Institution: University of Chester

Unit of Assessment: 26 Sport and Exercise Sciences, Leisure and Tourism

Title of case study 2: Managing fatigue and recovery in team sports

1. Summary of the impact

The main applied outcomes of this body of research have been: (i) changes to training, competition and between-match practices at St Helens and Warrington Wolves Super League clubs, and in Rugby Football League (RFL) generally, and England Handball Association; (ii) the development of appropriate monitoring strategies to manage player health, well-being and performance capability; and, (iii) the development of player and coach education resources.

2. Underpinning research

The initial research underpinning this impact case study was carried out between 2004 and 2012 and continues to the present day in the research of on-going PGR projects. The research evaluated player recovery after matches and the effect on subsequent match performance during intensified competition. Neuromuscular, biochemical and perceptual responses were measured in elite and sub-elite players in the days after a single match and during intensified competition (three representative matches in five days). In addition, match performance characteristics were measured using global positioning technology and video analysis. After a single match, creatine kinase, muscle soreness and sensations of fatigue were higher for up to two days in both forwards and backs. Neuromuscular function was lower on day one but not day two for both groups. Collisions for forwards were correlated with all markers of fatigue but only neuromuscular function was correlated with offensive contacts in backs. During intensified matches, upper and lower body neuromuscular function, perceived fatigue and creatine kinase deteriorated as the competition progressed. Cumulative fatigue corresponded to reductions in high speed running and tackling during matches later in the tournament. These findings have identified some of the key contributors to post match fatigue in rugby players and enable coaches to employ appropriate measurement strategies to manage player health and performance capacity.

This case study emanated from the research of a group consisting of four members of academic staff, supplemented by a core of PhD students: Dr Craig Twist (Leader/Senior Lecturer/Reader, 2004-present); Dr Jamie Highton (PhD student, 2007-2011/Lecturer, 2012-present); Dr Kevin Lamb (Reader, 1992-present); Dr Ceri Nicholas (Senior Lecturer, 2006-present); Dr Mark Waldron (PhD student, 2009-2012. Left to join University of New England, Australia, 2012); Dr Dave Sykes (PhD student, 2006-2010. Left to join Herriot-Watt University, 2011); Samantha Moss (PhD student, 2010-present); and Dr Dean Burt (PhD student/Research Technician, 2009-2013. Left to join Staffordshire University, 2013).

To better understand the factors that cause fatigue and identify the most appropriate tools to monitor its occurrence, the Group worked in close collaboration with St Helens RFC and the governing body for rugby league (RFL). Access was provided to elite and sub-elite players to evaluate performance during and after matches. Permission was granted from the club and governing body to disseminate the findings in a variety of formats so as to inform the wider games and similar sports. Indeed, the England Handball Association, with whom subsequent research has been conducted to develop appropriate coach and player education material, acknowledged the Group's work in rugby league.

3. References to the research

The basic research underpinning the impact was manifest in the following papers:

Johnston, R., Gibson, N.V., Twist, C., Gabbett, T.J., MacNay, S., & MacFarlane, N., (2013). Physiological responses to an intensified period of rugby league competition. *Journal of Strength and Conditioning Research*, *27(3)*, 643–654. DOI: 10.1519/ JSC.0b013e31825bb469. Medline indexed, impact factor: 1.795.

Twist, C., & Eston, R.G. (2005). The effects of exercise-induced muscle damage on maximal intensity intermittent exercise performance. *European Journal of Applied Physiology, 94(5),* 652-658. DOI: 10.1007/s00421-005-1357-9. Medline indexed, impact factor: 2.66.

Twist, C., & Sykes, D. (2011). Evidence of exercise-induced muscle damage following a simulated rugby league match. *European Journal of Sports Science*, *11(6)*, 401-409. DOI: 10.1080/17461391.2010.536575. Medline indexed, impact factor: 1.147

Twist, C., Waldron, M., Highton, J., Burt, D., & Daniels, M. (2012). Neuromuscular, biochemical and perceptual post-match fatigue in professional rugby league forwards and backs. *Journal of Sports Sciences*, *30(4)*, 359-367. DOI: 10.1080/02640414.2011.640707. Medline indexed, impact factor: 2.082

Twist, C., & Highton, M. (2013). Monitoring fatigue and recovery in rugby league players. *International Journal of Sports Physiology and Performance*, *8(5)*, 467-474. Available on request. Medline indexed, impact factor: 2.247.

4. Details of the impact

The beneficiaries of this applied research were primarily the management, coaching staff and players (senior and academy) of St Helens RFC (Date of impact: November 2010-September 2012), Warrington Wolves RFC (Date of impact: September 2008-September 2010) and the RFL (Date of impact: January 2011-July 2013). Contracts with all organizations have existed during the assessment period for employment of research students to conduct knowledge transfer activities (RFL, 2006-2010; Warrington Wolves RFC, 2006-2010; St Helens RFC, 2009-present) or funded studentships (England Handball Association: 2010-2013). Some of these contracts remain to ensure on-going impact from the original research or development of new research.

The outcomes of the research, applications and future direction of work were (and continue to be) reported to the management and coaching staff of St Helens RFC (at least bi-monthly) via one-to-one meetings and player/coach workshops. Findings from the research were also fed into national governing bodies – Rugby Football League, Football Association, England Handball Association, British Basketball Association and England Hockey Association – via presentations delivered by Group members at national coaching seminars (Football Association workshop for Sport Scientists, 2011; England Handball Association coaching seminars), one day workshops as part of the Level 4 UK Coaching Certificate (2010 and 2012) and invited Rugby Symposia at the 2009 and 2013 BASES Annual Conference – attended by sports scientist, coaches, players and researchers. The work is frequently acknowledged by leading administrators, practitioners and coaches as the basis for shaping current practice in monitoring fatigue and recovery in rugby players, e.g. staff at the RFL, Rugby Football Union and St Helens RFC (see 5.1).

The eight-month in-season playing demands comprise one match every 5-7 days with frequent (i.e. daily), often high intensity training bouts performed in between. Such demands necessitate that players are regularly monitored to limit fatigue that might impair health and performance. Accordingly, the main aim of the research has been to optimize the practices of elite team sports (namely rugby league) for monitoring player recovery. For example, the work emanating from the study by Twist et al. (2012) responded to a request by coaches at St Helens RFC seeking to better understand the time-course of recovery in players in the days immediately after a game. The research had four distinct aims based on the coaches' need to know: a) whether the current periodization of training in the days immediately after a game was appropriate; b) if recovery patterns differed between positional groups; c) the role of match demands on player recovery; and, d) the response to currently adopted recovery measures. The research provided a better understanding of these issues and enabled coaches to devise suitable training and monitoring strategies in the days immediately after a game in order to optimize player recovery. For example, *'This [research] has enabled us to programme training schedules more effectively after matches and better manage player fatigue on an individual basis. Indeed, recovery protocols and monitoring*

processes were changed as a consequence of the work conducted' (St Helens RFC, see 5.1). The research initiated many changes to the daily and seasonal practices of staff at St Helens RFC, including: the identification of meaningful changes in individual player well-being using a daily monitoring system; introduction of a neuromuscular monitoring protocol in the days after matches; the integration of match data with monitoring data to evaluate individual player recovery and training load; the implementation of a system for monitoring of individual player training load; and, the introduction of player education material to optimize health, performance and recovery (e.g. nutrition and recovery guidelines produced for Warrington Wolves and St Helens rugby clubs that are now provided to all players. From a position where player recovery and training schedules were based on coach intuition, the implementation of monitoring strategies to manage player fatigue and training practice content are seen as key impacts from the Group's work.

Minimal recovery between matches and training occurs frequently during tournament scenarios for team sport athletes. Accordingly, the Group sought to better understand the impact of intensified competition on player recovery and performance (Johnston et al., 2013) working in collaboration with colleagues from Heriot-Watt University, Australian Catholic University and the RFL. Findings were used by Home Nations coaches to guide player monitoring strategies during the international competitions, which subsequently informed player selection and game time throughout the tournament. Our work has been used to *'build an argument regarding the over use of players during the Easter period'* (RFL, 5.1). Additionally, the recovery practices of other sports have been influenced by our work, such as the Scotland Football squad and Scotland squash (Heriot-Watt University). Similarly, the work has since been extended with the England Handball Association (EHA) to inform their own practices during European training camps and tournaments. In an emerging sport with little or no previous sports science input, our research has assisted in the implementation of new policies and changed the approaches taken by coaches during tournaments. For example, the lead sport scientist has employed our recommendations for daily monitoring of player well-being and neuromuscular function to enable management of player training loads and recovery strategies during national and international competitions where multiple fixtures in 4-5 day tournaments are commonplace. This information has been critical with athletes who are unaccustomed to the rigours of international tournaments, so much so that the impact of our work has been *'useful to inform coaches of players more susceptible to injury or illness so that their practices can be adjusted. Monitoring is also used to identify players who have decreased physical performance, which can be used by coaches in team selection or to inform player match time*' (EHA, 5.1).

5. Sources to corroborate the impact

5.1 A folder of correspondence confirming the quotes attributed in section 4 and how the Group's work has informed strategies for managing player fatigue and recovery, including letters from:

- Head of Strength and Conditioning, St Helens RFC;
- Sport Scientist, Rugby Football Union;
- Sport Scientist, Heriot-Watt University/Scotland Rugby League/Scotland Football Association;
- Performance Director, Rugby Football League; and
- England Handball Association National Performance Manager

5.2 Rugby Symposium as part of the 2013 BASES Annual Conference: http://www.uclan.ac.uk/news/universities_reveal_power_of_science_in_top_flight_rugby.php

5.3 Highton, J. (2010) Nutritional and recovery information for St Helens Rugby League Club. Guidelines and presentations delivered to senior and junior players.

5.4 Sykes, D. (2010) *Nutrition*. For Warrington Wolves Rugby League Club. Booklet presented to senior and junior players.