 hours. Another study which analyzed muscle biopsy samples showed that severe muscle damage reduced the ability to restore muscle glycogen fully for as long as 10 days (O'Reilly et al, 1987). The contrasting results of these two studies can perhaps be attributed to the severity of muscle damage in the latter study (O'Reilly et al, 1987). The magnitude of muscle damage which occurs in rugby players is likely to be much less severe than damage which occurred in the laboratory study of O'Reilly et al (1987), therefore it is reasonable to assume that their muscle glycogen concentrations will take 24 hours or slightly more to replenish.

There is evidence to suggest that exercise capacity will be restored more effectively when a mixture of carbohydrate and protein is ingested during recovery compared to the same amount of carbohydrate alone (Betts et al, 2007). However in this study, the inclusion of protein in the solution did not offer more benefits than when a more concentrated carbohydrate solution of similar energy content to the carbohydrate plus protein supplement was ingested. However, another study found that consuming a carbohydrate plus protein or carbohydrate drink immediately after a bout of eccentric exercise which caused muscle damage, failed to enhance recovery of the muscle injury differently than occurred with the placebo drink (Green et al, 2008). This suggests that further studies are needed to develop more definitive guidelines on the recommendations of ingesting carbohydrate and protein immediately after exercise as the results seem to be influenced by the magnitude of muscle damage.

It is well-known that alcohol reduces glycogen restoration after exercise (Burke et al, 2003). The reason for this is that alcohol either has a direct effect on glycogen synthesis, or whether that the effect is indirect, by reducing the carbohydrate intake immediately after exercise. Another reason for avoiding alcohol in the acute period after a match or training session is that alcohol promotes diuresis

which will delay rehydration (Burke, 1997). Caffeine and other stimulants also promoting diuresis, thus delaying recovery after training/competition will be mentioned later on in this review.

Until further information becomes available prudent recommendations are that the goal should be to ingest 1 g carbohydrate per kilogram body mass in the first two hours after exercise, particularly of high glycemic index carbohydrate foods. This goal should extend to 7-10 g carbohydrate per kilogram body mass over 24 hours (Burke, 1997). There are obviously practical and logistical considerations which should include palatability of the fluid and gastrointestinal comfort (Burke, 1997).

Additional Hydration and Electrolytes

According to Armstrong et al (1985) prior dehydration can be detrimental to performance. Thus, rehydration following training sessions is an appropriate nutritional strategy for ensuring that work capacity is not diminished at the beginning of the next session (Barnett, 2006). Burke (2000) showed that a bodyweight loss of two percent or more during exercise will result in a reduction in aerobic output. Water alone is not the best means of restoring body fluids, since carbohydrate-electrolyte drinks display better intestinal absorption and reduce urine output (Reilly et al, 2005). Meltzer et al (2005) advocated that athletes who do not drink anything during exercise will perform less well than they would if they drank *ad libitum* (according to thirst). This "ad lib" recommendation must, however, not be interpreted as drinking as much as possible, since this has not been shown to improve performance and may even result in overhydration with serious complications (Meltzer et al, 2005). The "ad lib" approach although, not rigid and quantified, does still mean working to a plan and understanding the practical issues that may influence fluid accessibility in different sports. Shirreffs et al (1996) showed when drinks of an appropriate volume and sodium content are consumed following dehydration by 2% body mass, net fluid balance and plasma volume can be restored within 4 hours. It is unlikely that currently used recovery strategies would compromise this fluid replacement.

Avoiding Caffeine and Other Stimulants

Caffeine and caffeine-like substances may be present in some drinks. Caffeine has a diuretic effect and should be avoided in the post-exercise/match recovery period (Meltzer et al, 2005). Sources of caffeine include coffee, tea, some sports bars and gels, and chocolate bars. According to Meltzer et al (2005) caffeine increases arousal, but as a central nervous system stimulant it can be counterproductive by also increasing nervousness, anxiety and dehydration. In contrast to this Armstrong et al (2005) hypothesized that contrary to popular beliefs and research, caffeine consumption, in moderation, does not induce water and electrolyte imbalances or hyperthermia.

Hyperbaric Oxygen Therapy

Hyperbaric oxygen therapy involves exposure to whole-body pressure >1 atmosphere while breathing 100% oxygen (Staples et al, 1999). According to Staples et al (1999) the proposed mechanism by

which hyperbaric oxygen therapy may increase the rate of recovery from soft tissue injury include: reduction of local hypoxia and inflammation; promotion of vasoconstriction; reduction of neutrophil adhesion; free radical quenching; control of oedema; enhancement of leukocyte killing; and promotion of collagen synthesis and vessel growth processes. According to Barnett (2006) no studies have examined the effects of hyperbaric oxygen therapy on recovery from training in elite athletes. A recent meta-analysis examining the effect of hyperbaric oxygen therapy on delayed onset muscle soreness induced in untrained subjects found no evidence of improved speed of recovery and indication of increased interim pain during recovery (Bennett et al, 2005). In summary, the published research does not support the effectiveness of hyperbaric oxygen therapy as a recovery strategy in the training programmes of elite athletes (Barnett, 2006). The cost of treatment, both of equipment and appropriately qualified personnel, possible risk of oxygen toxicity and the risk of explosion are additional barriers to the use of hyperbaric oxygen therapy (Harrison et al, 2001) (Ishii et al, 2005)

Sleep

The relationship between sleep and recovery after exercise, particularly relating to performance, is receiving more attention as the link between sleep cognitive function and metabolic function becomes better understood. To fully understand the role that sleep has in the training process, and in particular during recovery, one needs to understand the different phases of sleep (Walters, 2002). There are five distinct states of consciousness associated with sleep - stages 1, 2, 3, 4 and rapid eye movement (REM). Stages 1 to 4 are often grouped together and referred to as non rapid eye movement sleep (NREM) (Walters, 2002). During the day, beta brainwaves dominate and reflect a mental state that is actively aware of the surroundings. As one lies down in preparation for sleep, beta waves are replaced by alpha waves. These are associated with a mental state of being awake yet relaxed. After about five to 20 minutes of alpha brainwave activity, the mind is prepared to enter stage 1 of sleep. This first stage can last from 10 seconds up to 10 minutes and is defined by theta brainwaves. During this stage respiration becomes shallow and muscle relaxation occurs. The stage is also associated with the feeling of falling and accompanied by a reflex response such as jerking of the arms or legs. As the person progresses into stage two the theta waves become intermingled with sleep spindles and K-complex waves. Sleep spindles, which can be measured by EEG signals, arguably define the beginning of actual sleep since the person is oblivious to most external stimuli. This stage lasts from 10 to 20 minutes. Stage 3 is defined by a combination of theta and delta brainwaves, with the delta brainwaves becoming more dominant. Stage 4, which is the deepest stage of sleep, is defined as the period when the theta waves disappear. Stage 3 and stage 4 together are called slow wave sleep. During slow wave sleep metabolic activity is at its lowest. Growth hormone is secreted during this phase so muscle repair and growth can be maximized (Walters, 2002).

After about 30 to 40 minutes of the delta sleep, the stage is reversed, reverting back to stage 3 and stage 4. REM sleep begins after this step. During REM sleep there is an increase in blood pressure, body temperature, breathing rate, heart rate and blood flow. Even though the eyelids are closed the

eyes move backwards and forwards. Dreams usually occur during REM sleep. There is also a return of beta brainwaves suggesting that the brain is more active. The cycling between the stages of sleep is repeated between four and six times a night with each cycle lasting about 90 minutes. As the duration of the sleep increases (i.e. after a few cycles) the duration of stage 3 and stage 4 decreases, while REM sleep increases (Walters, 2002). If sleep is disturbed before slow wave and REM sleep is achieved, the whole process restarts. It is known that disturbances in sleep (insufficient and poor quality, circadian rhythm disturbance) are the main factors that affect the restorative ability of sleep (Samuels, 2008).

It has been recommended that athletes should have at least seven to nine hours of sleep a night (Calder, 2004). This recommendation is far more than the average 6.1 hours per night established in a survey of 15,000 students (18 to 22 years) (Walters, 2002). If sleep is compromised in any way then the ability to adapt to training will be negatively affected. A study of competitive swimmers through a season showed that slow wave sleep (stages 3 and 4) formed a high percentage of total sleep in the onset (26%) and peak (31%) training periods, but was significantly reduced following a pre competition taper (16%)(Taylor et al, 1997). This suggests that slow wave sleep, which is associated with restoration and recovery, is reduced as the physical demands reduce. Another finding in this study is that the number of body movements during sleep was significantly higher when the swimmers were training high volume, suggesting some sleep disruption (Taylor et al, 1997).

Based on the understanding of sleep and how it contributes to recovery and restoration, there is reason to believe that "power naps" during the day will be beneficial for a rugby player. Research has shown that "power naps", defined as a brief period of daytime sleep lasting less than an hour, improves alertness, productivity and mood and may contribute to consolidating learning and improve performance of tasks involving visual discrimination (Mednick et al, 2002).

Practical guidelines for enhancing sleep, adapted from Jeffreys, (2005) are shown below. These guidelines become more relevant with travelling as maintaining good quality sleep becomes a particular challenge with touring teams, particularly when time zones are crossed.

Table 2.1: Practical guidelines for enhancing quality of sleep (adapted from Jeffreys, 2005).

Identify your sleep requirements and try to get this amount daily
Develop a pattern of sleeping and waking times
Practise relaxation techniques before going to bed
Try to avoid worrying about anything before going to bed
Make the bedroom as dark as possible (use a mask if necessary)
Try to maintain a quiet environment (use ear plugs if necessary)
Use a bed that is at least 15 cm longer than the body
Maintain a cool environment within the bedroom
Keep your head cooler than your body
If you do not fall asleep within 30 minutes, get out and do some relaxation work
Avoid ingesting high-protein meals, caffeine or alcohol in the few hours before going to bed

Electromyostimulation (EMS)

EMS involves the transmission of electrical impulses via surface electrodes to peripherally stimulate motor neurons eliciting muscular contractions (Barnett, 2006). It has been suggested by Martin et al (2004) that these contractions may be advantageous to recovery due to increased blood flow via the "muscle pump effect", which may enhance tissue repair, although no difference between EMS, passive or active recovery interventions was found. Similarly Lattier et al (2004) showed that EMS did not enhance recovery of the voluntary force-generating capacity of the knee extensors when compared to passive or active recovery. In summary, in the few studies conducted so far, EMS did not enhance the recovery process.

Psychological Strategies

This requires that the athlete is able to distance themselves from the stresses and worries of the game (Jeffreys, 2005). This form of recovery according to Jeffreys (2005) need to incorporate methods by which the athlete can disengage from the game and engage in relaxation activity. According to Calder (2003) there are four main psychological strategies that are used to enhance recovery: debriefing, emotional recovery, mental toughness skills and relaxation techniques.

Debriefing/Disengaging

Debriefing/disengaging is one of the most useful ways to evaluate performance and provide emotional and psychological recovery post training or post match (Calder, 2003). Jeffreys (2005) postulates that by committing themselves to a short written performance review, the athlete starts the disengagement process. Hogg (2002) outlined an excellent debriefing model that focuses on process rather than outcomes.

Emotional Recovery/Contingency Planning

Contingency planning is an important aspect of preparation for handling emotionally traumatic events. It is important for coaches to identify in advance the strategy or strategies that they will use if such situations arise (Calder, 2003). Mood lifting activities such as humor, comradery and team support is essential for athletes in extended competitions away from home.

Mental Toughness Skills

According to Calder (2003) skills associated with developing mental toughness or emotional control, are important strategies for athletes to use. A few studies have shown that mental training might help to prevent staleness (K ntta et al, 1998). This effect has been explained, according to Kentta et al (1998) by an increased recovery capacity or increased stress tolerance. Positive self-talk and developing positive body language is some of the effective skills that have been used (Loehr, 1992). These techniques can be used within training and match situations as well as afterwards and coupled with biofeedback techniques for greater effect (Calder, 2003).

Relaxation Techniques

According to Calder (2003) many relaxation techniques are available. The choice of relaxation activity will likely be individual to the athlete, and they need to experiment to find which strategies are most effective (Jeffreys, 2005). Some of the more common relaxation techniques include: meditation, progressive muscle relaxation, visualization, breathing exercises, music and flotation (Calder, 2003).

Non Steroidal Anti-Inflammatory Drugs (NSAIDS)

NSAIDS relieve pain and have anti-inflammatory properties (Lanier, 2003). These properties make them an attractive modality for the treatment of athletes after training and competition to possibly enhance recovery (Barnett, 2006) and are the most widely used medications for treating muscle injury (Lanier, 2003). Studies on strains and contusions suggest that the use of NSAIDS can result in a modest inhibition of the initial inflammatory response and the associated symptoms (Almekinders, 1999). However, the inhibition of the biological steps may cause negative effects later in the healing phase. Many studies have examined the acute affects of NSAIDS on muscle injury and the diverse findings suggest that NSAIDS have a dosage-dependent effect that may also be influenced by the time of administration (Cheung et al, 2003). Animal studies suggest that whilst NSAIDS may have a short-term positive effect on muscle repair, the long-term effects (four weeks) may be negative and associated with ineffectual or delayed muscle regeneration (Mishra et al, 1995). As a follow-up to this study the effects of anti-inflammatory therapy on satellite cell and fibroblast proliferation were studied in rats in an attempt to identify the mechanism of the delayed regeneration (Mishra et al, 1995). The authors found that both satellite cell and fibroblast proliferation were unaffected by the anti-inflammatory treatment and there were no significant differences in myotube or capillary production between treated and control animals. Therefore, the mechanism explaining the findings of Mishra et al (1995) are not known and are possibly associated with reducing inflammation, a biological process which is part of muscle regeneration (Scott et al, 2004). Such studies have not been performed in humans, and therefore the long-term effects of treatment with NSAIDS in humans are not well understood. It is beyond the scope of this review to go into any more detail so therefore interested readers are referred to other review papers (Lanier, 2003; Warden, 2005).

Combination Modalities

According to Barnett (2006) the potential benefits of combined recovery modalities have not been investigated thoroughly. Mondero et al (2000) combined active recovery and massage between two 5km time-trials for cyclists and found that the combination was more effective in clearing lactate and maintaining performance than used alone. Flanagan et al (1998) found that the consequences of combined recovery strategies (massage, active pool sessions, hot-cold showers, stretching, hydration and nutritional plans) prevented physical drop off, lowered the occurrence of influenza symptoms and produced a higher rating of overall wellness. According to K ntta et al (1998) regeneration strategies have been widely used, particularly in the former eastern European countries. These involve a reduction of all nonspecific training stressors (i.e. occupational, educational, financial and social

stressors) by incorporating rest, sleep, relaxation therapy, counseling, physiotherapy, saunas and massage into the routine of the athlete. According to Jeffreys (2005) active recovery should be followed by stretching which helps maintain muscle length and range of motion, and promote muscle relaxation.

Field Studies on Recovery

It has been mentioned before that one of the reasons for the varying results of many of the studies on recovery is that the laboratory derived protocols to induce fatigue/muscle damage may lack the specificity of replicating fatigue/muscle damage of training or competition. In an attempt to overcome this deficiency two studies have been conducted in the "field".

The first study examined the most effective recovery intervention during a 21 day preseason soccer training camp (Tessitore et al, 2007). Twelve 18-year-old elite soccer players were recruited for the study. The recovery modalities which were used in the study were passive, dry aerobic exercises, water aerobic exercises, and electrostimulation. Each intervention strategy lasted for 20 minutes. The performance outcome measures in the study were muscle power (squat jump, countermovement jump, bounce jumping) and 10 m sprinting speed which were recorded on four occasions, two days apart. The subjective ratings (perceived exertion and muscle pain) were also recorded before and five hours after the intervention. There were no significant effects of recovery intervention on any of the performance measures. Dry aerobic exercise and electrostimulation were slightly more beneficial than water aerobic exercises and passive rest on reducing muscle pain (Tessitore et al, 2007).

The second field study investigated whether immediate (15 to 20 minutes after the match) postgame recovery strategies enhanced the rate of recovery in Australian football players (Dawson et al, 2005). The treatments evaluated were stretching, pool walking and contrast temperature. For the stretching protocol the players had a supervised 15 minute session in which they did gentle static stretching of the legs and back. The stretches were held for 30 seconds and each stretch was repeated two to three times. For the pool walking protocol subjects underwent 15 minutes of easy walking (moving forwards, backwards and sideways) in the shallow end of a 28°C swimming pool. For the contrast temperature protocol the players alternated between standing in a hot (45 °C) shower for two minutes, then standing in waist deep icy water (12° C.) for one minute. This was repeated until five hot and four cold exposes had been completed. Additional ice was added to ensure that the water remained cold. In addition to these treatments, all players had a normal 25 minutes pool session the day after the match. For the control trial the subjects only performed the 25 minute pool session the day after the match. Muscle soreness was rated higher two days after the match compared to the rating before the match in all conditions. There were no differences in the rating of soreness between treatments, including the control. Furthermore, the recovery strategies did not enhance flexibility and muscle power. These results suggest that the additional recovery strategies performed immediately after the

match did not enhance recovery any better than just doing the 25 minutes of pool exercise the day after the match.

TRANSLATING RESEARCH ON RECOVERY STRATEGIES INTO PRACTICE

A review of the studies shows clearly that there are varied responses to all the treatments. This can be attributed to the different protocols for inducing fatigue/muscle damage and the outcome measures which are indirect markers of recovery. Many aspects of recovery are very difficult to measure in the laboratory, and the indirect markers of recovery lack the required precision to detect small, yet meaningful changes. Where does that leave the practitioner, driven by the desire to have an evidence-based approach to the management of the players? It would be foolish to conclude that recovery strategies do not have an affect, although a strict analysis of the studies might lead one to this conclusion. This approach would fail to acknowledge the anecdotal evidence which has "*stood the test of time*" and which suggests that there is a role for recovery strategies after training and competition. Whilst the specific details are not known, a logical interpretation of the available knowledge suggests that under certain circumstances there is a role for cryotherapy, active recovery, nutrition, compression garments, massage, stretching and "power" naps as part of a recovery strategy. The studies which have examined a combination of the strategies together, suggest that "something is better than nothing", so the details of the protocol should be custom-made based on the circumstances and equipment available to the support staff and team. It has been suggested that the recovery strategies should follow a pattern and become a habit (Jeffreys, 2007). Prior to embarking on a strategy for recovery, it is important that the rugby players are educated about the process so that they are fully informed about the protocol and assume some personal responsibility. It is important that within a team setting the recovery strategies adopted by the support staff become routine and almost ritualistic (Jeffreys, 2005). It is also prudent to individualize the recovery strategies for various players. For example, older players with a history of joint injuries might be handled differently to younger players. Also, players of different positions, who are faced with different physical demands, might also have different strategies after a match. The strategies which are going to be used should be customized for each player, discussed with the player and then implemented in a systematic way. Ambitious strategies which cannot be used when the team is traveling should be avoided as this may cause psychological problems with the players when they cannot use a procedure which they are accustomed to. It is with this as background that the next section will discuss some practical examples for implementing the different protocols.

RECOVERY AND INJURY RISK

For the coach and athlete, the primary goal of the training process is to enhance performance. However, it may be argued that enhancing performance is actually a process of intentionally repeating stimuli (exercise), which result in recovery-adaptation, while attempting to avoid overstress-overtraining and/or injury (Stone et al, 2003). There are basically two methods a coach and an athlete

can use to enhance the stimulus-recovery adaptation process and prevent injury: Reasonable planning and execution of the training program, which should include not only the training stimulus, but built in rest; Adopting reasonable methods or strategies of enhancing recovery-adaptation other than training (Stone et al, 2003). Recovery is one of the basic principles of training methodology (Rushall et al, 1990) and it has two primary roles: The first concerns monitoring the athlete's adaptation to training and stress so that appropriate recovery strategies can be determined. The second relates to the selection of specific recovery techniques and strategies to minimize any residual fatigue from training and competing (Figure 2.1).

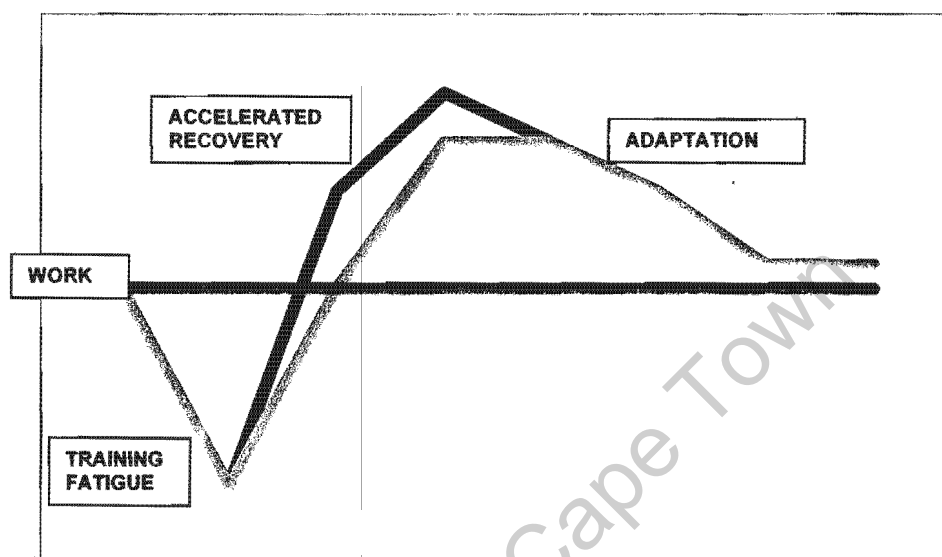


Figure 2.1: *The principle of recovery (adapted from Rushall et al, 1990)*

Selye's General Adaptation Syndrome (GAS), which can be used to model sports performance (Stone et al, 1991). Conceptually, adaptation or mal-adaptation is the summation of all stressors that an athlete may encounter (Figure 2.2). So, recovery-adaptation may be viewed as long-term interplay among various stressors and not just training.

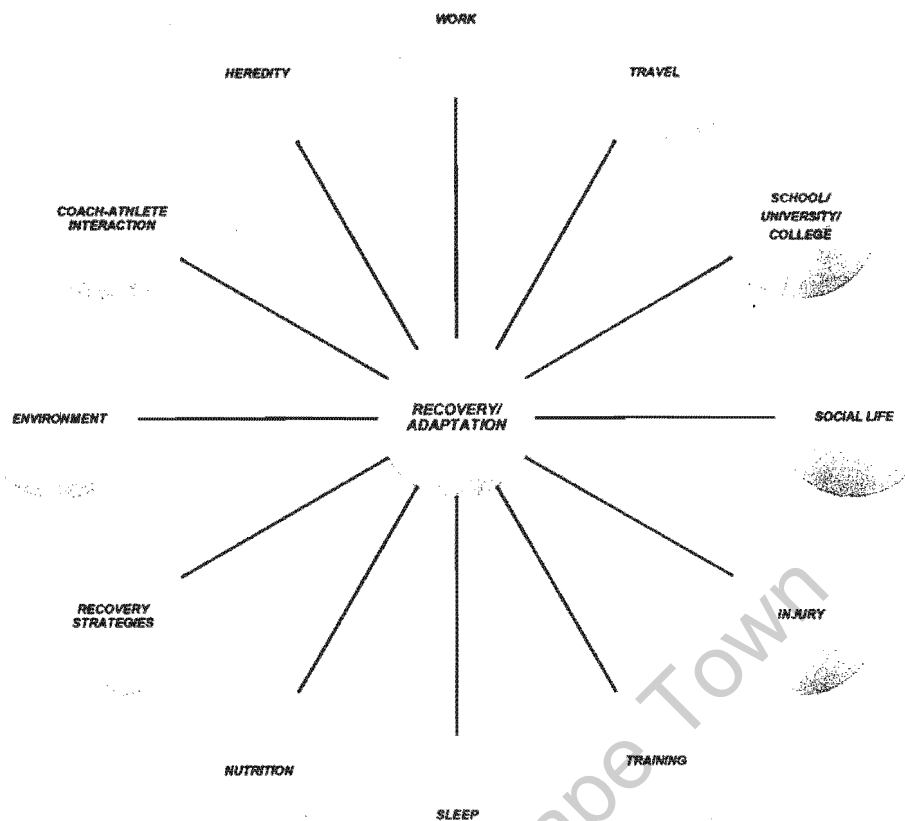


Figure 2.2: Interplay among stressors that can influence the recovery-adaptation relationship
(adapted from Stone et al, 1991)

The inability to recover not only effects adaptation, but also affects the athlete's ability to respond to the next training session/match leading to an overuse injury (Stone et al, 1991)

Monitoring the Training Process

Role of the Coach in Monitoring the Athlete

Calder (2003) noted that: "Each coach has a wealth of observational information about the indicators of poor adaptation and excessive fatigue". "It is important for each coach to identify what it is that they observe that is indicative of excessive stress and fatigue." In table 2.2 a "checklist" are listed enabling coaches to monitor an athlete's adaptation to training and stress.

Table 2.2: Example coaching checklist for monitoring an athlete's adaptation to training and stress (Calder, 2003).

Signs & Symptoms of Non-adaptive Responses	Coaching Observations
Athletes tells me he has: Heavy legs Doesn't feel good Legs are sore Feels tired	Direct Communication
Facial expression and color Posture Signs of frustration, etc.	Body Language
Poor skill execution Slow acceleration off the mark Heavy feet Poor or slow decision making / response time	Performance
Low motivation Low concentration Aggressiveness No self-confidence	Psychological
Poor eating habits Poor diet Poor sleep patterns External stresses	Gut feeling / 6th sense / Other things

Role of the Athlete in Monitoring Training Adaptations

Athletes should also monitor training adaptations through regular recordings in a training diary or log book. Calder (2003) mentions that: "Maintaining a daily record is an essential training tool for all athletes as it enables them to learn how to *evaluate* their stress levels and their adaptive responses."

There are four critical markers that should be regularly recorded by athletes including recordings of the quality of sleep, morning resting heart rate and morning body weight, and a daily rating of fatigue levels. These four variables may be the first warning to an athlete that he or she is not adapting well to training and other stresses (Calder, 2003).

In summary, Calder (2003) notes that: "recovery-adaptation is a multi-dimensional process that is driven by the training stimulus." Creative planning of the training process, which not only includes the training stimulus but also built in rest and recovery periods or strategies, can enhance recovery-

adaptation (Calder, 2003). A necessity is proper monitoring of training-recovery-adaptation. Ultimately, appropriate planning and monitoring of this process can result in superior sports performance.

CONCLUSION

Each medical support group develops their own protocol for enhancing recovery which may consist of a specific technique or a combination of techniques. The strategies that are currently used usually vary between teams. The scientific evidence supporting each protocol is in many cases lacking or not applied according to the principles of best practice. However, before recommendations can be made about recovery strategies it is important to know what practitioners are actually doing. At this stage this information is not available. With regards ice/cold water immersion, which is a popular recovery strategy used in a variety of sports, there does seem to be anecdotal evidence that the treatment is effective. However the scientific data supporting the efficacy of the treatment are lacking. A possible reason for the lack of scientific evidence is that there are different protocols and therefore any experimentation will only be relevant for the protocol tested.

To fill this void the aim of this study is to survey a representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) who are involved with rugby teams to find out which strategies they use to accelerate recovery of the players after training and matches. In particular the aim was to focus on the details of implementing ice/cold water immersion as a recovery strategy. This information is needed before studies can be designed to investigate the efficacy and mechanism of actions of the various procedures.

Chapter 3

A survey to determine the recovery strategies that medical support staff of rugby teams use to improve recovery of the players

ABSTRACT

Objective: To determine the strategies used to accelerate recovery of elite rugby players after training and matches. A secondary aim was to focus on the specifics of implementing ice/cold water immersion as recovery strategy. **Design:** A questionnaire-based cross sectional descriptive survey of most (n = 58) of the medical support staff of rugby teams who attended the inaugural Rugby Medical Association meeting. **Results:** Percentages expressing usage, not time spent per strategy. Most of the subjects had been involved with sport teams and using recovery strategies for 4-6 years. The majority of participants agreed that their planning and executing of recovery was part of a multi-disciplinary approach. Recovery strategies are utilized mostly after matches, followed by after every training session. Stretching and ice/cold water immersion was utilized the most (83%), followed by active recovery (74%) and massage (66%). More biokineticists and fitness trainers advocated the usage of stretching than their counterparts (medical doctors, physiotherapists). Hyperbaric oxygen and visualization were the strategies utilized the least. Ice/cold water immersion was rated as the most effective recovery strategy. Massage and additional sleep and rest (29%) were the strategies mostly used if a player is overtrained, where NSAIDS was mostly used for injured players (45%). The players' perception of ice/cold water immersion was the factor which influenced the medical staff the most in deciding to use this as a recovery strategy. Ice/cold water immersion is utilized mostly after matches and followed training sessions that were particularly hard. A summary of the details around implementation of ice/cold water therapy are: (i) the time to immersion after matches and total duration of immersion session was 0-5 minutes; (ii) 2-3 immersion sessions per average training week; (iii) only 14% of medical support staff using ice/cold water immersion measured the temperature of water with immersion; (iv) the average water temperature for immersion was 10 °C.; (v) ice cubes were used most frequently to cool water, and (vi) plastic drums were mostly used as the container for the water. **Conclusion:** In this survey the representative group of support staff provided insight into which strategies are utilized in South African elite rugby teams to accelerate recovery of the players after training and/or matches. This information can be useful for designing studies to investigate the efficacy and mechanism of actions of the various procedures and in particular ice/cold water immersion.

INTRODUCTION

Training and competition challenge the neurological, physiological, nutritional and psychological functions of the athlete (Calder, 2003). The degree to which each function is challenged depends on the focus of the training session i.e. endurance or speed or competition and the recovery between training sessions. The stressful components of training and competition may temporarily impair an athlete's performance (Barnett, 2006). To be able to cope with this adaptive stress, it is very important to recover from training/competition. Various modalities of recovery are utilized in an attempt to restore and adapt in preparation for the next training session/competition (Barnett, 2006). The ultimate aim of these modalities is to reduce fatigue, injury and the transient impairment in performance while encouraging effective adaptation. Equally as important as a warm up routine, is a recovery routine beginning immediately after training/competition (cool down) and continuing for up to 24 hours post training or competition.

There are different types of recovery. These include short-term and long-term recovery strategies. Short-term recovery strategies include recovery within a session to allow the player to reproduce a quality effort; recovery immediately following a session, a recovery session in itself which will speed up the recovery process. Long term recovery strategies include the off-season break from the game. This long-term recovery is essential to ensure that the player returns refreshed to the pre-season.

A review of the literature on the popular strategies which are used to accelerate recovery in rugby (cryotherapy, massage, stretching, compression garments, active recovery, nutrition, sleep and non-steroidal anti-inflammatories) (Chapter 2) shows that there is not overwhelming evidence supporting any of these techniques. This can be attributed to the fact that many of the studies are laboratory based and the protocols which are used to simulate training or competition may lack specificity. Another potential problem is that the markers which are used to define the state of recovery are indirect and also lack specificity.

Thus, before more general recommendations can be made about recovery strategies it is important to know what practitioners associated with rugby teams are actually doing. Whilst it may be concluded, based on anecdotal data, that recovery strategies are effective, there are insufficient data to support their effectiveness in an evidenced-based way.

Therefore the aim of this study was to survey a representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) who are involved with rugby teams to determine which strategies they use to accelerate recovery of the players after training and matches. In particular, details about ice/cold water immersion as a recovery strategy were investigated. This information is needed before studies can be designed to investigate the efficacy and mechanism of actions of the various procedures.

METHODS

STUDY DESIGN

This study was a questionnaire-based cross sectional descriptive survey.

SUBJECTS AND TESTING PROCEDURE

All the medical support staff of rugby teams (doctors, physiotherapist, biokineticists and fitness trainers) who attended the inaugural Rugby Medical Association conference linked to the South African Sports Medicine Association Conference in Pretoria (14-16th November, 2007) were invited to participate in the study. All participants (n = 58) were given information about the study, and assured that their names would not be linked to the data. They also had the option of withdrawing from the study at any time. They signed an informed consent form before completing a questionnaire (Addendum A). The questionnaire took about 15 minutes to complete. Participants completed the questionnaire after one of the sessions at the conference. After finishing each participant placed the unmarked questionnaire in a box. The sealed boxes were only opened after the conference had ended. All the data were therefore collected in such a manner that individual subjects were not identifiable, and confidentiality was at all times maintained. The study was approved by the Research and Ethics Committee of the Faculty of Health Sciences, University of Cape Town (Addendum C).

QUESTIONNAIRE

The information in the questionnaire was developed from the review paper on recovery strategies (Barnett, 2006) A sample of health professionals, who were similarly qualified to the health professionals who were targeted in this study, completed a draft form of the questionnaire. Any ambiguous questions were adjusted. The revised questionnaire was tested again and questions were adjusted where appropriate. A copy of the final questionnaire is shown in Addendum D..

DATA ANALYSIS

The answers to the questions were transcribed into a spreadsheet and checked before analysis.

STATISTICS

The descriptive data are presented as means and standard deviations or percentages. There was concern about lack of statistical power when the groups were subdivided hence we avoided using comparative statistics.

RESULTS

SUBJECTS

Of the 58 subjects that filled out the questionnaires 74% were male and 26% female. The majority of subjects were doctors (36%), followed by physiotherapists (33%), biokineticists (19%), fitness coaches (7%) and three other professions including a chiropractor, masseuse and dietitian.

Table 3.1 Profession of subjects (n=58)

<u>PROFESSION</u>	<u>PERCENTAGE</u>
DOCTORS	<u>36</u>
PHYSIOTHERAPISTS	33
BIOKINETICISTS	19
FITNESS COACHES	7
OTHER	5

The doctors were generally the eldest subjects (42 ± 8 years) and fitness coaches the youngest (28 ± 5 years). The majority of subjects were between 25 and 30 years of age Table 3.2 shows the spread of ages of all subjects.

Table 3.2 Age of subjects (n=58)

<u>AGE (YEARS)</u>	<u>PERCENTAGE</u>
20-25	7
25-30	<u>33</u>
30-35	16
35-40	17
40-45	9
45-50	12
50-55	4
55-60	2

EXPERIENCE OF SUBJECTS

The majority (48%) of the subjects had been using recovery strategies for 0 – 5 years followed by 28% of subjects using recovery strategies for 5 - 10 years, 12% for 10-15 years and 2% for 20-25 years. Some of the subjects (10%) were not currently using recovery strategies. It was decided to retain their responses in the subsequent analyses to ensure that the interpretation of the data was not bias.

Fifty-six % of all subjects agreed that the planning of the recovery was a multi-disciplinary approach and 47% agreed that the executing the recovery strategies involved a multi-disciplinary approach

TYPES OF RECOVERY STRATEGIES USED

Of the 17 post-match and/or training recovery strategies proposed in the questionnaire (Addendum D) stretching and ice/cold water immersion was utilized the most (83%), followed by active recovery (74%), and massage (66%). A breakdown of all the recovery strategies are shown in Table 3.3

Table 3.3 Recovery strategies used by respondents arranged in order of use (n=58)

<u>STRATEGIES</u>	<u>PERCENTAGE</u>
STRETCHING	83
ICE/COLD WATER IMMERSION	83
ACTIVE RECOVERY	74
MASSAGE	66
ADDITIONAL HYDRATION	59
NUTRITION: EXTRA CARBOHYDRATES	54
COMPRESSION GARMENTS	53
LIMITING/AVOIDING ALCOHOL USE	49
NUTRITION: EXTRA PROTEIN	49
NUTRITION: EXTRA ELECTROLYTES	48
NSAIDS	37
ADDITIONAL SLEEP AND REST	36
CONTRAST TEMPERATURE WATER IMMERSION	27
ELECTROMYOSTIMULATION	14
OTHER STRATEGIES	10
VISUALIZATION	7
HYPERBARIC OXYGEN	0

Other strategies included powerplate (vibration training), ice-room/freeze room therapy, physiological counseling, pre-post weighing and immuno-nutrition. These were unsolicited treatments and no further detail was provided.

DIFFERENCE BETWEEN PROFESSIONS IN UTILIZING THE TOP 3 RECOVERY STRATEGIES

All of the biokineticists (100%) and fitness coaches (100%) advocated the usage of stretching, followed by physiotherapists (89%) and doctors (71%). Biokineticists mostly (91%) advocated the usage of ice/cold water immersion, followed by physiotherapists (84%), fitness coaches (75%) and doctors (48%).

Active recovery was also mostly used by biokineticists (100%) followed by fitness coaches (75%), physiotherapists (74%) and doctors (67%).

EFFICACY RATINGS OF RECOVERY STRATEGIES

A summary of the efficacy of the various recovery strategies are shown in Figure 3.1 and Figure 3.2. The data are expressed as "counts" to avoid confusion with the denominator. The categories are defined as follows: 1 = completely ineffective, 2 = mildly ineffective, 3 = mildly effective, 4 = effective and 5 = extremely effective.

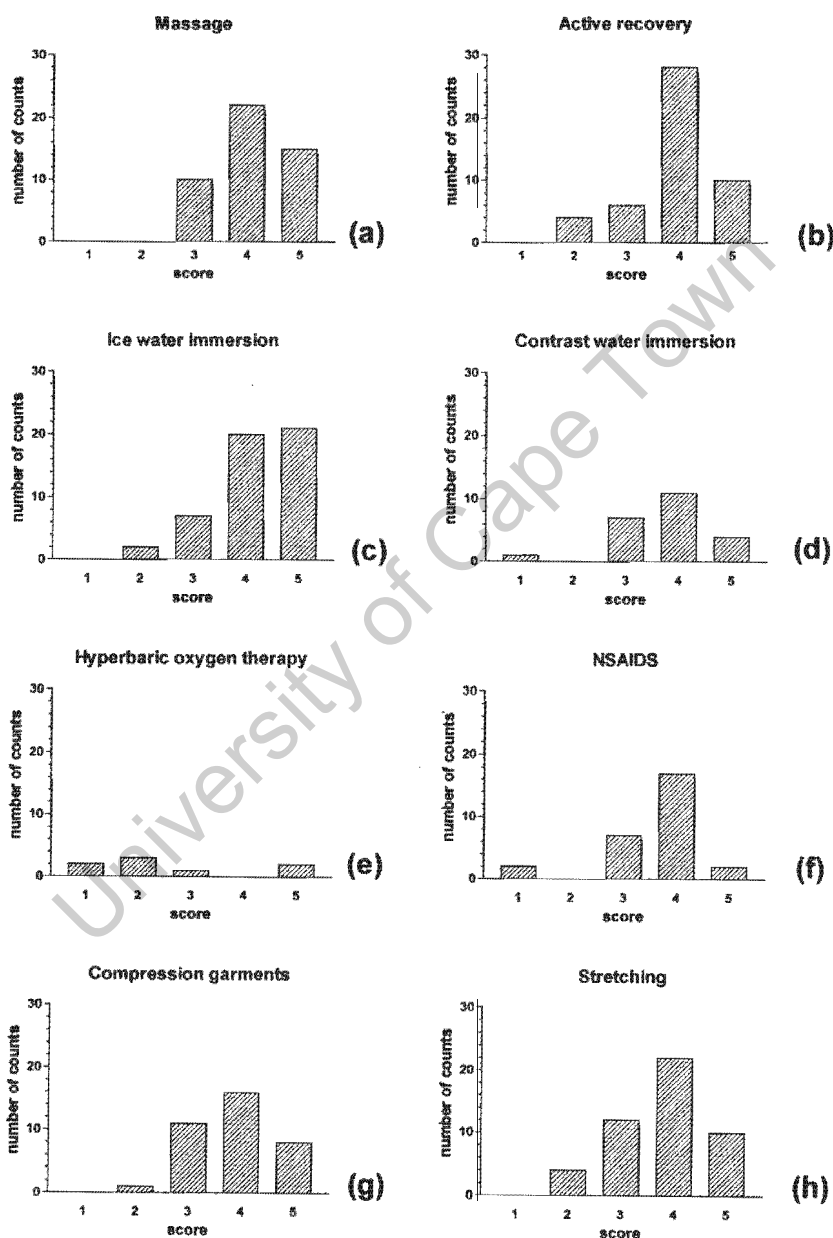


Figure 3.1 Rating of efficacy for (a) massage, (b) active recovery, (c) ice water immersion, (d) contrast temperature water immersion, (e) hyperbaric oxygen therapy, (f) non steroidal anti inflammatory, (g) compression garments and (h) stretching.

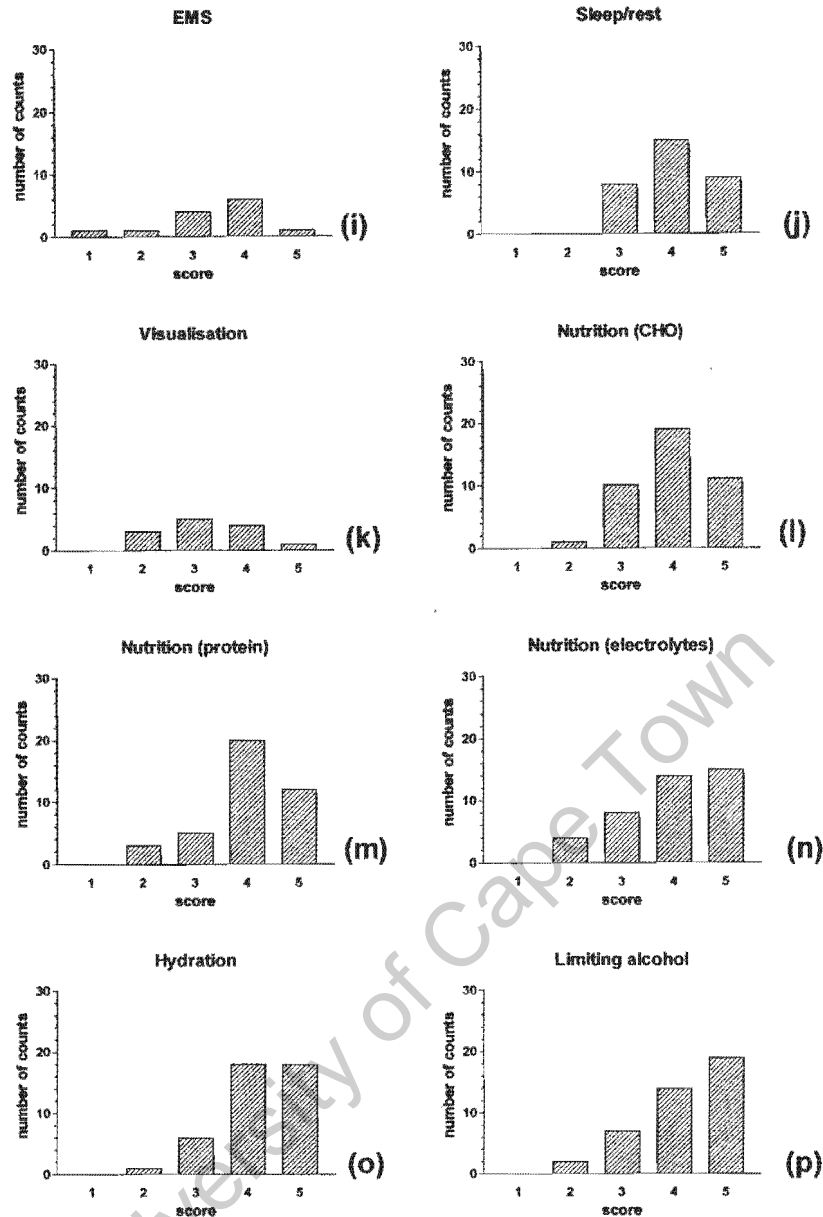


Figure 3.2. Rating of efficacy for (i) electromyostimulation, (j) additional sleep and rest, (k) visualization, (l) additional carbohydrates, (m) additional protein, (n) additional electrolytes, (o) hydration and (h) limiting alcohol

Ice/cold water immersion achieved the highest overall efficacy rating as recovery strategy with 34% of subjects rating it as “effective” and 36 % of subjects rating it “extremely effective”. The next highest efficacy rating was active recovery (48% and 17%; “effective” and “extremely effective” respectively), massage (38 % and 26% respectively) and additional hydration (31% and 31% respectively).

Table 3.4 explains when strategies for recovery are used. The sessions are coded as 1-after every single training session, 2-only if training was hard, 3- after every match, 4- only if match was hard, 5- if

player is overtrained or 6- if player is injured. The various recovery strategies are arranged according to the ranking established in Table 3.3.

Table 3.4 Various training and match situations and their association with recovery strategies. The values represent a percentage of the number of respondents (n=58)

<u>STRATEGY</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
STRETCHING	74	5	52	5	16	29
COLD/ICE WATER IMMERSION	28	41	67	12	14	26
ACTIVE RECOVERY	22	22	47	10	16	24
MASSAGE	5	17	33	14	29	43
ADDITIONAL HYDRATION	60	10	59	3	7	10
NUTRITION: EXTRA CARBOHYDRATES	45	17	55	3	5	3
COMPRESSION GARMENTS	17	12	22	7	7	36
LIMITING/AVOIDING ALCOHOL USE	47	9	64	5	17	29
NUTRITION: EXTRA PROTEIN	36	16	45	5	7	9
NUTRITION: EXTRA ELECTROLYTES	48	5	48	9	10	10
NSAIDS	0	3	3	7	10	45
ADDITIONAL SLEEP AND REST	7	16	22	14	29	17
CONTRAST TEMPERATURE WATER IMMERSION	12	12	29	2	5	10
ELECTROMYOSTIMULATION	0	3	0	3	5	17
OTHER STRATEGIES	3	2	5	3	2	0
VISUALISATION	2	0	2	3	2	0
HYPERBARIC OXYGEN	0	0	0	0	0	0
MEAN	24	11	33	6	11	18

KEY:

1-AFTER EVERY SINGLE TRAINING SESSION,

2-ONLY IF TRAINING WAS HARD,

3- AFTER EVERY MATCH,

4- ONLY IF MATCH WAS HARD,

5- IF PLAYER IS OVERTRAINED,

6- IF PLAYER IS INJURED

Stretching was the strategy mostly used after every single training session (74%) and ice/cold water immersion was the strategy which was used mostly after matches (67%). Massage and additional sleep and rest (29%) were the strategies mostly used if a player is overtrained, where NSAIDS was mostly used for injured players (45%). Interestingly it is also noted that Ice/Cold Water immersion is only used by 26% of subjects if the player is injured. This could be due to time constraints and practicality as normal ice application as mentioned in the Cryotherapy section is probably easier to perform if a player is injured.

Overall, based the mean of each match and training situation, recovery strategies were mostly used after matches (33%), followed by after every single training session.

FACTORS THAT INFLUENCED THE SUPPORT STAFF TO USE ICE/COLD WATER IMMERSION AS A RECOVERY STRATEGY

In the questionnaire subjects had the choice of systematic reviews, experimental trials, field studies, anecdotal evidence, players' perception or their own perception as the factors that might have influenced on their perception about ice/cold water immersion.

The perception the support staff had about the efficacy of ice/cold water immersion as a recovery strategy seemed to be influenced mostly be the feedback they had received from the players (57%) (Table 3.5). This and the other influential factors which formed opinions about the efficacy are shown in Table 3.5.

Table 3.5 Factors that influenced the support staff to use ice/cold water immersion as a recovery strategy (n=58)

<u>FACTOR</u>	<u>PERCENTAGE</u>
PLAYERS' PERCEPTION	<u>57</u>
MY PERCEPTION	55
SYSTEMATIC REVIEWS OF PUBLISHED STUDIES	52
EXPERIMENTAL TRIALS	26
ANECDOTAL EVIDENCE	21
FIELD STUDIES	9

To avoid overlapping of responses the "systematic reviews of published studies" and "experimental trials" were merged into one entity namely "scientific evidence". "Anecdotal evidence" and "my perception" were also merged as one entity namely "own perceptions". Following this re-analysis the scientific evidence was still secondary to other factors (Table 3.6)

Table 3.6 Factors that influenced the support staff to use ice/cold water immersion as a recovery strategy – (merged categories) (n=58)

<u>FACTOR</u>	<u>PERCENTAGE</u>
"OWN PERCEPTIONS"	<u>62</u>
"SCIENTIFIC EVIDENCE"	59
FIELD STUDIES	9
PLAYERS' PERCEPTION	57

PROTOCOLS FOR ICE/COLD WATER IMMERSION

Of the 58 subjects, 48 indicated that they used ice/cold water immersion as a recovery strategy (83%) and then 45 subjects completed the subsequent questions about ice/cold water immersion. Based on

their responses, 24 subjects used ice/cold water immersion after matches and training, 19 after matches only and two subjects use ice/cold water immersion after training only (Table 3.7). Note the difference in responses to table 3.4. This could be due to non-compliance to some of the questions.

Table 3.7 Responses to ice/cold water immersion questions

RESPONSES	<i>n</i>	<i>%</i>
USE ICE/COLD WATER IMMERSION	48	-
COMPLETED QUESTIONS ABOUT ICE/COLD WATER IMMERSION	45	-
USE ICE/COLD WATER IMMERSION AFTER MATCHES AND TRAINING	24	53
USE ICE/COLD WATER IMMERSION AFTER MATCHES ONLY	19	42
USE ICE/COLD WATER IMMERSION AFTER TRAINING ONLY	2	4

With regards to the different protocols used for ice/cold water immersion by medical staff of rugby teams in this study, the following protocols were utilized the most:

When ice/cold water immersion is used

Of the 45 subjects that completed questions about ice/cold water immersion, 43 (96%) utilized it after matches and 26 (58%) utilized it after training (Table 3.7).

Time to immersion after matches

Only 14 subjects (33 %) of the forty-three who use ice/cold water immersion after matches strictly controlled the time to apply the ice/cold water immersion. These data are shown in Figure 3.3. The data are expressed as "counts" to prevent the data from being over interpreted. The figure shows that most of the subjects applied the ice/cold water immersion between 0-5 minutes after matches, followed by 10-15 minutes and 15-20 minutes.

Time to immersion

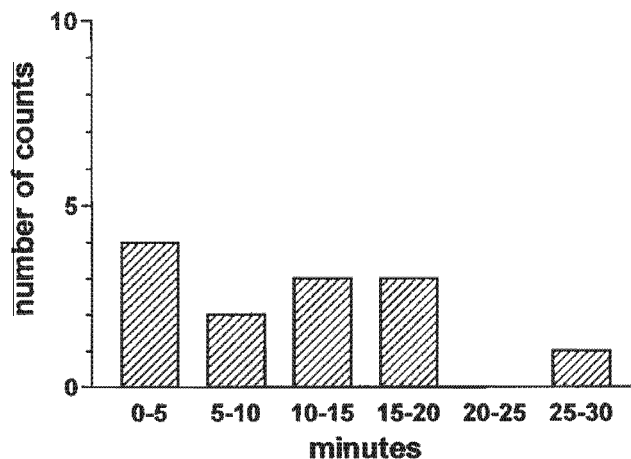


Figure 3.3 Time to immersion after matches (n= 14)

Ice/cold water immersion session protocols after matches

To avoid confusion, the following explanation regarding ice/cold water immersion is included:

One immersion session = x amount of single immersions

The total duration (in minutes) of the immersion session after matches is shown in Figure 3.4. Thirty of the forty three subjects using ice/cold water immersion (70%) control the total duration of immersion sessions. The most popular duration was 0 – 5 minutes (69% of the responses). The other options are shown in Figure 3.4. Once again the data are presented as “counts” to guard against an over interpretation of the data.

Total duration of immersion

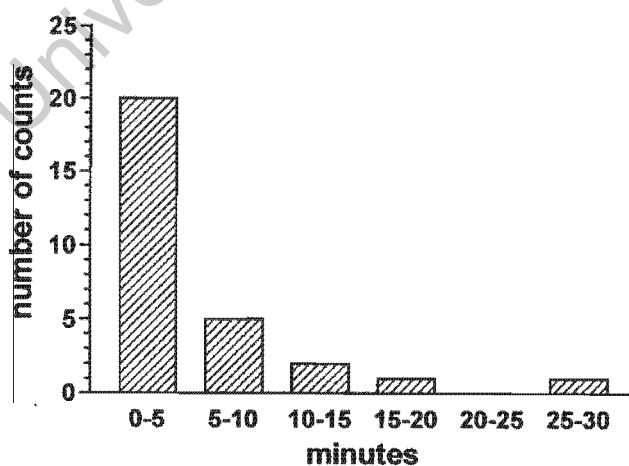


Figure 3.4 Total duration of immersion session after matches (n=30)

The duration of a single immersion is shown in Figure 3.5.

Sixty-six% of the 32 subjects that responded to this question agreed on a duration of 0-2 minutes per single immersion.

Duration of single immersion

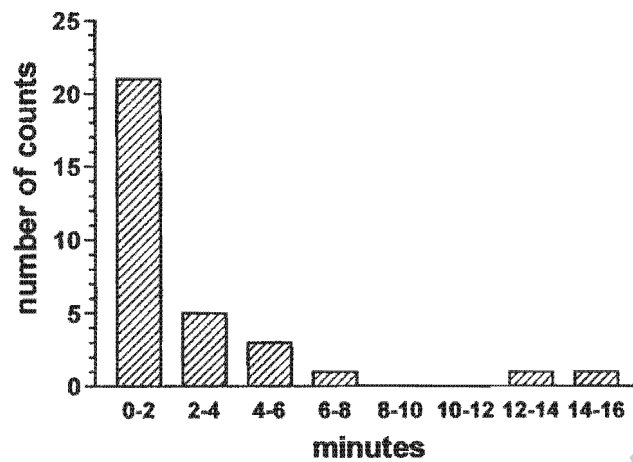


Figure 3.5 Duration of a single immersion after matches (n=32)

In Figure 3.6 the number of consecutive single immersions per session after matches is shown.

Thirty eight % of the 24 subjects who control the number of consecutive single immersions per session make use of one single immersion per session, followed by three single immersions per session (33%).

Number of consecutive immersions

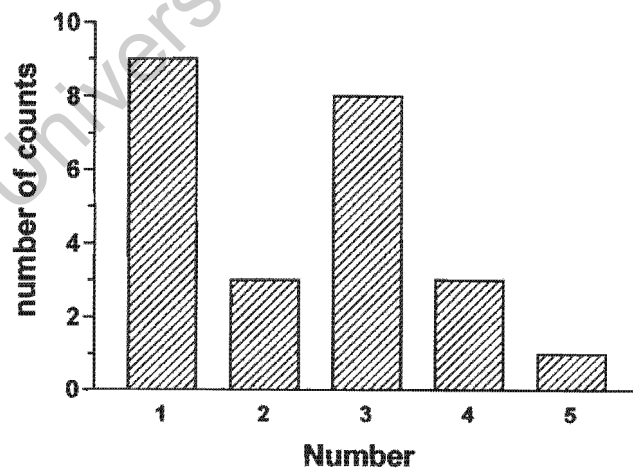


Figure 3.6 Number of consecutive immersions per total session after matches (n=24)

2-3 immersion sessions per average training week, including matches, is utilized by most (31%) of the 40 subjects that responded to this question (Figure 3.7).

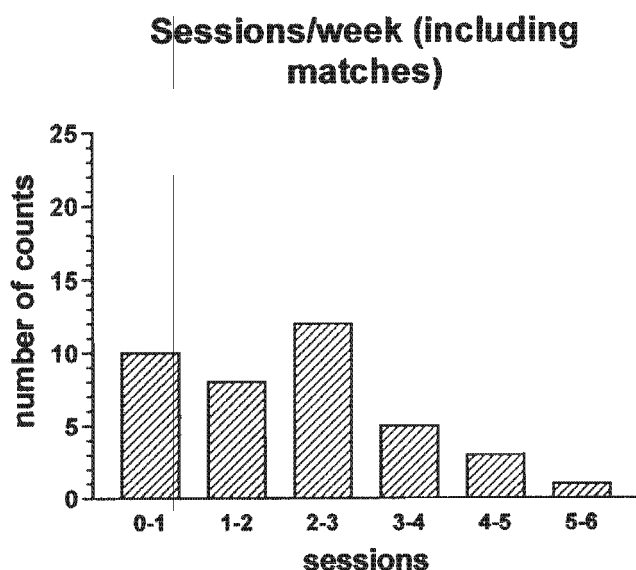


Figure 3.7 Number of immersion sessions per average training week, including matches (n=40)

Temperature of water for immersion after matches

Only 6 subjects (14%) measured the temperature of water with immersion. The reasons for not measuring the water temperature included that "the ice cubes in water were sufficiently cold" and "logistical issues". The average water temperature for immersion after matches was $10(\pm 3)$ °C as used by the subjects (14%) who measured the temperature.

Difference between matches and training ice/cold water immersion protocols

The subjects were questioned about their ice/cold water immersion protocols after matches and training protocols. Table 3.8 shows that there is a difference in ice/cold water immersion protocols for matches and training. Note that the n-value only represents the amount of subjects who answered the applicable questions.

Table 3.8 Difference between matches and training ice/cold water immersion protocols

RESPONSES	MATCHES	TRAINING
TIME AFTER ACTIVITY BEFORE IMMERSION (MIN)	12±9 (n=43)	5±3 (n=26)
DURATION TOTAL IMMERSION SESSION (MIN)	6±6 (n=30)	3±1 (n=26)
NUMBER OF CONSECUTIVE IMMERSIONS PER SESSION	2±1 (n=24)	2±1 (n=23)
DURATION PER SINGLE IMMERSION (MIN)	3±3 (n=32)	2±1 (n=23)
AVERAGE TEMPERATURE OF WATER (C°)	10±3 (n=6)	9±4 (n=4)

Table 3.9 shows the difference between the protocols of ice/cold water immersion as used by subjects after home matches, away matches and training, and also the containers used for these treatments. Ice cubes are most frequently used to cool water (77% after home matches, 81% after away matches and 81% after training) Plastic drums are mostly used as the container for the water (56% after home matches, 93% after away matches and 73% after training) (Table 3.9).

Table 3.9 How water is cooled for ice/cold water immersion and the containers used for these treatments. Data are expressed as a % of the number of subjects who answered this question.

<u>HOW WATER IS COOLED</u>	<u>HOME MATCH</u> n=43	<u>AWAY MATCH</u> n=43	<u>TRAINING</u> n=26
ICE CUBES	77	81	81
ICE BLOCK	47	56	46
ICE WATER	0	2	0
THERMOSTATICALLY	9	0	8
COLD RUNNING TAP WATER ONLY	0	2	0
COLD SWIMMING POOL WATER ONLY	5	9	0
 <u>TYPE OF CONTAINER</u>			
PLASTIC DRUM	56	93	73
PORTABLE JACUZZI	28	0	19
PORTABLE BATH	21	7	12
SWIMMING POOL	12	14	15
SHOWER	2	5	4

DISCUSSION

SUBJECTS

The first main finding of this study was that the professions (especially with regards to the doctors and physiotherapists) usually associated with the support staff of rugby teams were equally distributed. There was a bias of males (74%) compare to females (26 %) but this probably reflects the gender differences that occur in the members of the medical support team. The subjects in this survey with regards to sport team structures, and usage of recovery strategies were well experienced. Generally the doctors were the oldest and fitness coaches the youngest subjects. The majority (48%) of the subjects had been using recovery strategies for 0 – 5 years. Some of the subjects (10%) were not currently using recovery strategies. However it was decided to retain their responses in the subsequent analyses to ensure that the interpretation of the data was not bias.

Generally subjects agreed that the planning and executing of recovery was a multi-disciplinary approach.

In summary, it can be concluded that the group represented practitioners are dealing with issues around recovery of rugby players on almost a daily basis. Therefore their responses to the questions should be interpreted in this context. Due to the novelty of this survey, no other data could be found to compare with the above findings.

WHEN STRATEGIES ARE UTILIZED

Strategies for recovery are utilized mostly after training sessions (74%), followed by after every training session. It was found that stretching was the strategy mostly used after every single training session (74%) and ice/cold water immersion after every match (67%). Overall, based on the means of all match and training situations, recovery strategies were mostly used after matches (33%), followed by after training sessions.

Biokineticists mostly (91%) advocated the usage of ice/cold water immersion, followed by physiotherapists (84%), fitness coaches (75%) and doctors (48%). Active recovery was also mostly used by biokineticists (100%) followed by fitness coaches (75%), physiotherapists (74%) and doctors (67%). Again, due to the novelty of this survey, no other data could be found to compare with the above findings.

TYPES OF RECOVERY STRATEGIES USED

The second finding of this study is that stretching and ice/cold water immersion as a recovery modality was utilized the most, followed by active recovery and massage. "Other strategies" included powerplate (vibration training), ice-room/freeze room therapy, physiological counseling, pre-post weighing and immuno-nutrition. These were unsolicited treatments and no further detail was provided.

As discussed earlier, a review of the literature on the popular strategies which are used to accelerate recovery in rugby (cryotherapy, massage, stretching, compression garments, active recovery, nutrition, sleep and non-steroidal anti-inflammatories) shows that there is not overwhelming evidence supporting any of these techniques. This can be attributed to the fact that many of the studies are laboratory based and the protocols which are used to simulate training or competition may lack specificity. Another potential problem is that the markers which are used to define the state of recovery are indirect and also lack specificity. Practical experience as demonstrated in this survey indicates that once a recovery strategy is designed it should become ritualistic and habitual for the players within the team. They need to be educated about the importance of recovery and be expected to take some responsibility for their own recovery. Optimal recovery requires a multidimensional approach that addresses all aspects of the rugby player's lifestyle, such as sleep, nutrition, overall stress exposure and physiological recovery (Jeffreys, 2007). The next section will examine and compare results from this survey to the experimental evidence supporting or refuting the efficacy of

the often used recovery strategies in rugby. This will be followed by guidelines which have been established using evidence-based principles (where available) and anecdotal experience.

Stretching

The main goal of stretching is to increase the range of motion about joints. The data showing that this indeed occurs is convincing (Beaulieu, 1991; Thacker et al, 2004). Stretching is commonly advocated as a technique for reducing the risk of injury (Hartig et al, 1999) although the research does not necessarily support this (Thacker et al, 2004; Anderson, 2005).

The evidence supporting stretching as part of a recovery protocol is less convincing, although in this survey it was a very popular recovery strategy. Stretching was the strategy mostly used after every single training session (74%), followed by usage after every match (52%). Stretching was also mostly rated as an "effective" strategy by the 58 subjects in this survey. All of the biokineticists (100%) and fitness coaches (100%) advocated the usage of stretching, followed by physiotherapists (89%) and doctors (71%). While a mechanism by which stretching may enhance the recovery process has yet to be identified, it has been suggested that stretching may disperse oedema accumulated during tissue damage (Bobbert et al, 1986). This theory however has not been proved. Furthermore, there do not appear to be any studies that have investigated the effect of stretching between exercise sessions/matches on performance during post-recovery exercise/competition (Barnett, 2006). Stretching exercises have been shown to be ineffective in reducing the symptoms of muscle damage (Cheung et al, 2003; Connolly et al, 2003; Gulick et al, 1996; Mika et al, 2007). A comprehensive review of studies which had used stretching after exercise (total stretching time ranging from 300 to 600 seconds) with the goal of reducing muscle soreness, showed that 72 hours after exercise, pain had only reduced by 2% which was not regarded as meaningful (Anderson, 2005).

Active Recovery

Despite the lack of understanding of the mechanisms of active recovery, there are several studies which show that this method has some positive effects. For example, a recent study on rugby players showed that recovery rates (using creatine kinase in transdermal exudate as a marker) were similar for active recovery, contrast temperature water immersion and wearing lower body compression garments and were significantly better than passive recovery (Gill et al, 2006). Another study also showed that after high-intensity training a 15 minute treatment of either (i) active recovery (cycling at 30% VO_{2max}), (ii) massage or (iii) cold water immersion (15° C) improved recovery (measured by work performed) in contrast to a group which did not use any of these strategies (Lane et al, 2004).

In this survey, active recovery was used by 74% of subjects mostly after matches. It was also rated as an "effective" strategy by most subjects and used by more biokineticists, followed by fitness coaches, physiotherapists and doctors.

Active recovery enhances the removal of high levels of circulating lactate (Brooks et al, 2005). However, as discussed previously, the link between high levels of circulating lactate and impaired muscle function is dubious. It follows then that if active recovery has beneficial effects, the mechanism of action can then be attributed to other mechanisms.

However, not all studies show that active recovery has a beneficial physiological effect. Suzuki et al (2004) found that active recovery did not have any effect on recovery (measured by circulating creatine kinase and neutrophils) after a rugby match, although the players seemed to have better mental recovery after being exposed to an active recovery protocol consisting of low intensity exercise (Suzuki et al, 2004). Another study showed that low intensity exercise had a temporary analgesic effect on sore muscles, but no effect on recovery from muscle damage (Zainudden et al, 2006).

Active recovery needs to be an integral part of the training programme and implemented immediately after a training session (cool down), or after a match. Active recovery can also be structured into the programme on days of "easy" training. Active recovery needs to incorporate aerobic type activity with stretching exercises included in the protocol (Jeffreys, 2005). The activity should be of a sufficiently low intensity not to induce further fatigue, and also to assist with a psychological recovery, particularly after a tense match. Active recovery should always be performed in a non-competitive environment. A popular form of active recovery, particularly the day after a match is a pool session or a session of light jogging.. (Jeffreys, 2005) A possible future recommendation is for surveys to evaluate the specific type of active recovery, as there is many to choose from. The variety of protocols could also lead to different effects on the recovery process.

Cryotherapy

Cryotherapy is a term which describes a range of therapeutic treatments of cold aimed at lowering tissue temperature by the withdrawal of heat from the body (Chesterton et al, 2002). Treatment can be applied either in the form of ice packs, ice massage, ethyl chloride, cold air, cold water immersion (Mednick et al, 2002). More recently cryotherapy has been used as an ergogenic aid, as whole-body immersion in cold water before exercise in the heat has been associated with an improvement in performance (Booth et al, 1997; Marino, 2002). The basis for using cryotherapy and in particular ice/cold water immersion is on the assumption that it is effective for decreasing metabolic rate, inflammation, blood flow, and skin muscle and intra-articular temperatures (Merrick 1999).

Whether cryotherapy improves recovery remains open to debate. Relevant studies on cold-water immersion and contrast temperature therapy will be discussed and compared with the findings of this survey.

Ice/cold water immersion

Of the 58 subjects in this survey, 48 indicated that they used ice/cold water immersion as a recovery strategy (83%) of which biokineticists were represented the most, followed by physiotherapists, fitness coaches and doctors. Ice/cold water immersion achieved the highest overall efficacy rating as recovery strategy in this survey with 34% of subjects rating it as "effective" and 36 % of subjects rating it "extremely effective". Ninety-six % of subjects utilized ice/cold water immersion after matches and 58% utilized ice/cold water immersion after training. It is noted that the medical staff in this survey value ice/cold water immersion as a very important strategy for recovery after matches and/or training. Interestingly it is also noted that Ice/Cold Water immersion is only used by 26% of subjects if the player is injured. This could be due to time constraints and practicality as normal ice application as mentioned in the Cryotherapy section is probably easier to perform if a player is injured. Different studies about ice/cold water immersion will be reviewed and compared to results found in this survey.

A study reviewed the effectiveness of cold water immersion and active recovery in 10 well trained cyclists following high-intensity exercise conducted in hot conditions (34°C) (Vaile et al, 2008). The therapies consisted of either intermittent cold water immersion for 15 minutes at either 10°C, 15°C, 20°C, or a 15 minute continuous immersion at 20°, or active recovery. A 5 minute active recovery cool-down preceded the immersion in the study by Vaile et al (2008). In this survey only 33 % of the forty-three who use ice/cold water immersion after matches strictly controlled the time to apply the ice/cold water immersion. Most of the subjects applied the ice/cold water immersion between 0-5 minutes after matches, followed by 10-15 minutes and 15-20 minutes. In the study by Vaile et al (2008) recovery was assessed as a function of the total work performed after the treatment. The cold water immersion protocols all reduced the thermal heat strain of the subjects after the high-intensity exercise, compared to the active recovery protocol. There were no differences in total work performed between any of the cold water immersion protocols. However, the subjects were able to maintain their repeat performance in the heat following all of these interventions in contrast to treatment with active recovery. The authors concluded that cold water immersion may be a useful strategy in sports when they are going to be two training sessions a day performed in hot conditions. This study was not designed to investigate the effect on inflammation and muscle damage. The question was examined in another study where healthy active subjects were exposed to exercise which caused severe muscle soreness and dysfunction and elevated serum markers of muscle damage (myoglobin and creatine kinase activity). Subjects were then assigned to treatment which consisted of 10 minutes of cold water immersion (10°C) (Bailey et al, 2007). Compare this to a total duration of 0 – 5 minutes (69% of the responses) and the average water temperature for immersion after matches 10° C as used by the subjects (14%) who measured the temperature in this survey. Subjects had reduced muscle pain at 1, 24 and 48 hours after the exercise. The treatment had no effect on creatine kinase activity; however myoglobin was reduced one hour after the exercise. These results suggest that cold water immersion therapy reduces some of the symptoms of exercise-induced muscle damage. The authors postulated that the effect was manifested either through decreasing intramuscular temperature with a reduced

inflammatory response, or an alternative explanation for the findings is that immersion caused haemodynamic changes as a result of increased hydrostatic pressure.

In another study subjects stood in either cold water (8°C) or hot water (44°C) up to their gluteal folds for 10 minutes (Burke et al, 2001). In comparison, the medical staff of rugby teams who completed this survey immersed players for 6 minutes at 10 °C. All subjects (n = 45) exercised only the right lower limb using a modified proprioceptive neuromuscular facilitation flexibility protocol, consisting of 1 set of 4 repetitions. This procedure was followed for 5 consecutive days. The maximum active hip flexion was measured on the first and fifth days. Both groups had significant improvements in hamstring length (pretest to posttest), however, there were no significant differences between groups. The authors concluded that there was no advantage in using either hot or cold immersion to increase hamstring length in healthy subjects (Burke et al, 2001).

Regular exposure to cold therapy during training may compromise the adaptation of the muscle. This was shown in a study which examined the effects of regular cold application to exercised muscles after training (Yamane et al, 2006). Training occurred either by a cycle ergometer or a handgrip dynamometer and cold therapy consisted of cold water immersion (5°C for 20 minutes, short rest and then repeated). After six weeks significant training effects were more frequent in the control than in the cold group, including increases in artery diameters in the control but not in the cold group. The authors concluded that training-induced molecular and humoral adjustments during the bout of exercise, including muscle hyperthermia are physiological signals which are important for inducing training effects (myofiber regeneration, muscle hypertrophy and improved blood supply). These data suggest that cooling generally reduces the signals associated with increased muscle temperature and which may have a negative effect on training adaptations. This however should not be confused with the potential benefit effect of cold therapy in the treatment of tissue trauma, i.e. as part of the RICE treatment (Yamane et al, 2006). The so-called "negative" effects of cryotherapy were also shown in a study which examined cold water immersion in 40 untrained subjects who performed eccentric loading on one leg to induce muscle soreness (Sellwood et al, 2007). Immediately after exercise subjects were randomly assigned to either a cold water immersion group (5°C) or tepid water (24°C) for three minutes. Response to these interventions was measured at 24, 48 and 72 hours after the exercise. There were no differences between treatments with regards to swelling, muscle function or circulating creatine kinase activity. However, at 24 hours the cold water immersion group had more pain when doing a specific movement compared to the control group. This was a paradoxical finding which argued against the use of cold water therapy as a recovery strategy. As mentioned earlier, a distinction should be drawn between the responses of untrained subjects versus trained subjects. As this study used untrained subjects it would be interesting to see whether similar findings were obtained with this protocol in a group of more highly trained subjects.

With the search for determining the efficacy of cryotherapy treatment, several studies have been found. These studies used protocols consisting of predominantly eccentric actions to induce muscle

damage. The first of three studies searched is Eston et al (1999) who used an immersion protocol (15° C for 15 minutes after exercise and thereafter same treatment every 12 hours for seven sessions) following eccentric exercise which caused muscle damage. Although they showed that muscle stiffness was reduced, there were no other signs of enhanced muscle repair (Eston et al, 1999). Paddon-Jones et al (1997) which also used eccentric exercise as a way of inducing muscle damage, showed that cold water immersion (20 minute immersions in a 5 5° water bath, interspersed by 60 minute rest periods) was ineffective in reducing symptoms of muscle soreness.

In another study with a similar design, a group of subjects completed 100 drop jumps to induce muscle soreness, followed by 12 minutes of cold water immersion (15°C). This treatment was repeated every 24 hours thereafter for three days. Goodall et al (2008) found here that although there were measurable symptoms of muscle damage after the drop jumps, the subjects who had the cold water therapy did not have any advantage over the control subjects. The data from these laboratory studies (Eston et al, 1999; Goodall et al, 2008; Paddon-Jones et al, 1997) should however be interpreted with caution because they used eccentric actions to induce muscle damage, and therefore the association with tissue trauma arising from this intervention compared to the physiological trauma of a rugby match may be limited. When comparing different studies a number of factors need to be controlled, such as the intervention causing the fatigue and muscle damage, the type of cold water immersion protocol, the duration of exposure, the body area immersed and the immersion temperature. Given these limitations, the available data are rather sparse making it difficult to formulate an evidence-based decision about the efficacy of cold water immersion after rugby. However, physiological evidence aside, there does seem to be anecdotal evidence for using cold water immersion after a match or hard training session. Perhaps the ritual of undergoing the cold water therapy focuses attention on recovery, and the increased attention indirectly enhances the recovery process? Further research is needed to answer this question.

In order to identify an effective ice/cold water immersion protocol to be subjected to scientific scrutiny, it is necessary to calculate optimum parameters of ice/cold water immersion. Six prominent studies were selected and compared with the mean parameters of this survey after matches (Table 3.10). Thereafter a mean was calculated for all the parameters in the search for an effective protocol.

Table 3.10 Parameters for ice/cold water immersion in the current literature compared to this survey

PARAMETER	This Survey (mean)	Eston et al (1999)	Selfwood et al (2007)	Vaite et al (2008)	Bailey et al (2007)	Burke et al (2001)	Paddon-Jones et al (1997)	Mean
Time to immersion (min)	12	IMMEDIAT.	IMMEDIAT.	5	IMMEDIAT.	IMMEDIAT.	IMMEDIAT	
Total duration (min)	6	15	3	5	10	10	20	10
Duration single immersion (min)	3	15	1	1	10	10	20	9
Consecutive immersions	2	1	3	5	1	1	1	2
Immersion sessions pw	3	3.5	1	1	1	5	1	2
Temp of water(C°)	10	15	5	10/15/20	10	8	5	10
How water is cooled	ICE CUBES	N.A	MELTING ICED H2O	N.A	CRUSHED ICE	N.A	ICE	
Type of container	PLASTIC DRUM	N.A	N.A	INFLATABLE BATH	BATH	N.A	PLASTIC COOLER	

It is noted that the average parameters for ice/cold water immersion protocols in 6 studies and a survey is as follows: The total duration of ice/cold water immersion : 11 minutes ; duration of a single immersion: 9 minutes ; Consecutive immersions per session: 3 ; immersion sessions per week: 3 ; Temperature of water: 10 C°

Influence on perception for the use of ice/cold water immersion as recovery strategy

The perception support staff had about the efficacy of ice/cold water immersion as a recovery strategy seemed to be influenced mostly be the feedback they had received from the players (57%).

Despite its widespread use, most ice-water immersion protocols have not been evaluated, and evidence attesting to its efficacy is lacking.

Contrast-temperature water immersion

Contrast temperature therapy consists of alternative cold and hot treatment through contrast temperature baths or warm and cold packs (Cochrane, 2004). A reduction in oedema and bruising, vasodilation and vasoconstriction of blood vessels, blood flow changes, and influences on the inflammatory responses have been attributed to this modality (Higgins et al, 1998). Two studies have shown that contrast therapy had little effect on deep muscle temperature (Higgins et al, 1998; Myrer et al, 1997), thus causing the mechanism of action to be unclear. Therefore the theory that the effects of contrast therapy can be attributed to fluctuations in tissue temperature is not founded on experimental evidence.

The data found on contrast therapy water immersion supporting the efficacy of this therapy is equivocal. Hamlin (2007) used 20 rugby players to perform a repeated sprint test and then either allocated them to a contrast temperature water therapy or active recovery. The therapy consisted of three 1-minute immersion in cold water (8 - 10°C) up to hip height, alternated with three 1-minute hot water (38°C) showers. The active recovery protocol consisted of six minutes of slow jogging. The contrast temperature group had a decrease in blood lactate concentration three minutes after the procedure and also had lower heart rates after the procedure and later when the subjects did a further set of exercise. Another study has also shown a reduction in plasma lactate after intense exercise, following contrast water immersion (Morton, 2007). Here, the lower body of the subjects was immersed in hot (36°C) and cold (12° C) water baths, after a bout of high-intensity exercise. On average the exposure time was four minutes hot, one-minute cold (5 repetitions). Although the subjects exposed to the contrast water immersion had a marginal decrease in lactate concentration, it is questionable whether this small difference had any practical significance. In the current survey 27 percent of medical staff that utilize contrast temperature water immersion mostly after matches (29%) also rated it as "effective".

Although recommendations have been made about the ratio of warm to cold exposure and duration of treatment, there is lack of scientific evidence to support the efficacy of any of these combinations (Cochrane, 2004). At best it can be said that any protocol involving contrast temperature therapy is based on anecdotal experience.

Massage

Massage therapy (also known as soft tissue massage or soft tissue therapy) involves direct physical action on the soft tissues of the body, especially muscles, tendons and fascia (Brukner et al, 2000). It is widely used by athletes to prepare for exercise and accelerate recovery from training and competition (Weerapong et al, 2005). According to Brukner et al (2000) there are five different soft tissue techniques including longitudinal stroking, transverse friction, transverse gliding, sustained myofascial tension, digital ischemic pressure and petrissage as studied by Ogai et al (2008). Data collected from 12 major national and international athletic events between 1987 and 1998 showed that physiotherapists spend between 24 and 52% of their time using massage (Galloway et al, 2004). In the current survey 66% of subjects use it as an "effective" recovery strategy, mostly if the player is injured and after matches. Regular massage contributes to soft tissue recovery from intense athletic activity (Brukner et al, 2000). The premise upon which massage treatment exerts its effects are thought to be through decreasing oedema and reducing pain, enhancing blood lactate removal and promoting healing by increasing muscle blood flow. These proposed mechanisms are not always supported by the scientific evidence as demonstrated by Hemmings et al (2000); Ogai et al (2008) and Tiidus et al (1995), suggesting that the effects may be psychological. These results show once again that pain and muscle function are disassociated and that muscle pain should be used with caution as a clinical marker of how a muscle has recovered.

In a review of all the published studies on massage by Mika et al (2007) showed that most studies contain methodological limitations, including inadequate training of the massage therapists, insufficient duration of treatment, too few subjects in the experiment, or over or under working of muscles that limits the practical conclusions which can be derived. However, it may be concluded from all these studies that generally muscle soreness arising from DOMS is reduced with massage. Whether impaired muscle function also recovers after massage remains less clear. Furthermore, whether recovery is enhanced after massage is also unresolved. In conclusion, there are sufficient positive results from the peer-reviewed literature to support the application of massage as part of the recovery process; however there is need for further research to fully understand the mechanism of action.

Compression

According to Barnett (2006) along with commercial promotion, there appears to have been a lay acceptance that compression garments/clothing/tights aid in post-exercise recovery. To date, only a small number of studies have investigated this assumption. Compression is a therapeutic technique whereby external compression is applied following exercise or an injury. The theory behind this modality suggests that the external pressure reduces oedema by creating an external pressure gradient and reducing the efflux of fluid from capillaries. Furthermore, the space available for fluid leakage is reduced, minimising haemorrhage and haematoma formation. Certain types of compression treatments involve a dynamic immobilisation that reduces movement during the recovery process. Although the evidence for the efficacy of this treatment was largely anecdotal, recent studies suggest that compression can be effective in minimising swelling, improving the alignment and mobility of soft tissue and improving proprioception in an injured joint (Kraemer et al, 2001; Kraemer et al, 2004). The only study on compression garments and recovery from rugby showed that the players who wore lower body compression garments for 12 hours after the match showed similar signs of recovery (defined by clearance of creatine kinase from transdermal exudate) to players treated with active recovery and contrast temperature water immersion. All these treatments were better than no treatment at all (Gill et al, 2006).

Unlike cold therapy which should be applied intermittently, compression treatment should be applied constantly for at least 72 hours (Kraemer et al, 2004). Furthermore, it is important that the pressure of the compression garment does not exceed diastolic pressure which is about 40 to 60 mmHg for the upper limbs and 60 to 100 mmHg for the lower limbs. If the pressure exceeds these values blood flow will be impeded. Ideally the garment should create a distal to proximal pressure gradient to facilitate the removal of metabolites from the periphery towards the central circulation. This encourages fluid to move away from the high-pressure areas (site of injury) to the lower pressure areas (Kraemer et al, 2004). The commercial production of garments with these characteristics, designed to fit both the upper and lower body, has popularised this form of recovery treatment among rugby players. In the

current survey compression garments also proved to be an "effective" strategy for recovery, where 53% of subjects are using it mostly for injured players and after matches.

Nutrition

There are compelling reasons for embarking on a rehydration, and refuelling strategy immediately after a training session or match. The basis for this started over 40 years ago when it was shown that exercise performance (moderate to high-intensity) is related to muscle glycogen availability (Bergstrom et al, 1967) and that fatigue during such an activity is often associated with a depletion of muscle glycogen. Furthermore, it is known that muscle glycogen decreases during a rugby match (Jardine et al, 1988), and that for complete recovery these stores need to be replenished. Therefore, according to Betts et al (2007), it is logical to suggest that the rapid replenishment of carbohydrate stores will constitute a crucial component of recovery, either between matches or training sessions.

There is evidence to suggest that ingesting carbohydrates and soon immediately after exercise results in higher glycogen levels six hours later compared to if the carbohydrate was only ingested two hours after exercise (Sawka et al, 2007). This is probably the reason for the 54% of subjects in the current survey using increased carbohydrate and/or the 49% of subjects using increased protein intake as an "effective" recovery strategy, mostly after matches. However in the study by Betts et al (2007), the inclusion of protein in the solution did not offer more benefits than when a more concentrated carbohydrate solution of similar energy content to the carbohydrate plus protein supplement was ingested. Another study found that consuming a carbohydrate plus protein or carbohydrate drink immediately after a bout of eccentric exercise which caused muscle damage, failed to enhance recovery of the muscle injury differently than occurred with the placebo drink (Green et al, 2008). This suggests that further studies are needed to develop more definitive guidelines on the recommendations of ingesting carbohydrate and protein immediately after exercise as the results seem to be influenced by the magnitude of muscle damage.

Muscles that are damaged from the exercise do not restore their glycogen as efficiently as undamaged muscles (Costill et al, 1990) possibly as a result of transient insulin resistance (Kirwan et al, 1992). In a study by O'Reilly et al (1987) which analyzed muscle biopsy samples showed that severe muscle damage reduced the ability to restore muscle glycogen fully for as long as 10 days. The magnitude of muscle damage which occurs in rugby players is likely to be much less severe than damage which occurred in the laboratory study of O'Reilly et al (1987), therefore it is reasonable to assume that their muscle glycogen concentrations will take 24 hours or slightly more to replenish.

According to Burke et al (2000) alcohol is strongly linked with modern sport. It is well-known that alcohol reduces glycogen restoration after exercise (Burke et al, 2003). The reason for this is that alcohol either has a direct effect on glycogen synthesis, or whether that the effect is indirect, by reducing the carbohydrate intake immediately after exercise. Another reason for avoiding alcohol in

the acute period after a match or training session is that alcohol promotes diuresis which will delay rehydration (Burke, 1997). The above statement is confirmed by the current survey where 49% of subjects advised players to limit/avoid alcohol after matches and rated it as a very effective (5) recovery strategy mostly after matches.

Caffeine and caffeine-like substances may be present in some drinks. Caffeine also has a diuretic effect and should be avoided in the post-exercise/match recovery period (Meltzer et al, 2005). Sources of caffeine include coffee, tea, some sports bars and gels, and chocolate bars. According to Meltzer et al (2005) caffeine increases arousal, but as a central nervous system stimulant it can be counterproductive by also increasing nervousness, anxiety and dehydration. In contrast to this Armstrong et al (2005) hypothesized that contrary to popular beliefs and research, caffeine consumption, in moderation, does not induce water and electrolyte imbalances or hyperthermia.

Until further information becomes available prudent recommendations are that the goal should be to ingest 1 g carbohydrate per kilogram body mass in the first two hours after exercise, particularly of high glycemic index carbohydrate foods. This goal should extend to 7-10 g carbohydrate per kilogram body mass over 24 hours (Burke, 1997). There are obviously practical and logistical considerations which should include palatability of the fluid and gastrointestinal comfort (Burke, 1997)

Additional Hydration and Electrolytes

According to Armstrong et al (1985) prior dehydration can be detrimental to performance. Thus, rehydration following training sessions is an appropriate nutritional strategy for ensuring that work capacity is not diminished at the beginning of the next session (Barnett, 2006). Rehydration is even more important with training in hot or humid conditions (Brukner et al, 2000). Burke (2000) showed that a bodyweight loss of two percent or more during exercise will result in a reduction in aerobic output. Water alone is not the best means of restoring body fluids, since carbohydrate-electrolyte drinks display better intestinal absorption and reduce urine output (Reilly et al, 2005). Meltzer et al (2005) advocated that athletes who do not drink anything during exercise will perform less well than they would if they drank *ad libitum* (according to thirst). This "ad lib" recommendation must, however, not be interpreted as drinking as much as possible, since this has not been shown to improve performance and may even result in overhydration with serious complications (Meltzer et al, 2005). The "ad lib" approach although, not rigid and quantified, does still mean working to a plan and understanding the practical issues that may influence fluid accessibility in different sports. Shirreffs et al (1996) showed when drinks of an appropriate volume and sodium content are consumed following dehydration by 2% body mass, net fluid balance and plasma volume can be restored within 4 hours. It is unlikely that currently used recovery strategies would compromise this fluid replacement. Brukner et al (2000) suggests carbohydrate drinks of concentrations of 7% or less as common choice after training/matches. In the current survey 59% and 48% of subjects used additional hydration and electrolytes respectively as a "very effective" recovery strategy, mostly after matches and/or training.

Non steroidal anti-inflammatory drugs (NSAIDS)

NSAIDS are widely used in the treatment of sporting injuries. The first NSAIDS used were aspirin and salicylates, while more recently other NSAIDS have been introduced (Brukner et al, 2000). NSAIDS relieve pain, fever and have anti-inflammatory properties (Lanier, 2003). These properties make them an attractive modality for the treatment of athletes after training and competition to possibly enhance recovery (Barnett, 2006) and are the most widely used medications for treating muscle injury (Lanier, 2003). In the survey on the medical staff of rugby players in South Africa 37% of subjects use NSAIDS as an "effective" strategy for recovery, mostly for injured players (45%). Concern has been raised over the use of NSAIDs early in injury and recovery therapy (24-48 hours), because the initial inflammatory response coincides with muscle repair; regeneration and growth (Tidball, 2005). Inflammation is a necessary component in the healing process and without it repair would not take place (Stovits et al, 2003). Stovits et al (2003) also added that if these medicines are used too early following injury or as recovery modality, they will reduce the inflammatory response and may actually delay acute healing, slow muscle regeneration and compromise recovery.

Other studies on strains and contusions also suggest that the use of NSAIDS can result in a modest inhibition of the initial inflammatory response and the associated symptoms (Almekinders, 1999). However, the inhibition of the biological steps may cause negative effects later in the healing phase. Many studies have examined the acute affects of NSAIDS on muscle injury and the diverse findings suggest that NSAIDS have a dosage-dependent effect that may also be influenced by the time of administration (Cheung et al, 2003). Animal studies suggest that whilst NSAIDS may have a short-term positive effect on muscle repair, the long-term effects (four weeks) may be negative and associated with ineffectual or delayed muscle regeneration (Mishra et al, 1995). As a follow-up to this study the effects of anti-inflammatory on satellite cell and fibroblast proliferation were studied in rats in an attempt to identify the mechanism of the delayed regeneration (Mishra et al, 1995). The authors found that both satellite cell and fibroblast proliferation were unaffected by the anti-inflammatory treatment and there were no significant differences in myotube or capillary production between treated and control animals. Therefore, the mechanism explaining the findings of Mishra et al (1995) are not known and are possibly associated with reducing inflammation, a biological process which is part of muscle regeneration (Scott et al, 2004). Such studies have not been performed in humans, and therefore the long-term effects of treatment with NSAIDS in humans are not well understood. It is beyond the scope of this review to go into any more detail so therefore interested readers are referred to other review papers (Lanier, 2003; Warden, 2005).

Additional Sleep and Rest

Additional Sleep and Rest as recovery strategy accounted for 36 % of subjects in the survey, mostly if a rugby player is overtrained. Passive rest, particularly in the form of sleep is an area that is not well understood by either coaches or athletes (Calder, 2003). The relationship between sleep and recovery

after exercise, particularly relating to performance, is receiving more attention as the link between sleep cognitive function and metabolic function becomes better understood.

It has been recommended that athletes should have at least seven to nine hours of sleep a night (Calder, 2004). This recommendation is far more than the average 6.1 hours per night established in a survey of 15,000 students (18 to 22 years) (Walters, 2002). If sleep is compromised in any way then the ability to adapt to training will be negatively affected. However, according to Calder (2003), too much sleep can be detrimental to performance as it can slow down the central nervous system and lead to increased levels of melatonin that can leave the athlete feeling slow and lethargic. A study of competitive swimmers through a season showed that slow wave sleep (stages 3 and 4) formed a high percentage of total sleep in the onset (26%) and peak (31%) training periods, but was significantly reduced following a pre competition taper (16%) (Taylor et al, 1997). This suggests that slow wave sleep, which is associated with restoration and recovery, is reduced as the physical demands reduce. Another finding in this study is that the number of body movements during sleep was significantly higher when the swimmers were training high volume, suggesting some sleep disruption (Taylor et al, 1997).

Based on the understanding of sleep and how it contributes to recovery and restoration, there is reason to believe that "power naps" during the day will be beneficial for a rugby player. Research has shown that "power naps", defined as a brief period of daytime sleep lasting less than an hour, improves alertness, productivity and mood and may contribute to consolidating learning and improve performance of tasks involving visual discrimination (Mednick et al, 2002). Reilly et al (2005) suggested that match administrators should allow minimum 72 hours between competitive matches to alleviate physiological strain and allow adequate rest.

Hyperbaric oxygen, visualization and "other strategies"

Hyperbaric oxygen, visualization and "other strategies" were utilized the least by the medical staff of rugby teams in this survey. "Other strategies" included powerplate (vibration training), ice-room/freezer room therapy, physiological counseling, pre-post weighing and immuno-nutrition. These were unsolicited treatments and no further detail was provided.

Conclusion/summary

Each medical support group develops their own protocol for enhancing recovery which may consist of a specific technique or a combination of techniques. The strategies that are currently used usually vary between teams. The scientific evidence supporting each protocol is in many cases lacking or not applied according to the principles of best practice. However, before recommendations can be made about recovery strategies it is important to know what practitioners are actually doing. At this stage this information is not available. With regards ice/cold water immersion, which is a popular recovery strategy used in a variety of sports, there does seem to be anecdotal evidence that the treatment is

effective – however the scientific data supporting the efficacy of the treatment are lacking. A possible reason for the lack of scientific evidence is that there are different protocols and therefore any experimentation will only be relevant for the protocol tested.

To fill this void the representative group of support staff (doctors, physiotherapists, biokineticists and fitness trainers) in this survey who are involved with rugby teams provided insight into indication which strategies are utilized in South African elite rugby teams to accelerate recovery of the players after training and/or matches.

This information will therefore be very useful for studies designed to investigate the efficacy and mechanism of actions of the various procedures and in particular stretching and ice/cold water immersion as the most popular recovery strategy.

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Chapter 4

Summary and Conclusion

Recovery modalities are gaining wide acceptance among elite athletes and especially professional rugby players. Sporting bodies are investing time and money in providing these modalities and therefore, further research and better consideration of the evidence of their effectiveness appear warranted.

To partly fulfill the need of evidence this survey was done and compared to current best research. The subjects in this study, with vast experience in sport structures and recovery, used mostly stretching, ice/cold water immersion, active recovery and massage, as part of a multidisciplinary approach. Hyperbaric oxygen, vibration training and controlled participation were utilized the least.

A review of the studies shows clearly that there are varied responses to all the treatments. This can be attributed to the different experimental protocols for inducing fatigue/muscle damage and the outcome measures which are indirect markers of recovery. Many aspects of recovery are very difficult to measure in the laboratory and the indirect markers various aspects of recovery lack the required precision to detect small, yet meaningful changes. Where does that leave the practitioner, driven by the desire to have an evidence-based approach to the management of the players? It would be foolish to conclude that recovery strategies do not have an affect, although a strict analysis of the studies might lead one to this conclusion. This approach would fail to acknowledge the anecdotal evidence which has "*stood the test of time*" and which suggests that there is a role for recovery strategies after training and competition. Whilst the specific details are not known, a logical interpretation of the available knowledge suggests that under certain circumstances there is a role for cryotherapy, active recovery, nutrition, compression garments, massage, stretching and "power" naps as part of a recovery strategy. The studies which have examined a combination of the strategies together, suggest that "something is better than nothing", so the details of the protocol should be custom-made based on the circumstances and equipment available to the support staff and team. It has been suggested that the recovery strategies should follow a pattern and become a habit (Jeffreys, 2007). Prior to embarking on a strategy for recovery, it is important that the rugby players are educated about the process so that they are fully informed about the protocol and assume some personal responsibility. It is important that within a team setting the recovery strategies adopted by the support staff become routine and almost ritualistic (Jeffreys, 2005). It is also prudent to individualize the recovery strategies for various players. For example, older players with a history of joint injuries might be handled differently to younger players. Also, players of different positions, who are faced with different physical demands, might also have different strategies after a match. The strategies which are going to be used should be customized for each player, discussed with the player and then implemented in a systematic way. Ambitious strategies which cannot be used when the team is

traveling should be avoided as this may cause psychological problems with the players when they cannot use a procedure which they are accustomed to.

In the search for an optimum recovery protocol that could be subjected to scientific scrutiny, the above recommendations made by the authors could be used for future scientific testing. There were however limitations in this survey that need to be acknowledged. These will be outlined below:

The researcher could have added at which level the subject has worked in whether it may be school, club, provincial or national. The majority of the subjects worked mainly at a provincial and national level, but there were limited subjects only involved at club and school level. This could have influenced the value of the information obtained in this study. The researcher could also have included the type of active recovery (swimming, cycling or jogging) in this study as it is thought that there is a difference in the effects of recovery between the three disciplines. Also the researcher could have added the question of which body area was immersed in ice/cold water immersion as recovery strategy.

For future purposes other studies could be aimed at the different levels of sport as well as the different types of sport, especially high intensity sports such as soccer, field hockey and basketball.

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Appendices

Addendum A

Subject Information Sheet

Title of the study:

A survey to determine the recovery strategies of rugby players which are used by medical support staff of rugby teams

Dear Colleague

Thank you for the opportunity of asking you to participate in this survey. We are trying to find out which strategies support staff involved with professional rugby teams use to assist players with their recovery after training and matches. We are aware that everyone has a favourite protocol that they use but that this differs between teams. Before we are in a position to test the efficacy of treatment we need to know which techniques are popular and how they are prescribed. We aim to find out which techniques are used by doing a questionnaire-based survey. The questionnaire will take approximately 15-20 minutes to complete.

If you agree to participate, please complete the informed consent form and then the questionnaire. You are then asked to place the questionnaire and the informed consent form in two separate unidentifiable blank envelopes. You are then requested to place these in separate boxes that will be provided. These boxes and envelopes will only be opened on completion of the conference.

Therefore, at all times confidentiality will be maintained and you will not be identifiable on the questionnaire. You will not be required to write your name on the document. We only ask that you answer the questions as honestly and accurately as possible.

Should you choose not to participate, you are free to insert the uncompleted questionnaire in the envelope, and place it in the sealed containers.

All the data will be kept confidential, and will be stored in a locked environment. Data will be analyzed and reported on collectively in the form of a dissertation, presentations, and/or publications in the medical literature.

Thank you very much for your participation in this important study.

Associative Professor Mike Lambert

David Van Wyk

Addendum B

Informed Consent Form

Title of the study:

A survey to determine the recovery strategies of rugby players which are used by medical support staff of rugby teams

Dear Colleague

Thank you for considering taking part in this study. The main aim of this study is to determine the strategies which support staff involved with professional rugby teams use to assist the players with recovery after training and matches. We aim to explore these issues in a questionnaire-based survey. Please read sign the following if you agree to participate in the study.

I (full names) _____ hereby confirm that:

1. I have read the attached "Subject Information Sheet" and am familiar with the research study details
2. I will be requested to complete a previously validated questionnaire pertaining to "*Recovery Modalities in Rugby Players*"
3. The questionnaire will take approximately 15-20 minutes to complete
4. The questionnaire is anonymous, and I understand that I can not be identified (separate blank unidentifiable envelopes and boxes will be used, and the content will only be opened on completion of the conference)
5. All the questionnaires and study records will be kept in a safe locked environment
6. Data from the research study may be presented or published in the medical literature in the form of a dissertation, presentation or research paper
7. I am aware that I can, at any stage, withdraw from the study, and that this will not in any way affect my participation in the conference

Signed:

Research subject: _____

Date: ____ / ____ 2007

Investigator _____

Date: ____ / ____ 2007

Addendum C

Ethics approval letter

UNIVERSITY OF CAPE TOWN



Health Sciences Faculty
Research Ethics Committee
Room E52-24 Grootte Schuur Hospital Old Main Building
Observatory 7925
 Telephone [021] 406 6338 • Facsimile [021] 406 6411
 e-mail: iamees.ernjedi@uct.ac.za

07 September 2007

REC REF: 386/2007

A/Prof M Lambert
 Human Biology
 UCT/MRC Research Unit for Exercise Sciences and Sports Medicine
 Newlands

Dear A/Prof Lambert

PROJECT TITLE: A SURVEY TO DETERMINE THE RECOVERY STRATEGIES OF RUGBY PLAYERS WHICH ARE USED BY MEDICAL SUPPORT STAFF OF RUGBY TEAMS

Thank you for submitting your study to the Research Ethics Committee for review.

It is a pleasure to inform you that the Ethics Committee has formally approved the above-mentioned study.

This serves to confirm that the University of Cape Town Research Ethics Committee complies to the Ethics Standards for Clinical Research with a new drug in patients, based on the Medical Research Council (MRC-SA), Food and Drug Administration (FDA-USA), International Convention on Harmonisation Good Clinical Practice (ICH GCP) and Declaration of Helsinki guidelines.

The Research Ethics Committee granting this approval is in compliance with the ICH Harmonised Tripartite Guidelines E6: Note for Guidance on Good Clinical Practice (CPMP/ICH/135/95) and FDA Code Federal Regulation Part 50, 56 and 312.

Please note that the ongoing ethical conduct of the study remains the responsibility of the principal investigator.

Please quote the REC. REF in all your correspondence.

ernjedi

Office use:

Addendum D: Recovery Modalities in Rugby Players**1. BACKGROUND INFORMATION**

Date:.....

1.1 How old are you now? _____ years

1.2 What is your profession? (✓)

Doctor

Physiotherapist

Biokineticist

Fitness

Coach

Other(explain)

--	--	--	--

1.3 What is your gender?

Male

Female

--	--

1.4 How old were you when you qualified for your profession? _____ years

1.5 How long have you been working in a sports team structure? _____ years

1.6 How many years have you been using any modalities to improve physiological and/or psychological recovery after matches and or training?

_____ years

1.7 Who **plans** the recovery strategies in your team after competing or training? (✓)

Myself

Someone else

Multidisciplinary approach

My team does not use recovery strategies

--	--	--	--

1.8 Who **executes** the recovery strategies in your team after competing or training? (✓)

Myself

Someone else

Multidisciplinary execution

My team does not use recovery strategies

--	--	--	--

2.1 Which modalities do you make use, alone or in combination, to improve physiological and/or psychological recovery of the players after training or competition? (✓ for "Yes")

- | | |
|--------------------------------------|--------------------------|
| Massage | <input type="checkbox"/> |
| Active recovery | <input type="checkbox"/> |
| Ice/Cold water immersion | <input type="checkbox"/> |
| Contrast Temperature Water immersion | <input type="checkbox"/> |
| Hyperbaric Oxygen Therapy | <input type="checkbox"/> |
| NSAIDS | <input type="checkbox"/> |
| Compression Garments | <input type="checkbox"/> |
| Stretching | <input type="checkbox"/> |
| Electromyostimulation | <input type="checkbox"/> |
| Additional sleep and rest | <input type="checkbox"/> |
| Visualization | <input type="checkbox"/> |
| Nutrition: extra carbohydrates | <input type="checkbox"/> |

Continued overpage

- Nutrition: extra protein
- Nutrition: extra electrolytes
- Additional Hydration
- Limiting/Avoiding alcohol use
- Other strategies:

(State other strategies).....

2.2 Based on your personal experience, please rate the efficacy of the following modalities in improving the players' physiological and/or psychological recovery after training or competition. Please provide an answer for each mode.

Use a scale of 1 to 6, where;
 1 = completely ineffective, 2 = mildly ineffective, 3 = mildly effective, 4 = effective, 5 = extremely effective, 6 = I do not use this procedure

- Massage
- Active recovery
- Ice/Cold water immersion
- Contrast Temperature Water immersion
- Hyperbaric Oxygen Therapy
- NSAIDS
- Compression Garments
- Stretching
- Electromyostimulation
- Additional sleep and rest
- Visualization
- Nutrition: extra carbohydrates
- Nutrition: extra protein
- Nutrition: extra electrolytes
- Additional Hydration
- Limiting/Avoiding alcohol use
- Other strategies:

(state other strategies).....

2.3 Choose the one modality that you have rated the best in question 2.2 and describe why you are using it?

.....

FOR QUESTIONS 3.1 – 3.18 YOU CAN (✓) MORE THAN ONE ANSWER

3.1 If you use MASSAGE to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.2 If you use ACTIVE RECOVERY (jogging/cycling/swimming/spinning) to aid recovery, indicate when you use this procedure. (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.3 When do you make use of CONTRAST TEMPERATURE WATER IMMERSION to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.4 When do you make use of HYPERBARIC OXYGEN THERAPY to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.5 If you use NON-STEROIDAL ANTI-INFLAMMATORIES (NSAIDS) to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.6 If you use COMPRESSION GARMENTS to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.7 If you use STRETCHING to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.8 If you use ELECTROMYOSTIMULATION to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.9 If you use ADDITIONAL SLEEP AND REST to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.10 If you use VISUALIZATION to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.11 If you use EXTRA CARBOHYDRATES to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.12 If you use EXTRA PROTEIN to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

3.13 If you use EXTRA ELECTROLYTES to aid recovery, indicate when you use this procedure: (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.14 If you use EXTRA HYDRATION to aid recovery, indicate when you use this procedure: (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.15 If you advocate ALCOHOL LIMITATION/AVOIDANCE to aid recovery, indicate when you use this procedure: (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)

3.16 If you use OTHER RECOVERY STRATEGIES to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it

PLEASE EXPLAIN THE STRATEGY.

.....

.....

3.17 If you use ICE/COLD WATER IMMERSION to aid recovery, indicate when you use this procedure; (✓)

- 1 = after every single training session
- 2 = only if the training session was particularly hard
- 3 = after every match
- 4 = only if the match was particularly hard
- 5 = if the player is overtrained
- 6 = if the player is injured
- 7 = never use it
- 8 = I use it for another reason (explain)
-
-

**4. Indicate how your perceptions about ice/cold water immersion have been formed
(You can (✓) more than one option)**

- Systematic reviews of the literature
- Experimental trials
- Field studies
- Anecdotal evidence
- Player's perceptions that it works
- My perception that it works

IGNORE THE NEXT QUESTION IF YOU DO USE ICE/COLD WATER IMMERSION

5. If you do not use ice/cold water immersion please indicate the reason why you do not? (You can (✓) more than one answer)

Based on my perception

Based on the players' perception

Based on scientific evidence

IF YOU DO NOT USE ICE/COLD WATER IMMERSION TO AID RECOVERY YOU CAN STOP HERE – Thank you for you time!

**IF YOU MAKE USE OF ICE/COLD WATER IMMERSION AFTER TRAINING ONLY:
GO TO QUESTION 7**

6. If you make use of ice/cold water immersion after matches, please answer the following:

6.1 Is the time to the start of an immersion session after matches strictly controlled? (✓ one)

Yes No

If you answered YES. How many minutes? ..minutes..

6.2 Is the total duration per immersion session strictly controlled? (✓ one)

Yes No

If you answered YES, what is the total duration per ice/cold water immersion session per player? minutes.

6.3 Is the number of consecutive single immersions per session strictly controlled? (✓ one)

Yes No

6.3.1 If you answered YES, how many single immersions make up one total session? immersions.

6.3.2 What is the duration per single immersion? minutes.

6.4 Do you measure the temperature of the water? (✓ one)

Yes No

If your answer is No (i.e. you do not measure the temperature)

6.4.1 Why not?

If your answer is Yes,

6.4.2 What is the average temperature of the water? degrees.

6.5 What do you use to measure the temperature?

Thermometer

My own judgement

6.6 How is the water cooled when playing **away from home**? (✓ answers – you can have more than one choice)

- Ice cubes in water
- Ice block in water
- Ice water only
- Thermostatically
- Cold running tap water only
- Cold swimming pool water only

6.7 How is the water cooled when playing **at home**? (✓ answers – you can have more than one choice)

- Ice cubes in water
- Ice block in water
- Ice water only
- Thermostatically
- Cold running tap water only
- Cold swimming pool water only

6.8 What do you make use of as the container for the ice/cold water when playing **away from home**? (✓ answers)

- Plastic drum
- Portable Jacuzzi
- Portable bath
- Swimming pool
- Shower

6.9 What do you make use of as the container for the ice/cold water when playing **at home**? (✓ answers)

- Plastic drum
- Portable Jacuzzi
- Portable bath
- Swimming pool
- Shower

6.10 Do all players always make use of the immersion? (✓ one)

- Yes No

If your answer to question 6.10 is No (i.e not all players use immersion), then; :

6.10.1 Which players do make use of the immersion? (you can ✓ more than one)

- Majority Forwards
- Majority Backs
- Only the Injured players
- Majority of the players with the exception of a few
- All the players, except the injured ones

6.10.2 Why do you think that some of the players do not make use of the immersion?

- They are injured
- They do not like ice/cold water
- They have their own beliefs about recovery

6.11 If players with injuries do not make use of the immersion, indicate which injuries? (you may answer (✓) more than one)

- Lacerations and/or open wounds
- Contusions
- Suspected fractures
- Suspected concussion
- Muscle and/or ligament strains and sprains
- Any type of injury
- Other injuries (explain)
-
- None of the above

6.12 How many ice/cold water immersion sessions per average training week do you perform, **including** matches?

sessions.

IF YOU MAKE USE OF ICE/COLD WATER IMMERSION AFTER MATCHES ONLY, AND NOT TRAINING YOU CAN STOP HERE – Thank you for you time!

7. If you make use of ice/cold water immersion after training, please answer the following:

7.1 Is the time to the start of an immersion session after training strictly controlled? (✓ one)

Yes No

If you answered YES. How many minutes? ..minutes..

.....

7.2 Is the total duration per immersion session strictly controlled? (✓ one)

Yes No

7.2.1 If you answered YES to Question 7.2, what is the total duration per ice/cold water immersion session per player?

minutes.

7.3 Is the number of consecutive single immersions per session strictly controlled? (✓ one)

Yes No

7.3.1 If you answered YES, how many single immersions make up one total session? immersions.

7.3.2 What is the duration per single immersion? minutes.

7.4 Do you measure the temperature of the water? (✓ one)

Yes No

If your answer to question 7.4 is No (i.e. you do not measure the temperature)

7.4.1 Why not?

If your answer to question 7.4 is Yes, (i.e. you do measure the temperature)

7.4.2 What is the average temperature of the water? degrees.

7.4.3 If your answer to question 7.4 is Yes, What do you use to measure the temperature?

Thermometer

My own judgement

7.5 How is the water cooled after training at home? (✓ answers – you can have more than one choice)

Ice cubes in water

Ice block in water

Ice water only

Thermostatically

Cold running tap water only

Cold swimming pool water only

7.6 What do you make use of as the container for the ice/cold water when training at home? (✓ answers)

Plastic drum

Portable Jacuzzi

Portable bath

Swimming pool

Shower

7.7 Do all players always make use of the immersion after training? (✓ one)

Yes No

If your answer to question 7.7 is **No** (i.e. all players make use of the immersion after training)

7.7.1 Which players do make use of the immersion? (you can ✓ more than one)

- Majority Forwards
- Majority Backs
- Only the Injured players
- Majority of the players with the exception of a few
- All the players, except the injured ones

7.7.2 Why do you think that some of the players do not make use of the immersion?

- They are injured
- They do not like ice/cold water
- They have their own beliefs about recovery

7.8 If players with injuries **do not make use** of the immersion, indicate which injuries? (you may answer (✓) more than one)

- Lacerations and/or open wounds
- Contusions
- Suspected fractures
- Suspected concussion
- Muscle and/or ligament strains and sprains
- Any type of injury
- Other injuries (explain)
-
- None of the above

Thank you for your time!