Integrated guidelines for return-to-play decision-making after musculoskeletal injury in rugby union

CM Wall

In fulfilment of the degree

DOCTOR of Philosophy
Human Movement Science
(Biokinetics)
in the
Faculty of Humanities
Department of Exercise and Sports Sciences
at the
University of the Free State
2018

Supervisor: **Prof. F.F. Coetzee**

Declaration

I declare that the thesis hereby submitted for the philosophiae doctor degree at the University of the Free State is my own independent work, except to the extent indicated in the reference citations, and has not previously been submitted by me to another University/Faculty. I furthermore yield copyright of the thesis in favour of the University of the Free State.

The co-authors of the articles in this thesis, Prof. Derik Coetzee and Prof. Robert Schall hereby give permission to the candidate, Miss Christine Wall to include their articles as part of a Ph.D. thesis. The contribution (advisory and supportive) of these co-authors was kept within reasonable limits, thereby enabling the candidate to submit this thesis for examination purposes. The thesis, therefore serves as fulfilment of the requirements for the Ph.D. degree in Biokinetics (Human Movement Science) in the Department of Exercise- and Sport Sciences in the Faculty of Humanities at the University of the Free State.

Signed on this ______________________day of _______________________2018.

____________________ ____________________

Prof. F.F. Coetzee C.M. Wall

Supervisor PhD Student

Acknowledgments

I wish to express my deepest appreciation to the following people and organizations for their role in the completion of this study

- **Prof Derik Coetzee**

'success is walking from failure to failure

with no loss of enthusiasm' – Winston Churchill

Your endless motivation sustained me throughout the study. You are the best cheerleader any student could ask for! Thank you for your input, your guidance, your knowledge and continuous positive impact.

- **Prof Schall** – for guidance regarding statistics
- **South African Rugby Union (Clint Readhead)** – for their support of this study and for providing me with information.
- **The University of the Free State** – for providing the infrastructure in which I could complete this study.
- **My parents**

'*behind every child who believes in herself,*

are parents who believed in her first' – Matthew Jacobson

Your belief in me has always strengthened me and given me the courage to soar.

- **My heavenly Father**

'Each of you should use whatever gifts you have received to serve

others, as faithful stewards of God's grace in its various forms….to Him be the glory

and the power for ever and ever' – 1 Peter 4:10-11

Summary

Integrated Guidelines for Return-to-Play Decision-making after Musculoskeletal Injury in Rugby Union

Background: Re-injuries in rugby union have become a factor of major concern. The severity of these injuries is usually far greater than that of new injuries. Since no standardized protocol for RTP decision-making in rugby union exists in literature, decisions are often made subjectively according to the practitioners' expertise and experience.

Aims: The main objective of this study is to create a set of guidelines to assist practitioners in rugby union with the RTP decision-making process. The guidelines will form the basis of further research in RTP decision-making in order to accurately quantify the process.

Method: **T**he exploratory mixed-method design is used in this study which equipped the researcher with information relevant to RTP decision-making in rugby union and it forms the basis for the formulation of RTP guidelines for rugby union. Literature was synthesised to develop an e-Delphi questionnaire. The e-Delphi questionnaire was then sent to the medical teams of Currie Cup rugby union across South Africa.

Results: Three steps of integrated guidelines for RTP decision-making in rugby union were established. **Step 1**: Evaluation of Health Status included: Pain, Instability, Personal Medical History (including age), Strength, Range of Motion, Functional tests, Psychological state, Potential Seriousness and the Orthopaedic Surgeon's opinion. **Step 2**: Evaluation of Participation Risk included: Position Played, Competitive level and the Ability to Protect. **Step 3**: Decision Modifiers include: Timing and Season, Masking of the Injury, Conflict of Interest and the Fear of Litigation. Numerical weights were given to each of the factors. The need for such guidelines was recognized in both the literature and by practitioners.

Conclusions: The guidelines set forth in this study will help to direct practitioners in their decision-making process regarding RTP in rugby union. The guidelines however need more in-depth investigated to ultimately help reduce re-injuries in rugby union.

Take home sentence: Even though rehabilitation should be focussed on the injury, RTP decision-making should be more focussed on the demands that the player and per implication the injury, will have to face upon RTP.

Keywords: Return to play; rugby union; injury; rehabilitation; protocols; models; guidelines

Table of Contents

Declaration

Acknowledgements

Summary

Clarification of Key Concepts

Content of Thesis

List of Tables

List of Figures

List of Abbreviations

Clarification of Key Concepts

Medical team/staff

Professional sports teams employ medical professionals to deal with their players. The size of such a medical team will depend on factors such as the size of the sporting team, the standard of competition and financial concerns. A medical team can consist of sports physicians, medical doctors, physiotherapists, biokineticists, and other para-medical professionals (Bruckner & Khan, 2006:954).

Rehabilitation

A problem-solving method intended to reduce disability and handicap. The primary emphasis of rehabilitation is on decreasing symptoms and limitations at the level of activity and participation, and contains personal and environmental aspects (Khan *et al.,* 2012:89).

Rugby Union

A collision team sport played with a rugby ball on a field. A team consists of 15 players and 8 reserves. The team includes forward and back line players with each player performing a specific role. A rugby match lasts for 80 minutes with two 40-minute halves (Duthie *et al.,* 2003).

Treatment

The sum of all interventions provided to an athlete/patient during an episode of care (World Confederation for Physical Therapy, 2014).

Return to play (RTP)

The process by which a player or athlete is presumed to be safe to return to their desired activity. The demands of the sport should meet with the degree of healing (Orchard, 2014; Creighton *et al*., 2010 & Beardmore *et al*., 2005).

Chapter 1: Problem Statement and Aim of the Study

1.1 Introduction **2**

1.2 Problem Statement **5**

1.3 Research Questions **6**

1.4 Aims of the Study **6**

1.5 Structure of the Thesis **7**

1.6 Methodology **8**

1.7 References **10**

Chapter 2: Literature Review: Return-to-Play Decision-making in Rugby Union

2.1 Introduction 18

2.2 Rugby union and injuries 19

2.2.1 Injury occurrence 19

(a) Injury occurrence: Professional level 19

(b) Injury occurrence: Amateur and Schoolboy level 21

(c) Injury occurrence: Other forms of the game 22

2.2.2 Nature of rugby injuries 23

2.2.2.1 Injury location 23

(a) Injury location: Professional level 23

(b) Injury location: Amateur and schoolboy level 24

(c) Injury location: Other forms of the game 26

2.2.2.2 Injury type and severity 26

(a) Injury type and severity: Professional level 26

(b) Injury type and severity: Amateur and schoolboy level 28

(c) Injury type and severity: Other forms of the game 29

2.2.3 Body side 30

2.2.4 Injury event 31

(a) Tackles, rucks and mauls 31

(b) The scrum 32

(c) Walking and running 33

2.2.3 Recurrent injuries in rugby union 33

2.3. Rehabilitation 36

2.4. Return to play 37

2.4.1. STEP 1: Evaluation of health status 39

2.4.1.1 Patient demographics 39

2.4.1.2 Symptoms 40

(a) Pain 40

(b) Instability 41

(c) Swelling 42

2.4.1.3 Personal medical history 42

2.4.1.4 Signs 43

(a) Strength 43

(b) Range of motion 44

2.4.1.5 Laboratory tests 44

2.4.1.6 Functional tests 45

2.4.1.7 Psychological state 47

2.4.1.8 Potential seriousness 47

2.4.1.9 Orthopaedic surgeon’s evaluation and medical staff 48

2.4.2 STEP 2: Evaluation of participation risk 49

2.4.2.1 Type of Sport: Demands of Rugby Union 49

2.4.2.1.1 Physiological demands 49

2.4.2.1.2 Physical demands 50

(a) Tackles, rucks and mauls 51

(b) The scrum 51

(c) Walking and running 52

2.4.2.1.3 The laws of the game 52

2.4.2.2 Position played 54

2.4.2.3 Limb dominance 55

2.4.2.4 Competitive level 55

2.4.2.5 Ability to protect 56

2.4.3 STEP 3: Decision modification 57

2.4.3.1 Timing and season 57

2.4.3.2 Pressure from the player 57

2.4.3.3 External pressure 58

2.4.3.4 Masking the injury 59

2.4.3.5 Conflict of interest 59

2.4.3.6 Fear of litigation 60

2.4.4 Maintenance Program 61

2.5 Conclusion 61

2.6 References 62

Chapter 3: Research Methods and Procedures

3.1 Introduction 74

3.2 Theoretical perspectives on the Research Design 74

3.2.1 Theory Building 74

3.2.2 Types of Methods 75

3.2.3 The Research Design in this Study 76

3.3 Research Methods and Procedures 76

3.3.1 Literature Review 78

3.3.2 Document Analysis 78

3.3.3 The Focus-Group Discussion 79

3.3.4 Sample Selection 79

3.3.5 Focus-Group interview for this study 79

3.3.6 The e-Delphi Technique 80

3.3.6.1 Theoretical Aspects 81

3.3.6.2 The e-Delphi Questionnaire in thus Study 81

3.3.6.3 Sample Selection 82

3.3.6.4 Description of Sample 83

3.3.6.5 Pilot Study 83

3.3.6.6 Data Gathering 83

3.3.6.7 Data Analysis 83

3.3.6.8 Data Interpretation 84

3.4 Trustworthiness 84

3.5 Ethical Considerations 86

3.6 Conclusion 86

3.7 References 87

Chapter 4: The Focus Group Discussion

4.1 Introduction 91

4.2 The Focus-Group Discussion 92

4.2.1 Results and findings of the focus group discussion 92

a) The three steps of Creighton's RTP model for decision-making n sport as the basis of this study 92

b) The relevance of such a model within a team sport such as rugby union 93

c) The use of the e-Delphi research method 94

d) The participants chosen to partake in the e-Delphi 94

4.3 Conclusion 95

4.4 References 95

Chapter 5: Integrated Guidelines from Practice and Literature on Return-to-Play decision-making in Rugby Union

5.1 Introduction 98

5.2 The Participants 98

5.3 Clarifying the focus of the Questionnaire 98

5.4 Procedure for administration of the e-Delphi Questionnaire 99

5.5 Format of the Questionnaire and Presentation of the Responses 99

5.5.1 Format of the Questionnaire 99

5.5.2 Presentation and analysis of Responses 100

5.6 Responses to Step 1 101

5.6.1 Patient Demographics 102

5.6.2 Symptoms: (a) Pain 102

(b) Instability 103

(c) Swelling 104

5.6.3 Personal Medical History 105

5.6.4 Signs: (a) Strength 105

(b) Range of Motion 106

5.6.5 Laboratory Tests 107

5.6.6 Functional Tests 108

5.6.7 Psychological State 109

5.6.8 Potential Seriousness 109

5.6.9 Orthopaedic Surgeons Opinion 110

5.7 Responses to Step 2 111

5.7.1 Type of Sport 112

5.7.2 Position Played 112

5.7.3 Limb dominance 113

5.7.4 Competitive Level 114

5.7.5 Ability to Protect 115

5.8 Responses to Step 3 116

5.8.1 Timing and Season 116

5.8.2 Pressure from the Player 117

5.8.3 External Pressure 118

5.8.4 Masking of the Injury 120

5.8.5 Conflict of Interest 121

5.8.6 Fear of Litigation 122

5.9 Responses to the Importance of the Research 123

5.9.1 Standardized RTP guidelines for musculoskeletal injuries in rugby union is relevant 124

5.9.2 Standardized RTP guidelines for musculoskeletal injuries in rugby union could potentially reduce the prevalence of re-injuries 125

5.10 Conclusion 127

5.11 References 127

Chapter 6: Integrated Guidelines for Return-to-Play decision-making for musculoskeletal injury in Rugby Union

6.1 Introduction 129

6.2 Discussion of Accumulated Research 130

6.2.1 Step 1: Evaluation of Health Status 130

6.2.1.1 Patient Demographics 130

6.2.1.2 Symptoms: (a) Pain 131

(b) Instability 131

(c) Swelling 131

6.2.1.3 Personal Medical History 132

6.2.1.4 Signs: (a) Strength 132

(b) Range of Motion 132

6.2.1.5 Laboratory Tests 133

6.2.1.6 Functional Tests 133

6.2.1.7 Psychological State 134

6.2.1.8 Potential Seriousness 134

6.2.1.9 Orthopaedic Surgeons Opinion 134

6.2.2 Step 2: Evaluation of Participation Risk 134

6.2.2.1 Type of Sport 135

6.2.2.2 Position Played 135

6.2.2.3 Limb dominance 135

6.2.2.4 Competitive Level 136

6.2.2.5 Ability to Protect 136

6.2.3 Step 3: Decision Modification 136

6.2.3.1 Timing and Season 137

6.2.3.2 Pressure from the Player 137

6.2.3.3 External Pressure 137

6.2.3.4 Masking of the Injury 138

6.2.3.5 Conflict of Interest 138

6.2.3.6 Fear of Litigation 138

6.2.4 Evaluation of the Importance of the Research 139

6.2.4.1 Relevance of Standardized RTP guidelines for musculo-skeletal injuries in rugby union 139

6.2.4.2 Standardized RTP guidelines for musculo-skeletal injuries in rugbyu union could potentially reduce the pre-valence of re-injuries 139

6.3 Proposed Integrated Guidelines for Return to Play Decision-making in Rugby Union 140

6.3.1 Schematic representation of the findings 142

6.3.2 Explanation of the schematic representation 140

6.3.2.1 Step 1: Evaluation of Health Status 140

6.3.2.2 Step 2: Evaluation of Participation Risk 141

6.3.2.3 Step 3: Decision Modifiers 141

6.4 Conclusion 143

6.5 References 143

Chapter 7: Reflections on the Research

7.1 Introduction 148

7.2 The Research Topic 149

7.2.1 Personal Obstacles 149

7.2.2 Interpersonal Obstacles 149

7.2.3 Theoretical Obstacles 150

7.2.4 Practical Obstacles 150

7.3 The Way Forward 151

7.4 Final Thoughts 152

Appendixes

Appendix A: ECUFS Ethics Approval

Appendix B: Letter of Support from the SARU

Appendix C: Letter of Communication

Appendix D: Information Document

Appendix E: Informed Consent

Appendix F: Article: *Return-to-Play in Sport: A Decision-based Model* (Creighton *et al.,* 2010)

Appendix G: e-Delphi Questionnaire: Round 1

Appendix H: e-Delphi Questionnaire: Round 2

List of Tables

Chapter 2:

Table 1: New injuries compared to recurrent injuries in terms of average severity for English Professional Rugby 35

List of Figures

Chapter 1:

Figure 1.1 The structure of the Thesis 8

Chapter 3:

Figure 3.1: Illustration of the sequential nature of the mixed-method research design used in the study 76

Figure 3.2: Schematic outline of research questions and research methodology 77

Chapter 6:

Figure 6.1: Integrated guidelines for return-to-play decision-making in rugby union 142

List of Abbreviations

ACL	Anterior Cruciate Ligament
bpm	beats per minute
FFA	Functional field assessment
GPS	Global Positioning System
HPCSA	Health Professionals Council of South Africa
IRB	International Rugby Board (prior to 2015)
kN	kilo Newton
m	metre
MCL	Medial Collateral Ligament
RICG	Rugby Injury Consensus Group
ROM	Range of Motion
RTP	Return to Play
RWC	Rugby World Cup
SARU	South African Rugby Union
U/9	Under 9
U/13	Under 13
U/16	Under 16
U/17	Under 17

U/18	Under 18
US	United States (of America)
US$	United States Dollar
vs	versus
WR	World Rugby (after 2015)
WRWC	Woman’s Rugby World Cup

Integrated guidelines for return-to-play decision-making after musculoskeletal injury in rugby union

Chapter 1

Problem Statement and Aim of the study

1.1 Introduction

1.2 Problem Statement

1.3 Research questions

1.4 Aims of the Study

1.5 Structure of the Thesis

1.6 Methodology

1.7 References

1.1 Introduction

The 2011 Rugby World Cup, one of the largest sporting events in the world, had an injury incidence of 89.1/1000 player-match-hours (Fuller *et al.,* 2013). A mean severity (in number of days to return to play) of 23.6 days was reported for these injuries, with 14% of the injuries being recurrent (Fuller *et al.,* 2013). The same tendency is seen in schoolboy rugby union (RU), where re-injuries were found to be accountable for 31% of reported injuries (Wall *et al.,* 2011). On all levels of play, recurrent injuries are often more severe than initial injuries (Brooks *et al.,* 2005). Previous injuries and premature return-to-play (RTP) are the strongest predictors for future injury *(Beardmore et al.,* 2005). Beardmore *et al.* (2005) also stated that the high incidence of re-injury in rugby union could therefore potentially be reduced through the use of standardised RTP assessment procedures.

Return-to-play decision making in sport has long since been a topic of uncertainty with no structures or transparency (Beardmore *et al.,* 2005; Creighton *et al.,* 2010). In the absence of

RTP criteria, management often make decisions based on their own perceived strengths and expertise (Beardmore *et al.,* 2005). However, it is without a doubt that RTP decisions are fundamental to the practice in sport management teams, but alarmingly, RTP decisions also vary greatly for the same medical condition and circumstances (Creighton *et al.,* 2010). To devise a structured and appropriate rehabilitation program and eventually RTP criteria, a thorough understanding of the demands on rugby union players is necessary (Eaton & George, 2006).

Firstly, tackling accounts for approximately half of all rugby union injuries (McIntosh & McCrory, 2005), resulting in the greatest associated loss of playing time (Fuller *et al.,* 2007). High tackles, or tackles involving a shoulder charge were also identified as further risk factors (Wilson *et al.,* 2002). It is, however, difficult to change tackle laws without altering the nature of the game (Holtzhausen *et al.,* 2006). Besides the tackle, the other physical demands of rugby union are very unique, as it involves ball-carrying and frequent, powerful full-body contact (other than tackling) with minimum protective gear (Beardmore *et al.,* 2005; Marshall *et al.,* 2005). On average a rugby union player covers a distance of 6 953m during a game with an average heart rate of 172 beats per minute or 80 to 85% of their VO_2max (Cunniffe *et al.*, 2009). Phases of high intensity activities as well as phases of low-intensity activities are logged during matches (Eaton & George, 2006). High-intensity activities involve sprinting, rucking, mauling and scrummaging, while low-intensity activities refer to activities such as standing, walking and jogging. Furthermore, great differences exist in the demands for each playing position as confirmed by GPS measurements, highlighting the importance of position-specific rehabilitation and RTP criteria (Reid *et al.,* 2013). Even though the demands of rugby union are familiar - there is still an inability to provide satisfactory assessment and information regarding a player's functional abilities (Beardmore *et al.,* 2005).

A model for RTP decision making in sport has been introduced by Creighton *et al.* (2010). The model consists of three steps, namely: 1. Health status or medical factors, 2. Participation risks or participation modifiers and 3. Decision modifiers. During the first step of evaluating health status, factors taken into account include symptoms, personal medical history, signs, laboratory tests, functional tests, physiological state and potential seriousness (Creighton *et al.,* 2010). Symptoms such as pain, joint stiffness and instability are indicative of incomplete tissue healing. Prior injury, muscle weakness, inflexibility and kinetic chain breakage could

influence return to play and the probability of re-injury (Lee *et al.,* 2001). Pre-injury strength and range of motion are cited as signs for RTP (Podlog & Eklund, 2009; Krabak & Kennedy, 2008). Isokinetic testing should confirm strength of 90 – 95% of the uninjured or contra-lateral limb with the flexibility deficit viewed as equally important. Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI of CT scans. The interaction of muscular strength, ROM, endurance, confidence and proprioception should be tested through functional testing specific to the sport's demands (Creighton *et al.,* 2010). Manoeuvres related to the sport, such as running, cutting and jumping should be done without any significant abnormal movement patterns (Krabak & Kennedy, 2008).

Step 2 of Creighton's model takes into account the type of sport, position played, competitive level, ability to protect, and limb dominance. As rugby is a collision sport, it poses a greater risk of injury when compared to non-contact sports (Creighton *et al.,* 2010). In rugby union, great variations exist between the demands of forward and backline players, as well as unique demands between every positional group (Deutsch *et al.,* 2007; Quarrie *et al.,* 2013). Competitive athletes are more likely to take risks; they also have greater speed, strength and size, resulting in higher forces and stresses (Creighton *et al.,* 2010). Taping and bracing can only be used to a certain extent in rugby union, as it can limit movement, and could potentially pose a threat to the player or other players (Marshall *et al.,* 2005).

Creighton's final step involves decision modification. This includes the timing and season, pressure from the athlete, external pressure, masking the injury, conflict of interest and the fear of litigation. Financial or performance advantages during a certain time in season could outweigh the potential disadvantages. External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation. Legally, the final decision has to be made by the team clinician or physician, even if the athlete is of age (Creighton *et al.,* 2010). It is thus very important that the team's best interest is also aligned with the athlete's best interest. The players and staff always need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery (Wikstrom *et al.,* 2006).

Literature regarding the demands of rugby union should therefore be incorporated into functional rehabilitation and gradual progression into sport-specific tasks, over a period of time to allow tissue to adapt to specific demand posed explicitly by each position in rugby union (Beam, 2002; Eaton & George, 2006). Even though the above-mentioned literature defines game demands, it remains difficult to accurately measure the demands in sports such as rugby union, in comparison with demands for individual sports (Hartwig, 2009). It will be the aim of this study to integrate what is known in the field of rehabilitation and RTP within rugby union and the model for RTP decision-making, presented by Creighton *et al.* (2010).

1.2 Problem Statement

Injury incidence in rugby union is one of the highest across sports (Williams *et al.,* 2013). High re-injury rates are also reported, associated with greater severity, longer periods of unavailability of players, reduced team performances and greater player morbidity and financial loss for players and franchises. One of the presumed reasons for the high re-injury rates are premature RTP (Beardmore *et al.*, 2005). Decision-making regarding RTP after injury, is always difficult. The vast number of factors contributing to the decision-making process not only influences the player's immediate state but can also greatly affect his future (Tol *et al.,* 2014). As there are no tried and tested guidelines, protocols or models for decision-making in rugby union, it is reliant on subjective medical professionals involved with the team, who are usually more clinically focussed and often lack an in-depth understanding of the functional requirements of rugby (Beardmore *et al.,* 2005).

The total player, physical and psychological load should be taken into account in RTP decision-making. The physical demands of rugby union are unique and should form an integral part of the RTP decision-making process as an athlete should be prepared to meet the total demands of his sport (Kegerreis, 1983). Beardmore *et al*. (2005) stated that functional ability assessment remains constrained within rugby union, bringing about an inability to provide adequate information for RTP decision-making. Furthermore, the high incidence of re-injury in rugby union could potentially be reduced through the use of standardised RTP assessment procedures (Beardmore *et al.,* 2005).

To conclude, it is clear from the literature that there is a lack of clear scientific evidence of RTP decision-making for musculoskeletal injury in rugby union, and RTP decisions lack standardization (Brukner, 2005; Lam *et al.,* 2009; Creighton *et al*., 2010). More significantly, this information gap may lead to confusion and disagreement within the medical team (Sport Physicians, Biokineticist and Physiotherapist), the rugby player and the coaching staff. Guidelines may help an inexperienced medical team in medical decision- making. It is thus crucial to continuously explore the development of a model or guideline to assist in the decision-making process of RTP within rugby union.

1.3 Research Questions

The following questions will be addressed:

1. What is known in the literature surrounding RTP decision-making for musculo-skeletal injuries in rugby union?

2. What is seen as important for RTP decision-making for musculo-skeletal injuries in practice, more specifically in the team environment of rugby union?

3. Is there a need to synthesise the available literature on RTP and to propose guidelines for RTP decision-making for musculo-skeletal injuries in medical management teams in rugby union?

4. Is it possible to develop a comprehensive, integrated model or guidelines to assist medical teams in rugby union to make an informed decision as to whether a rugby player with a musculo-skeletal injury may safely return to practice or competition?

1.4 Aim and objectives of the study

The main aim of the study was to formulate an integrated guidelines RTP after musculoskeletal injury in rugby union. In order to achieve the main aim of the study, two research objectives were formulated, namely:

1. To synthesize the literature concerning RTP decision-making for musculo-skeletal injury in rugby union.

2. The formulation of a guideline for RTP decision-making for musculo-skeletal injury in rugby union by means of a focus group and a national e-Delphi survey.

These guidelines will help to clarify the RTP decision processes for rugby union management teams, and will hopefully decrease controversy in the RTP decision-making process.

1.5 Structure of the Thesis

The thesis will be presented in 6 chapters, as illustrated in Figure 1 (below). Chapter 1 will consist of the problem statement, research questions, aims of the study and methodological considerations. Literature regarding all influences on RTP decision-making in rugby union will be discussed in Chapter 2. The research design and methodology of the study will be discussed in Chapter 3. Chapter 4 gives a description of the focus-group discussion. A qualitative research approach will be used for the e-Delphi survey, supplemented with some quantitative elements. This study, aims to equip the researchers with information relevant to RTP decision-making in rugby union, and forms the basis for the formulation of RTP guidelines for rugby union. Chapter 5 marries the literature synthesized concerning RTP decision-making in rugby union with the e-Delphi outcome (Chapter 3) to deliver a model or guidelines for RTP in rugby union. Chapter 6 will present a discussion, conclusion and recommendations for further study in this area. Hereafter, some reflections on the study, the process and the outcome will be given in Chapter 7. Referencing is done according to the Harvard method, with a list of references at the end of each chapter.

The thesis will be submitted for approval according to the UFS Guidelines for post graduate studies. In the interest of quality, and to facilitate examination, the font and spacing is consistent throughout the thesis. The tables and figures are placed in the text.

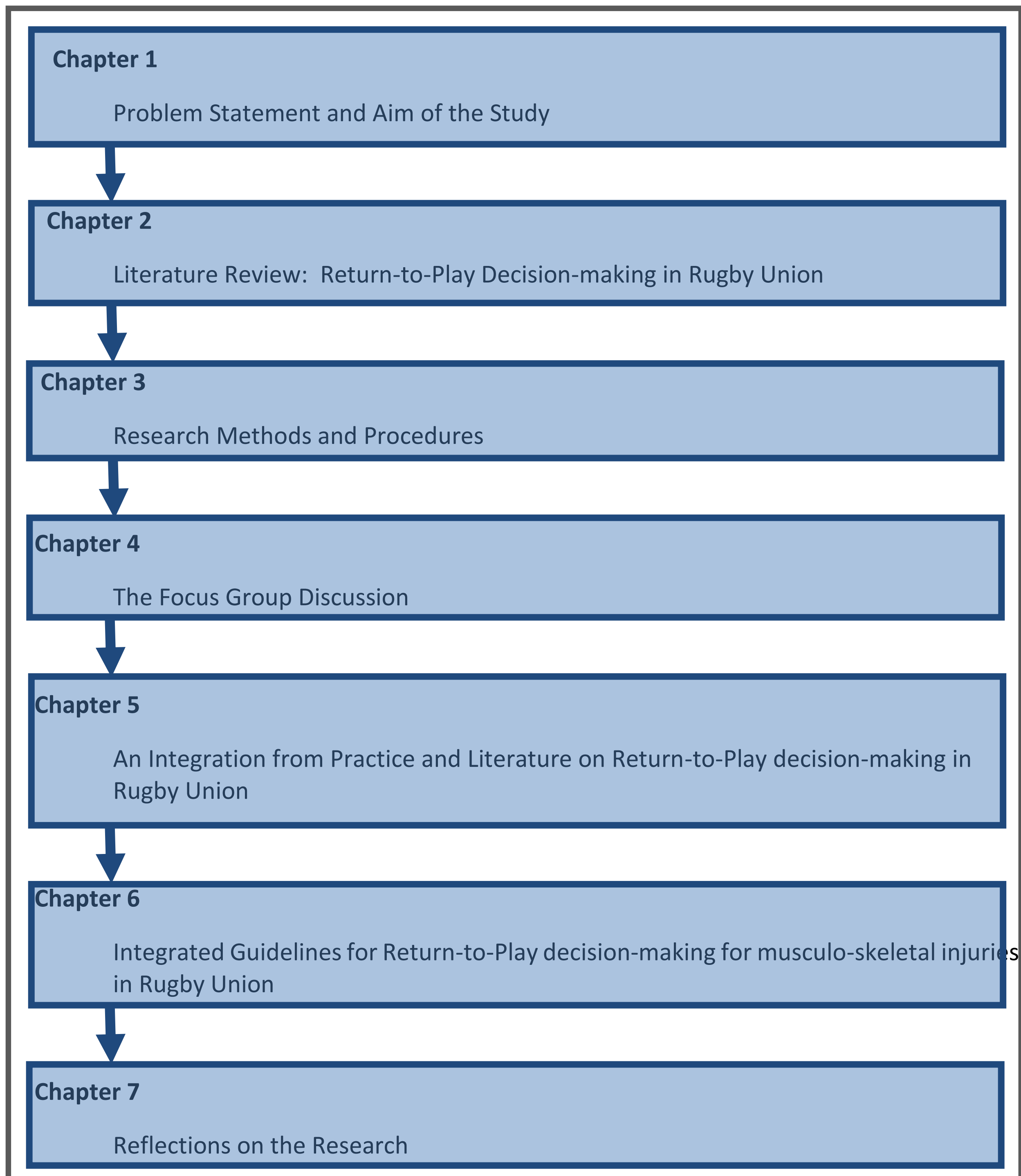


Figure 1.1: The structure of the Thesis

1.6 Methodology

To address the aims and objectives of this thesis the researcher make use of an exploratory, mixed-method design of a sequential nature. This design is characterised by a qualitative

phase of research which is followed by a quantitative phase. Therefore, the methodology of this thesis consisted of a mixed-method research design approach. The quantitative paradigm assigns numbers to the perceived qualities of things, emphasising the qualification of construction of a number of related themes (Babbie & Mouton, 2001). The qualitative approach provides an in-depth description of a group of people or community. An insider perspective of the group and their practices is studied as it is embedded in the life will of the group under scrutiny. Qualitative research presents data in words and is interpretive compared to quantitative research which presents its data in numbers and seeks to explain why things happen. The qualitative research method will be used mainly to provide an in-depth knowledge and insight into RTP decision-making of the medical management team members in rugby union, while information gathered by the e-Delphi will be quantified for accurate measurement and interpretation of results. De Villiers *et al*. (2005) also stated that the Delphi technique is a method for the collection of "opinions on a particular topic", such as the role of medical team management in RTP decision-making in rugby union. It is therefore important to note "particularly the opinions of experts on the topic". In conclusion, the Delphi method is based on the premise that "pooled intelligence" enhances individual judgement and culminates in an enhanced collective opinion of experts such as RTP decision-making in rugby union. Therefore, the quantitative research approach was used for the e-Delphi survey, supplemented by some qualitative elements.

In this thesis, the mixed-method design equipped the researchers with information relevant to RTP decision-making in rugby union and it forms the basis for the formulation of RTP guidelines for rugby union. The selection of experts for this e-Delphi survey involved the current medical management team members of SA Rugby franchises who were asked to serve on the e-Delphi panel. The national medical experts (n=15) were all current medical management-team members drawn from the 14 Rugby unions (Blue Bulls, Border Rugby, Eastern Province, Free State, Golden Lions, Griffons, Griqualand West, Kwazulu-Natal, Leopards Rugby, Mpumalanga Rugby, Southern Western Districts and Western Province Rugby Union). The e-Delphi survey consisted of two rounds. The two rounds focused on collecting consensus opinions from the experts on the RTP as a basis for the development of a RTP decision guideline. The data collection process consisted of a semi-structured questionnaire. Items included in the questionnaire for the two rounds of the survey were

based on the data collected in the prior literature review (Keggereis, 1983; Garraway *et al*., 2000; Beam, 2002; Drezner, 2003; Croisier, 2004; Liston *et al*., 2006; Beardmore *et al*., 2005; Croisier *et al*., 2008; Orchard *et al*., 2005; Wilkstrom *et al.,* 2006; Deutsch *et al*., 2007; Askling *et al*., 2010; Creighton *et al*., 2010; Hamilton, 2011; Clanton, *et al*., 2012; Herring *et al*., 2012; Poulis, 2012; Petersen & Zantop, 2013; Shultz *et al*., 2013; Tol *et al*., 2014; Orchard, 2014). The questionnaire for the first round consisted of a three-point Likert scale (agree/partially agree/disagree) (i.e. quantitative component); in round two a two-point Likert indicated whether the participant agreed or disagreed. This was followed by an open-ended question at the end of each section whereby additional comments or suggestions could be given (i.e. qualitative component). After completion of these two rounds (during which stabilisation was reached) of the e-Delphi survey, the results were used to compile a framework for the RTP decision guidelines. Round two provided the e-Delphi panel with a final opportunity (during which stabilisation was reached) to review the draft framework from round one, and to provide feedback.

1.7 References

ASKLING, C.M.; NILSSON, J. & THORSTENSSON, A. 2010. A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of The ESSKA,* 18(12): 1798 – 1803.

BABBIE, C. & MOUTON, J. 2001. The practice of social research. Cape Town: Oxford Univesity Press.

BEAM, J.W. 2002. Rehabilitation including sport-specific functional progression for the competitive athlete. *Journal of Bodywork and Movement Therapies*, 6(4): 205–219.

BEARDMORE, A.L.; HANDCOCK, P.J. & REHRER, N.J. 2005. Return-to-play after injury: practices in New Zealand rugby union. *Physical Therapy in Sport*, 6(1): 24–30.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2005. A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad. *British journal of sports medicine*, 39(5): 288–293.

BRUKNER, P. 2005. Return to play--a personal perspective. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 459–60.

CLANTON, T.O.; MATHENY, L.M.; JARVIS, H.C. & JERONIMUS, A.B. 2012. Return to play in athletes following ankle injuries. *Sports Health,* 4(6): 471-474.

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

CROISIER, J. 2004. Factors Associated with Recurrent Hamstring Injuries. *Sports Medicine*, 34(10): 681–695.

CROISIER, J.; GANTEAUME, S.; BINET, J. GENTY, M. & FERRET, J. 2008. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. *The American journal of sports medicine*, 36(8): 1469–75.

CUNNIFFE, B.; PROCTOR, W.; BAKER, J.S. & DAVIES, B. 2009. An evolution of the physiological demands of elite rugby union using global positioning system tracking software. *Journal of Strength and Coditioning Research.* 23(4): 1195 – 1203.

DEUTSCH, M.U.; KEARNEY, G.A. & REHRER, N.J. 2007. Time-motion analysis of professional rugby union players during match-play. *Journal of sports sciences*, 25(4): 461–472.

DE VILLIERS, M.R.; DE VILLIERS P.J. & KENT, A.P. 2005. The Delphi technique in health sciences education research. *Medical Teacher*, 27(7): 639-643.

DREZNER, J.A. 2003. Practical management : Hamstring muscle injuries. *Clinical Journal of Sports Medicine*, 13(1): 48–52.

EATON, C. & GEORGE, K. 2006. Position specific rehabilitation for rugby union players. Part II: Evidence-based examples. *Physical Therapy in Sport*, 7(1): 30–35.

FULLER, C.W.; SHEERIN, K. & TARGETT, S. 2013. Rugby World Cup 2011: International Rugby Board injury surveillance study. *British journal of sports medicine*, 47(18): 1184–91.

FULLER,C.W.; BROOKS, J.H.M.; CANCEA, R.J.; HALL, J. & KEMP, S.P.T. 2007. Contact events in rugby union and their propensity to cause injury. *British journal of sports medicine*, 41(12): 862–867.

GARRAWAY, W.M.; LEE, A.J.; HUTTON, S.J.; RUSSEL, E.B.A.W. & MACLEOD, D.A.D. 2000.

Impact of professionalism on injuries in rugby union. *British journal of sports medicine*, 34(6): 348–351.

HAMILTON, B. 2011. Return to Play Criteria Following Anterior Cruciate Ligament Surgery. Unpublished disssertation. Utah State University.

HARTWIG., T.B. 2009. Training and competition demands of adolescent rugby union players. Unpublished Phd Dissertation. Australian Catholic University.

HERRING, S.A.; BERGFIELD, J.A.; BOYD, J.; DUFFEY, T.; FIELDS, K.B.; GRANA, W.A.; INDELICATO, P.; KIBLER, W.B.; PALLAY, R.; PUTUKIAN, M. & SALLIS, R.E. 2012. The team physician and the return-to-play decision: a consensus statement-2012 update. *Medicine and science in sports and exercise*, 44(12): 2446–2448.

HOLTZHAUSEN, L.J.; SCHWELLNUS, M.P.; JAKOET, I. & PRETORIUS, A.L. 2006. The incidence and nature of injuries in South African rugby players in the rugby Super 12 competition. *South African medical journal*, 96(12): 1260–1265.

KEGERREIS, S. 1983. The construction and implementation of functional progressions as a component of athletic rehabilitation. *The Journal of orthopaedic and sports physical therapy*, 5(1): 14–19.

KRABAK, B. & KENNEDY, D.J. 2008. Functional rehabilitation of lumbar spine injuries in the athlete. *Sports medicine and arthroscopy review*, 16(1): 47–54.

LAM,M.; FONG, D.T.P.; YUNG, P.S.H.; HO, E.P.Y.; CHAN, W.Y. & CHAN, K.M. 2009. Knee stability assessment on anterior cruciate ligament injury: Clinical and biomechanical approaches. *Sports medicine, arthroscopy, rehabilitation, therapy & technology*, 1(1): 20-29.

LEE, A.J.; GARRAWAY, W.M.; HEPBURN, W. & LAIDLAW, R. 2001. Influence of rugby injuries on players' subsequent health and lifestyle: beginning a long term follow up. *British journal of sports medicine*, 35(1): 38–42.

LISTON, K.; REACHER, D.; SMITH, A. & WADDINGTON, I. 2006. Managing Pain and Injury in Non-elite Rugby Union and Rugby League: A Case Study of Players at a British University. *Sport in Society*, 9(3): 388–402.

MARSHALL, S.W.; LOOMIS, D.P.; WALLER, A.E.; CHALMERS, D.J.; BIRD, Y.N.; QUARRIE, K.L. & FEEHAN, M. 2005. Evaluation of protective equipment for prevention of injuries in rugby

union. *International journal of epidemiology*, 34(1): 113–118.

McINTOSH, A.S. & McRORY, P. 2005. Preventing head and neck injury. *British journal of sports medicine*, 39(6): 314–318.

ORCHARD, J. 2014. What role for MRI in hamstring strains? An argument for a difference between recreational and professional athletes. *British journal of sports medicine*, 48(18): 1337–1338.

ORCHARD, J.; BEST, T.M. & VERRALL, G.M. 2005. Return to play following muscle strains. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 436–441.

PETERSEN, W. & ZANTOP, T. 2013. Return to play following ACL reconstruction: survey among experienced arthroscopic surgeons (AGA instructors). *Archives of orthopaedic and trauma surgery*, 133(7): 969–977.

PODLOG, L. & EKLUND, R.C. 2009. High-level athletes' perceptions of success in returning to sport following injury. *Psychology of Sport and Exercise*, 10(5): 535–544.

POULIS, I. 2012. Approaches to conflicts between treatment recommendations and patients' decisions in physiotherapy: a case study. *Physical Therapy Reviews*, 17(3): 184–189.

QUARRIE, K.L.; HOPKINS, W.G.; ANTHONY, M.J. & GILL, N.D. 2013. Positional demands of international rugby union: Evaluation of player actions and movements. *Journal of Science and Medicine in Sport*, 16(4): 353–359.

REID, L.C.; COWMAN, J.R.; GREEN, B.S. & COUGHLAN, G.F. 2013. Return to play in elite rugby union: application of global positioning system technology in return-to-running programs. *Journal of sport rehabilitation*, 22(2): 122–129.

SHULTZ, R.; BIDO, J.; SHRIER, I.; MEEUWISSE, W.H.; GARZA, D. & MATHESON, G.O. 2013. Team clinician variability in return-to-play decisions. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 23(6): 456–461.

TOL, J.L.; HAMILTON, B.; EIRALE, C.; MUXART, P.; JACOBSEN, P. & WHITELEY, R. 2014. At return to play following hamstring injury the majority of professional football players have residual isokinetic deficits. *British journal of sports medicine*, 48(18), pp.1364–1369.

WALL, C.M.; BRUWER, E.J. & WILDERS, C.J. 2011. Injury prevalence and return to play criteria

in South African schoolboy rugby union. Unpublished Master's Thesis. Ptchefstroom, South Africa: North-West University.

WIKSTROM, E.; TILLMAN, M.D.; CHMIELEWSKI, T.L. & BORSA, P.A. 2006. Measurement and evaluation of dynamic joint stability of the knee and ankle after injury. *Sports medicine (Auckland, N.Z.)*, 36(5): 393–410.

WILSON, B.D.; QUARRIE, K.L.; MILBURN, P.D. & CHALMERS, D.J. 1999. Nature and circumstances of tackle injuries in rugby union. *Journal of Science and Medicine in Sport*, 2(2): 153-162.

Chapter 2

Literature Review: Return to Play Decision-making in Rugby Union

2.1 Introduction

2.2 Rugby union and injuries

2.2.1 Injury occurrence

2.2.1.1 Injury occurrence: Professional level

2.2.1.2 Injury occurrence: Amateur and Schoolboy level

2.2.1.3 Injury occurrence: Other forms of the game

2.2.2 Nature of rugby injuries

2.2.2.1 Injury location

(a) Injury location: Professional level

(b) Injury location: Amateur and schoolboy level

(c) Injury location: Other forms of the game

2.2.2.2 Injury type and severity

(a) Injury type and severity: Professional level

(b) Injury type and severity: Amateur and schoolboy level

(c) Injury type and severity: Other forms of the game

2.2.3 Body side

2.2.4 Injury event

(a) Tackles, rucks and mauls

(b) The scrum

(c) Walking and running

2.2.3 Recurrent injuries in rugby union

2.3. Rehabilitation

2.4. Return to play

2.4.1. STEP 1: Evaluation of health status

2.4.1.1 Patient demographics

2.4.1.2 Symptoms

(a) Pain

(b) Instability

(c)Swelling

2.4.1.3 Personal medical history

2.4.1.4 Signs

(a) Strength

(b) Range of motion

2.4.1.5 Laboratory tests

2.4.1.6 Functional tests

2.4.1.7 Psychological state

2.4.1.8 Potential seriousness

2.4.1.9 Orthopaedic surgeon’s evaluation or medical staff

2.4.2 STEP 2: Evaluation of participation risk

2.4.2.1 Type of Sport: Demands of Rugby Union

2.4.2.1.1 Physiological demands

2.4.2.1.2 Physical demands

(a) Tackles, rucks and mauls

(b) The scrum

(c) Walking and running

2.4.2.1.3 The laws of the game

2.4.2.2 Position played

2.4.2.3 Limb dominance

2.4.2.4 Competitive level

2.4.2.5 Ability to protect

2.4.3 STEP 3: Decision modification

2.4.3.1 Timing and season

2.4.3.2 Pressure from the player

2.4.3.3 External pressure

2.4.3.4 Masking the injury

2.4.3.5 Conflict of interest

2.4.3.6 Fear of litigation

2.4.4 Maintenance Program

2.5 Conclusion

2.6 References

2.1. Introduction

Rugby union became a professional sport in 1995, elevating participation on all levels of the game, increasing the level of competitiveness and also adding to training regimes (Bathgate *et al.,* 2002; Garraway *et al.,* 2000). An increase in both the physical and mental vigour of professional players also brought about a higher prevalence of injury across the sport (Garraway *et al*., 2000). Even more alarming is the rate of re-injuries (Fuller *et al.,* 2013; Fuller *et al.,* 2010; Brooks *et al.,* 2005a; Brooks *et al.,* 2005c; Bathgate *et al.,* 2002). Despite the heightened injury prevalence, players often opt to play even when injured as they put themselves under constant internal pressure, aided by pressure from coaches and team mates (Dijkstra *et al.,* 2014). It is reported that within rugby union greater emphasis is placed on clinical recovery and anatomical healing than the ability of an injured player or injury to endure the specific demands of rugby union (Beardmore *et al.,* 2005).

The correct and timely rehabilitation and return-to-play (RTP) decision-making is consequently becoming a more and more vital part of sport (Stracciolini *et al.,* 2007). The integrity of the sports medicine practitioner is also under constant scrutiny, as the health management of the player, optimized individual performance and team performance are of equal importance (Dijkstra *et al.,* 2014). The conundrum faced is the decision between early return-to-play and risk of re-injury. This conundrum will persist as long as there is a lack of a quantifiable, validated and reliable RTP decision-making protocol (Tol *et al.,* 2014). A model for RTP decision-making in sport was introduced by Creighton *et al.* (2010) to assist in the process, to decrease controversy and to identify gaps in practice areas.

This chapter will explore the demands of the modern game of rugby union, the epidemiology of rugby injuries, and RTP assessment procedures. This summary of available information will aid sport medicine teams, coaches and specialist coaches in decisions regarding training regimes, rehabilitation protocols and RTP in order to improve performance during training and match-play. Therefore, the aim of this literature review is to provide a basis of knowledge for the subsequent e-Delphi questionnaires in order to eventually create a framework for sport medicine teams, coaches and specialist coaches with regard to RTP decision-making in rugby union and the implications of these decisions.

2.2 Rugby union and injuries

Rugby Union is rated amongst professional team sports, as having one of the highest incidences of match injuries amongst professional team sports (Williams *et al.,* 2013). The importance of research in rugby injury epidemiology is highlighted by the frequency of surveillance studies requested by the International Rugby Board (IRB) during the major events in the rugby calendar, such as the Rugby World Cup. Surveillance studies have been part of Rugby World Cups (RWC) ever since the start of the professional era (Fuller *et al*., 2017; Fuller *et al*., 2013; Fuller *et al*., 2008; Best *et al*., 2005; Jakoet & Noakes, 1998). The results obtained from these surveillance studies not only emphasise the inherent risk of rugby union, but also warrant subsequent attention to injury management and RTP models for the sport.

Seeing that the successful implementation of injury management relies greatly on the correct characterisation of injuries (Palmer-Green *et al.,* 2013), the IRB established a Rugby Injury Consensus Group (RICG) to draw up appropriate definitions and methodology for recording and reporting injuries in rugby union (Fuller *et al.,* 2007). A rugby injury was henceforth defined as "*any physical complaint, which was caused by a transfer of energy that exceeded the body's ability to maintain its structural and/or functional integrity, sustained by a player during a rugby match or rugby training, irrespective of the need for medical attention or time-loss from rugby activities. An injury that results in a player receiving medical attention is referred to as a 'medical-attention' injury and an injury that results in a player being unable to take a full part in future rugby training or match play as a 'time-loss' injury'*" (Fuller *et al.,* 2007). Consensus regarding definitions and methodology also provides a platform for comparison.

2.2.1 Injury occurrence

(a) Injury occurrence: Professional level

The Rugby World Cup is considered as one of the largest sporting events in the world. It has been contested between teams from six continents, every 4 years since 1987 (Fuller *et al.,* 2013). RWC injury surveillance studies show similar results for the 2007, 2011 and the 2015 Rugby World Cups. The most recent RWC, 2015, showed an injury incidence of 90.1 match

injuries per 1000 player-match-hours. An alarmingly high severity of injuries resulted in 5151 player days absent (Fuller *et al*. 2017). During the 2011 RWC, a total of 5046 player-days were lost from matches and training due to injury, which translates to 89.1 injuries per 1000 player hours (Fuller *et al.,* 2013). The mean severity for injuries during the 2011 RWC was 23.6 days for match injuries and 26.9 days for training injuries. The results for the 2011 RWC were similar to the results collected from the 2007 RWC (Fuller *et al.,* 2013). A total of 83.9 injuries per 1000 player-match hours were reported (Fuller *et al.,* 2008). There was thus a distressing upward trend reported by RWC surveillance studies, with a 28% increase in injury severity from 2011, and a 117% increase compared to the 2007 RWC (Fuller *et al*., 2017).

A study of the English World Cup squad for the 2003 RWC saw a higher incidence of injuries during matches than previously reported. These matches included preparation matches as well as matches played during the RWC 2003. A total of 218 injuries per 1000 match hours was reported (Brooks *et al.,* 2005a). This massively high injury prevalence was ascribed to a broader definition of injury by the researcher as well as complicating biases such as players maintaining a higher body mass and being subjected to a 30% increase in ball in-play time during the 2003 RWC (Brooks *et al.,* 2005b).

The 2012 Super Rugby Tournament produced 83.3 injuries per 1000 player match hours amongst the five South African teams taking part (Schwellnus *et al.,* 2014). In professional English Premiership clubs, training injuries have been reported as 2.0 per 1000 player-hours (Brooks *et al.,* 2005c) with an average time loss of 24 days. Match injuries were reported as 91 injuries per 1000 player-hours with an average day loss of 18 days (Brooks *et al.,* 2005b). Injury rates amongst elite Australian rugby union players were monitored between 1994 and 2000, during which an overall rate of 69 injuries per 1000 hours of game time was reported (Bathgate *et al.,* 2002). During the 1999 Super 14 Rugby tournament, an injury incidence of 55.4 injuries per 1000 player game hours was reported with an incidence of 4.3 injuries per 1000 for player training hours (Holtzhausen *et al.,* 2006). Even though the latter studies were concluded before the RICG's consensus on injury reporting was released, the results are similar to other studies.

(b) Injury occurrence: Amateur and Schoolboy level

Injury probability amongst 14 to 17 year old rugby players has been reported to be as high as 90% (Junge *et al.,* 2004). The injury incidence during the 2008 and 2010 IRB U/20 Junior World Championships and Junior World Rugby Trophies were determined to be 57.2 per 1000 player-match-hours, with 55.3 for forwards and 59.4 amongst the backs (Fuller *et al.,* 2011). The study concluded that injury risk in U/20 rugby is significantly lower than in full international rugby, albeit the nature and cause of injuries are similar (Fuller *et al.,* 2011).

The 2011 South African Rugby Union Youth tournaments (U/13, U/16 and U/18) saw an overall injury incidence of 47.9 injuries per 1000 match hours. There was no significant difference in injury incidence over the age range as reported in other literature, although there was an increase in the absolute number of injuries reported (Brown *et al.,* 2012). Injuries within an English community youth rugby club (U/9-U/17) were documented to find an increase of injury risk and severity with an increase of age. An overall injury rate of 24 injuries per 1000 player hours was reported for the 2008-2009 season (Haseler *et al.,* 2010). Injury data were collected during the 2005 and 2006 United States high schools rugby seasons, reporting injury incidence of 5.2 injuries per 1000 total athletic exposures, with 1.3 injuries per 1000 practice hours and 15.2 injuries per 1000 match exposures (Collins *et al.,* 2008). The study did however not make use of the consensus statement for injury data reporting in rugby (Fuller *et al.,* 2007), making further comparison difficult. Surveillance of the Scottish' 1993-1994 rugby season concluded that schoolboy rugby is safer than senior club rugby (Lee & Garraway, 1996). An injury prevalence of 86.8 injuries per 1000 player-seasons for schoolboys and 367.0 injuries per 1000 player-seasons for club rugby was reported. Injury incidence in eight premier grade rugby union teams in New Zealand were reported as 52 injuries per 1000 player-match hours (Schneiders *et al.,* 2009). All the elite Junior Rugby Union players of Western Australia were observed for a 26 week period including the 1997 National Championship campaign (McManus & Cross, 2004). An injury incidence of 13.3 injuries per 1000 player hours was reported.

A 2009 systematic review of the epidemiology of adolescent rugby injuries indicated difficulty in injury definitions and data collection procedures, making comparison difficult. Injuries that did, however, need medical attention, ranged between 27.5 and 129.8 injuries per 1000

match hours. An increase in age was again found to be associated with higher injury rates (Bleakley *et al.,* 2011). Higher injury rates were reported for the beginning of the season (Lee & Garraway 1996; Bleakley *et al.,* 2011). The Poisson model for risk analysis was used to transform population-based incidence of injury into average probabilities of injury to individual players. The study analysed 10 rugby injury-incidence studies with specified age groups to find an injury incidence ranging from 7 to 129.8 injuries per 1000 player hours, over the age groups, which translated into an average injury probability of 12 to 90% over a season (Parekh *et al.,* 2012). The study advocated that these probability figures should be used to educate and communicate the risk involved in rugby union to the public.

Serious neck injuries amongst U/19 rugby players in Great Britain and Ireland occurred from 1996 to 2010 (MacLean & Hutchison, 2012). A total of 36 injuries were recorded, with 16 of these injuries presenting with complete neurological loss, 9 injuries with incomplete neurological injury and 11 with cervical column injury without spinal cord damage.

(c) Injury occurrence: Other forms of the game

During the 2010 IRB Women's Rugby World Cup (WRWC), an injury incidence of 35.5 injuries per 1000 player hours were reported (Taylor *et al.,* 2011). The 2006 WRWC reported a match-injury incidence of 37.5 injuries per 1000 player hours with a practice injury incidence of 12.5 injuries per 1000 player hours (Schick *et al.,* 2008). Backs sustained a higher injury incidence of 42.2 injuries per 1000 player hours compared to 39.3 injuries per 1000 player hours sustained by forwards, even though the front row had the highest injury rate.

The Ontario Women's Senior Provincial rugby team in Canada were monitored over the 1997 season and 1998 World Championships (Carson *et al.,* 1999). An injury incidence of 7.1 injuries per 1000 player hours was recorded and 12 injuries per 1000 athletic exposures. They found these statistics to be comparable with other women's contact and collision sports, and lower than injury incidence in male rugby union. Women's collegiate rugby union teams were observed over the 2005-2006 season and determined an injury prevalence of 17.1 injuries per 1000 player game hours, much lower than injury rates for men's professional club and international rugby (Kerr *et al.,* 2008). Players in four USA Rugby local area seven's

tournaments were observed, finding an overall injury rate of 55.4 injuries per 1000 playing hours (Lopez *et al.,* 2012). For men, the injury incidence was recorded as 74.7 injuries per 1000 playing hours, whereas women only had an injury incidence of 10 injuries per 1000 playing hours.

The 2008-2009 IRB Sevens World Series (8 tournaments) and the 2009 Rugby World Cup Sevens were surveyed for injury incidence (Fuller *et al.,* 2010). An incidence of 106.2 injuries per 1000 player hours was reported with a mean severity of 45 days. This study found a higher injury incidence amongst Rugby Sevens than international 15-man Rugby, as well as a significantly higher injury severity (Fuller *et al.,* 2010).

In summary, data collection and analysis has only recently (2007) been standardized in terms of definitions, methodology and interpretation. Definitions for injury incidence, injury classification and severity of the injury differed widely between studies preceding this statement. This made comparison of injury incidence over certain periods of time difficult, which in turn renders the influence of an injury prevention or rehabilitative program complex. It is, however, clear from the above mentioned literature, that injuries in rugby union are high, varying from 24 injuries per 1000 player hours to 106.2 injuries per 1000 player hours. The importance of injury prevention, rehabilitation and safe return-to-play after injury is thus undisputedly warranted within rugby union.

2.2.2 Nature of rugby injuries

The nature of rugby union injuries should be classified by location, type, body-side and injury event according to the consensus statement on research in rugby union injuries (Fuller *et al.,* 2007).

2.2.2.1 Injury location

(a) Injury location: Professional level

During the 2015 RWC, the most frequently injured musculoskeletal location was the knee (Fuller *et al.,* 2017). Collectively, the lower limbs contributed 52.2% of the total injuries reported. Injuries sustained during matches in the 2011 RWC were most commonly to the

shoulders of backs and to the head/face for forwards. The incidence of posterior thigh injuries was also high (Fuller *et al.,* 2013). During both matches and training, the knee was the most injured area in the 2007 RWC. This was followed by die posterior thigh and shoulder in matches and by the posterior thigh in training (Fuller *et al.,* 2008).

English Premiership teams during the 2002 to 2004 seasons, displayed the most common injuries amongst the forwards as anterior cruciate ligament (ACL) injuries whereas backs more frequently sustained hamstring injuries during match-play (Brooks *et al.,* 2005b). Lower limb injuries were reported as the highest amongst training injuries (68%), while upper limb injuries were of greater severity (Brooks *et al.,* 2005c). The thigh was indicated as the most commonly injured amongst lower extremity injuries, during training, with training injuries to the knee being the most severe. Shoulder injuries during training were the most common and most severe amongst upper extremity injuries.

Amongst Australian Wallaby rugby union players during 1994 to 2000, the head was found to be the most commonly injured body site, followed by the knee, thigh and ankle (Bathgate *et al.,* 2002). Bathgate *et al.* (2002) also indicated that injuries to the knee accounted for 25% of the more severe injuries, and 40% of all knee injuries were reported as severe Furthermore, hamstring strains or tears comprised 53% of injuries to the thigh. During preparation for the 2003 RWC, English players sustained most injuries to the lower limb (60%) and the upper limb (17%) during training (Brooks *et al.,* 2005a). Lower limb injuries also accounted for the greatest number of injuries (48.1%) during the 2012 Super Rugby Tournament, with upper limb injuries (25.6%) being the second most injured area (Schwellnus *et al.,* 2014). The 1999 Super Rugby (Super 12) Tournament saw the most common injury sites to be the hip and pelvis (19.3%), followed by the head and knee (12.9% each)(Holtzhausen *et al.,* 2006).

(b) Injury location: Amateur and schoolboy level

In a systematic review of injuries amongst adolescent rugby union players, the head and neck, upper limb, and lower limb were all found to be common sites of injury (Bleakley *et al.,* 2011). More specifically, the 2008 and 2010 U/20 Junior World Championships and Junior World Rugby Trophies saw the most vulnerable locations for injury as the shoulder or clavicle,

followed by the ankle and the knee (Fuller *et al.,* 2011). The lower extremities were found to be the most vulnerable area during the 2011/2012 South African Rugby Union Youth Tournaments (U/13, U/16 and U/18)(Brown *et al.,* 2015), as well as the 1997 Western Australian Junior Rugby Championships (McManus & Cross, 2004). Amongst the U/9 to U/17 English community club rugby in the 2008/2009 season, the knee and shoulder were found to be equally vulnerable to injury (Haseler *et al.,* 2010). Injuries amongst high school rugby players in the United States during the 2005/2006 seasons were primarily to the head, followed by the ankle and shoulder (Collins *et al.,* 2008).

Surveillance of the Scottish 1993-1994 rugby season of both schoolboy and club rugby, suggested that club players sustained dislocations more regularly, strains and sprains to the hip and thigh, as well as back strains and sprains and dislocations, strains and sprains to the knee were also noted (Lee & Garraway, 1996). Amongst the schoolboys however, upper limb fractures were more common. Fractures to the clavicle and hand were the most common upper limb fracture for both schoolboys and club players. During the 2002 season, eight premier grade rugby union teams (non-professional) from New Zealand were observed to find the most common site for injury to be the face, followed by the knee and shoulder (Schneiders *et al.,* 2009). The facial injuries, however, were classified as slight, thus not influencing the rest of the season, and mostly not even on the rest of the game.

(c) Injury location: Other forms of the game

During the 2010 and 2006 WRWC, injuries to the knee were the most common (Taylor *et al.,* 2011; Schick *et al.,* 2008). The 2010 tournament, however, saw a high number of ankle injuries as well, while the 2006 tournament saw an equal amount of neck injuries compared to knee injuries. In the USA, female collegiate rugby players sustained a higher prevalence of knee injuries compared to their male counterparts' higher prevalence of shoulder injuries (Kerr *et al.,* 2008).

The 2008/2009 IRB's Seven Series saw the most injuries occur to the lower limb (70%) (Fuller *et al.,* 2010). During an amateur rugby union sevens tournament, the head and neck were

found to be the most frequently injured sites, followed by the upper extremities, the trunk and the lower extremities (Lopez *et al.,* 2012).

Rugby union poses a great injury risk for all body sites, with a particular threat to the knee joint. The posterior thigh and the shoulder are also areas that are vulnerable in rugby union. Greater care should be given to reducing injuries to these sites and also to reduce the occurrence of re-injury to these areas.

2.2.2.2 Injury type and severity

The main groupings for injury types in rugby union are bone, joint (non-bone) and ligament, muscle and tendon, skin, brain, spinal cord, peripheral nervous system and other (Fuller *et al.,* 2007). Injury severity is defined in the consensus statement as "*The number of days that have elapsed from the date of injury to the date of the player's return to full participation in team training and availability for match selection. Injuries should be categorized as follows:*

Slight *0–1 days*

Minimal *2–3 days*

Mild *4–7 days*

Moderate *8–28 days*

Severe *>28 days*

Career-ending and

Non-fatal catastrophic injuries" (Fuller *et al.,* 2007).

(a) Injury type and severity: Professional level

The preparation phase of England's 2003 RWC squad saw the most common injury diagnosis to be muscle and tendon (50%) and joint (non-bone) and ligament (41%) injuries (Brooks *et al.,* 2005a). The severity of injuries to the backs was lower than that of the forwards. An

average of 18 days per injury was lost during this time, with recurrent injuries resulting in an average of 27 days lost per injury. It was furthermore determined that 23% of an average club's squad will be unavailable for selection at any time during a season due to injury.

For the duration of two seasons of 11 English Premiership clubs, 34% of the total injuries were sustained in the preseason, involving mainly muscle injuries for the backline players and a combination of muscle, ligament and back injuries amongst the forwards (Brooks *et al.,* 2005c). Muscle and tendon injuries were most common, followed by joint (non-bone) and ligament injuries, though the severity of joint (non-bone) and ligament injuries was significantly higher. The severity of injuries sustained by forwards during training amounted to a total of 3533 days missed. Of these, 840 days were a result of lumbar disc or nerve root injuries and 491 were the result of shoulder dislocations or instabilities. The backs sustained injuries resulting in a total of 2246 days lost of which 502 days were ascribed to hamstring muscle injuries (excluding haematomas/contusion) and 489 days by ACL injuries (Brooks *et al.,* 2005c).

Over the 2002 to 2004 seasons of English Premiership rugby, 12 clubs with 546 players in total were observed during match-play. The number of days missed by forwards sustaining ACL injuries accumulated to 988 days, knee meniscal or articular cartilage injuries amounted to 923 days and dislocations or instability of the shoulder added up to 746 days missed. The total amount of days missed by forwards due to match injuries added up to 6868 days over the two season period. The backs suffered 1176 days lost due to hamstring muscle injuries (excluding haematomas/contusions) a further 957 days were lost due to dislocation or instability to the shoulder and 870 days due to Medial-Collateral ligament (MCL) injuries (Brooks *et al.,* 2005b). The total amount of days lost by backline players over the two seasons amounted to 6463 days. The Australian Wallabies rugby union players suffered most frequently from soft tissue injuries (55%) during the period 1994 to 2000. More specifically, the injuries were joint or ligament sprains or tears (25.2%), followed by musculo-tendinous strains or tears (20.3%) and then contusions and haematomas (9.8%) (Bathgate *et al.,* 2002)**.**

Posterior thigh muscle strains were found to be the most common match injury during the 2011 RWC and knee ligament match injuries, which included five anterior cruciate and three medial collateral ligament sprains which were responsible for the greatest time loss (Fuller *et*

al., 2013). Hamstring injuries, followed closely by knee ligament injuries were reported as the most common type of injury during the 2015 RWC. The severity of knee ligament injuries is reportedly the highest, with the subsequent most days lost. An alarming statistic regarding the severity of injuries during RWC was made, indicating that the days lost due to injury increased from 2369 player-days-absent for the 2007 RWC to 4020 player-days-absent for the 2011 RWC to an astonishing 5151 player-days-absent reported for the 2015 RWC (Fuller *et al*., 2017).

Eleven English Premiership teams were observed during the 2002 through to 2004 seasons. Knee ligament and posterior thigh muscle injuries were the most common. However, shoulder dislocations or instabilities along with lumbar disc, nerve or canal injuries caused the most days missed. Shoulder dislocations and instabilities and stress fractures to the foot caused the most absent days from high volume training (Fuller *et al.,* 2008). The 152 players from the South African franchises that took part in the 2012 Super Rugby tournament sustained 160 time-loss injuries (Schwellnus *et al.,* 2014). Of these injuries 42% were considered moderate or severe. Soft tissue injuries to muscle or tendon accounted for 50% of the total injuries, whereas joints or ligaments made up 33% of injuries sustained. The same tendency was recorded amongst three of the four South African teams during the 1999 Super Rugby (then Super 12) tournament, where ligament sprains and musculo-tendinous strains or tears made up 50% of all injuries recorded (Holtzhausen *et al.,* 2006).

In spite of professional teams' access to scientifically proven injury prevention programs for hamstring and ACL injuries, the occurrence and severity of these types of injuries are still astonishingly high.

(b) Injury type and severity: Amateur and schoolboy level

The 2008 and 2010 IRB U/20 Junior World Championships and Junior World Rugby Trophies saw a mean severity for injuries at 22.4 days. The lower limb ligaments and muscle were the main type of injury reported (Fuller *et al.,* 2011). The South African Rugby Union Youth tournaments of 2011 and 2012 saw 190 players suffering time loss injuries. Of the 171 injured

players that could be contacted after the tournaments, only 42% sought further treatment. Joint, ligament or tendon injuries were found to be most prevalent time-loss injuries among all the age categories (U/13 to U/18). There were a total of 390 reported treatments for the injuries that occurred during these Youth tournaments, accumulating to a total treatment cost of US$ 80 228. Injuries classified as severe, had a total cost of US$ 1551 (Brown *et al.,* 2015).

Amid U/9 to U/17 English community rugby clubs a reported 59% of injuries were deemed moderate or severe, with a statistically significant increase in severity with an increase in age (Haseler *et al.,* 2010). The study reported three injuries within the U/17 group as 'career ending', but also reported these injuries as an ACL injury and two meniscal tears, which should not necessarily be deemed career ending. The study, however, did not report further on the types of injuries sustained.

A literature review of injuries amongst adolescent rugby players concluded that the greatest time loss is associated with fractures and dislocations of the upper limbs and knee ligament injuries (Bleakley *et al.,* 2011). Severe injuries have an occurrence of 1.1623 to 1.721 per 1000 playing hours, which is low, compared to the occurrence of severe injuries amongst professional players which amounts to 15.1 injuries per 1000 match hours. The 2005/2006 US high school rugby season saw 160 injuries with a time loss of greater than 21 days. Of these severe injuries, 41% were due to a fracture and 19.4% due to ligament sprains (Collins *et al.,* 2008). Western Australian Youth players suffered their most severe injuries to the shoulder (McManus & Cross, 2004).

Haematomas, ligament tears/sprains and muscle tears/strains were reported to be the most common amongst premier grade rugby teams in New Zealand over the 2002 season (Schneiders *et al.,* 2009). Thirty-seven percent of the injuries were deemed moderate or severe.

(c) Injury type and severity: Other forms of the game

Joint, (non-bone) or ligament injuries were recorded most often during the 2010 WRWC, with knee-ligament injuries making up 15% of the total injuries. Knee-ligament injuries also resulted in the most days lost (Taylor *et al.,* 2011). The 2006 WRWC saw the majority of

injuries to be sprains or ligament injuries, followed by muscle strains, tears or cramps (Schick *et al.,* 2008). The study unfortunately did not report on the severity of the injuries. The injury type reported highest amongst New England Collegiate woman's rugby during the 2005-2006 seasons was ligament sprains. Knee injuries were cited to have the highest severity (Kerr *et al.,* 2008).

During an amateur rugby sevens tournament held in 2010, the most common type of injury was ligament sprains, hematoma/contusion and muscle strain (Lopez *et al.,* 2012). The occurrence of ligament sprains was significantly higher than any other type of injury. Of all the injuries, 33.3% were deemed moderate and 12.5% were deemed severe. Over the 2008 2009 World Sevens Series, the most common type of injury recorded was joint (non-bone) or ligament injuries, adding up to 52% of the total injury count. The reported injuries had a mean severity of 45 days and a median severity of 24 day.

Although a wide array of injury types occur frequently in rugby union, joint (non-bone) or ligament injuries seem to be a common phenomenon. As ACL preventative measures have been found to be successful, more attention should be given to other preventative strategies for this type of injury. Joint (non-bone) or ligament injuries are also usually associated with greater severity, which further emphasizes the need for preventative measures. The character of rugby union is however one of impact, collisions and awkward grounding of players, making complete prevention of such injuries impossible.

2.2.3 Body side

The 2011 RWC saw no significant differences in the numbers of injuries sustained to the dominant compared to the non-dominant side in either the upper or lower limbs. Match play significance for the upper limbs of p=0.317 amongst the forwards, p=0.835 amongst the backs and for the lower limbs p=0.527 amongst the forwards and p=0.869 for the backs were calculated (Fuller *et al.,* 2013). During the 2007 RWC however, the backs were significantly more likely to acquire a lower limb injury to their non-dominant leg (p=0.001) as well as their

non-dominant upper limb (p=0.020). Yet again, no significant data were found for either the lower limb (p=0.876) or the upper limb (0.617) amongst the forwards (Brooks *et al.,* 2008).

Literature regarding injury occurrences in the dominant versus non-dominant side is limited, and more attention should be given to reporting it. Side of injury forms part of the consensus statement for injury research in rugby union (Fuller *et al.,* 2007). This also implicates RTP decision-making, as much literature focuses on the non-dominant limb being as strong as the dominant limb for return to be made, even though it is not known, but rather assumed that the non-dominant limb is more susceptible to injury.

2.2.4 Injury event

The physical nature of rugby union lends itself to injuries ranging from slight contusions to more complex injuries, with multiple injury diagnoses from a single or multiple events involving the same player in the same game. Match and training injuries should be separated. Contact injuries, including injuries resulting from tackling, tackled, maul, ruck, lineout, scrum, collision or other should be indicated, as well as non-contact injuries. If the injury resulted from a violation of the laws of the game by the match referee, it should also be indicated (Fuller *et al.,* 2007).

(a) Tackles, rucks and mauls

The contact situation is associated with the highest incidence of injury (72%), more so for forwards than backs (Brooks *et al.,* 2005b). Illegal collision tackles or shoulder charges cause both the highest incidence, and the most severe injuries per event compared to other contact events (Roberts *et al.,* 2014). High velocity, open play tackles with limited preparation time for the tackle for both the tackler and ball carrier most often result in injury. Tackling more often causes upper limb injuries with lower limb injuries being more common for the ball carrier (Roberts *et al.,* 2014).

Tackles are related to the highest injury incidence in community rugby union, with illegal collision tackles posing the greatest risk of injury per contact event (Roberts *et al.,* 2014). During the 2003 to 2005 seasons of the New Zealand national rugby team (All Blacks), all

tackles during all games were observed and analysed using video data (Quarrie & Hopkins, 2008). Due to tackles, 1348 injuries were assessed on the field, with 211 of these injuries requiring the player to be replaced. The injuries mostly resulted from high or middle tackles from the front or the side, but a higher injury rate per tackle was indicated for tackles made from behind or from the side. The player with the ball was most prone to head or neck injuries resulting in replacement. The tackler was more prone to injury when making a low tackle. The predominant mechanism for lower limb injuries was the increased loading from another player. Seven injuries occurred per 1000 tackle events or 35 per 1000 player-hours. There is a higher replacement rate when there are one or two tacklers involved compared to three or more tacklers involved. Injuries resulting from tackles taking place during sprinting were 3 to 5 times more frequent than injuries at lower speeds. High-speed injuries were also more severe (Quarrie & Hopkins, 2008).

Tackles, rucks and mauls were the highest contributors to injuries sustained in matches for the English World Cup Squad of 2003, with 50 injuries per 1000 match hours being ascribed to being tackled and 35 injuries per 1000 match hours due to rucks or mauls (Brooks *et al.,* 2005a). The tackle is responsible for 61% of occurring injuries, five times more than any other contact situation in rugby union (Nicol *et al.,* 2011; Hendricks & Lambert, 2010; Fuller *et al.,* 2007). Rucks or mauls cause the most injuries to forwards, whilst tackle injuries occur more frequently amongst backs (Brooks *et al.,* 2005b). Although tackles are deemed as the event responsible for the highest number of injuries with the greatest severity, tackles are also the most common contact event. Collisions in turn, were 70% more likely to result in injury than tackles or scrums (Fuller *et al.,* 2007). The English Premiership 2003-2004 and 2005-2006 seasons judged line-outs to have the lowest associated injury risk, followed by mauls and tackles, followed by collisions and scrums.

(b) The scrum

Even though scrums have a proportionally lower frequency of serious neck injuries compared to the tackle, the neck injuries sustained in the scrum are more severe and associated with an increased risk of permanent spinal cord injuries. These injuries most often occur in the case of the scrum engagement or a collapsed scrum (MacLean & Hutchison, 2012). Scrum injuries account for 11% of injuries sustained by forwards. Collapsed scrums in community

rugby union pose a particularly higher risk of severe injury in comparison with scrums that do not collapse. Successful scrums have a relatively low injury risk, compared to tackles. However, collapsed scrums have a fourfold greater injury incidence and a six fold incidence of greater severity of injury compared to successful scrums (Roberts *et al.,* 2014).

(c) Walking and running

During training sessions of the 2003 English World Cup squad, endurance running and contact elements had the highest risk of injury (Brooks *et al.,* 2005a). Endurance running caused 35 injuries per 1000 exposure hours. Running is cited as the predominant cause of injury in the context of these training injuries, whereas the injuries sustained due to skills training, were more severe (Brooks *et al.,* 2005c). Running and kicking are cited as the most common cause of hamstring injuries in rugby union (Heading, 2009).

2.2.5 Recurrent injuries in rugby union

It is important to distinguish between new injuries and recurrent injuries. The criteria for defining recurrent injuries are as follows: '*An injury of the same type and at the same site as an index injury and which occurs after a player's return to full participation from the index injury. A recurrent injury occurring within 2 months of a player's return to full participation is referred to as an 'early recurrence'; one occurring 2 to 12 months after a player's return to full participation as a 'late recurrence'; and one occurring more than 12 months after a player's return to full participation as a 'delayed recurrence'*(Fuller *et al.,* 2007). The objective of rehabilitation and return-to-play decision-making should thus be focussed primarily on eliminating early recurrences, minimizing late recurrences and reducing or eliminating delayed recurrences.

Previous injury remains the strongest predictor of future injury (Beardmore *et al.,* 2005). Alarming and powerful re-injury statistics are indicated in rugby, presumably due to premature RTP. We should bear in mind that certain risk factors associated with the possible recurrence of the injury could in all probability already have been implicated in the initial injury (Croisier, 2004). It is also hypothesized that long seasons, a lack of a proper off-season and inadequate pre-seasons can contribute to the high number of recurrent injuries sustained

by professional rugby union players (Holtzhausen *et al.,* 2006; Brooks *et al.,* 2005c). There is, however, a lack of sufficient knowledge surrounding patterns and prevalence of recurrent and chronic overuse injuries in professional rugby union (Holtzhausen *et al.,* 2006). The proven notion of previous injuries being the strongest predictor of recurrent injuries should therefore bear the most weight in recurrence discussions.

Recurrent injuries made up 11.6% of injuries reported for the 2017 RWC (Fuller *et al*., 2017). Match injuries during the 2011 RWC consisted of 14% recurrent injuries, similar to that of previous studies in elite rugby (Fuller *et al.,* 2013). Of these recurrent injuries, 42% were shoulder/clavicle injuries (four subluxations and two acromion-clavicular joint sprains). Recurrent injuries also contributed 17% to the number of training injuries sustained. One specific recurrent injury, a cervical disc prolapse, resulted in a 129-day loss.

For English professional rugby during the 2011-2012 season, 75% of recurrent injuries occurred within one month after RTP occurred (Kemp *et al*., 2013) The highest percentage of these recurrent injuries were to the lower limb (70%). More distinctively, 33% were to muscle, and 10% to joint and ligament and 10% to tendon injuries (RFU, 2013). Below is a summary of all new and recurrent injuries sustained by English professional rugby union players per season (Kemp *et al*., 2013). During the 2002 to 2004 seasons of English Professional rugby, recurrent injuries which occurred during matches made up 18% of all injuries, with severity being higher for recurrent injuries compared to the new injuries (Brooks *et al.,* 2005b). The same tendency occurred with regard to training injuries, as 19% of injuries occurring during training were recurrent and subsequently more severe, as 14 more days were lost due to these injuries, compared to the initial injuries (Brooks *et al.,* 2005c).

Table 1 summarizes the average severity of injuries sustained by English Professional players from 2002 up to 2012. Even though recurrent injuries do not make up the majority of reported injuries, they should be given more attention as the severity level is so much higher. A greater severity results in the unavailability of players for longer periods of time, reduced team performances and greater player morbidity and financial loss for players and franchises.

Table 1: New injuries compared to recurrent injuries in terms of average severity for English Professional Rugby (Adopted from RFU 2013).

Season	Average Severity of New Injuries (days missed from training)	Average Severity of Recurrent injuries (days missed from training)
02-03	14	23
03-04	18	33
05-06	20	29
06-07	21	33
07-08	19	20
08-09	21	34
09-10	21	29
10-11	21	25
11-12	27	23

Amateur and professional rugby clubs from the Scottish Borders were monitored before the dawn of professionalism, during the 1993-1994 season. New injuries predominated, but during the 1997-1998 season, after professionalism, 56% of all injuries to professional players were recurrent as was 29% for amateurs (Garraway *et al.,* 2000). Australian Wallabies rugby union players had an overall re-injury rate of 10% from 1994 to 2000 (Bathgate *et al.,* 2002). A study on the 1999 Super-12 competition it emerged that 13% of injuries were re-injuries to the same structure (Holtzhausen, 2001).

The high incidence of re-injury in rugby union could potentially be reduced through the use of standardised RTP assessment procedures (Beardmore *et al.,* 2005). As there are no consensus in decision-making processes following muscle strains, or any other injury, it is suggested that earlier return to play in team sports should be allowed, accepting low to moderate injury recurrence risk (Orchard *et al.,* 2005). The challenge now lies in understanding and possibly quantifying the risk of re-injury when returning a player to the field must be decided. Furthermore, communication of risk in sport is an underdeveloped

element of injury risk management (Parekh *et al.,* 2012). With understanding comes calm, acceptance and power, creating positivity and contentment.

2.3. Rehabilitation

Pre-determined, clinically based therapeutic techniques are used for the restoration of muscular strength and endurance, flexibility and ROM during the rehabilitation process (Beam, 2002). Traditional clinical therapy does however not necessarily secure the safest and quickest return for a sportsperson back to competition. It is thus essential to incorporate sport-specific demands within the aggressive rehabilitation of a sportsperson. Correct and timely rehabilitation of injuries are becoming a more and more vital component of sport (Stracciolini *et al.,* 2007). Prognosis and the date of resumption of play are not only important to the player, but also the team, management and other corporate affiliates.

The rehabilitation of musculoskeletal injuries in sport is expected to facilitate recovery through an active approach (Gianotti *et al.,* 2009). Focus during rehabilitation should be placed on correcting inflexibilities and strength deficits (Krabak & Kennedy, 2008). Rehabilitation should not only reduce signs and symptoms associated with an injury, but should also ensure safe and effective RTP by augmenting clinical rehabilitation with functional progression and sport-specific tasks (Eaton & George, 2006). Rehabilitation of a sports person should enhance the acquisition or reacquisition of skills in order for it to be safely and effectively performed following an injury. As such, functional progression is integral (Kegerreis, 1983). Rehabilitation should subject a player, over a period of time, to demands at least as rigorous as the demands to be encountered in a match and also specific to the playing position (Beam, 2002). Specific criteria for progression in rehabilitation programs are however not well described and rarely validated (Tol *et al.,* 2014). As great variations in demands exist between playing positions in rugby union, rehabilitation should be adjusted accordingly (Eaton & George, 2006).

Access and commitment to rehabilitation plays an integral part in the process. Often youth or amateur players will have to wait for appointments or treatments and are not able to attend rehabilitation on a regular basis, extending recovery time. Other responsibilities, such

as school, work, social activities etc could hinder an amateur or school player's rehabilitation process compared to that of a professional player (Haseler *et al.,* 2010).

The most important and complex stage of rehabilitation is arguably the RTP decision-making stage, as it impacts the availability of the player and the risk of re-injury (Tol *et al.,* 2014). RTP decision-making is also not a simple process, as it involves a multitude of factors to be taken into consideration. During rehabilitation the main focus should be on the injury, but when it is time to make decisions regarding RTP, the injury alone cannot be taken into account. Emphasis should shift towards the ability of the player, and per implication, the injury to sustain the particular demands that he will meet upon return.

2.4. Return to play

Return-to-play or return-to-sport is defined as the medical clearance of an athlete for full participation in sport without any strength, practice or competition restrictions (Creighton *et al.,* 2010). It is detrimental to assume that clinically based success alone will assure safe RTP (Kegerreis, 1983) as safe RTP does not only involve anatomical and functional recovery, but the demands on the player are equally, if not more, important (Orchard, 2014). It is, however, reported that rugby union places greater emphasis on clinical recovery and anatomical healing than the ability of an injured player or injury to endure the specific demands of rugby union. Functional ability assessment remains constrained within rugby union resulting in an inability to provide adequate information for RTP decision-making (Beardmore *et al.,* 2005). Consequently, premature RTP and incomplete recovery remains a major contributor to injury in rugby union (Beardmore *et al.,* 2005). A vicious cycle of chronic injuries or even permanent disability could furthermore be propelled into motion when players are returned to play before a full recovery from injury has been made (Wikstrom *et al.,* 2006). An athlete should therefore be prepared to meet the total demands of his sport (Kegerreis, 1983).

A possible contributing factor to early RTP could be explained by a 2005 New Zealand study where it was found that support personnel's training and experience hugely influenced RTP decision-making, which is usually more clinically focused and often lacks an in-depth understanding of the functional requirements of rugby. In other words, due to the absence

of RTP criteria, management often make decisions based on their own perceived strengths and expertise (Beardmore *et al.,* 2005).

The completion of a fitness test is often reported by the media as the ultimate decider for RTP, but is found to be irrelevant or of low priority amongst RTP decision-makers (Azadian *et al.,* 2011; Beardmore *et al.,* 2005). A summary of factors comparing a more conservative or a more rapid approach RTP is given by Orchard *et al*. (2005). The factors that could influence a medical team to take the more conservative route in the RTP decision-making process of an injured player, includes a persisting strength and flexibility deficit, older players and the early stages of the season. Factors signifying that earlier return could be transparent include the ability to perform all functional activities during training, younger players with adequate experience of playing with an injury, and play-offs or must-win games (Orchard *et al.,* 2005).

In the RTP decision-making processes specifically for muscle strains, the main factors to take into account are strength and flexibility testing, imaging, functional field testing and risk management strategies (Orchard *et al.,* 2005). Isokinetics have been indicated as mandatory for RTP decision-making after muscle strains. More recently, the use of MRI has been indicated as a major contributing factor, as is functional field testing, although field testing hosts its own inherent risks of re-injury (Brukner, 2005). The risks of field testing add to the risks associated with training injuries. For instance, fitness testing proved to have the highest injury incidence amongst backs and forwards during England's preparation for the 2003 RWC (Brooks *et al.,* 2005c). In a consensus statement of sports physicians, RTP decision-making was decided to be based upon the following factors: the restoration of musculoskeletal, cardiopulmonary and psychological function, restoration of sport-specific function and sport-specific skills. The ability to safely perform (with or without modification or bracing), with no risk to the player himself or other participants as well as compliance with federal, state or local governing bodies' legislation (Herring *et al.,* 2012).

The greatest question is one of time: When? When is the time right to return a player to the field, when have all of the above conditions been met. The high incidence of re-injury in rugby union could potentially be reduced through the answering of this questing through a standardised RTP assessment procedure (Beardmore *et al.,* 2005).

A model for RTP decision-making in sport in general was devised by Creighton *et al.* (2010). The model is very comprehensive and will thus form the foundation of the study. The model is based on 3 steps within the decision-making process: the health status of the player or athlete, the risk of participation in the chosen sport and other decision modifiers. The three steps, and the related factors within each step, are discussed below. The 3 steps cannot be seen as separate, but should be viewed in context as mutually exclusive.

2.4.1. STEP 1: Evaluation of health status

The biological, psychological and functional planes of the athlete or player are considered in the first step. This step has to be taken first as it is the corner piece of the puzzle. It can also be described as the evaluation of the amount of healing that has taken place and a comparison to the previous state of the affected tissue (Creighton *et al.,* 2010).

2.4.1.1 Patient demographics

Sex and age can influence decision-making due to hormonal and age-related factors with regard to tissue regeneration (Creighton *et al.,* 2010). An immature skeleton subject to repetitive movement can suffer different types of injuries compared to that of an adult. This can be due to the vulnerability of the musculoskeletal system of the immature skeleton, particularly at the site of growth cartilage (Kerssemakers *et al*. 2009). Consequently, injuries in youth athletes, be they acute or overuse, deserve specific consideration (Frisch *et al.,* 2009). During growth and development of a child, the body undergoes a number of changes, some potentially contributing to injuries specifically in contact sports (Haseler *et al.,* 2010). Increased testosterone in boys leads to pubertal changes that can increase aggression and risk-taking behaviour. An increase in maximum momentum can also be expected as there is an increase in strength, speed and power with an increase in age. This could further the possibility of injury as there is a prospective increase in potential force transference.

In a study on high school learners' injury patterns, no significant differences were found in injury diagnosis, time loss or final injury outcome based on age or height (Collins *et al.,* 2008). An increase in age does, however, bring about a higher incidence of overall injury in schoolboy rugby union (Bleakley *et al.,* 2011). Adolescent and youth front-row players' neck MRI's were

compared to a control group and found that the front-row players showed significant degenerative alterations, probably linked to repetitive cervical trauma experienced during scrummaging (Berge *et al.,* 1999). These changes also correlated with the age of the test subjects. In the case of hamstring injuries, specifically, an increased risk is associated with age (older players are at greater risk) and race (black players are at greater risk) (Orchard *et al.,* 2005).

In the context of the complete model, patient demographics was, however, found to be of little importance by practitioners involved in sports medicine in the RTP decision-making process (Shultz *et al.,* 2013).

2.4.1.2 Symptoms

Stiffness or sensation of joint stability are often used by clinicians in the evaluation of health status (Creighton *et al.,* 2010). Symptoms investigated by the clinician usually include pain, stability and swelling. The discussion of these symptoms is, however, very limited in the available literature.

(a) Pain

Pain is postulated as an essential indicator of presumed incomplete healing (Creighton *et al.,* 2010). The inability to perform functional tasks without pain is seen as a risk factor for recurrent muscle strain injuries (Orchard *et al.,* 2005). The IRB advocates the best advice to be: 'if it hurts, don't play' (Rugby Ready, 2011). It is, however, not an obsolete rule, but rather a guideline, as many other factors also play a role in decision-making and will become apparent in the discussions below. Distinction should be made between pain during activities of daily living and pain experienced during training (Roberts & Funk, 2013).

Pain, as well as the fear of pain can influence a player's RTP (Tjong *et al.,* 2014a). The time to pain-free walking after a hamstring injury was sustained, can help predict the time to RTP (Moen *et al.,* 2014). Helping a player towards pain-free movement and subsequent medium-intensity running should be the primary goals of the first two phases of rehabilitation in rugby union (Reid *et al.,* 2013).

It should also be taken into consideration that rugby players have a tendency to deny the existence of pain, to conceal pain or depersonalise pain, inhibiting the use of subjective pain scales. Even when a player is medically advised not to play, there is little effect on an injured player's determination to play. This is not only a phenomenon seen amongst elite or professional players, but it may be a deeply rooted characteristic of sport at all levels (Liston *et al.,* 2006).

(b) Instability

Joints such as the ankle and the knee rely on dynamic restraints to maintain stability during functional tasks due to the lack of bony congruence (Wikstrom *et al.,* 2006). Functional stability has been defined as passive restraints of the ligaments, joint geometry, and active restraints generated by the muscles and joint-compressive forces during activity (Noyes in Kegerries, 1983).

Knee instability after ACL reconstruction is a key factor in safe RTP decision-making (Lam *et al.,* 2009). Dynamic evaluation of the reconstructed ACL will involve jumping, landing, pivoting and running. This puts high rotational stress on the knee, assessing the resistance of the structure to the usual injury mechanism. Three-way cutting and four-way jumping have been indicated in assessing knee stability after ACL reconstruction (Lam *et al.,* 2009). It is also noted that the injured knee should be compared to the uninjured knee in terms of stability when RTP decisions are evident. ACL reconstruction alone cannot restore mechanical knee stability (Wikstrom *et al.,* 2006). Retraining of the dynamic stabilisers is necessary to improve neuromuscular function to compensate for the static stabilisers. Even after rehabilitation, there still seems to be a deficit in dynamic joint stability, adding to the rate of re-injury and indicating a possible gap in rehabilitation programs. If an altered weight-bearing pattern still exists on the point of RTP, the potential of re-injury despite rehabilitation will remain.

Lower back pathological instability can be caused by weakness or imbalance in the kinetic chain. This can be corrected by means of a comprehensive core strengthening program. A variety of factors must be balanced and managed to enable a player with lower back pain and instability to return to play (Krabak & Kennedy, 2008).

During a throwing or passing movement, the concentric contraction of the internal rotators of the shoulder execute the technique, but the eccentric contraction from the external rotators have to maintain stability in the shoulder in order to protect the joint from injury (Forthomme *et al.,* 2005). The strengthening of the rotational muscles of the shoulders is paramount in the management of the non-operated unstable shoulder (Gill & Zarins, 2003).

Clinical laxity tests alone cannot provide reliable predictions for functional stability (Noyes in Kegerries, 1983). Joint instability could easily be missed if static testing conditions alone are used. Dynamic methods are therefore advocated to ensure more challenging and possibly more effective tests in assessing joint stability for RTP (Wikstrom *et al.,* 2006).

2.4.1.2 (c) Swelling

During rehabilitation caution should be given to negative healing responses such as pain or swelling, which could be indicative of an overly aggressive rehabilitation protocol (Beam, 2002). Progression in rehabilitation and subsequent RTP should thus not be made if swelling is visible. Symptomatic treatment should then be given to reduce to potentially negative response (Beam, 2002). There should be no visible swelling after performing sport-specific activities (Petersen & Zantop, 2013). Joints should be free from swelling or effusion upon RTP (Creighton *et al.,* 2010).

2.4.1.3 Personal medical history

Family history and a player's medical history could predispose the player to other medical conditions or injuries (Creighton *et al.,* 2010). Prior injury, muscle weakness, inflexibility and kinetic chain breakage could influence RTP and the probability of re-injury (Lee *et al.,* 2001). A condition-specific medical history is essential in the evaluation of the injured player (Herring *et al.,* 2002). An astonishing 52% of players who sustained an injury early on in the Western Australian junior rugby season, went on to sustain an injury with greater severity later on, albeit that the injury was not necessarily a recurrence (McManus & Cross, 2004). The history of a specific injury should reflect in the outcome of the current injury's assessment or analysis

(Marshall *et al.,* 2005). In the development and implementation of injury-prevention programs, injury history is cited alongside personalised position-specific prevention programs as the most important in devising these programs (Brooks & Kemp, 2011)

2.4.1.4 Signs

Pre-injury strength and range of motion are cited as crucial signs for RTP (Podlog & Eklund 2009; Krabak & Kennedy, 2008).

2.4.1.4 (a) Strength

Objective strength testing can be obtained through isokinetic testing (Beam, 2002). Isokinetic testing should confirm strength of 90 – 95% of the uninjured or contra-lateral limb with the flexibility deficit viewed as equally important (Croisier *et al.,* 2008; Croisier, 2004; Drezner, 2003). Isokinetic assessment may assist in the lowering of recurrent injuries (Orchard *et al.,* 2005). Isokinetic testing and training forms a vital part of comprehensively evaluating and treating an injury, as it permits objective and isolated testing and training (Ellenbecker & Davies, 2000). However, a study done on professional football players returning to sport after hamstring injury, suggested that 67% of clinically recovered hamstring injuries still showed an isokinetic hamstring deficit of more than 10% (Tol *et al.,* 2014). This questions the necessity of full isokinetic readiness for RTP, but a football-specific rehabilitation program was deemed necessary. The association between isokinetic strength deficit and re-injury, was, however, not investigated in this study (Tol *et al.,* 2014). Isokinetics should thus be seen as a tool in clinical assessment, rehabilitation and performance (Ellenbecker & Davies, 2000). It is suggested that isokinetic deficits should be compared to baseline measurements preceding injury and not only compared to the uninjured limb (Tol *et al.,* 2014).

It is interesting to note that in the long run, even preoperative quadriceps strength deficits have a negative functional outcome after ACL reconstruction. In a two year follow-up, individuals with a preoperative strength deficit of more than 20%, still had an abnormal muscular asymmetry (Eitzen *et al.,* 2009).

2.4.1.4 (b) Range of motion

Unrestricted range of motion (ROM) is advised for most injury types and sites (Petersen & Zantop, 2013; Hamilton, 2011; Askling *et al.,* 2010). Orthopaedic surgeons' second most cited criterion for RTP after ACL reconstruction was free range of motion (ROM), only seconded by a negative Lachman test (Petersen & Zantop, 2013). The new active flexibility test for hamstring strain RTP evaluation appears to be reliable and valid (Askling *et al.,* 2010). This test offers useful additional information for RTP as it is a test of ROM through active ballistic hip flexion. Even though recorded differences may be minute, apprehension or insecurity in performing the active test with the injured leg could be indicative of not being ready to return. The dorsiflexion lunge test has been proven reliable in predicting future ankle injuries in cricket and soccer. Dorsiflexion less than 9 to 10 cm in this test is considered as restricted, signifying a greater risk of re-injury and also limitations in normal functional activities (Clanton *et al.,* 2012). Comparing ROM bilaterally may be useful, but it is limited in cases where a difference in flexibility existed prior to the injury. This might be the case for unilateral kickers in a rugby team (Askling *et al.,* 2010).

2.4.1.5 Laboratory tests

Improved prognostic assessment and injury assessment should be used in the RTP decision-making process (Orchard *et al.,* 2005). Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI of CT scans (Creighton *et al.,* 2010). The value of an MRI for muscle strain injuries in the professional world of sport often lies in the objective worth of the test, as it reminds the player and coach that a real injury is present and therefore a real risk exists in playing the player before full recovery is made (Orchard, 2014). MRI severity of muscle strain injury should not be the most important determinant for return-to-play (Orchard, 2014). The value of MRI studies of an injured hamstring has recently been deemed irrelevant for RTP decision-making (Reurink *et al.,* 2014). MRI studies show intramuscular increased signal intensity in 89% of all clinically recovered hamstring injuries at the time of RTP. Low-signal intensity is observed in one-third of the clinically recovered hamstring injuries at this time, indicating newly developed fibrous tissue. Normalization of signal intensity on fluid-sensitive sequences does not seem to be indicative of RTP readiness

(Reurink *et al.,* 2014). In this study five re-injuries were reported out of the 53 test subjects. It is thus advised that more research be done across broader population groups.

Recently, the active ballistic hamstring flexibility test has been introduced to determine readiness for play after a hamstring injury (Askling *et al.,* 2010). The test involves the use of an electro-goniometer with the subject doing an active straight-leg raise as fast as possible. This test was found to be better able to detect remaining injury signs than commonly used clinical examination, such as palpation, manual strength assessment etc. (Askling *et al.,* 2010). This test is, however, only prescribed once all other clinical tests indicate full recovery.

2.4.1.6 Functional tests

Stop-jumping and cutting movements should be practiced in a laboratory setting to assess functional knee stability before RTP decisions are made (Lam *et al.,* 2009). Functional testing, including accelerations and direction changes can often be completed pain-free before the player has returned to full isokinetic strength or normal MRI scans (Orchard *et al.,* 2005). Functional testing should provide an objective measurement in the rehabilitation process and RTP decision-making (Clanton *et al.,* 2012). The T-test measures agility and movement in multiple directions, with high validity in RTP decision-making. Speed, strength, energy and dexterity can be evaluated by the Sargent or vertical jump test. The explosive power of the lower limb can thus reliably be tested. Unilateral balance and dynamic neuromuscular control can be tested by the star excursion balance test (SEBT) and also the Y balance test, which is an instrumented version of the SEBT (Clanton *et al.,* 2012).

Manoeuvres related to the sport, such as running, cutting and jumping should be done without any significant abnormal movement patterns (Krabak & Kennedy, 2008). The interaction of muscular strength, ROM, endurance, confidence and proprioception should be tested through functional testing specific to the sport's demands (Creighton *et al.,* 2010). Dynamic restraints are relied upon during high-level activities to maintain joint stability (Wikstrom *et al.,* 2006). Testing of these dynamic restraints should be conducted through multiple evaluation techniques, including preparatory EMG, force plate data and kinematics. A global and holistic analysis of dynamic restraint function and the possibility of failing during

dynamic tasks could then be established (Wikstrom *et al.,* 2006). A functional field assessment (FFA) is deemed a necessity before RTP can be made. This should consist of the staged progression of volume and intensity in performing direction changes, sprints, interval running, jumps, one-on-one attacking and defending and mimicking muscle fatigue during the game. As the sport-specific field test is the ultimate test for player readiness, loading the injured muscle or joint with game-like demands, it subsequently carries its own inherent risk (Tol *et al*., 2014).

Little scientific evidence exists to support functional field testing to determine readiness to play after muscle strain injuries (Orchard *et al.,* 2005). Objective functional testing, testing balance, proprioception, strength, range of motion and agility can assess an athlete's physical readiness (Clanton *et al.,* 2012). Completing these functional tests can also add to psychological readying of a player.

Balance tests, a vertical drop-jump test and one-legged hop tests are often used in assessment of readiness (Petersen & Zantop, 2013). Before RTP is made, fitness tests should be conducted mimicking pre-season rugby skills and movement tests including tackling, sidestepping, jumping etc. This information should then be compared to pre-season profiles to determine readiness for return (Rugby Ready, 2011). Functional testing is performed to assess sport-specific, rehabilitation, and psychological function as it gives confidence and motivation to do better. As with a sport- specific functional progression program, assessments should not exceed tolerance levels of the athlete (Beam, 2002). Safe RTP rests should be based on adequately demonstrating the physical capacity to perform at the optimal level, henceforth minimizing the risk of re-injury (Reid *et al.,* 2013).

The use of GPS measurements should be incorporated into the rehabilitation process to prepare the player for the level and volume of loads that will be expected upon return. This can complement safety of RTP (Reid *et al.,* 2013). Although the number of GPS studies has grown considerably over the past few years, a still greater number of players, injuries and games are needed to effectively enhance both performance and rehabilitation (Reid *et al.,* 2013).

2.4.1.7 Psychological state

Injury rehabilitation is not only a physical process, but also a psychological process. Moreover physical readiness does not always coincide with psychological readiness (Tjong *et al.,* 2014a). The athlete may be at a greater risk of re-injury, or underperforming, if the athlete does not feel ready to play again. The Injury-Psychological Readiness-to-Return-to-Sport (I-PRRS) Scale has been developed to monitor psychological readiness for return-to-play. It should be used for the duration of the physical rehabilitation process to assure complete athlete readiness (Glazer 2009). RTP following injury can be more safely acquired when functional testing is coupled with psychological assessment by means of the I-PRRS (Clanton *et al.,* 2012).

In 1997 Taylor and Taylor described the phases of psychological rehabilitation as initial return, confirmation of recovery, return to physical and technical ability, high intensity training and return to competition. Injured players often make use of avoidance coping techniques; this facilitates short-term control of coping strategies as well as long-term benefits for injured players (Carson & Polman, 2010). The emotional benefits are elevated even more if the player undertook alternate work within their sporting organization. Anecdotal reports and empirical investigations have shown that athletes toward the end of the rehabilitation process often want greater autonomy in the decision to RTP as they do not necessarily feel physically or psychologically ready to return (Podlog & Eklund, 2007b).

A deeply rooted characteristic exists in players to tolerate high levels of pain while training and competing, if they believe it to be for the good of the team (Liston *et al.,* 2006). Players may experience fear due to doubts about the quality of their future performances, fear of failure or the fear of re-injury (Podlog & Eklund, 2007b). Unrealistic fear of re-injury could exacerbate an injury (Azadian *et al.,* 2011). By examining an athlete's facial expression and confidence when completing drills, one can determine his psychological readiness for RTP (Beam, 2002).

2.4.1.8 Potential seriousness

Players and staff need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery (Wikstrom *et al.,* 2006).

The review does, however, state that mandatory educational interventions and rule enforcement are useful in the reduction of neurological injuries in rugby union (Cusimano *et al.,* 2010)

2.4.1.9 Orthopaedic surgeon's evaluation and medical staff

Surgeons do not take into account muscle function, jump and alignment tests and proprioception when advising a player to RTP after surgery, despite the fundamental part these factors play in RTP decision-making (Petersen & Zantop, 2013). This could create confusion for the player. The team physician should coordinate and evaluate the player throughout the rehabilitation processes as he/she is the person ultimately responsible for RTP decision-making (Herring *et al.,* 2002).

An orthopaedic surgeon's advice to relinquish sport after ACL reconstruction is cited as a less common contributor in RTP decision-making (Tjong *et al.,* 2014b). In an article describing a survey among experienced surgeons regarding their RTP guidelines in patients with ACL reconstruction, the majority of the surgeons did not consider muscle function, jump test, alignment tests and proprioception as relevant RTP criteria (Petersen & Zantop, 2013). A timeline of greater than six months was indicated by 63.5% of the surgeons for returning to competitive sports. Literature shows that the vascular and cellular remodelling process of autogenous tendon grafts justifies a period of at least 8 months before returning to sports. Not only is the remodelling at risk in the earlier stages of rehabilitation following ACL reconstruction, but deficits in proprioception, balance, strength and neuromuscular control have been proven to persist (Madhavan & Shields, 2011; Eitzen *et al.,* 2009; Hiemstra *et al.,* 2007).

Outside of the professional rugby scene, players are often subject to community-based doctors and physiotherapists. They are less likely to buy into the ethics surrounding sport, and are also less likely to compromise on RTP because they are not part of the sports-net (Liston *et al.,* 2006). The conspiratorial alliance of medical teams involved in sport, is often more lenient in RTP decision-making as they are more adept at taking the holistic approach (Nixon, 1992).

Step 1 of the RTP decision-making process is thus focussed on the player's health status. Clinical knowledge and reasoning regarding the injury and the player as a holistic being is taken into account within the first step. There are some of the factors described above that warrant further research as the available literature is somewhat limited in this regard. It is however clear that some factors carry more weight within the RTP decision-making process than others and should be investigated accordingly.

2.4.2. STEP 2: Evaluation of participation risk

The risk of participation in a specific sport is evaluated, taking into account the sport's risk modifiers (Creighton *et al.,* 2010).

2.4.2.1 Type of Sport: Demands of Rugby Union

RTP decision-making should be approached with a thorough understanding of the inherent demands of the activity being returned to, as the likelihood of an identical recurrent trauma is high (Kegerreis, 1983). To devise a structured and appropriate rehabilitation program and eventually RTP criteria, a thorough understanding of the demands on rugby union players is necessary (Eaton & George, 2006). The fact that the demands of the game will remain the same makes it possible for a general RTP protocol, as every injury needs to be able to sustain the same demands.

2.4.2.1.1 Physiological demands

The anaerobic glycolytic metabolism provides the greatest source of energy for the forwards, as they are involved in regular non-running intense activities. Rugby matches are classified as an intermitted type of activity, using aerobic as well as anaerobic energy systems. All playing positions rely greatly on all energy systems for sustained energy (Deutsch *et al.,* 2007). Oxygen uptake per kilogram is higher in backline players than forwards. Backline players are often shorter, lighter and have a lower body-fat percentage compared to forwards (Scott *et al.,* 2003). Forwards rely greatly on their anaerobic glycolytic metabolism as they are regularly

involved in intense activities such as rucks, mauls etc., causing them to spend more time doing high-intensity work (13%) compared to backline players (4.5%).

An average heart rate of 154 beats per minute (bpm) was recorded for u/21 players in a match (Deutsch *et al.,* 2007). An average heart rate of 172 bpm was indicated by Cunniffe *et al.,* (2009) for elite rugby union players during a match. As soccer and rugby are both intermittent exercises, parallels can be drawn in terms of physiological responses. For intermittent exercise, anaerobic energy provision is more important compared to continuous exercise at the same average speed (Drust *et al.,* 2000). The Yo-Yo test is often used to validate fitness performance in soccer (Krustrup *et al.,* 2003). Aerobic loading approach maximal values during the Yo-Yo intermittent recovery test, with additional high taxing on the aerobic energy systems.

2.4.2.1.2 Physical demands

Currently, research is very much focussed on video-analysis, time-motion analysis and heart-rate monitoring to acquire a better understanding of the demands of rugby union. During international rugby matches, it has been confirmed that specific physical demands are put on specific positional groups. These positional differences has practical implications, not only for conditioning programs, substituting players during matches (Lacome *et al.,* 2014), but also in terms of rehabilitation and RTP.

Many studies also include GPS monitoring of players during practices and matches. The information could improve the understanding of the quality and quantity of load or work to facilitate best-practice advice during training (Cunniffe *et al.,* 2009; Hartwig *et al.,* 2008). One such a study found that high-load, high-impact training in adolescent rugby union players could compromise optimal performance (Hartwig *et al.,* 2008). According to another GPS study amongst professional players, an average distance of 6,953m is covered during a game, with greater running distances recorded in the second half. An average distance of 19,7m was covered during the 87 moderate-intensity runs recorded. Backs covered a greater total distance and entered the high-speed zone more frequently (34 vs 19) than their forward counterparts (Cunniffe *et al.,* 2009)

Greater body size and strength have been reported since the inception of the professional era (Williams *et al*., 2013; Sedeaud *et al*., 2012; Creighton *et al.*, 2010; Duthie, 2006). Body composition, i.e. percentage fat and muscle mass impacts the potential to create force (Duthie, 2006). Forwards became 6.63kg heavier and 0.61cm taller, while backs became 6.68kg heavier and 1.09cm taller from 1987 to 2007 (Sedeaud *et al.,* 2012). In the course of the preparation and participation in the RWC 2003, the English squad reported an increase in players' average body mass with a decrease in skin-fold measurements (Brooks *et al.,* 2005a). Performance in rugby union is linked to the greater size of the players in a team (Sedeaud *et al.,* 2012).

(a) Tackles, rucks and mauls

Tackles account for approximately half of all rugby union injuries (McIntosh & McCrory, 2005), resulting in the greatest associated loss of playing time (Fuller *et al.,* 2007). High tackles or tackles involving a shoulder charge were also identified as further risk factors (McIntosh & McCrory, 2005). It is, however, difficult to change tackle laws without altering the nature of the game (Holtzhausen *et al.,* 2006). According to the VERUSCO website for rugby union statistics, up to 3 106 tackles were made by a team during the 16-games Super Rugby tournament in 2012. A single player completed up to 312 tackles during the same tournament. The team kicked up to 433 times in the series. Statistics for the 2011 Rugby World Cup showed 1 040 tackles by a team, 102 tackles by an individual, 165 kicks and 1 264 passes during the 4 group games played (Fuller *et al.,* 2013).

Other physical demands of rugby union involve ball-carrying and frequent, powerful full-body contact (other than tackling) with minimum protective gear (Beardmore *et al.,* 2005; Marshall *et al.,* 2005). Rucks and mauls accumulated to an average of 144 per game, three to five rucks or mauls per minute of ball possession (Kemp *et al*., 2013). The ruck and maul elements of the game caused most injuries to forwards, and being tackled caused most injuries to back s during matches (Brooks *et al.,* 2005b).

(b) The scrum

During the engagement phase of a rugby scrum, compression forces of 16.5 kilo Newton (kN) with sustained compression forces of 8.3 kN is reported for international elite packs. The

magnitude of these forces could be potentially hazardous for chronic spine injuries. Teams on a higher participation level manage to exploit better technique and/or physical conditioning to produce a more effective action at the initial engagement (Preatoni *et al.,* 2013). During the 2012 six-nations competition 50% of all scrums collapsed (Anon, 2014).

(c) Walking and running

Phases of high intensity activities as well as phases of low-intensity activities are logged during matches (Eaton & George, 2006). High-intensity activities involve sprinting, rucking, mauling and scrummaging, while low-intensity activities refer to activities such as standing, walking and jogging. The intensity of rugby union varies greatly during a game between walking and standing (37% of the time) and sprinting (6% of the time) (Cunniffe *et al.,* 2009). A distance of 19,7 m was covered on average for each of the 87 moderate-intensity runs performed by the players (Cunniffe *et al.,* 2009).

On average, a distance of 6,953 m is covered over a game of 83 minutes of rugby union (Cunniffe *et al.,* 2009). Distances of 5,400m were recorded for forwards, while a distance of 6,300m for backs was documented by Quarrie *et al.* (2013). High-intensity activities do not lessen through the duration of the game. Greater distances are, however, reported for the first 10 min compared to minute 50 – 60 and 70 – 80 (Roberts *et al.,* 2008). During the 2007 RWC, the rugby ball was in play for 44% of the game time, showing an increase in ball-in-play compared to the 1991 RWC, which saw only 31% of ball carrying in the game (Kemp *et al*., 2013).

2.4.2.1.3 The laws of the game

The demands of rugby union are constantly evolving, as the laws of the game change. The IRB founded a Laws Project Group in 2004, which focuses on the Laws of Rugby to increase the appeal of the game and to make it safer (IRB, 2013). Experimental Law Variations are tested in minor competitions in both the southern and northern hemisphere and are then also tested during larger, professional competitions (Fuller *et al.,* 2009). One such example are the experimental laws tested in the 2008 Tri-Nations, Super 14, Currie Cup and Vodacom Cup competitions held in the southern hemisphere. Administrative law variations included the role of the assistant referee, procedural law variations included the categorisation of

penalty offences versus free-kicks, technical law variations included carrying the ball back into the 22-metre line and quick lineout throws. Law variations that could have a direct effect on injuries included the number of players in a lineout, pre-grip and lifting of lineout jumpers. During the tackle, a player who is on his feet is allowed to play the ball with his hands and defending players are allowed to pull down a maul. These laws were experimentally changed to effect a higher speed in the game as well as longer ball-in-play time and an indirect lowering of injury incidence. It was however found that there was no change in the injury incidence, nature or cause of injury for the duration of the experimental period (Fuller *et al.,* 2009).

According to the International Rugby Board's Laws of the Game handbook (2013), an amendment trial is being made to the number of nominated substitutes or replacements in an international match. Where there are currently eight players allowed, only seven were previously allowed. This allows for a full front row to be substituted during a game, if necessary. The rule further implies that six suitably trained and experienced players in the front row should be available on the bench (Law 3.5a). This ensures that the scrum can continue to be safely contested, even if substitutions are made throughout the entire front row (Law 3.14c).

The 2013 IRB rulebook also cites a change in scrum formation, as the previous 2007 'crouch-touch-pause-engage' sequence is replaced by the new 'crouch-touch-set' sequence. The 2007 sequence was designed to standardize the distance between the two sets of forwards, to biomechanically and theoretically reduce the collision forces during engagement with the aim of lowering injury rates and reducing the number of collapsed scrums (Gianotti *et al.,* 2008). This 2007 scrum law was found to be effective in the first year of its implementation within New Zealand rugby in the reduction of acute scrum-related head and neck injuries. The South African Rugby Union's injury prevention programme, BokSmart, acknowledge that the efficacy of a new scrum law for the prevention of catastrophic head, neck and spine injuries should be given a 5 to 10 year implementation period, but alternative measures should be put into place for immediate impact on the prevalence of these injuries (Hendricks *et al.,* 2014). Hence, passive engagement in the younger age-groups commenced at the start of the 2013 South African rugby season. Pre-scrum binding before engagement was also introduced for age groups up to under-16 level. Under-18 and under-19 schoolboy as well as amateur senior club rugby have an active engagement with pre-scrum binding. This ensures

that there is a reduced impact, a closer distance between front rows with the engagement is formed resulting in fewer collapsed scrums and safer scrimmaging (Hendricks *et al.,* 2012). These laws have been implemented worldwide by the IRB since September 2013.

2.4.2.2 Position played

Throughout the 15 players on the rugby field, a wide spectrum of physical attributes and anthropometric profiles is represented, each adding to the demand on the specialized nature of the position (Reid *et al.,* 2013).

The IRB continuously works on encouraging a more spectator-friendly sport by altering the rules of the game to have more ball-in-play time, lessening set pieces and creating more frequent scoring opportunities. This in turn increases the demands on players' tactical and technical abilities respective to their playing positions (Reid *et al.,* 2013).

Although great variations exist between the demands of forward and backline players, there are also unique demands within every positional group (Deutsch *et al.,* 2007; Quarrie *et al.,* 2013). Forwards can be categorised into 5 subgroups, namely: props, hookers, locks, flankers and number 8 forwards (Quarrie *et al.,* 2013). Forwards spend less time standing and walking (66.5%) compared to the backs (77.8%) (Cunniffe *et al.,* 2009). Back-row forwards are more involved in aspects of broken play, but also assist in rucks and mauls (Deutsch *et al.,* 2007). Gaining and retaining possession is mainly the responsibility of front-row forwards, while back-row forwards perform more sprinting and tackling (Deutsch *et al.,* 2007). An average of 19 (12 to 35) scrums and 31 (21 to 45) line-outs were reported during the 48 games of the RWC in 2007 (Kemp *et al*., 2013). Higher contact loads are reported for forwards per match, including scrums, rucks, tackles and mauls (Quarrie *et al.,* 2013).

Five subgroups for backs are defined as scrum-half, fly-half, midfield back, wings and fullback (Quarrie *et al.,* 2013). Back-line players perform 34 sprints per game, whereas forwards only execute 19 sprints in a game (Cunniffe *et al.,* 2009). Inside backs assist more with confrontational aspects, such as rucking and mauling than the outside backs, who are even more involved in the running aspects of play (Deutsch *et al.,* 2007).

It should also be taken into account that the back row and inside backs were the two positional groups with the highest injury prevalence during the 2007 and 2011 RWC ; (Fuller *et al.,* 2013; Fuller *et al.,* 2008). The inside backs particularly had the highest prevalence during the 2011 RWC while the back row forwards had the highest prevalence in the 2007 RWC (Fuller *et al.,* 2013; Fuller *et al.,* 2008). The hooker and outside centre were the playing positions at greatest risk of the most severe injuries amongst 12 English Premiership teams over the 2002 to 2004 seasons (Brooks *et al.,* 2005b).

2.4.2.3 Limb dominance

During the RWC 2007, lower-limb injuries amongst backs were more likely sustained to their non-dominant leg, whereas no significant trends were found for forwards in terms of dominance (Fuller *et al.,* 2008). In the case of upper-limb injuries amongst backs, the non-dominant arm was again found to be more likely injured, with no significance for upper limb injuries amid forwards (Fuller *et al.,* 2008). The 2011 RWC showed no significant differences in injuries to dominant or non-dominant upper or lower limbs (Fuller *et al.,* 2013).

Limb dominance plays a role in RTP decision-making, as a dominant limb could be more prone to repeated stress during activities (Creighton *et al.,* 2010). Time to stabilization should be determined between dominant and non-dominant limbs in knee and ankle rehabilitation and RTP (Wikstrom *et al.,* 2006)

2.4.2.4 Competitive level

After the 1995 Rugby World Cup, the International Rugby Board adopted professionalism, resulting in the players having greater physical and mental robustness, increased strength and pace. The demands of international matches appear to be higher in terms of distance covered by players at relatively fast running speeds ($<5m.s^{-1}$) compared to lower levels of professional rugby union (Quarrie *et al.,* 2013). The problem now arises that the incidence of recurrent injuries in rugby union has also been elevated since professionalism. Individual professional

players appear to have greater morbidity with injury compared to amateur players (Garraway *et al.,* 2000).

The phenomenon also filtered down to amateur players. Since the dawn of the professional era (1994), injury rates have almost doubled (Garraway *et al.,* 2000). A significant difference exists between friendly/second team matches and Premiership of National Cup matches concerning injury incidence and severity (Brooks *et al.,* 2005b).

In all-age specific groups, this higher prevalence over the same period of time was indicated by Garraway *et al.* (2000), it was particularly prominent in younger players. Training demands in adolescent rugby union players are very hard to determine, as there is participation in other sports and varied physical activity (Hartwig *et al.,* 2008). Best-practice advice is thus compromised due to inadequate load quantifying and monitoring of such players.

The Australian Wallabies team's injuries were recorded for the period from 1994 to 2000. The injury rate pre-professionalism (1994-1995) were recorded as 47 injuries per 1000 player hours with a rise in injury rates post-professionalism to 74 injuries per 1000 player hours (Bathgate *et al.,* 2002).

2.4.2.5 Ability to protect

Taping, bracing splinting or padding has been indicated as supplementary in the reduction of risk for certain injuries (Creighton *et al.,* 2010). However, the effectiveness of injury preventative protective equipment in rugby union is limited (Marshall *et al.,* 2005).

External ankle support was shown to be dependent on the material properties and application method of the tape as well as on the existing stability of the ankle (Hume & Gerrard, 1998). Taping provides limited mechanical support for the ankle joint, but has proprioceptive properties that it acts as a psychological reminder to consciously modify loads on the lower limb. The external ankle support used, should restrict extreme inversion of the ankle. This restriction will however decrease during the course of exercise, especially if taping is used. Ankle bracing or taping has no effect on performance in rugby union, whether it be to enhance or reduce performance (Hume & Gerrard, 1998).

There is some supportive evidence in rugby union for the use of mouth-guards, padded headgear and support sleeves. The effectiveness of the support sleeves, could be ascribed to better stabilization of the joint, due to the increased muscle activation because of the presence of the sleeve, or the insulation provided in cold weather conditions (Marshall *et al.,* 2005). According to a systematic review, the evidence to support mouth-guard and headgear effectiveness is limited (Cusimano *et al.,* 2010).

Taping and bracing can only be used to a certain extent in rugby union, as it can limit movement, and could potentially pose a threat to the player or other players (Marshall *et al.,* 2005). The IRB provides an approved, publicly available list of shoulder padding and headgear according to IRB Regulation 12 (IRB Website).

2.4.3 STEP 3: Decision modification

2.4.3.1 Timing and season

Financial or performance advantages during a certain time of the season, could outweigh the potential disadvantages (Creighton *et al.,* 2010). As there will be little or no benefit in accelerated return during the off-season, there are potential financial and career benefits if accelerated return is made for a play-off game (Creighton *et al.,* 2010).

Time of the season is also indicated as a risk factor for injury, as the highest incidence of injuries is reported for the pre-season period (Brooks *et al.,* 2005b). During the pre-season period it is rationalized that a player can be side-lined for an extra week, but that same rationale can lead to a player being played for an important final (Orchard 2014; Tol *et al.,* 2014). The coach often makes decisions with the team's best interest in mind, risking a player prematurely (Orchard, 2014).

2.4.3.2 Pressure from the player

Patients should have some degree of feasible and appropriate decisional control regarding their treatment, as this ensures better outcomes for the patients. Decisional control adds to

greater self-reported treatment adherence and satisfaction (Ghane *et al.,* 2014). Benefits of active participation in treatment decision-making include better coping with negative decision-related emotions such as anxiety, as well as greater functional ability (Luce 2005; Greenfield *et al.,* 1985).

Due to the deeply rooted characteristics of players at all levels, players are often adamant to return prematurely (Liston *et al.,* 2006). The primary decision lies with the clinician, having more experience evaluating the level of risk. The athlete is, however, in the unique position of experiencing the injury and has other interests such as potential scholarships or contracts and personal goals within the sport which must be taken into consideration upon RTP (Creighton *et al.,* 2010).

Players often see health as only a small part of their welfare, and only consider what is best for him in the here and now. The possible consequences should be considered and the player's own notion of welfare should be discussed. An elite athlete is defined by continuously being on the border of his/her capacities, which in turn borders on possible injuries. An elite athlete lives at the limits of physical pain and psychological constraint in order to achieve their goals (Poulis, 2012).

2.4.3.3 External pressure

External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation (Creighton *et al.,* 2010). External pressure to take risks affecting a player's health can be very obvious, but also very subtle, making it hard to discern (Poulis, 2012).

The effect of injured players can be significant in terms of performance, results and morale of the rest of the team or club (Woods *et al.,* 2002). Due to the limitations on the pool of talented players unavailable for play, there is often a decrease in match attendance and team performance (McIntosh & McCrory, 2005; Woods *et al.,* 2002). Injuries also impact the financial state of a club (Woods *et al.,* 2002) as there are costs in the form of medical fees and increased insurance premiums. It is a natural tendency in professional sport for both the

player and coach to pretend that the pain is not real, the player should be able to push through the existing pain (Orchard, 2014).

The medical team involved with a sports team often self-impose pressure in their desire to retain their position within the team by rushing RTP (Best & Brolinson, 2005). Players who stay involved with the team and receive support from the coach and teammates, may feel more confident and supported on RTP. This has the potential to directly and indirectly play a role in the rehabilitation process, outcome and ultimately RTP performance (Podlog & Eklund, 2007b).

Coaches often believe that they can recognise an athlete's personality, his pain tolerance and his motivational level. They furthermore suggest that there are 'training nuts', 'mentally tough' and 'soft' players (Podlog & Eklund, 2007a). With these feelings, coaches often influence RTP decision-making.

2.4.3.4 Masking the injury

Rugby players often see an injury as an obstacle to overcome, dealing with it in one of three ways: accepting the hindrance, hiding the effects of the injury by compensating, or ignoring the injury altogether and playing as if it does not exist (Fenton & Pitter, 2010). Local anaesthetics are often used to mediate such masking of injuries in sport medicine, as it allows injured players to participate (Herring *et al.,* 2012; Creighton *et al.,* 2010). This could potentially increase the risk of worsening the injury (Creighton *et al.,* 2010). Body language is often altered by sportsmen to hide pain (Roderick, 2012). During the 2007 RWC, six players were reportedly injected with corticosteroids (Fuller *et al.,* 2008), while 10 players were injected with corticosteroids during the 2011 RWC (Fuller *et al.,* 2013).

2.4.3.5 Conflict of interest

The medical professionals involved with sports teams are under pressure – be it implicit or self-imposed (Poulis, 2012). The strong focus on performance for professional athletes, often presents an unique ethical challenge for a medical team, not seen in the general population

(Murthy *et al.,* 2012). Ethically, clinicians in a team setting are still obligated to advocate for the player, in spite of their obligation to the team as a paid employee (Murthy *et al.,* 2012; Creighton *et al.,* 2010). Conflicts thus arise, as the best option for the team and the best for the player are not necessarily aligned (Creighton *et al.,* 2010). The obligation of the clinician relies foremost on the patient, patient confidentiality, informed consent and the maintenance of clinical excellence. Cognisance of this, assists in decision-making (Murthy *et al.,* 2012).

In dealing with professional athletes, information regarding their health status is considered as part of their employment record, making patient confidentiality difficult. It is thus advocated that an open and honest approach to the player and the management team be taken (Murthy *et al.,* 2012). Transparency follows as the best policy (Creighton *et al.,* 2010).

When RTP is evident, a player should be fully informed of the potential dangers associated with the particular injury that could still exist (Best & Brolinson, 2005), any advice, instructions and limitations should be properly documented (Creighton *et al.,* 2010).

''Science, by itself, cannot supply us with an ethic"

-Bertrand Russell as quoted by Best and Brolinson (2005).

2.4.3.6 Fear of litigation

Creighton defined this point as 'a special form of conflict of interest' as it focuses on the clinician's welfare, with the fear based on the possible benefits and harm the athlete may be subject to (Creighton *et al.,* 2010).

Legally, the final decision has to be made by the team clinician or physician, even if the athlete is of age (Creighton *et al.,* 2010). It is thus very important that the team's best interest is also aligned with the athlete's best interest (Creighton *et al.,* 2010). The players and staff always need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery (Wikstrom *et al.,* 2006).

2.4.4 Maintenance program

It has become apparent through the research of rehabilitation and RTP decision-making that a maintenance program should be implemented upon RTP. It is important for the player to maintain a certain degree of cardiovascular strength and fitness during the rehabilitation phase, limiting de-conditioning and reducing time to RTP (Beam, 2002). A total bod- focussed protocol will also prepare the player for more successful RTP. This may often include non-weight bearing or partial weight-bearing activities such as swimming or cycling (Beam, 2002; Kegerreis, 1983). Upon return, the athlete should be placed within a strength and flexibility maintenance programme to reduce the chance of re-injury (Beam, 2002). The athlete must accept responsibility to continue the strength and flexibility programme and to recognize the potential for re-injury.

2.5. Conclusion

The knowledge per se is not necessarily influential, but the application of knowledge makes it powerful. The purpose of this project is to provide background for the development of a model for RTP decision-making in rugby union for injuries in general. To make the readily available information and knowledge of injury sites in rugby union powerful, it should be applied to all injury management procedures to positively impact the sport. While it is not the aim of this study to judge which test best suits each component or factor contributing to RTP decision-making in rugby union, it is the aim of this study to integrate literature and practice; and in so doing develop a framework of guidelines for practitioners in rugby union for use in their RTP decision-making process.

2.6. References

ANON. 2014. Statistical Analysis and Match Review – Six Nations 2014. IRB Game Analysis. International Rugby Board.

ANON. 2009. BokSmart Position Statement: Return to Play. South African Rugby Union.

ASKLING, C.M.; NILSSON, J. & THORSTENSSON, A. 2010. A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of The ESSKA,* 18(12): 1798 – 1803.

AZADIAN, E.; MAJLESI, M. & KARIMI, L. 2011. Investigating the Present Procedure in Return to Play after Injury in Athletes of Football Primary League in Iran. *Australian Joutnal of Basic and Applied Sciences,* 5(12): 1466 – 1470.

BATHGATE, A.; BEST, J.P.; CRAIG, G. & JAMIESON, M. 2002. A prospective study of injuries to elite Australian rugby union players. *British journal of sports medicine*, 36(4):265–269.

BEAM, J.W. 2002. Rehabilitation including sport-specific functional progression for the competitive athlete. *Journal of Bodywork and Movement Therapies*, 6(4): 205–219.

BEARDMORE, A.L.; HANDCOCK, P.J. & REHRER, N.J. 2005. Return-to-play after injury: practices in New Zealand rugby union. *Physical Therapy in Sport*, 6(1): 24–30.

BERGE, J.; MARQUE, B.; VITAL, J.; SENEGAS, J. & CAILLE, J. 1999. Age-related changes in the cervical spines of front-line rugby players. *The American journal of sports medicine*, 27(4): 422–429.

BEST, J.P.; McINTOSH, A.S. & SAVAGE, T.N. 2005. Rugby World Cup 2003 injury surveillance project. *British journal of sports medicine*, 39(11): 812–817.

BEST, J.P. & BROLINSON, P.G. 2005. Return to play: the sideline dilemma. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 403–404.

BLEAKLY, C.; TULLY, M. & O'CONNOR, S. 2011. Epidemiology of adolescent rugby injuries: a systematic review. *Journal of athletic training*, 46(5): 555–565.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2005a. A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad. *British journal of sports medicine*, 39(5): 288–293.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2005b. Epidemiology of injuries in English professional rugby union: part 1 match injuries. *British journal of sports medicine*, 39(10): 757–766.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2005c. Epidemiology of injuries in English professional rugby union: part 2 training Injuries. *British journal of sports medicine*, 39(10): 767–775.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2008. An assessment of training volume in professional rugby union and its impact on the incidence, severity, and nature of match and training injuries. *Journal of sports sciences*, 26(8): 863–873.

BROOKS, J.H.M. & KEMP, S.P.T. 2011. Injury-prevention priorities according to playing position in professional rugby union players. *British journal of sports medicine*, 45(10): 765–775.

BROWN, J.C.; VILJOEN, W.; LAMBERT, M.I. READHEAD, C.; FULLER, C.; VAN MECHELEN, W. & VERHAGEN, E. 2015. The economic burden of time-loss injuries to youth players participating in week-long rugby union tournaments. *Journal of Science and Medicine in Sport*, 18(4): 394–399.

BROWN, J.C.; VERHAGEN, E.; VILJOEN, W.; READHEAD, C.; VAN MECHELEN, W.; HENDRICKS, S. & LAMBERT, M.I. 2012. The incidence and severity of injuries at the 2011 South African Rugby Union (SARU) Youth Week tournaments. , 24(2): 49–54.

BRUKNER, P. 2005. Return to play--a personal perspective. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 459–60.

CARSON, F. & POLMAN, R.C.J. 2010. The facilitative nature of avoidance coping within sports injury rehabilitation. *Scandinavian journal of medicine & science in sports*, 20(2): 235–40.

CARSON, J.D.; ROBERTS, M.A. & WHITE, A.L. 1999. The Epidemiology of Women's Rugby Injuries. 9: 75–78.

COLLINS, C.L.; MICHELI, L.J.; YARD, E.E. & COMSTOCK, R.D. 2008. Injuries sustained by high

school rugby players in the United States, 2005-2006. *Archives of pediatrics & adolescent medicine*, 162(1): 49–54.

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

CROISIER, J. 2004. Factors Associated with Recurrent Hamstring Injuries. *Sports Medicine*, 34(10): 681–695.

CROISIER, J.; GANTEAUME, S.; BINET, J. GENTY, M. & FERRET, J. 2008. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. *The American journal of sports medicine*, 36(8): 1469–75.

CUNNIFFE, B.; PROCTOR, W.; BAKER, J.S. & DAVIES, B. 2009. An evolution of the physiological demands of elite rugby union using global positioning system tracking software. *Journal of Strength and Coditioning Research.* 23(4): 1195 – 1203.

CUSIMANO, M.D.; NASSIRI, F. & CHANG, Y. 2010. The effectiveness of interventions to reduce neurological injuries in rugby union: a systematic review. *Neurosurgery*, 67(5):1404–1418.

DEUTSCH, M.U.; KEARNEY, G.A. & REHRER, N.J. 2007. Time-motion analysis of professional rugby union players during match-play. *Journal of sports sciences*, 25(4): 461–472.

DIJKSTRA, H.; POLLOCK, N.; CHAKRAVERTY, R. & ALONSO, J.M. 2014. Managing the health of the elite athlete: a new integrated performance health management and coaching model. *British Journal of Sports Medicine*, 48(7): 523–531.

DREZNER, J.A. 2003. Practical management : Hamstring muscle injuries. *Clinical Journal of Sports Medicine*, 13(1): 48–52.

DRUST, B.; REILLY, T. & CABLE, N.T. 2000. Physiological responses to laboratory-based soccer-specific intermittent and continuous exercise. *Journal of Sports Sciences*, 18(11): 885–92.

EATON, C. & GEORGE, K. 2006. Position specific rehabilitation for rugby union players. Part II: Evidence-based examples. *Physical Therapy in Sport*, 7(1): 30–35.

EITZEN, I.; HOLM, I. & RISBERG, M.A. 2009. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. *British Journal of Sports Medicine*, 43(5): 371–376.

ELLENBECKER, T.S. & DAVIES, G.J. 2000. The application of isokinetics in testing and rehabilitation of the shoulder complex. *Journal of athletic training*, 35(3): 338–50.

FENTON, L.T. & PITTER, R. 2010. Keeping the Body in Play. *Research Quarterly for Exercise and Sport*, 81(2): 212–223.

FORTHOMME, B.; MAQUET, D.; CRIELAARD, J.M. & CROISIER, J.L. 2005. Shoulder isokinetic assessment : A critical analysis. *Isokinetics in Exercise Science*, 13: 59–60.

FRISCH, A.; CROISIER, J.L.; URHAUSEN, A.; SEIL, R. & THEISEN, D. 2009. Injuries, risk factors and prevention initiatives in youth sport. *British medical bulletin*, 92: 95–121.

FULLER, C.W.; MOLLOY, M.G.; BAGATE, C.; BAHR, R.; BROOKS, J.H.M.; DONSON, H.; KEMP, S.P.T.; McCRORY, P.; McINTOSH, A.S.; MEEUWISSE, W.H.; QUARRIE, K.L.; RAFTERY, M. & WILEY, P. 2007. Consensus statement on injury definitions and data collection procedures for studies of injuries in rugby union. *British journal of sports medicine*, 41(5): 328–331.

FULLER,C.W.; BROOKS, J.H.M.; CANCEA, R.J.; HALL, J. & KEMP, S.P.T. 2007. Contact events in rugby union and their propensity to cause injury. *British journal of sports medicine*, 41(12): 862–867.

FULLER. C.W.; RAFTERT, M.; READHEAD, C.; TARGETT, S.G.R. & MOLLOY, M.G. 2009. Impact of the International Rugby Board ' s experimental law variations on the incidence and nature of match injuries in southern hemisphere professional rugby union. *South African Medical Journal,* 99(4): 232–237.

FULLER, C.W.; LABORDE, F.; LEATHER, R.J. & MOLLOY, M.G. 2008. International Rugby Board Rugby World Cup 2007 injury surveillance study. *British journal of sports medicine*, 42(6): 452–459.

FULLER, C.W.; TAYLOR, A.; KEMP, S.P.T. & RAFTERY, M. 2017. Rugby World Cup 2015: World Rugby injury surveillance study. *British Journal of Sports Medicine*, 51(1): 51–57.

FULLER, C.W. & MOLLOY, M.G. 2011. Epidemiological study of injuries in men's international under-20 rugby union tournaments. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 21(4): 356–8.

FULLER, C.W.; SHEERIN, K. & TARGETT, S. 2013. Rugby World Cup 2011: International Rugby Board injury surveillance study. *British journal of sports medicine*, 47(18): 1184–91.

FULLER, C.W.; TAYLOR, A. & MOLLOWY, M.G. 2010. Epidemiological study of injuries in international Rugby Sevens. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(3): 179–184.

GARRAWAY, W.M.; LEE, A.J.; HUTTON, S.J.; RUSSEL, E.B.A.W. & MACLEOD, D.A.D. 2000. Impact of professionalism on injuries in rugby union. *British journal of sports medicine*, 34(6): 348–351.

GHANE, A.; HUYNH, H.P.; ANDREWS, S.E.; LEGG, A.M.; TABUENCA, A. & SWEENY, K. 2014. The relative importance of patients' decisional control preferences and experiences. *Psychology & health*, 29(10): 1105–1118.

GIANOTTI, S.; HUME, P.A.; HOPKINS, W.G.; HARAWIRA, J. & TRUMAN, R. 2008. Interim evaluation of the effect of a new scrum law on neck and back injuries in rugby union. *British journal of sports medicine*, 42(6): 427–430.

GIANOTTI, S.; QUARRIE, K.L. & HUME, P.A. 2009. Evaluation of RugbySmart: a rugby union community injury prevention programme. *Journal of science and medicine in sport / Sports Medicine Australia*, 12(3): 371–375.

GILL, T.J. & ZARINS, B. 2003. Open repairs for the treatment of anterior shoulder instability. *The American journal of sports medicine*, 31(1): 142–153.

GLAZER, D.D. 2009. Development and preliminary validation of the Injury-Psychological Readiness to Return to Sport (I-PRRS) scale. *Journal of athletic training*, 44(2): 185–189.

GREENFIELD, S.; KAPLAN, S. & WARE, J.E. 1985. Expanding Patient Involvement in Care. *Annals of Internal Medicine*, 102(4): 520–528.

HAMILTON, B. 2011. Return to Play Criteria Following Anterior Cruciate Ligament Surgery. Unpublished disssertation. Utah State University.

HARTWIG., T.B. 2009. Training and competition demands of adolescent rugby union players. Unpublished Phd Dissertation. Australian Catholic University.

HARTWIG, T.B.; NAUGHTON, G. & SEARL, J. 2008. Defining the volume and intensity of sport participation in adolescent rugby union players. *International journal of sports physiology and performance*, 3(1): 94–106.

HASELER, C.M.; CARMONT, M.R. & ENGLAND, M. 2010. The epidemiology of injuries in English

youth community rugby union. *British journal of sports medicine*, 44(15): 1093–1099.

HENDRICKS, S.; LAMBERT, M.I.; BROWN, J.C.; READHEAD, C. & VILJOEN, W. 2014. An evidence-driven approach to scrum law modifications in amateur rugby played in South Africa. *British journal of sports medicine*, 48(14): 1115–1119.

HENDRICKS, S.; KARPUL, D.; NICOLLS, F. & LAMBERT, M. 2012. Velocity and acceleration before contact in the tackle during rugby union matches. *Journal of sports sciences*, 30(12): 1215–1224.

HENDRICKS, S. & LAMBERT, M. 2010. Tackling in Rugby: Coaching Strategies for Effective Technique and Injury Prevention. *International Journal of Sports Science and Coaching*, 5(1): 117–136.

HERRING, S.A.; KIBLER, W.B. & PUTUKIAN, M. 2002. The team physician and return-to-play issues: a consensus statement. *Medicine and science in sports and exercise*, 34(7): 1212–1214.

HERRING, S.A.; BERGFIELD, J.A.; BOYD, J.; DUFFEY, T.; FIELDS, K.B.; GRANA, W.A.; INDELICATO, P.; KIBLER, W.B.; PALLAY, R.; PUTUKIAN, M. & SALLIS, R.E. 2012. The team physician and the return-to-play decision: a consensus statement-2012 update. *Medicine and science in sports and exercise*, 44(12): 2446–2448.

HIEMSTRA, L.A.; WEBBER, S.; MACDONDALD, P.B. & KRIELLAARS, D.J. 2007. Contralateral limb strength deficits after anterior cruciate ligament reconstruction using a hamstring tendon graft. *Clinical Biomechanics*, 22(5): 543–550.

HOLTZHAUSEN, L.J. 2001. The Epidemiology of Injuries. *International Sports Medicine Journal*, 2(2): 1–13.

HOLTZHAUSEN, L.J.; SCHWELLNUS, M.P.; JAKOET, I. & PRETORIUS, A.L. 2006. The incidence and nature of injuries in South African rugby players in the rugby Super 12 competition. *South African medical journal = Suid-Afrikaanse tydskrif vir geneeskunde*, 96(12): 1260–1265.

HUME, P.A. & GERRARD, D.F. 1998. Bracing and Taping in Rugby Union. *Sports Medicine*, 25(5): 285–312.

International Rugby Board. 2013. Laws of the Game: Rugby Union. Published by ISBN.

JAKOET, I. & NOAKES, T.D. 1998. A high rate of injury during the 1995 Rugby World Cup. *South African Medical Journal*, 88(1): 45–47.

KEGERREIS, S. 1983. The construction and implementation of functional progressions as a component of athletic rehabilitation. *The Journal of orthopaedic and sports physical therapy*, 5(1): 14–19.

KEMP, S.; BROOKS, J.; FULLER, C.; ANSTISS, T.; SMITH, A.; TAYLOR, A., TREWARTHA, G. & STOKES, K. 2013. England professional rugby injury surveillance project: 2011 – 2012 Season report. Rugby Football Union.

KERR, H.; CURTIS, C.; MICHELI, L.J.; KOCHER, M.S.; ZURAKOWSKI, D.; KEMP, S.P.T. & BROOKS, J.H.M. 2008. Collegiate rugby union injury patterns in New England: a prospective cohort study. *British journal of sports medicine*, 42(7): 595–603.

KERSSEMAKERS, S.P.; FOTIADOU, A.N.; DE JONGE, M.C.; KARANTANAS, A.H. & MAAS, M. 2009. Sport injuries in the paediatric and adolescent patient: a growing problem. *Pediatric radiology*, 39(5): 471–484.

KRABAK, B. & KENNEDY, D.J. 2008. Functional rehabilitation of lumbar spine injuries in the athlete. *Sports medicine and arthroscopy review*, 16(1): 47–54.

KRUSTRUP, P.; MOHR, M.; AMSTRUP, T.; RYSGAARD, T.; JOHANSEN, J.; STEENBERG, A.; PEDERSEN, P.K. & BANGSBO, J. 2003. The yo-yo intermittent recovery test: physiological response, reliability, and validity. *Medicine and science in sports and exercise*, 35(4): 697–705.

LACOME, M.; PISCIONE, J.; HAGER, J.P. & BOURDIN, M. 2014. A new approach to quantifying physical demand in rugby union. *Journal of sports sciences*, 32(3): 290–300.

LAM,M.; FONG, D.T.P.; YUNG, P.S.H.; HO, E.P.Y.; CHAN, W.Y. & CHAN, K.M. 2009. Knee stability assessment on anterior cruciate ligament injury: Clinical and biomechanical approaches. *Sports medicine, arthroscopy, rehabilitation, therapy & technology*, 1(1): 20-29.

LEE, A.J.; GARRAWAY, W.M.; HEPBURN, W. & LAIDLAW, R. 2001. Influence of rugby injuries on players' subsequent health and lifestyle: beginning a long term follow up. *British journal of sports medicine*, 35(1): 38–42.

LEE, A.J. & GARRAWAY, W.M. Epidemiological comparison of injuries in school and senior club rugby. *British journal of sports medicine*, 30(3): 213–217.

LEE, A.J., GARRAWAY, W.M. & ARNEIL, D.W. 2001. Influence of preseason training, fitness, and existing injury on subsequent rugby injury. *British journal of sports medicine*, 35(6): 412–

417.

LISTON, K.; REACHER, D.; SMITH, A. & WADDINGTON, I. 2006. Managing Pain and Injury in Non-elite Rugby Union and Rugby League: A Case Study of Players at a British University. *Sport in Society*, 9(3): 388–402.

LOPEZ, V.; GALANO, G.L.; BLACK, C.M.; GUPTA, A.T.; JAMES, D.E.; KELLEHER, K.M. & ALLEN, A.A. 2012. Profile of an American amateur rugby union sevens series. *The American journal of sports medicine*, 40(1): 179–184.

LUCE, M.F. 2005. Decision making as coping. *Health psychology : official journal of the Division of Health Psychology, American Psychological Association*, 24(4): 23-28.

MACLEAN, J.G.B. & HUTCHISON, J.D. 2012. Serious neck injuries in U19 rugby union players: an audit of admissions to spinal injury units in Great Britain and Ireland. *British journal of sports medicine*, 46(8): 591–594.

MADHAVEN, S.; SHIELDS, R.K. 2011. Neuromuscular responses in individuals with anterior cruciate ligament repair. *Clinical Neurophysiology*, 122(5): 997–1004.

MARSHALL, S.W.; LOOMIS, D.P.; WALLER, A.E.; CHALMERS, D.J.; BIRD, Y.N.; QUARRIE, K.L. & FEEHAN, M. 2005. Evaluation of protective equipment for prevention of injuries in rugby union. *International journal of epidemiology*, 34(1): 113–118.

McINTOSH, A.S. & McRORY, P. 2005. Preventing head and neck injury. *British journal of sports medicine*, 39(6): 314–318.

McMANUS, A. & CROSS, D.S. 2004. Incidence of injury in elite junior Rugby Union: a prospective descriptive study. *Journal of science and medicine in sport / Sports Medicine Australia*, 7(4): 438–445.

MOEN, M.H.; REURINK, G.; WEIR, A.; TOL, J.L.; MAAS, M. & GOUDSWAARD, G.J. 2014. Predicting return to play after hamstring injuries. *British Journal of Sports Medicine*, 48: 1358–1363.

MURTHY, A.M.; DWYER, J. & BOSCO, J.A. 2012. Ethics in sports medicine. *Bulletin of the NYU hospital for joint diseases*, 70(1): 56–59.

NICOL.,A.; POLLOCK, A.; KIRKWOOD, G.; PAREKH, N. & ROBSON, J. 2011. Rugby union injuries in Scottish schools. *Journal of public health*, 33(2): 256–261.

ORCHARD, J. 2014. What role for MRI in hamstring strains? An argument for a difference between recreational and professional athletes. *British journal of sports medicine*, 48(18): 1337–1338.

ORCHARD, J.; BEST, T.M. & VERRALL, G.M. 2005. Return to play following muscle strains. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 436–441.

PALMER-GREEN, D.; FULLER, C.; JAQUES, R. & HUNTER, G. 2013. The Injury/Illness Performance Project (IIPP): A Novel Epidemiological Approach for Recording the Consequences of Sports Injuries and Illnesses. *Journal of Sports Medicine*, 20 (13): 1–9.

PAREKH, N.; HODGES, S.D.; POLLOCK, A.M. & KIRKWOOD, G. 2012. Communicating the risk of injury in schoolboy rugby: using Poisson probability as an alternative presentation of the epidemiology. *British journal of sports medicine*, 46(8): 611–613.

PETERSEN, W. & ZANTOP, T. 2013. Return to play following ACL reconstruction: survey among experienced arthroscopic surgeons (AGA instructors). *Archives of orthopaedic and trauma surgery*, 133(7): 969–977.

PODLOG, L. & EKLUND, R.C. 2009. High-level athletes' perceptions of success in returning to sport following injury. *Psychology of Sport and Exercise*, 10(5): 535–544.

PODLOG, L. & EKLUND, R.C. 2007a. Professional Coaches' Perspectives on the Return to Sport Following Serious Injury. *Journal of Applied Sport Psychology*, 19(2): 207–225.

PODLOG, L. & EKLUND, R.C. 2007b. The psychosocial aspects of a return to sport following serious injury: A review of the literature from a self-determination perspective. *Psychology of Sport and Exercise*, 8(4): 535–566.

POULIS, I. 2012. Approaches to conflicts between treatment recommendations and patients' decisions in physiotherapy: a case study. *Physical Therapy Reviews*, 17(3): 184–189.

PREATONI, E.; STOKES, K.A.; ENGLAND, M.E. & TREWARTHA, G. 2013. The influence of playing level on the biomechanical demands experienced by rugby union forwards during machine scrummaging. *Scandinavian Journal of Medicine and Science in Sports*, 23(3): 178-184.

QUARRIE, K.L.; HOPKINS, W.G.; ANTHONY, M.J. & GILL, N.D. 2013. Positional demands of international rugby union: Evaluation of player actions and movements. *Journal of Science*

and Medicine in Sport, 16(4): 353–359.

QUARRIE, K.L. & HOPKINS, W.G. 2008. Tackle injuries in professional Rugby Union. *The American journal of sports medicine*, 36(9): 1705–1716.

REID, L.C.; COWMAN, J.R.; GREEN, B.S. & COUGHLAN, G.F. 2013. Return to play in elite rugby union: application of global positioning system technology in return-to-running programs. *Journal of sport rehabilitation*, 22(2): 122–129.

REURINK, G.; GOUDSWAARD, G.J.; TOL, J.L.; ALMUSA, E.; MOEN, M.H.; WEIR, A.; VERHAAR, J.A.N.; HAMILTON, B. & MAAS, M. 2014. MRI observations at return to play of clinically recovered hamstring injuries. *British journal of sports medicine*, 48(18): 1370–1376.

ROBERTS, S.B. & FUNK, L. 2013. The development and validation of a scoring system for shoulder injuries in rugby players. *British journal of sports medicine*, 47(14): 920–926.

ROBERTS, S.B.; TREWARTHA, G.; ENGLAND, M. & STOKES, K.A. 2014. Collapsed scrums and collision tackles: what is the injury risk? *British journal of sports medicine*, 0: 1–6.

ROBERTS, S.B.; TREWARTHA, G.; HIGGITT, R.J.; EL-ABD, J. & STOKES, K.A. 2008. The physical demands of elite English rugby union. *Journal of sports sciences*, 26(8): 825–833.

RODERICK, M.J. 2012. An Unpaid Labor of Love: Professional Footballers, Family Life, and the Problem of Job Relocation. *Journal of Sport & Social Issues*, 36(3): 317–338.

SCHICK, D.M.; MOLLOY, M.G. & WILEY, J.P. 2008. Injuries during the 2006 Women's Rugby World Cup. *British journal of sports medicine*, 42(6): 447–451.

SCHNEIDERS, A.G.; TAKEMURA, M. & WASSINGER, C.A. 2009. A prospective epidemiological study of injuries to New Zealand premier club rugby union players. *Physical therapy in sport : official journal of the Association of Chartered Physiotherapists in Sports Medicine*, 10(3): 85–90.

SCHWELLNUS, M.P.; THOMSON, A.; DERMAN, W.; JORDAAN, E.; READHEAD, C.; COLLINS, R.; MORRIS, I.; STRAUSS, O.; VAN DER LINDE, E. & WILLIAMS, A. 2014. More than 50% of players sustained a time-loss injury (>1 day of lost training or playing time) during the 2012 Super Rugby Union Tournament: a prospective cohort study of 17 340 player-hours. *British Journal of Sports Medicine*, 48(1): 1306–1315.

SCOTT, A.C.; ROE, N.; COATS, A.J. & PIEPOLI, M.F. 2003. Aerobic exercise physiology in a

professional rugby union team. *International Journal of Cardiology,* 87(2):173-177.

SHULTZ, R.; BIDO, J.; SHRIER, I.; MEEUWISSE, W.H.; GARZA, D. & MATHESON, G.O. 2013. Team clinician variability in return-to-play decisions. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 23(6): 456–461.

STRACCIOLINI, A.; MEEHAN, W.P. & d'HEMECOURT, P.A. 2007. Sports Rehabilitation of the Injured Athlete. *Clinical Pediatric Emergency Medicine*, 8(1): 43–53.

TAYLOR, A.E.; FULLER, C.W. & MOLLOY, M.G. 2011. Injury surveillance during the 2010 IRB Women's Rugby World Cup. *British journal of sports medicine*, 45(15): 1243–1245.

TJONG, V.K.; MURNAGHAN, M.L.; NYHOF-YOUNG, J.M. & OGILVIE-HARRIS, D.J. 2014. A qualitative investigation of the decision to return to sport after anterior cruciate ligament reconstruction: to play or not to play. *The American journal of sports medicine*, 42(2): 336–342.

TOL, J.L.; HAMILTON, B.; EIRALE, C.; MUXART, P.; JACOBSEN, P. & WHITELEY, R. 2014. At return to play following hamstring injury the majority of professional football players have residual isokinetic deficits. *British journal of sports medicine*, 48(18), pp.1364–1369.

WIKSTROM, E.; TILLMAN, M.D.; CHMIELEWSKI, T.L. & BORSA, P.A. 2006. Measurement and evaluation of dynamic joint stability of the knee and ankle after injury. *Sports medicine (Auckland, N.Z.)*, 36(5): 393–410.

WILLIAMS, S.; TREWARTHA, G.; KEMP, S. & STOKES, K. 2013. A Meta-Analysis of Injuries in Senior Men's Professional Rugby Union. *Sports Medicine*, 43(10): 1043–1055.

WOODS, C.; HAWKINS, R.; HULSE, M. & HODSON, A. 2002. The Football Association Medical Research Programme : *British journal of sports medicine*, 36(6), pp.436–442.

Footnote

The International Rugby Union (IRB) changed its name in 2015 to World Rugby (WR). References to IRB thus refers to 2015 and prior whereas WR refers to the period from 2015.

Chapter 3

Research Methods and Procedures

3.1 Introduction

3.2 Theoretical perspectives on the Research Design

3.2.1 Theory Building

3.2.2 Types of Methods

3.2.3 The Research Design in this Study

3.3 Research Methods and Procedures

3.3.1 Literature Review

3.3.2 Document Analysis

3.3.3 The Focus Group Discussion

3.3.4 The Pilot Study

3.3.5 Data Gathering

3.3.6 Data Analysis

3.3.7 Data Interpretation

3.3.8 The Delphi Technique

3.3.8.1 Theoretical Aspects

3.3.8.2 The Delphi Questionnaire in thus Study

3.3.8.3 Sample Selection

3.3.8.4 Description of Sample

3.4 Trustworthiness

3.5 Ethical Considerations

3.6 Conclusion

3.7 References

3.1 Introduction

The aim of the study, as stipulated in Chapter 1 is to provide guidelines for RTP decision-making after musculoskeletal injuries in rugby union. As the study pursued is one characterised by vast complications, a mixed method of research has been followed to ensure sufficient deep rich data. Chapter 3 will henceforth provide theoretical perspectives on the research design and methods selected for achieving the aims of the study. Detailed description and discussion of the methodology of the literature review, document analysis, focus group selection and the e-Delphi Questionnaire will be presented. The chapter will conclude with the discussion of trustworthiness and ethical issues that are applicable to this study.

3.2 Theoretical perspectives on the Research Design

3.2.1 Theory Building

Appropriate research design is critical in any scientific research process. Qualitative and quantitative research, each with its own relative value, and shortfalls have been described and used for over a century (David & Sutton, 2004; Johnson & Onwuegbuzie, 2004). Quantitative research methods and designs position the researcher as completely separate from the phenomenon under investigation. The paradigm's inquiry should be objective, unbiased, emotionally detached and unconcerned with the objects of the study (Cresswell, 1994).

Conversely, in qualitative research generalisations are neither desirable nor meaningful, unless they are properly contextualised (Johnson & Onwuegbuzie, 2004). It is therefore a more prominent research modality in educational and social research (Babie, 1995). Logic flows from specific to general and explanations are derived from the gathered data. The subjective researcher is then the only source of reality and as such cannot be separated from the subject (Guba, 1990). Qualitative reporting consists of rich, thick and detailed descriptions of the collected data (Babie & Mouton, 2001). In summary, quantitative research focuses mainly on data obtained by measurements, which may be statistically analysed, while qualitative research emphasizes the description of the occurring phenomenon (Polgart & Thomas, 1995).

A third research paradigm described as mixed-method research has been defined as a class of research where a combination of both qualitative and quantitative techniques is used in a single study (Creswell & Plano Clark, 2007). This method was developed to attempt better understanding of a research problem and also to add to the validity and reliability of the findings (Creswell, 1998). It follows that a combination of qualitative and quantitative methods has definite advantages as it is an expansion of the primary assumption that research methods should follow research questions (Creswell & Plano Clark, 2007; Johnson & Turner, 2003). Subsequently, it was decided that a mixed-method design would be greatly beneficial in the answering of the research questions set in chapter 1 of this study.

3.2.2 Types of Methods

The study was built on three main research methods. Firstly, a retrospective review of available literature, document and content analysis (Niewenhuis, 2007). Reviews of existing literature and documents were applied in a way consistent with the overall design and strategy of the study (Creswell, 2009). The literature review not only assists in providing a framework for establishing the importance of the research but also provides an assumption-free source of raw data (Creswell, 2009).

Secondly, a focus-group discussion. The details of the RTP decision-making model used in the study was discussed as well as the essence of what was needed to achieve. Thirdly, the e-Delphi method was used, consisting of a questionnaire to collect and distil judgements of

experts (current medical management teams of rugby unions teams) using a series of questions and statements (Skulmoski, *et al.,* 2007).

3.2.3 The Research Design in this Study

This specific study is a response to the need for an exploratory mixed-method research design with a sequential nature. Qualitative data was gathered by means of a literature review in order to explore the topic further using the quantitative data as well as qualitative data gathered through the e-Delphi questionnaires. The method is depicted in the figure below:

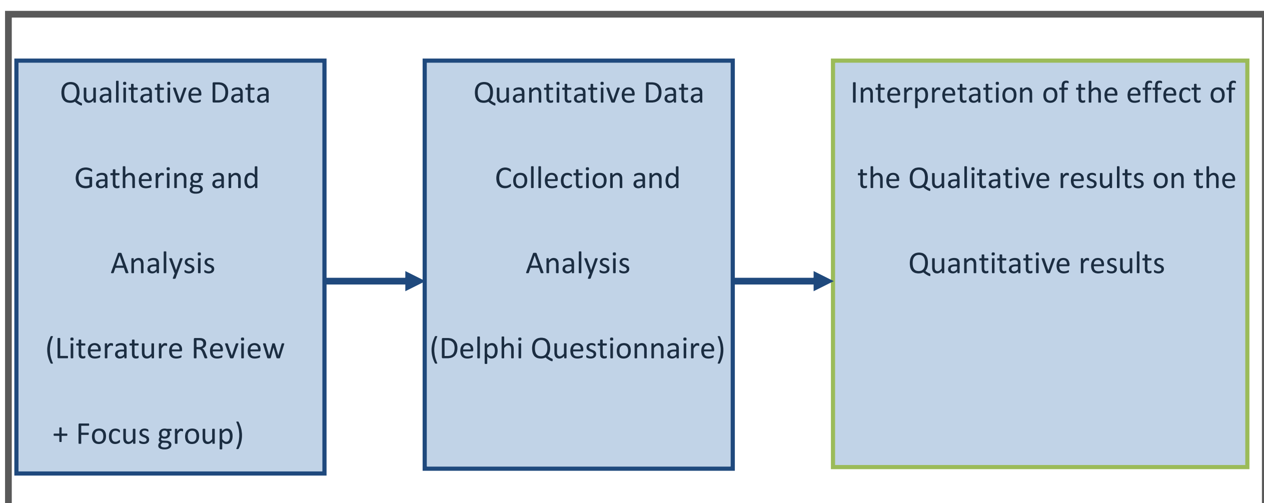


Figure 3.1: Illustration of the sequential nature of the exploratory mixed-method research design used in the study

Figure 3.1 gives an overview of the methodology used in the study to accomplish the research objectives and aims set in chapter 1. These methods will now be explained further with specific reference to the aims and objectives of this study.

3.3 Research Methods and Procedures

To be able to appreciate the study as a whole, it is important to view the methodology against the background of the research questions set in the first chapter. They are as follows:

1. What is known in literature surrounding RTP in rugby union?

2. What is seen as important for RTP decision-making in practice, more specifically in the team environment of rugby union?

3. Is it possible to develop a comprehensive, integrated model or guidelines to assist in RTP decision-making process in rugby union?

4. Is there a need for such a model or guidelines?

Different methods were used to attempt to answer the above-mentioned research questions. Below, Figure 3.2 illustrates the way in which each of the research questions set in Chapter 1 will be answered through the specific research process pertaining to each question.

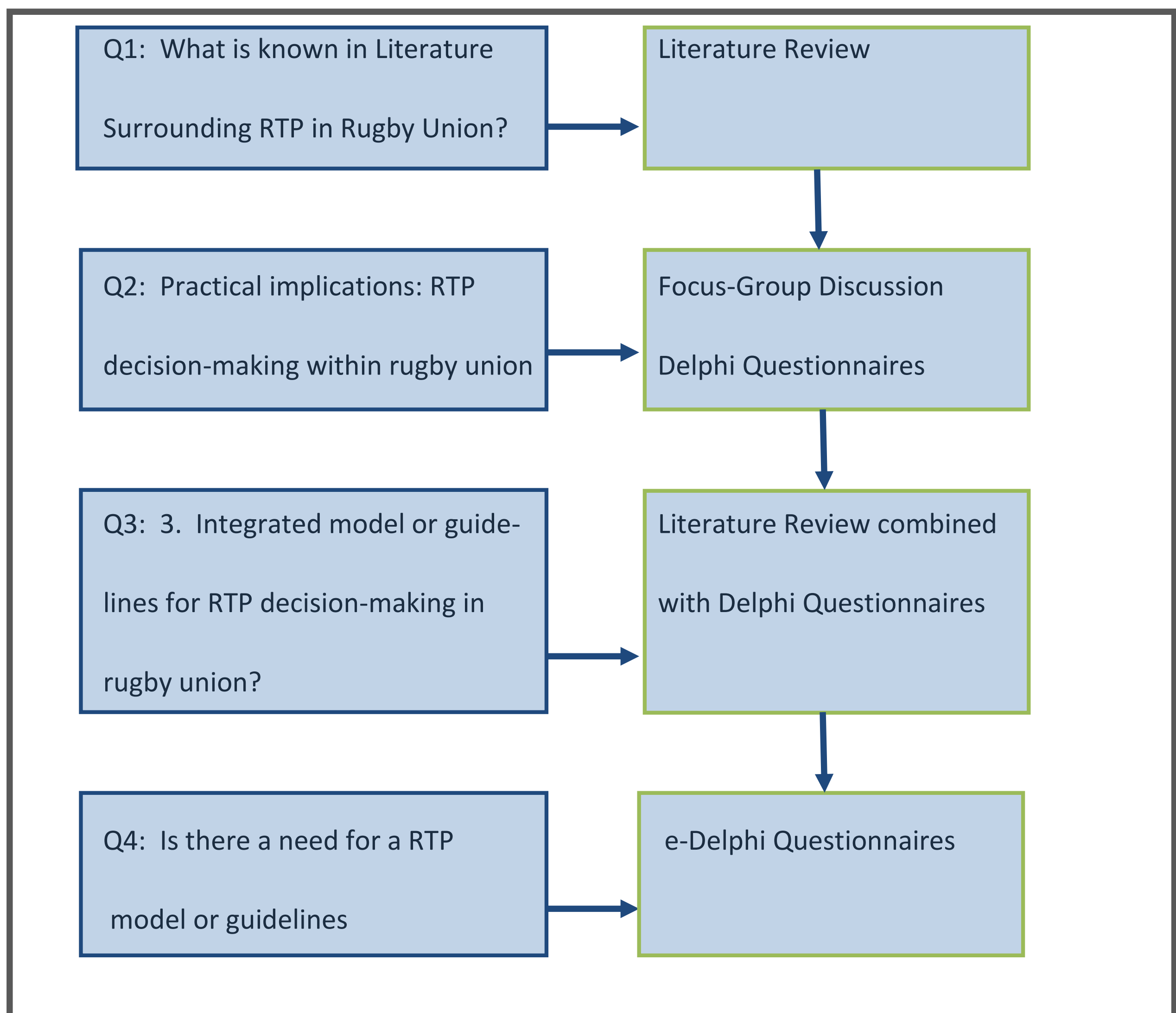


Figure 3.2: Schematic outline of research questions and research methodology

3.3.1 Literature Review

A comprehensive literature review had to be done in order to contextualise the study against any and all existing theoretical knowledge. This also provided the researcher with sufficient background information to appreciate the vast topic at hand (Singleton & Straits, 1999) as well as to develop the questionnaires used in the subsequent chapters. The literature review is given in Chapter 2 of this thesis. As mentioned in Chapter 1, a variety of search engines were used in gathering information. This includes EbscoHost, ScienceDirect, Google Scholar and other available publications on the UFS library search engines. Key words and combinations of key words used during the search included 'rugby union', 'injury', 'rehabilitation', return-to-play', 'protocols', 'models', 'guidelines'. Regretfully, very little research could be found on the holistic topic of RTP in rugby union, a fair amount of research could, however, be found on the different aspects surrounding the topic.

3.3.2 Document Analysis

The general background compiled from the literature review highlighted the RTP model suggested by Creighton *et al.* (2010). This constituted a further and more in-depth search of literature within the framework of this specific model. This advanced search was done in order to answer the first research objective or aim as indicated in Chapter 1, namely:

"To synthesize the literature concerning RTP decision-making in rugby union"

The second part of the search consisted of an in-depth investigation of each of the different aspects of the model presented by Creighton *et al.* (2010). The model is presented in three steps of RTP decision-making. Each step has a number of underlying aspects to take into account. Each of these aspects were accordingly searched, described and discussed and where it was felt to be necessary, aspects were added to the original model. All of the above is discussed in Chapter 2.

The literature review and document analysis resulted in the essential introductory knowledge and also the starting point for the subsequent e-Delphi Questionnaire as presented in Chapter 5.

3.3.3 The Focus-Group Discussion

The background derived from the literature review highlighted the need for more insights into study field of RTP in rugby union. A focus-group discussion was held to discuss the second objective of the study, namely:

"**The formulation of a guideline for RTP decision-making in rugby union by means of a focus group and a national e-Delphi survey**".

Focus-group discussions are often used in social research or in cases where the subject of the study is new or relatively unexplored (Babbie, 1995). As there was limited research found in literature and no holistic data on RTP decision-making in rugby union specifically, a focus-group discussion seemed the logical way to gather new and rich data surrounding the study field.

3.3.4 Sample selection

Purposeful sampling – where the researcher's knowledge of the research aims were used to choose participants to further help understand the problem and research questions (Babbie, 1995). The focus-group participants were selected by the researcher due to their insights, knowledge and experience in the field of the research topic, securing information to enrich, strengthen and enhance the meaningfulness of the data (Skinner, 2007).

3.3.5 Focus group interview for this study

The focusgroup discussion was structured in line with the literature review (Keggereis, 1983; Garraway *et al*., 2000; Beam, 2002; Drezner, 2003; Croisier, 2004; Liston *et al*., 2006; Beardmore *et al*., 2005; Croisier *et al*., 2008; Orchard *et al*., 2005; Wilkstrom *et al.,* 2006; Deutsch *et al*., 2007; Askling *et al*., 2010; Creighton *et al*., 2010; Hamilton, 2011; Clanton, *et al*., 2012; Herring *et al*., 2012; Poulis, 2012; Petersen & Zantop, 2013; Shultz *et al*., 2013; Tol *et al*., 2014; Orchard, 2014) forming the backdrop for the discussion. The literature review highlighted the RTP model created by Creighton *et al.* (2010) as being comprehensive and

inclusive. This model consequently formed the basis of the discussion that followed with specific reference to:

- The three steps of RTP decision-making suggested by Creighton *et al*. (2010) as the basis of this study
- The relevance of such a model within a team sport such as rugby union.
- The use of the e-Delphi method in this study
- The most appropriate participants to complete the Delphi questionnaires.

In this study the researcher purposefully invited only experts whom she felt would have the necessary **experience, knowledge and insights related to the research topic,** thereby ensuring that their responses would be meaningful data. Two members of the focus group had more than 15 years' experience in RTP in Rugby union, have published extensively and were involved in 4 Rugby World Cups. The focus-group discussion commenced in the boardroom of the Department of Exercise and Sport at the University of the Free State. We recognised (Morgan, 1997) that the focus groups should ideally have between 6-10 participants, however, care was taken by the researcher not to include the focus-group experts in the sample potential e-Delphi panellists.

3.3.6 The e-Delphi Technique

The lack of a holistic model or guidelines for RTP decision-making in rugby union in literature prompted the researcher to obtain the opinions of experts who work within the field of RTP in rugby union. Logically, additional quantitative and qualitative data was gathered through the answering of an e-Delphi questionnaire by knowledgeable professionals in the above-mentioned field. The e-Delphi questionnaire was therefore used to answer to the second research objective, namely:

"The formulation of a guideline for RTP decision-making in rugby union by means of a focus group and a national e-Delphi survey".

3.3.6.1 Theoretical aspects

Where knowledge on a specific subject or phenomenon is insufficient, the Delphi method is predominantly useful. The method has been widely used and described since the first documented use thereof by the US military in the 1950's. The Delphi method is described by four key fundamentals (Rowe & Wright, 1999):

* **Anonymity of the participants** – as the participants do not know each other, they are free to express their own opinion and are not pressured by a group to conform.
* **Iteration** – the participants are given the opportunity to refine their views as the process continues through various rounds.
* **Controlled feedback** – the researcher gives summarized feedback to all the participants, affording them the opportunity to rethink, reflect, clarify and change their own views.
* **Statistical aggregation of responses** – this allows for quantitative analysis and interpretation of data.

3.3.6.2 The e-Delphi questionnaire in this study

As previously stated the e-Delphi questionnaire in this study was based mainly on the RTP decision-making model developed by Creighton *et al.* (2010). Other factors found in literature (Keggereis, 1983; Noyes in Kegerries, 1983; Garraway *et al*., 2000; Beam, 2002; Herring *et al.,* 2002; Drezner, 2003; Croisier, 2004; Liston *et al*., 2006; Beardmore *et al*., 2005; Croisier *et al*., 2008; Orchard *et al*., 2005; Wilkstrom *et al.,* 2006; Deutsch *et al*., 2007; Askling *et al*., 2010; Creighton *et al*., 2010; Hamilton, 2011; Clanton, *et al*., 2012; Herring *et al*., 2012; Poulis, 2012; Petersen & Zantop, 2013; Shultz *et al*., 2013; Tol *et al*., 2014; Orchard, 2014) that could be integral in RTP decision-making in rugby union were also added to the questionnaires. The final e-Delphi questionnaire was divided into the 3 Steps of Creighton's model and then a section on the respondents' view on the importance and relevance of the research. The focus of the e-Delphi was thus to establish whether each of the factors within the three steps of RTP decision-making is seen as important to decision-makers in the practice of rugby union.

The necessity of the e-Delphi was brought about due to the lack of comprehensive literature on RTP decision-making guidelines or models in rugby union. It is therefore the hope of the researcher that this baseline RTP model or guidelines that will be derived from the comprehensive e-Delphi questionnaire and paired with the known literature (Keggereis, 1983; Garraway *et al*., 2000; Beam, 2002; Drezner, 2003; Croisier, 2004; Liston *et al*., 2006; Beardmore *et al*., 2005; Croisier *et al*., 2008; Orchard *et al*., 2005; Wilkstrom *et al.,* 2006; Deutsch *et al*., 2007; Askling *et al*., 2010; Creighton *et al*., 2010; Hamilton, 2011; Clanton, *et al*., 2012; Herring *et al*., 2012; Poulis, 2012; Petersen & Zantop, 2013; Shultz *et al*., 2013; Tol *et al*., 2014; Orchard, 2014), will be able to assist practitioners in the RTP decision-making process regarding injured players in rugby union.

3.3.6.3 Sample selection

The medical teams of all 14 top Rugby Unions (Blue Bulls, Border Rugby, Eastern Province, Free State, Golden Lions, Griffons, Griqualand West, Kwazulu-Natal, Leopards Rugby, Mpumalanga Rugby, Southern Western Districts and Western Province Rugby Union) in South Africa were invited to participate in this study. A rugby medical management teams consists of experienced and knowledgeable Sports Physicians, Biokineticists and Physiotherapists with good practical insights in the field of RTP in rugby union. Therefore, the e-Delphi questionnaires were chosen purposefully and carefully by the researcher to ensure that the required level of experience, knowledge and insights in the field of RTP in rugby union will be met. This in turn would ensure that valid and reliable data could be gathered to ultimately satisfy the objectives and aims of the study (Bryman, 2004; Creswell 2009). A total of 15 participants gave informed consent to participate in the answering of the e-Delphi questionnaires. Fortunately, 14 participants completed each of the respective rounds of the e-Delphi process, resulting in 93% participation. One document from the first round was corrupted and could not be opened by the researcher, while another participant did not complete the second round of the e-Delphi.

3.3.6.4 Description of the sample selection

In this e-Delphi, the participants consisted of sports physicians and physiotherapists employed by the top rugby unions in South Africa. All participants were registered with the HPCSA as well as with their respective professional bodies.

3.3.6.5 Pilot study

Due to the very select nature of participants no pilot study was done prior to conducting the e-Delphi questionnaires. All of the statements, information and sections were, however, carefully examined by the researcher and supervisor of the study before each round was sent out to the participants.

3.3.6.6 Data gathering

The e-Delphi questionnaire was e-mailed to the 15 participants over two rounds. The participants completed the questionnaire electronically, where after they returned the questionnaires to the researcher, also via e-mail. The e-mail also included a brief background on the research, detailed explanation of the questionnaire and how the participants were to complete the questionnaire. The format of the e-Delphi remained the same throughout the two rounds. Minor alterations were made to two of the statements after the first round of the Delphi. This was done in order to accommodate the views and opinions of the majority of participants.

3.3.6.7 Data Analysis

Responses were recorded individually by the researcher. Data were reported numerically as well as by percentage. For round one, consensus was reported for an agreement level of 80%, this meant that 12 out of the 15 respondents were in agreement. In round two however, consensus was reported for an agreement level of 86% (13 out of 15). The high level of agreement required for consensus to be reported adds to the reliability of the study.

Analysis and presentation of data were simplified through the use of colour. Where consensus was reached within the first round of the e-Delphi questionnaires, the statements were highlighted in green. Consensus after the second round were indicated in blue reached after the second round, and as such, statements where consensus could not be reached, were left un-highlighted. Results were thereby presented in a column using the same colour coding for each of the participants. The column also indicated the majority selection and percentage of agreement.

3.3.6.8 Data Interpretation

The e-Delphi questionnaire results were interpreted and compared to the preceding research processes. This included the literature review and focus-group interview. The researcher's own knowledge, insights and experience were used to combine the results of all the research processes. In so doing the second research objective could be addressed, namely:

"**To develop from the literature and current practices a model or guidelines for RTP decision-making in rugby union"**

3.4 Trustworthiness

Data for this study were obtained using mixed methods of research. This included a literature review, focus-group discussion and the e-Delphi technique, all adding to the reliability of the study. Qualitative information was gathered through the literature review (Keggereis, 1983; Garraway *et al*., 2000; Beam, 2002; Drezner, 2003; Croisier, 2004; Liston *et al*., 2006; Beardmore *et al*., 2005; Croisier *et al*., 2008; Orchard *et al*., 2005; Wilkstrom *et al.,* 2006; Deutsch *et al*., 2007; Askling *et al*., 2010; Creighton *et al*., 2010; Hamilton, 2011; Clanton, *et al*., 2012; Herring *et al*., 2012; Poulis, 2012; Petersen & Zantop, 2013; Shultz *et al*., 2013; Tol *et al*., 2014; Orchard, 2014), as well as the focus-group discussion. This was further strengthened by information of both a quantitative and qualitative nature gathered through the e-Delphi questionnaire technique. Through combining and interpreting the data from the

different sources, the validity and reliability of the study was strengthened (Adler & Ziglio, 1996; Delbeg *et al.*, 1975).

Validity recognises the soundness and effectiveness of the research tool, while reliability is defined as the consistency by which a measuring instrument will perform (Leedy, 1997). It follows that reliability and validity are an integral part of research in terms of the questionnaires used, the focus group discussion and the analysis and interpretation of the data, such as was used in this study. To further strengthen the study, the validity and reliability in the study will now be discussed.

Credibility of the study was established by correctly identifying suitable subjects for the field of study. This was done by the researcher. Transferability of the findings might be limited due to the specific nature of field of study. However, since multiple sources of information were used, the reproduction of the study elsewhere is strengthened. Conditions, under which the study took place, remained unchanged. The collected data confirms the study and various sources used in the study adds to the trustworthiness of the study. The qualitative paradigm is reflected in these alternative constructs (Lincoln & Guba, 1985).

The main aim of any interview, such as the focus group discussion, is to obtain reliable and valid information (Fielding, 2003). Validity and reliability in this study were obtained in a number of ways, including specific questions designed to enrich and explain issues regarding the study during the focus-group discussion. These questions were carefully and meaningfully designed from the knowledge derived from the literature review surrounding RTP in rugby union. From this, a rich and elaborate description of the phenomenon under investigation could be compiled (Merriam, 2002). The research questions, methodology, data and findings of the study were done in such a way that a strong chain of evidence could be maintained, adding to the validity of the study (Leedy, 1997). The focus group discussion was carefully transcribed and answers discussed to ensure the full disclosure between the researcher and the rest of the focus group. Data analysis and interpretation processes were critically reflected upon by the researcher to add to the final validity and reliability of the study (Merriam, 2002).

3.5 Ethical Considerations

Participants in both the e-Delphi questionnaires and focus groups did so voluntarily. A background on the study was provided to both groups, with an informed consent form and a copy of the article written by Creighton *et al.* (2010). Names and identities of the individual participants remained anonymous (Please see Appendixes B - E). Data was captured electronically on the researcher's private computer. The promoter also had access to the files through a secure *Dropbox* account.

Ethical approval was obtained through the University of the Free State's Faculty of Health Sciences (Appendix E), with Ethical Approval: ECUFS nr 142/2014. Ethical approval ensures that the research at hand is done in an ethical manner with sufficient academic merit for the fulfilment of the requirements of a PhD study.

3.6 Conclusion

Theoretical perspectives on the methodology surrounding a mixed-method research design together with the associated methods used in this study were presented in this chapter. The literature review, focus-group discussion and e-Delphi questionnaire created the cornerstones of the research. The validity, reliability and ethical considerations surrounding the study were also discussed in this chapter. A more detailed description of the focus-group discussion will be given in Chapter 4.

3.7 References

ADLER, M. & ZIGLIO, E. 1996. Gazing into the oracle. Bristol, PA: Jessica Kingsley Publishers.

ASKLING, C.M.; NILSSON, J. & THORSTENSSON, A. 2010. A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of The ESSKA,* 18(12): 1798 – 1803.

BABBIE, E. 1995. *The practice of social research. Belmont*, CA: Wadswort Publishing Company

BABBIE, C. & MOUTON, J. 2001. The practice of social research. Cape Town: Oxford Univesity Press.

BEAM, J.W. 2002. Rehabilitation including sport-specific functional progression for the competitive athlete. *Journal of Bodywork and Movement Therapies*, 6(4): 205–219.

BEARDMORE, A.L.; HANDCOCK, P.J. & REHRER, N.J. 2005. Return-to-play after injury: practices in New Zealand rugby union. *Physical Therapy in Sport*, 6(1): 24–30.

BRYMAN, A. 2004. *Social research methods*. New York: Oxford University Press.

CLANTON, T.O.; MATHENY, L.M.; JARVIS, H.C. & JERONIMUS, A.B. 2012. Return to play in athletes following ankle injuries. *Sports Health,* 4(6): 471-474.

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

CRESWELL, J.W. 1994. *Research design: qualitative and quantitative approaches*. California: Sage Publications.

CRESWELL, J.W. 1998. Qualitative Inquiry and research design: choosing among five traditions. Thousand Oaks, CA: Sage Publications.

CRESWELL, J.W. & PLANO CLARK, V.L. 2007. *Designing and conducting mixed-methods research*. Thousand Oaks, CA: Sage Publications.

CRESWELL, J.W. 2009. *Research design*. Thousand Oaks, CA: Sage Publications.

CROISIER, J. 2004. Factors Associated with Recurrent Hamstring Injuries. *Sports Medicine*, 34(10): 681–695.

CROISIER, J.; GANTEAUME, S.; BINET, J. GENTY, M. & FERRET, J. 2008. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. *The American journal of sports medicine*, 36(8): 1469–75.

DAVID, M. & SUTTON, C.D. 2004. *Social Research (The basics).* London, UK: Sage Publications.

DELBEQ, A.; VAN DE VEN, A. & GUSTAFSON, D.H. 1975. *Group techniques for program planning: A guide to nominal group and Delphi processes.* Glenview, USA: Scott, Foresman & Company.

DEUTSCH, M.U.; KEARNEY, G.A. & REHRER, N.J. 2007. Time-motion analysis of professional rugby union players during match-play. *Journal of sports sciences*, 25(4): 461–472.

DREZNER, J.A. 2003. Practical management : Hamstring muscle injuries. *Clinical Journal of Sports Medicine*, 13(1): 48–52.

FIELDING, N.G. 2003. *Interviewing II.* Surrey, UK: Sage Publications.

GARRAWAY, W.M.; LEE, A.J.; HUTTON, S.J.; RUSSEL, E.B.A.W. & MACLEOD, D.A.D. 2000. Impact of professionalism on injuries in rugby union. *British journal of sports medicine*, 34(6): 348–351.

GUBA, E. 1990. *The paradigm dialogue*. Newbury Park, CA, Sage Publications.

HAMILTON, B. 2011. Return to Play Criteria Following Anterior Cruciate Ligament Surgery. Unpublished disssertation. Utah State University.

HERRING, S.A.; KIBLER, W.B. & PUTUKIAN, M. 2002. The team physician and return-to-play issues: a consensus statement. *Medicine and science in sports and exercise*, 34(7): 1212–1214.

JOHNSON, B. & ONWUEGBUZIE, A.J. 2004. Mixed-methods research: A research paradigm whose time has come. *Educational Researcher,* 33(7):14-26.

JOHNSON, B. & TURNER, L.A. 2003*. Data collection strategies in mixed-methods research*. Thousand Oaks, CA: Sage Publications.

KEGERREIS, S. 1983. The construction and implementation of functional progressions as a component of athletic rehabilitation. *The Journal of orthopaedic and sports physical therapy*, 5(1): 14–19.

LEEDY, P.D. 1997. *Practical research: Planning and design*. New Jersey: Prentice Hall.

LINCOLN, Y.S. & GUBA, E.G. 1985. *Naturalistic inquiry*. Beverly Hills, CA: Sage Publications.

LISTON, K.; REACHER, D.; SMITH, A. & WADDINGTON, I. 2006. Managing Pain and Injury in Non-elite Rugby Union and Rugby League: A Case Study of Players at a British University. *Sport in Society*, 9(3): 388–402.

MORGAN, D.L. 1997. *Focus groups as qualitative research*. Thousand Oaks, CA: Sage Publications.

MERRIAM, S.B. 2002. *Qualitative research in practice*. Lavoisier S.A.S

NIEUWENHUIS, J. 2007. Analysing qualitative data. In Maree, K. (Ed.) *First steps in research*. Pretoria: Van Schaik Publishers.

ORCHARD, J. 2014. What role for MRI in hamstring strains? An argument for a difference between recreational and professional athletes. *British journal of sports medicine*, 48(18): 1337–1338.

ORCHARD, J.; BEST, T.M. & VERRALL, G.M. 2005. Return to play following muscle strains. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 436–441.

PETERSEN, W. & ZANTOP, T. 2013. Return to play following ACL reconstruction: survey among experienced arthroscopic surgeons (AGA instructors). *Archives of orthopaedic and trauma surgery*, 133(7): 969–977.

POLGART, S. & THOMAS, S.A. 1995. *Introduction to research in the health sciences.* Melbourne: Churchill Livingston.

POULIS, I. 2012. Approaches to conflicts between treatment recommendations and patients' decisions in physiotherapy: a case study. *Physical Therapy Reviews*, 17(3): 184–189.

ROWE, G. & WRIGHT, G. 1999. The Delphi technique as a forecasting tool: Issues and analysis. *International Journal of Forecasting*, 15: 353.

SINGLETON, R. & STRAITS, B.C. 1999. *Approaches to social research.* USA: Oxford University Press.

SHULTZ, R.; BIDO, J.; SHRIER, I.; MEEUWISSE, W.H.; GARZA, D. & MATHESON, G.O. 2013. Team clinician variability in return-to-play decisions. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 23(6): 456–461.

SKULMOSKI, G.J.; HARTMAN, F.T. & KRAHN, J. 2007. The Delphi method for graduate research. Journal of International Technology Education. 6: 1-21.

TOL, J.L.; HAMILTON, B.; EIRALE, C.; MUXART, P.; JACOBSEN, P. & WHITELEY, R. 2014. At return to play following hamstring injury the majority of professional football players have residual isokinetic deficits. *British journal of sports medicine*, 48(18), pp.1364–1369

WIKSTROM, E.; TILLMAN, M.D.; CHMIELEWSKI, T.L. & BORSA, P.A. 2006. Measurement and evaluation of dynamic joint stability of the knee and ankle after injury. *Sports medicine (Auckland, N.Z.)*, 36(5): 393–410.

Chapter 4

The focus group discussion

4.1 Introduction

4.2 The Focus-Group Discussion

4.2.1 Results and findings of the focus-group discussion

4.2.1.1 a) The three steps of Creighton's RTP model for decision-making in sport as the basis of this study

4.2.1.2 b) The relevance of such a model within a team sport such as rugby union

4.2.1.3 c) The use of the e-Delphi research method

4.2.1.4 d) The participants chosen to partake in the e-Delphi

4.3 Conclusion

4.4 References

4.1 Introduction

Chapter 3 identified the qualitative linear model design of the study, indicating the three research methods used to gain sufficient raw data for this study. The methods consisted of the literature review (Chapter 2), the focus-group discussion (discussed in this Chapter) and the resulting e-Delphi method (chapter 5). This chapter will henceforth describe the focus-group discussion and its role in choosing, formulating and applying the e-Delphi method.

4.2 The Focus-Group Discussion

As indicated previously, the aim of any interview or focus-group discussion should be to obtain information that is relevant, reliable and valid (Fielding, 2003). Using an agenda and questions premeditated by the researcher, validity and reliability could be ensured. The main focus areas of the discussion were:

a) The three steps of Creighton's RTP model for decision-making in sport as the basis of this study.

b) The relevance of such a model within a team sport such as rugby union.

c) The use of the e-Delphi research method.

d) The participants chosen to partake in the e-Delphi.

The discussion group met in the boardroom of the Department of Exercise and Sport at the University of the Free State. Present at the discussion were experts in the different aspects of the study, including two experts in RTP in rugby union, an expert on the e-Delphi technique and an expert in bio-statistical analysis. The discussion was audio recorded to assist in the analysis thereof, identifying responses and other interesting comments made that could be relevant for the study.

4.2.1 Results and findings of the focus-group discussion

The results of the focus-group discussion will be presented as it was discussed, i.e. by focus area and relevant questions.

(a) The three steps of Creighton's RTP model for decision-making in sport as the basis of this study

Question (a)1: ***In your opinion, is Creighton's model for RTP decision-making in sport, comprehensive enough? Should certain factors be left out or added?***

The feeling of the focus group was that the presented model is a good representation of what is necessary to make decisions regarding RTP. It was however felt that for the focus of the study, the 'patient demographics' factors were not relevant.

'patient demographics for this study is not relevant as the players are all males between the ages of 18 and 35 years old. Age is a more important factor when dealing with adolescents' .

'age should rather be considered with personal medical history'

For the purpose of maintaining the meticulous nature of research, the group decided that the factor should be left in the questionnaire for the first round, but could be left out of the latter rounds if there were a less than 50% agreement level regarding its importance in round one.

A factor that was evident in research as well as in the experience of the group members, but not included in the original model, was the influence of the orthopaedic surgeon. It was decided by the group that it should be added to the study.

(b) The relevance of such a model within a team sport such as rugby union

Question (b) 1: ***Is a RTP model in rugby union relevant or useful?***

The group unanimously agreed that such a model could be useful and is currently very relevant. There was some concern as to how such a model could be implemented. Thus, the researcher contacted the South African Rugby Union to gain their support for the study and in so doing open a door to implementing such a model.

Question (b)2: ***Should the relevance of the study be tested by means of the questionnaires?***

It was the feeling of the group that it is a very obvious way of validating the research. Asking the participants whether, they thought it was necessary to have a RTP decision-making model for rugby union as the participants would ultimately be the principal users of such a model.

c) The use of the e-Delphi research method

Question (c) 1: ***What method of research should be used?***

After much deliberation on the possible methods that could be used for data capturing in this study, it was decided that the e-Delphi would be the most relevant, and also most practical. As discussed in Chapter 3, the e-Delphi method is often used when there is a lack of research in a certain area. It is also an excellent way to gather sufficient quantitative as well as qualitative data. Furthermore, an e-Delphi ensures the anonymity of the participants, controlled feedback, the possibility of statistical aggregation of the responses and also iteration.

'Another possibility is to go to each of the participation unions for a fortnight to observe and question the medical personnel.'

This statement was discussed at length, but it was decided that is was not practical, due to the following factors:

- Time – the researcher would have to take immense time out from work.
- Related costs – the costs of staying in different cities for prolonged periods of time
- Bias – the researcher could influence the daily functioning of the Medical Staff, as well as their answers.

d) The participants chosen to partake in the e-Delphi

Question (d) 1: ***Which participants would be best suited in terms of experience, education and knowledge in the field of RTP in rugby union?***

The first thoughts of the discussion group were to include the Medical Staff of the Top 10 rugby playing countries in the world, as logic dictated that they are the top authorities on medical related issues within rugby union. A few speed bumps arose, however:

- World rugby provided the researcher with the contact details of the heads of the Medical teams of the Top 10 countries. Responses from these participants were negligible.

- It was also the feeling of some of the Heads of the International team that RTP decision-making did not necessarily lie with them, as it is usually the decision of the provincial or club team to return a player to play, whereafter he would be available for national side selection.

It followed logically that if the international medical teams would not be suitable, the provincial rugby teams' medical staff would be. The questionnaires, with supporting documentation were thus sent to all members of Medical Staff at the different rugby unions across South Africa, including Sports Physicians, Physiotherapists and Biokineticists.

4.3 Conclusion

In conclusion, it was the decision of the focus group, that an e-Delphi questionnaire, distributed amongst local rugby unions' medical staff would be the most appropriate means of research for this study. The RTP decision-making model published by Creighton *et al*. (2010) was designated as the most comprehensive and applicable in the research, with the evaluation of the importance of such research added to the questionnaires.

4.4 References

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

FIELDING, N.G. 2003. *Interviewing II.* Surrey, UK: Sage.

Chapter 5

Results: Results stemming from the e-Delphi questionnaire

5.1 Introduction

5.2 The Participants

5.3 Clarifying the focus of the Questionnaire

5.4 Procedure for administration of the e-Delphi Questionnaire

5.5 Format of the Questionnaire and Presentation of the Responses

5.5.1 Format of the Questionnaire

5.5.2 Presentation and analysis of Responses

5.6 Responses to Step 1

5.6.1 Patient Demographics

5.6.2 Symptoms: (a) Pain

(b) Instability

(c) Swelling

5.6.3 Personal Medical History

5.6.4 Signs: (a) Strength

(b) Range of Motion

5.6.5 Laboratory Tests

5.6.6 Functional Tests

5.6.7 Psychological State

5.6.8 Potential Seriousness

5.6.9 Orthopaedic Surgeons' Opinion

5.7 Responses to Step 2

5.7.1 Type of Sport

5.7.2 Position Played

5.7.3 Limb dominance

5.7.4 Competitive Level

5.7.5 Ability to Protect

5.8 Responses to Step 3

5.8.1 Timing and Season

5.8.2 Pressure from the Athlete

5.8.3 External Pressure

5.8.4 Masking of the Injury

5.8.5 Conflict of Interest

5.8.6 Fear of Litigation

5.9 Responses to the Importance of the Research

5.9.1 Standardized RTP guidelines for musculo-skeletal injuries in rugby union is relevant

5.9.2 Standardized RTP guidelines for musculo-skeletal injuries in rugby union could potentially reduce the prevalence of re-injuries

5.10 Conclusion

5.11 References

5.1 Introduction

In order to present meaningful and comprehensive guidelines for RTP decision-making in rugby union, current practices should also be investigated. Hence, Chapter 5 will deal with the findings derived from the e-Delphi questionnaires regarding the circumstances surrounding RTP within professional rugby unions. The basis of the questionnaires, as discussed earlier, was formulated in terms of the literature review (Chapter 2) and the focus-group discussion (Chapter 4).

5.2 The Participants

A detailed description of the e-Delphi method with its corresponding construction, administration and participant selection was given in Chapter 3. To summarize, all participants were employed by the top professional rugby unions in South Africa as part of their respective medical teams. Participants were either sports physicians, physiotherapists, or biokineticists.

5.3 Clarifying the focus of the questionnaire

As noted in Chapter 3, the questionnaire was divided into 4 sub-categories, the 3 Steps of RTP decision-making suggested by Creighton's model with the fourth category establishing the worth of a RTP model in rugby union (Creighton *et al*., 2010). All of this was done to speak to the second, third and fourth objectives set out in Chapter 1, which are listed below:

- **What is seen as important for RTP decision-making in practice, more specifically in the team environment of rugby union?**
- **Is it possible to develop a comprehensive, integrated model or guidelines to assist in RTP decision-making processes in rugby union?**
- **Is there a need for such a model or guidelines?**

The 3 Steps of the questionnaire or 3 Steps format of the RTP decision-making process (24 statements) focused on obtaining an understanding of what happens with regards to RTP

inside the professional milieu of rugby union. This involves understanding how practitioners in a multi-disciplinary team sport environment go about making decisions on RTP.

The last category of the questionnaire (two statements) aimed at establishing purely whether practitioners in a multi-disciplinary team sport environment felt that a RTP model or guidelines for rugby union would be beneficial and/or helpful to the decision-making process.

Each of the statements within the 4 categories of the questionnaire will be discussed and analysed in Chapter 5. As the e-Delphi was conducted over two rounds, the results of each round will be noted, with the ultimate result, i.e. when consensus and/or stability was reached, and will then be discussed in detail.

5.4 Procedure for administration of the e-Delphi Questionnaire

As indicated in Chapter 3, the e-Delphi questionnaires were e-mailed to the 15 participants. The participants were given sufficient time to complete the questionnaires and regularly reminded thereof by the researcher. Upon completion after each round, the questionnaires were e-mailed back to the researcher. A detailed description of the study, the description of the e-Delphi format as well as a copy of the article presented by Creighton *et al.* (2010) for RTP in sport, were attached for each participant prior to the commencement of the e-Delphi method. The format of the e-Delphi remained unchanged during the two rounds, although there were slight alterations to some of the statements.

5.5 Format of the Questionnaire and Presentation of the Responses

5.5.1 Format of the Questionnaire

For the first round of the questionnaire, participants had to indicate their responses as follows:

Fully agree: **Must be considered in the RTP decision-making process (A weight of 2 was given in the analysis of the data)**

Partially agree: **Can be considered in the RTP decision-making process (A weight of 1 was given in the analysis of the data)**

Disagree: **Should not be considered in the RTP decision-making process (A weight of 0 was given in the analysis of the data)**

The participants were also encouraged to comment on each of the statements if they felt it necessary.

In the second round of the e-Delphi, participants were instructed to indicate their level of agreement only as **agree** or **disagree**. This was done in order to encourage decision-making amongst the participants.

5.5.2 Presentation and analysis of responses

The Delphi Method constructs a group communication process, which is effective in allowing a group of individuals, as a whole, to deal with a complex problem (Linstone & Turoff, 2002: Online). Rich and meaningful results were obtained through the Delphi by selecting individual participants and structuring a group-communication process.

A Delphi process is known by various rounds involving initial exploration of the subject under discussion. The first round focuses on the contribution of the individual. The rounds thereafter provide the participants with a summary of the group's view (the other members level of agreement as well as any comments made). Two to three rounds of the Delphi process usually prove sufficient to establish stability. Few or no changes are seen in further rounds and, unnecessary rounds are an irritation to participants (Linstone & Turoff 2001: Online).

When a certain percentage is reported for a statement, consensus is reached. In this study, consensus was reported when **85.7%** (**12 out of 14 participants**) agreed on a statement, regardless of the round. Keeping the above mentioned in mind, the e-Delphi process in this study was concluded after two rounds. After each round the individual responses of the participants were analysed. The e-Delphi process is described in Chapter 3, as a quantitative method of research striving for consensus amongst an expert panel on a certain subject

matter. The high percentage of agreement for consensus to be adjudicated in this study adds to the power of the study.

A colour coding system was used to indicate results to the participants and also to assist in the analysis of the results. Statements highlighted in **green** indicate that consensus (as described above) was reached after round 1 (i.e. 11 out of 14 respondents agreed, i.e. 78.6%). Statements highlighted in **blue** indicate that consensus (as described above) was reached after round 2 (i.e. 12 out of 14 respondents agreed, i.e. 85.7%). Statements highlighted in **red** indicate that stability was reached after round two, even though consensus regarding the statement could not be reached. The responses of each participant are given in the results column for every statement, the agreement percentage is also given here within. Below each column comments are made on the statement which are derived from comments made by the participants, or both.

It should also be noted that the respondents were instructed to complete the questionnaires from the viewpoint of their current employment within a professional rugby union team and not from their broader experience and professional knowledge. In other words, the questionnaire is only applicable to professional male rugby union players.

5.6 Responses to Step 1

Step 1 of Creighton's model is indicated as the step where Health Status is evaluated. In this step all medical factors surrounding the patient are evaluated. Creighton suggested 8 factors contributing to decision-making in step 1. Two of these factors also involved sub-categories which were added to the questionnaire. The researcher added another factor (namely the orthopaedic surgeons' opinion) as this feature in the literature as well as in own experience.

5.6.1 Patient demographics

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Patient demographics	Patient demographics: Sex and age can influence decision-making due to hormonal and age-related factors relating to tissue regeneration. It is however found to be of little importance in sports medicine.	**2**	**1**	**0**	**1 0 1 0 - 0 0 2 1 2 1 - 1 2 2** **46%** **Round 1**

Comment: Seeing that all of the participants are employed by professional rugby unions, the influence of patient demographics is nullified. All players are males between the ages of 18 and 35 years. Due to the meticulous nature of research, it was, however, included in the first round of the e-Delphi questionnaires. Consensus was not reached but it was clear that patient demographics are seen as an important factor influencing RTP decision-making in such a selected population. It is furthermore the view of the focus-group that age will be taken into account alongside the patient's medical history and not as a deciding factor on its own. The factor was thereof not included in the second round of the e-Delphi.

5.6.2 Symptoms: (a) Pain

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses

Pain	Pain is postulated as an essential indicator of presumed incomplete healing. Pain is seen as a risk factor for recurrent muscle strain injuries.	2	1	0	2 2 2 2 - 2 2 2 1 2 2 2 2 2 1 92% Round 1

Comment: Pain is indicated in the e-Delphi as an important factor to consider in RTP decision-making, with an agreement percentage of 92%. It was noted by one of the participants that pain is a messenger from the injured area to the brain which indicates that it should definitely be considered in RTP decision-making. Consensus was thus reached after the first round of the e-Delphi.

(b) Instability

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
3. Instability	Clinical laxity tests alone cannot provide reliable predictions for functional stability	2	1	0	2 2 1 2 - 2 2 2 0 2 2 1 2 1 2 82% Round 1

Comment: Regarding instability, one of the participants noted that if functional testing or sport-specific testing was satisfactory, a certain degree of instability can be accepted (an example given was for MCL and ATFL injuries). Another participant noted that if a degree of laxity is present, more attention should be given to neuromuscular control. However, with frank instabilities, the risk of recurrent injuries and/or early onset of osteoarthritis is greatly increased. With an agreement level of 82%, consensus was reached after round 1 for the importance of considering instability in the RTP decision-making process.

(c) Swelling

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Swelling	There should be no visible swelling or effusion with RTP or after performing sport-specific activities	**2**	**1**	**0**	**1 1 1 2 - 1 1 1 1 2 1 1 1 2 1** **61%** **Round 1**
	Literature indicates that there should be no visible swelling or effusion after performing sport-specific activities and with RTP. It was, however, given only a 60.7% importance rating amongst the respondents. Players often return with little visible swelling, especially with contusions of chronic knee effusions. It is also noted that slight effusions may be evident in knees or ankles after heavy training days in the process of RTP. However, swelling or effusion is also named as an indicator of what is happening at the site of injury.	**1**		**0**	**- 0 1 1 1 1 0 1 1 1 1 1 1 1 0** **73.3%** **Round 2**

Comments: Swelling is not seen as an important factor in RTP decision-making, with only 73.3% reported after the second round. Stability was thus reached for this factor.

5.6.3 Personal Medical History

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Personal Medical History	Family history and a player's medical history could predispose the player to other medical conditions or injuries. Condition-specific medical history is essential in evaluation	**2**	**1**	**0**	**2 2 1 1 - 0 2 2 2 2 2 2 2 2 2** **86%** **Round 1**

Comment: Throughout the literature it is significant to note that personal medical history should play a role in the RTP decision-making process. Previous injury is given as one of the most indicative factors of future injury. One of the respondents also highlighted that if a player has diabetes, their peripheral sensation could be decreased. With an agreement level of 86%, personal medical history has consensus after round one and should therefore be included in RTP decision-making guidelines.

5.6.4 Signs: (a) Strength

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses

Strength	Objective strength testing through isokinetic testing, confirming strength of 90 – 95% of the uninjured or contra-lateral limb	2	1	0	**2 1 2 2 - 1 1 1 2 2 2 2 2 2 1** **82%** **Round 1**

Comment: A participant commented that strength should not be seen as the be-all-and-end-all of RTP decision-making. A player with chronic neuropraxia could for example, return to play with 80% of strength, as it sometimes takes too long to obtain 100% strength. The limb or demands on the limb as well as the position/role/sport should be assessed. Loss of strength, as was noted by another participant, could lead to underperformance, re-injury or overuse of other parts of the kinetic chain. It is however clear that strength should be a consideration in RTP decision-making in professional rugby union.

(b) Range of Motion

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Range of Motion	Unrestricted range of motion (ROM) is advised for most injury types and sites	2	1	0	**2 2 1 2 - 1 1 2 2 2 2 2 0 2 2** **82%** **Round 1**

Comment: A loss of ROM was indicated by one of the participants as a potential contributing factor to underperformance, re-injury of even overuse of other parts of kinetic chain. On the other hand, another participant noted that a knee with an ACL reconstruction might never regain full extension. There is accordingly some leniency, but ROM should definitely be considered in RTP decision-making in professional rugby union as evident by the consensus reached after round one.

5.6.5 Laboratory Tests

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
8. Laboratory Tests	Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI, CT scans or electro-goniometer.	**2**	**1**	**0**	**1 0 1 1 - 1 2 2 1 1 1 1 2 1 1** **57%** **Round 1**
	Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI, CT scans or electro-goniometer. Only 57% of respondents saw laboratory tests as useful in RTP decision-making. It was noted that some special tests can be misleading, but should be considered, as ultrasounds, CT scans and MRI's may assist in the assessment process. It was also indicated that the clinician or specialist involved in the decision-making process should be able to fully comprehend the test results to be of use. Radiologic evidence of healing in fractures is important but, for example	**1**		**0**	**- 1 0 1 1 0 0 1 1 0 1 1 1 1 0** **60%** **Round 2**

	with tendon overuse the 'ultrasound picture recovery' lags well behind the clinical picture showing load capacity.				

Comments: Very low support was indicated for Laboratory tests in the RTP decision-making process. Only 60% was reported after round two, ensuring stability for this factor.

5.6.6 Functional Tests

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Functional Tests	Interaction of muscular strength, ROM, endurance and proprioception should be tested through functional testing specific to the sport's demands. This adds to the psychological readiness of a player.	**2**	**1**	**0**	**2 2 2 2 - 2 2 2 2 2 2 2 1 2 2** **96%** **Round 1**

Comment: Functional testing is seen as vitally important in RTP decision-making amongst the respondents. Consensus was reached at 96% and as pointed out by a participant, the best indicator of readiness for specific demands.

5.6.7 Psychological State

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Psychological State	Physical readiness does not always coincide with psychological readiness. Unrealistic fear of re-injury could exacerbate an injury.	**2**	**1**	**0**	**2 1 2 2 - 2 2 2 1 2 2 1 2 2 2** **89%** **Round 1**

Comment: Consensus was achieved at 89% agreement. A respondent noted that psychological inability can be just as detrimental as physical inability. Another comment suggested that some players needed to be pushed while others should rather be reassured that they are safe to RTP. Yet another respondent noted that if there are huge psychological issues, it would be wise not to let the player return.

5.6.8 Potential Seriousness

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Potential Seriousness	Players and staff need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery	**2**	**1**	**0**	**2 2 2 2 - 2 2 2 2 2 1 2 1 2 2** **93%** **Round 1**

Comment: An agreement of 93% was reported for potential seriousness as a factor of consideration in RTP decision-making. Three of the participants noted that the consequences need to be explained to players in order for them to make informed decisions on RTP.

5.6.9 Orthopaedic Surgeon's Opinion

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Orthopaedic Surgeon's Opinion	The team physician should coordinate and evaluate the player. Surgeons do not take into account muscle function, jump and alignment tests and proprioception when advising a player to RTP after surgery	**2**	**1**	**0**	**1 2 2 1 - 1 2 1 1 2 2 1 2 1 2** **75%** **Round 1**
	The team physician should coordinate and evaluate the player. Surgeons do not take into account muscle function, jump and alignment tests and proprioception when advising a player to RTP after surgery. Medical staff indicated a 75% agreement as they feel that the specialist needs to understand the demands and rehabilitation goals in order for them to have a say in RTP	**1**		**0**	**- 1 1 1 1 1 1 1 1 0 1 1 1 1 1** **86.6%** **Round 2**

	decision-making. It should also be a specialist in a joint and not a general orthopaedic surgeon. Furthermore, evaluation should be dependent on the experience and interests of the orthopaedic surgeon. However, if there were a grafting or other procedures done by the surgeon, they should guide the player and medical staff as to when it is safe to participate in full training with the relevant exposures considered. They should not however make the decision when the athlete is ready for full practice with contact, as that will depend on where the player is functionally and mentally.				

Comments: Consensus was reached after the second round of the e-Delphi, with 86.6% of respondents noting that the Orthopaedic Surgeon's opinion or guidelines should be considered in the RTP decision-making process.

5.7 Responses to Step 2

In Step 2 of the RTP decision-making process, the risk associated with participation in a certain sport, position and time is evaluated. The type of sport is obviously a very meaningful

consideration, but seeing as the questionnaires in this study specifically address rugby union and its known risks, the type of sport was only included in the first rounds of the questionnaires. There are five factors contributing to Step 2 as indicated by Creighton, and reported below.

5.7.1 Type of Sport

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Type of Sport	RTP decision-making should be approached with a thorough understanding of the inherent demands of the activity being returned to, as the likelihood of an identical recurrent trauma is high.	**2**	**1**	**0**	**2 2 2 2 - 2 2 2 2 2 2 2 2 2 2** **100%** **Round 2**

Comments: A 100% agreement was reported on the relevance of the sport type in the decision-making process of RTP. As mentioned above, rugby union is the subject of research in this study and as such it was not included in the second round of the questionnaires.

5.7.2 Position Played

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Position Played	Although great variations exist between the demands of forward and backline players, there are also unique	**2**	**1**	**0**	**2 2 2 1 - 1 2 2 2 2 2 2 2 2 2** **92.8%** **Round 1**

	demands between every positional group.				

Comments: The position of the injured player is seen as a very important factor for consideration in RTP decision-making in rugby union. Consensus was reported after the first round with 92.8%.

5.7.3 Limb Dominance

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Limb Dominance	Limb dominance plays a role in RTP decision-making as a dominant limb could be more prone to repeated stress during activities.	**2**	**1**	**0**	**2 1 1 1 - 0 1 1 1 1 2 2 2 2 2** **67.8%** **Round 1**
	Limb dominance plays a role in RTP decision-making as a dominant limb could be more prone to repeated stress during activities. An agreement level of 67.8% was reported for limb dominance. Limb-dominant readiness can potentially lead to further overload of the non-dominant limb.	**1**		**0**	**- 0 0 0 1 0 0 1 1 0 1 0 1 1 1** **50%** **Round 2**

Comments: Limb dominance is not seen as a deciding factor in RTP decision-making in rugby union, with stability being reached after the second round.

5.7.4 Competitive Level

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Competitive Level	Injury incidence has increased over all levels of play since the dawn of the professional era.	**2**	**1**	**0**	**1 1 2 0 - 0 2 2 2 2 2 2 1 2 2** **67.8%** **Round 1**
	Injury incidence has increased over all levels of play since the dawn of the professional era. Only a 67.8% level of agreement was indicated. It was noted that the professional era could lead to irrational decisions, but also that RTP is better monitored since the dawn of the professional era.				**- 1 1 1 1 1 1 1 1 1 1 1 1 1 1** **100%** **Round 2**

Comments: The competitive level of the player should be taken into account for RTP decision-making. With 100% agreement after round two.

5.7.5 Ability to Protect

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Ability to Protect	Taping, bracing splinting or padding has been indicated as supplementary in the reduction of risk of certain injuries.	**2**	**1**	**0**	**0 0 1 2 - 1 1 1 2 2 2 2 2 1 2** **67.8%** **Round 1**
	Taping, bracing splinting or padding has been indicated as supplementary in the reduction of risk of certain injuries. Only 67.8% of respondents thought that the ability to protect should be considered in RTP decision-making. A reason given is that as it may help in the RTP process and also once the player has returned, it should not influence the RTP decision.	**1**		**0**	**- 1 1 1 1 1 1 1 1 1 1 1 1 1 1** **100%** **Round 2**

Comments: The ability to protect an injured area should be taken into consideration during the RTP decision-making process. In round two, 100% of respondents agreed to this.

5.8 Responses to Step 3

Step 3 is defined by Creighton as the Decision Modification stage. There are six factors identified that are categorized under this step. They are reported below.

5.8.1 Timing and Season

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Timing and Season	Pre-season, it is rationalized that a player can be side-lined for an extra week, but that same rationale could lead to a player being played for an important final	**2**	**1**	**0**	**2 2 1 1 – 1 2 1 1 2 2 1 1 1 1** **67.8%** **Round 1**
	Pre-season, it is rationalized that a player can be side-lined for an extra week, but that same rationale could lead to a player being played for an important final. 67.8% of respondents agreed that timing and season does play a role in the RTP decision-making process. It was indicated that it is a risk-versus-reward kind of situation and although the respondents do not like to				**- 1 1 1 1 1 1 1 1 1 1 1 1 1 1** **100%** **Round 2**

	admit it, timing and season do play a role.				

Comments: Timing and season are factors to consider according to the respondents, as 100% agreed on this factor's importance in RTP decision-making. Consensus was thus reached after round two.

5.8.2 Pressure from Player

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Pressure from Player	Due to the deeply rooted characteristics of players at all levels, players are often adamant to return prematurely. An elite athlete lives on the limits of physical pain and psychological constraint in order to achieve their goals	**2**	**1**	**0**	**1 1 1 1 – 0 1 1 1 2 0 1 1 1 2** **50%** **Round 1**
	Due to the deeply rooted characteristics of players at all levels, players are often adamant about returning prematurely. An elite athlete lives at the limits of physical pain and psychological constraint in order to achieve	**1**		**0**	**- 0 0 1 1 0 0 1 1 1 1 1 1 1 1** **71.4%** **Round 2**

	their goals. Only 50% of respondents agreed that pressure from a player influences RTP decision-making. The inherent character of a player and the informed decision-making of a player are sometimes in conflict. It is however dependent on the player. One respondent was of the opinion that the decision should sometimes be left to the player if the consequences have been properly explained to the player. This will only, however, take place if playing could potentially enhance recovery and has minimal risk.				

Comments: Pressure from the player should not be a consideration for RTP in rugby union, as only 71.4% of participants agreed on this aspect in round two. Stability was reached.

5.8.3 External Pressure

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses

External Pressure	External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation	2	1	0	**2 1 1 1 – 0 1 1 2 2 0 0 2 0 2** **53.6%** **Round 1**
	External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation. Only 53.6% of respondents saw external pressure as having a place in RTP decision-making. One respondent was very adamant that external pressure should play no role in RTP decision-making				**- 0 1 1 1 0 0 1 1 1 1 1 1 1** **78.6%** **Round 2**

Comments: It was indicated by the respondents that external pressure should not have a role in RTP decision-making. Consensus was reached after the second round.

5.8.4 Masking of the Injury

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Masking of the Injury	Local anaesthetics are often used to mediate such masking of injuries in sport medicine, as they allow injured players to participate	**2**	**1**	**0**	**1 1 1 1 – 1 0 1 2 2 1 1 0 1 1** **50%** **Round 1**
	Local anaesthetics are often used to mediate such masking of injuries in sport medicine, as they allow injured players to participate. Only 50% of respondents saw a role for masking an injury in RTP decision-making. Considerations indicated included the anatomical site of the injury as well as the severity of the injury. Another respondent felt that it was unethical and illegal. One other respondent felt that if the player fully understood all the consequences and risks involved and was still willing to play, he would use a local anaesthetic, but only if it is	**1**		**0**	**- 1 1 1 1 0 – 1 1 1 1 1 1 1 1** **85.7%** **Round 2**

	unlikely to put the player at unnecessary risk.				

Comments: Masking an injury does have a place in RTP decision-making in rugby union. Consensus was reached on this factor after the second round with an agreement percentage of 85.7%.

5.8.5 Conflict of Interest

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Conflict of Interest	Conflict of interest can arise, as what is best for the team and best for the player are not necessarily aligned.	**2**	**1**	**0**	**0 1 2 2 – 0 1 2 2 2 1 2 1 0 2** **64.3%** **Round 1**
	Conflict of interest can arise, as what is best for the team and best for the player are not necessarily aligned. A percentage of 64.3% was awarded for conflict of interest. It was reported that the player's welfare should firstly be taken into account followed by that of the team. It should also be considered that an unfit player is not always best for the team. The	**1**		**0**	**- 1 1 1 1 1 0 1 1 1 1 1 1 1 1** **92.9%** **Round 2**

	onus should lie with the medical professional to keep a player who in his medical opinion should not play.				

Comments: In round 2 the respondents reached consensus that conflict of interest does influence RTP decision-making in rugby union with 92.9%.

5.8.6 Fear of Litigation

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
Fear of Litigation	Creighton defined this point as 'a special form of conflict of interest' as it focuses on the clinician's welfare, with the fear based on the possible benefits and harm the athlete may be subject to	**2**	**1**	**0**	**2 1 1 1 – 1 2 2 1 2 1 2 0 1 2** **67.8%** **Round 1**
	Creighton defined this point as 'a special form of conflict of interest' as it focuses on the clinician's welfare, with the fear based on the possible benefits and harm the athlete may be subject to.	**1**		**0**	**- 1 1 1 1 1 1 1 1 1 1 1 1 1** **100%** **Round 2**

	67.8% of respondents indicated that fear of litigation does play a role in RTP decision-making. Players should therefore make informed decisions and give written consent should there be disagreements. A respondent felt that if the player and coaching staff wish to overrule the medical practitioner, they have to sign a document to acknowledge that they are going against his advice and that they are taking the risk.				

Comments: Even though some respondents felt that fear of litigation should not interfere with RTP decision-making, they acknowledged that this is indeed the case. After round two consensus was reached at 100%.

5.9 Responses to the Importance of the research

The last category of the e-Delphi questionnaire required the expert panel to validate the importance of the research and determine whether it could be beneficial to their day to day decision-making.

5.9.1 Standardized RTP guidelines for musculo-skeletal injuries in rugby union is relevant

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
A Standardized RTP model for musculo-skeletal injuries in rugby union is relevant	Alarming and powerful re-injury statistics are indicated in rugby, presumably due to premature RTP	2	1	0	**2 0 2 2 – 0 0 1 1 2 2 2 2 1 0** **60.7%** **Round 1**
Standardized RTP guidelines for musculo-skeletal injuries in rugby union is relevant	Alarming and powerful re-injury statistics are indicated in rugby, presumably due to premature RTP. Amongst the respondents, 60.7% indicated that an RTP protocol could be relevant in rugby union. Reservations included that rugby has very unique demands, there should be guidelines rather than a fixed protocol, the guidelines should leave space for clinical reasoning depending on the experience and knowledge of the healthcare provider, there should not be a recipe approach and that it is relevant if it is standardized				**- 0 1 1 1 1 1 1 1 1 1 1 1 1 1** **92.9%** **Round 2**

	to injury, demographics, types of sport, position played etc.				

Comments: After round one of the e-Delphi, the original statement was altered due to the comments made by the respondents. The necessity for the revised statement was evident after round two, as consensus was reached with 92.9%, indicating that guidelines for RTP decision-making in rugby union is relevant.

5.9.2 Standardized RTP guidelines for musculo-skeletal injuries in rugby union could potentially reduce the prevalence of re-injuries

Statement	Description	Fully Agree	Partially Agree	Disagree	Responses
26. A Standardized RTP model for musculo-skeletal injuries in rugby union could potentially reduce the prevalence of re-injuries	The high incidence of re-injury in rugby union could potentially be reduced through the use of standardised RTP assessment procedures	**2**	**1**	**0**	**2 0 2 2 – 1 1 1 1 2 2 2 2 1 0** **67.8%** **Round 1**
Standardized RTP guidelines	The high incidence of re-injury in rugby union could				**- 0 1 1 1 1 1 1 1 1 1 1 1 1 1**

for musculo-skeletal injuries in rugby union could potentially reduce the prevalence of re-injuries	potentially be reduced through the use of standardised RTP assessment procedures. There was a 67.8% agreement level amongst respondents that a standardized protocol could potentially reduce re-injuries. Again, it was indicated that guidelines would be preferred to a protocol. A protocol was also indicated to be an important tool in the RTP decision-making toolbox as the healthcare provider is often faced with people's emotions. One respondent, however, felt that there is no space for a recipe approach in RTP decision-making.				**92.9%** **Round 2**

Comments: As with the previous statement, the original statement of 5.9.2 was altered according to respondents' comments. Consensus was again reached after round 2 with 92.9%. This indicated that respondents saw the value in RTP decision-making guidelines to potentially reduce the prevalence of re-injuries in rugby union.

5.10 Conclusion

The results from the e-Delphi method were presented in this Chapter. The results captured in this Chapter will assist the researcher in presenting guidelines for RTP decision-making in rugby union. Greater insights, knowledge and understanding of such guidelines were established in Chapter 5 and will henceforth be unpacked and discussed in Chapter 6.

5.11 References

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

Chapter 6

Integrated Guidelines for Return-to-Play Decision-making in Rugby Union

6.1 Introduction

6.2 Discussion of Accumulated Research

6.2.1 Step 1: Evaluation of Health Status

6.2.1.1 Patient Demographics

6.2.1.2 Symptoms: (a) Pain

(b) Instability

(c) Swelling

6.2.1.3 Personal Medical History

6.2.1.4 Signs: (a) Strength

(b) Range of Motion

6.2.1.5 Laboratory Tests

6.2.1.6 Functional Tests

6.2.1.7 Psychological State

6.2.1.8 Potential Seriousness

6.2.1.9 Orthopaedic Surgeons' Opinion

6.2.2 Step 2: Evaluation of Participation Risk

6.2.2.1 Type of Sport

6.2.2.2 Position Played

6.2.2.3 Limb dominance

6.2.2.4 Competitive Level

6.2.2.5 Ability to Protect

6.2.3 Step 3: Decision Modification

6.2.3.1 Timing and Season

6.2.3.2 Pressure from the Athlete

6.2.3.3 External Pressure

6.2.3.4 Masking of the Injury

6.2.3.5 Conflict of Interest

6.2.3.6 Fear of Litigation

6.2.4 Evaluation of the Importance of the Research

6.3 Proposed Integrated Guidelines for Return-to-Play Decision-making in Rugby Union

6.3.1 Schematic representation of the findings

6.3.2 Explanation of the schematic representation

6.4 Conclusion

6.5 References

6.1 Introduction

The main vision of the researcher in this study was to create a model, framework or set of guidelines to assist practitioners in the RTP decision-making process within the field of rugby union.

It was important to establish the known science behind RTP decision-making; thus, a literature review was inevitable (Chapter 2). Upon completion of the literature review, ideas

surrounding the literature, the methodology of research and the practical implications of RTP in rugby union were circulated by an expert panel during the focus-group discussion (Chapter 4). From the knowledge and insights gathered through these processes, an e-Delphi questionnaire was drafted and sent to experts in the field of RTP and rugby union. These results were reported in Chapter 5. Chapter 6 will strive to integrate all the above-mentioned information platforms to ultimately present guidelines to assist practitioners in RTP decision-making in rugby union.

6.2 Discussion of the Accumulated Research

Each factor will be discussed in terms of the literature, the focus-group discussion and the e-Delphi responses.

6.2.1 Step 1: Evaluation of Health Status

As was evident from the outset, a logical train of thought is detectable in any RTP decision-making process. Creighton identified the first step as the Evaluation of Health Status.

6.2.1.1 Patient Demographics

Patient demographics include sex and age. According to the literature, hormonal changes in adolescents creates vulnerability in the immature skeleton, especially at the site of growth cartilage, contributing to injury risk specifically in contact sports (Kerssemakers *et al*., 2009; Creighton *et al*., 2010; Haseler *et al*., 2010). This factor, however, was seen by the researcher as inadmissible as the current research was focussed only on male rugby union players between the ages of 18 and 35 years. Age can however influence decision-making in rugby union, but it was the feeling of the focus group that age should be seen as part of a player's personal medical history and not as a deciding factor on its own. The factor was thus only included in the first round of the e-Delphi questionnaires, and even then, the participants did not see patient demographics as being influential in their specific patient profile. The results therefore reflect that patient demographics has little importance in the RTP decision-making in sports medicine (Shultz *et al.,* 2013), and more particularly, rugby union.

6.2.1.2 Symptoms: (a) Pain

Pain is described in the literature as an essential indicator of presumed incomplete healing (Creighton *et al*., 2010; Orchard *et al*., 2005). It is also well known that due to the very nature of sportsmen, they have a tendency to play hurt (Liston *et al*., 2006). Pain was indicated by the participant in the e-Delphi as a very important consideration in RTP decision-making, receiving consensus at 92% after the first round. Participants noted that pain is a messenger from the injured area to the brain to indicate incomplete healing.

(b) Instability

According to the literature, dynamic stability during functional tasks should be seen as an important factor in RTP decision-making (Wilkstrom *et al*., 2006; Lam *et al*., 2009). This was further strengthened by the findings in this study, where participants noted that if functional performance was efficient, a certain degree of instability could be allowed. Additionally, it was noted that if a degree of laxity was present, improved neuromuscular control should be emphasized. Agreement was consequently reached after the first round, with 82%. Another participant also indicated that if there is a frank instability, the risk of re-injury and/or early onset of osteoarthritis was dramatically increased.

(c) Swelling

The literature indicates that there should be no visible swelling or effusion after performing sport-specific activities and subsequent RTP (Creighton *et al*., 2010; Peterson & Zantop, 2013). Controversially, the e-Delphi indicated no consensus on this matter after the two rounds. Participants indicated that players are often allowed to return with slight visible swelling, especially with contusions or chronic knee effusions. Slight effusions may be evident in knees or ankles after heavy training days in the process of RTP. Another participant also indicated that swelling should be seen as a sign of what is occurring at the site of injury.

6.2.1.3 Personal Medical History

A condition-specific medical history is an integral part of evaluating an injured player as prior injury vastly influences the probability of re-injuries (Lee *et al*., 2001; Herring *et al*., 2002). It is furthermore a well-documented fact that re-injuries are often more severe than initial injuries, highlighting the importance of personal medical history in the RTP decision-making process (McManus & Cross, 2004; Brooks *et al*., 2005; Fuller *et al*., 2013). The literature was supported by the finding of the e-Delphi as consensus was reached on this factor after the first round. Participants also indicated that previous injury is indicative of future injury. Another consideration was noted, that if a player has diabetes, their peripheral sensation could be affected.

6.2.1.4 Signs: (a) Strength

The literature indicates objective strength testing as a prominent factor in the RTP decision-making process (Beam, 2002; Drezner, 2003; Crosier *et al*., 2008). This includes isokinetic strength testing to show strength deficits of only 5 – 10% between the injured and uninjured limbs. It is well noted in literature that baseline measurements should also be met at the point of RTP (Eitzen *et al*, 2009; Tol *et al*., 2014). The importance of strength in RTP is underlined by the findings of this study, as participants agreed on this factor within the first round of the e-Delphi. It was noted that it should not be the be-all-and-end-all of decision-making as chronic neuropraxia could be acceptable on return with 80% of strength regained, depending on the position or role. It was also noted that a strength discrepancy could lead to underperforming, re-injury or overuse of other parts of the kinetic chain.

(b) Range of Motion

Literature advises unrestricted or free ROM for most injury types and sites (Askling *et al*., 2010; Hamilton, 2011; Peterson & Zantop, 2013). Baseline flexibility should also be taken into account when assessing ROM for RTP (Askling *et al*., 2010). Limited ROM was indicated by one of the participants as a possible contributing factor for underperformance, re-injury

and/or overuse of other structures. It was summarized that some leniency should, however, be allowed for ROM as full ROM is not always a possibility after surgery such as ACL reconstruction. The consensus of the e-Delphi was that ROM should be a contributing factor in RTP decision-making in rugby union.

6.2.1.5 Laboratory Tests

Controversy exists in literature regarding the role of laboratory tests in RTP decision-making. Although objective evidence regarding tissue healing can be obtained through tests such as MRI and CT scans, the value of these tests within the RTP decision-making process has been questioned. Structures have been deemed functionally healed and players successfully returned to sport despite laboratory tests indicating incomplete healing (Askling *et al*., 2010; Orchard, 2014; Reurink *et al*., 2014). Literature was further supported by the results of this study as consensus could not be reached regarding this factor. Participants indicated that there is definite room for laboratory tests within the rehabilitation process, but its importance in RTP is vague.

6.2.1.6 Functional Tests

Evident in both literature and this study, functional tests are of extreme importance in RTP decision-making. Functional tests combine muscular strength, ROM, endurance, confidence and proprioception to assess a player and also the injury against the demands of the sport as well as the player's specific positional demands (Wilkstrom *et al*., 2006; Krabak & Kennedy 2008; Creighton *et al*., 2010; Tol *et al*., 2014). It is important that these tests do not exceed the tolerance levels of the player (Beam, 2002). A participant in the e-Delphi commented that functional testing is the best predictor of RTP readiness. Consensus was reached after the first round of the e-Delphi process.

6.2.1.7 Psychological State

Psychological readiness does not always coincide with physical readiness (Tjong *et al*., 2014) and as one of the participants in the e-Delphi noted, psychological inability can be just as detrimental to a player as physical inability. Consensus was reached after the first round of the e-Delphi process, indicating that the psychological state of the player should be carefully and comprehensively assessed as part of the RTP decision-making process.

6.2.1.8 Potential Seriousness

The medical staff of a team has the innate responsibility towards players and other staff members to guide and educate them regarding permanent disability and chronic injuries that could result from insufficient recovery (Wilkstrom *et al*., 2006). This is supported by the findings of this study as consensus was reached after the first round.

6.2.1.9 Orthopaedic Surgeons' Opinion

Orthopaedic surgeons provide medical staff with guidelines towards recovery for certain procedures done; they should however not be involved in RTP decision-making as they do not incorporate factors such as strength, muscle function and proprioception in their decisions (Peterson & Zantop, 2013). Participants in the study noted that orthopaedic surgeons should guide them in the RTP decision-making process whenever grafting and other procedures were done by the said surgeon. Pertaining to the literature as well as the findings of this study, an orthopaedic surgeon’s opinion or guidelines should be considered as a factor within the rehabilitation process rather than the RTP process.

6.2.2 Step 2: Evaluation of Participation Risk

Following the clearance of a player's health status, his participation risk should be evaluated.

6.2.2.1 Type of Sport

The results stemming from this study are clearly supportive of the literature, in that the type of sport under scrutiny is of vital importance in RTP decision-making. The respondents agreed wholeheartedly that the type of sport is essential in the decision-making process. Literature further indicates that the demand of rugby union should be considered to be well understood by members of the medical staff making the decision to return a player to the field of play (Eaton & George, 2006). It should also be remembered that all players (irrespective of the injury) should be able to meet all the demands of the game (within their specific positional demands as discussed below). As rugby is an ever-evolving sport, the rules of the game continuously change to add to the excitement of the game and also to make the game as safe as possible, while maintaining the innate physical and sometimes brutal nature of the game (Fuller *et al*., 2009; Hendricks *et al*., 2014).

6.2.2.2 Position Played

Different physical attributes and anthropometrical profiles are necessary in different positions within rugby union (Reid *et al.,* 2013). Consequently, the nature and prevalence of injuries amongst the different positions do exist (Brooks *et al*., 2005; Deutsch *et al*., 2007; Fuller *et al*., 2013). This factor is highlighted through the e-Delphi questionnaire resulting in consensus after the first round.

6.2.2.3 Limb dominance

Literature reports no clear-cut differences for limb dominance in terms of injuries for rugby union. Limb dominance was also found to be irrelevant by the e-Delphi process as stability was reached after the second round. One respondent, however, reported that if an injury on the dominant limb is not fully ready for RTP, overload of the non-dominant limb could be the result.

6.2.2.4 Competitive Level

It is interesting to note that the participants only had 67.8% level of agreement after the first round, but after round two, there was 100% agreement. Comments made by the participants included the view that there is better monitoring of injuries and RTP since the inception of the professional era. However, the professional era also brought greater pressures resulting in irrational decisions. This is supported by literature indicating that injury prevalence has significantly increased since professionalism, with the incidence of re-injuries also being higher (Garraway *et al*., 2000; Hartwig *et al*., 2008). The greater prevalence of injuries is not only reported at the professional level, but also at amateur and even schoolboy level (Garraway *et al.,* 2000; Quarrie *et al*., 2013).

6.2.2.5 Ability to Protect

The effectiveness of taping, bracing, splinting and padding has not been fully proven in literature (Marshall *et al*., 2005; Creighton *et al*., 2010). There is limited evidence to support taping, mouth-guards, padded headgear and support sleeves in the prevention of injuries (Marshall *et al*., 2005; Cusimano *et al*., 2010). The controversy surrounding the topic is also evident in the results of this study as 67.8% agreed in the first round and 100% agreed after round two. One respondent indicated that the ability to protect should not influence RTP decision-making, but could assist in the process of RTP.

6.2.3 Step 3: Decision Modification

The final step of the RTP decision-making process as indicated by Creighton, involves factors that could modify decision-making. Decision modifiers cannot be used to determine RTP, but are valuable in the context of participation risk. Interestingly, none of the factors within this section achieved consensus after the first round, emphasizing that decision modification is not used to determine RTP, but rather to assist in the process of evaluating participation risk.

6.2.3.1 Timing and Season

A participant noted that timing and season is a risk-versus-reward kind of situation. Furthermore, the respondents admitted that though they do not like to admit it, timing and season do play a role in the RTP decision-making process. Literature supports this in reporting that decisions are often made in the team's best interest rather than the player's best interest. Likewise, staff can rationalise that a player be side-lined for another week during the pre-season, but should be allowed to play in the event of an important final (Orchard 2014; Tol *et al*., 2014). Consequently, consensus was reached after round two of the e-Delphi questionnaire, acknowledging the influence of timing and season in the RTP decision-making process.

6.2.3.2 Pressure from the Player

Some level of decisional control regarding treatment and RTP should remain with the player in order to add to greater adherence and satisfaction (Ghane *et al*., 2014). Literature and the respondents both indicate that players should be involved in the rehabilitation process, but should not have an effect on RTP decision-making.

6.2.3.3 External Pressure

External pressure refers to pressure from coaches, team mates, team-administrators, agents, fans, relatives and even media, resulting in unnecessary pressure and also misinformation (Creighton *et al*., 2010). The pressure perceived from these external sources is often very subtle, making it hard for the player and also medical staff to discern the facts of a particular situation (Poulis, 2012). One of the respondents was very adamant that external pressure should play no role in RTP decision-making. It was also the collective opinion of the group that external pressure should not play any role in RTP decision-making.

6.2.3.4 Masking of the Injury

Local anaesthetics are often used in sports medicine to mask an injury, allowing the player to continue despite an existing injury (Creighton *et al*., 2010; Herring *et al*., 2012). This study found that local anaesthetics are useful in RTP decision-making and if the player fully comprehends the risks involved, they should be allowed. The collective feeling of the group was that there is a definite place in RTP for masking of the injury, finding consensus after the second rounds. One participant, however, stated after the first round that this practice is both unethical and illegal. The findings on this matter again illustrate that masking of the injury could potentially modify decisions regarding RTP in rugby union.

6.2.3.5 Conflict of Interest

A very unique ethical challenge is faced by medical teams involved in high performance sports, as they have an obligation towards both the team and the player (Creighton *et al*., 2010; Murphy *et al*., 2012). It is evident in the results of this study that this is not necessarily an easy feat. Consensus could only be reached after the second round of the e-Delphi questionnaires, with respondents indicating that the player should always be put first. The internal struggle again advocates that this factor be seen as a decision modifier.

6.2.3.6 Fear of Litigation

Fear of litigation should be seen as a special form of conflict of interest, which involves the clinician, as well as the athlete's welfare (Creighton *et al.,* 2012). Respondents reached consensus only after the second round. Comments made included the view that in the event of the medical staff disagreeing with the player and/or coaching staff on readiness to RTP, a document should be signed by the player and/or staff to protect the medical team. This should, however, only be allowed once all the risks are well understood by both the player and coaching staff.

6.2.4 Evaluation of the Importance of the Research

As very little research is available on RTP decision-making protocols, models or guidelines and their application in rugby union, the researcher decided to add a section to the e-Delphi questionnaire pertaining to the value or usefulness of such guidelines. Two questions were thus added, as discussed below:

6.2.4.1 Relevance of Standardized RTP guidelines for musculo-skeletal injuries in rugby union

It is reported that greater emphasis is often placed on anatomical healing and clinical recovery than on the ability of the injured player or injury to endure the specific demands of rugby union (Beardmore *et al*., 2005). Furthermore, the absence of RTP criteria in rugby union, forces a medical team to make decisions based on their own perceived strengths, experiences and expertise. Respondents were adamant in their rejection of a standardized protocol for RTP decision-making, opting for a set of guidelines to assist a medical team in the RTP decision-making process instead. Consensus was reached after the second round.

6.2.4.2 Standardized RTP guidelines for musculo-skeletal injuries in rugby union could potentially reduce the prevalence of re-injuries

Chronic injuries or even permanent disability is a probability when premature RTP occurs (Wilkstrom *et al*., 2006). The rate of re-injuries could potentially be reduced through the use of standardized RTP assessment procedures (Beardmore *et al*., 2005). Respondents indicated that a RTP decision-making protocol would be a great asset in their RTP decision-making toolbox, but it was, however, again evident that this should comprise guidelines for RTP, and not a set-in-stone protocol. Consensus was reached after the second round.

6.3 Proposed Integrated Guidelines for Return to Play Decision-making in Rugby Union

Stemming from the literature as well as the findings in this study, it is evident that there is room for guidelines for RTP decision-making in rugby union. It is the aim of this study to provide a preliminary framework of RTP guidelines for rugby union, accepting that more in-depth research within the framework will be necessary.

6.3.1 Schematic representation of the findings

Figure 6 (page 142) gives a schematic representation of the findings of the study, resulting in integrated guidelines for the decision-making process of RTP in rugby union.

6.3.2 Explanation of the schematic representation

The integrated guidelines derived from the study are primarily aimed at assisting a clinician with basic understanding of both physiology and the demands of rugby union to make decisions regarding RTP. The guidelines are comprehensive, but further investigation into each of the factors should be done.

6.3.2.1 Step 1: Evaluation of Health Status

The decision-making guidelines presented in figure 6 should be followed step by step. This leads to Step 1 being the first barrier in the decision-making process. If a player is not able to meet the demands of the first step, he cannot be assessed through the second and third steps.

Step 1 evaluates the health status of the player. It is within this step that the clinician takes into account the individual player as well as the specific injury. Each of the factors contributing to this step was identified by literature and affirmed by the practitioners who participated in the e-Delphi questionnaires. A combined or integrated understanding of RTP decision-making derives from this process.

6.3.2.2 Step 2: Evaluation of Participation Risk

The next step in the decision-making process takes into account the demands or stresses that the player and the injury will be subject to upon return. The second step includes the level of competition, the position of the player as well as the ability to protect the player or injury by means of external aids. It is important to evaluate the injury against the specific demands of the specific position in which the player will have to play, as the positional differences in rugby union are vast. It could also be of value to communicate with the coaching staff in order to change a player's role or position if this could reduce the risk of re-injury in any way.

6.3.2.3 Step 3: Decision Modifiers

The final step of the RTP decision-making guidelines presented is a step that could influence the decision once the other two steps have been considered. Factors such as the time in season and the possibility of masking the injury for the duration of the game are scrutinised with this step.

It should thus be stressed that decision modifiers cannot be used to determine RTP, but should rather be used in the context of the evaluation of the participation risk.

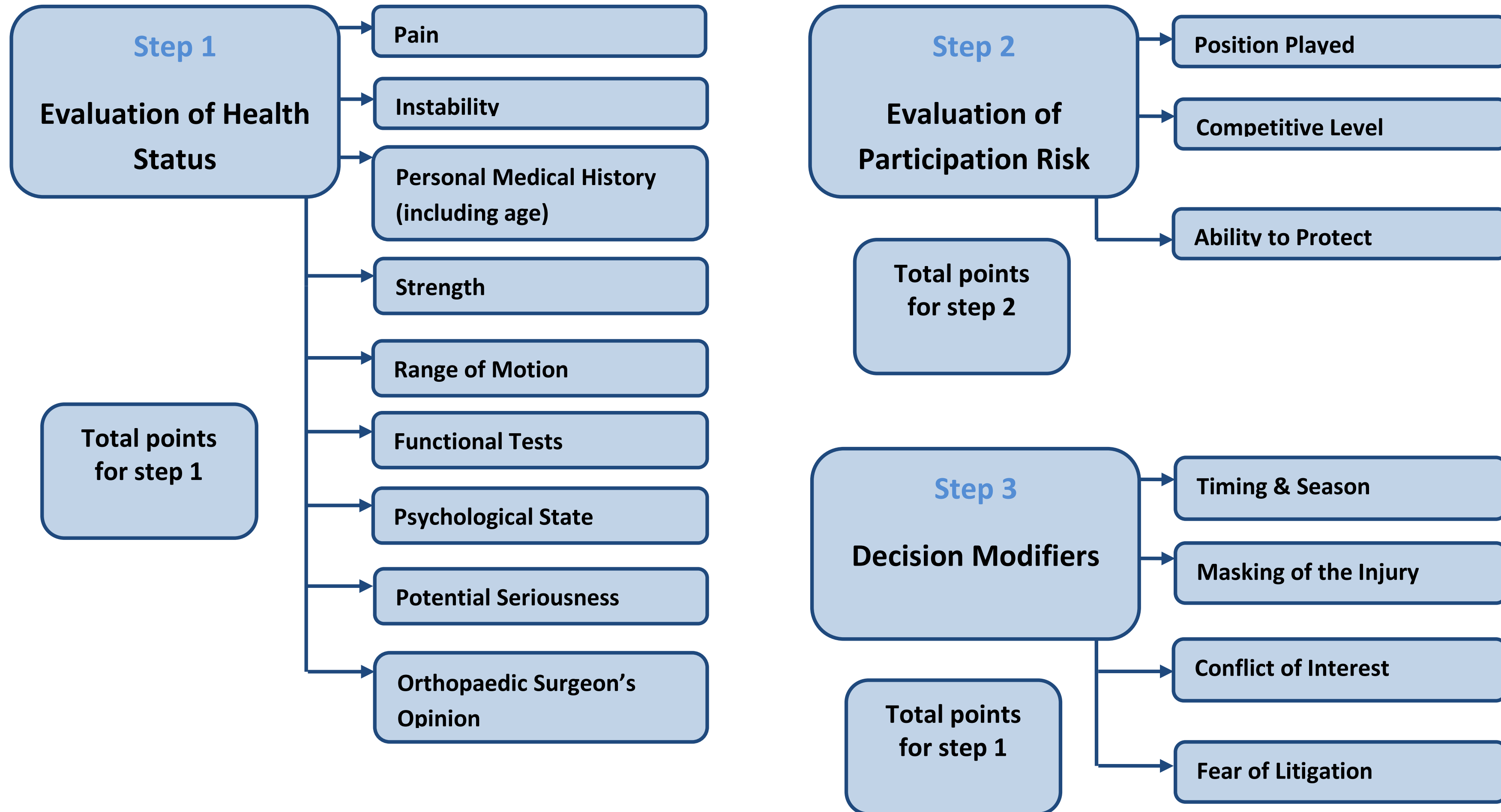


Figure 6: Integrated guidelines for RTP decision-making in rugby union

6.4 Conclusion

In conclusion, RTP decision-making in rugby union is not a one dimensional process. While it is important to evaluate the player and the injury as objectively as possible within the first step of the RTP guidelines, it is also important to take into account various factors contributing to the participation risk of the player and the subsequent decision modifiers. The researcher also recognises that the guidelines given can be somewhat vague and clinicians will still have to draw on their own expertise and experience to assess some of the factors. Further investigation into each of the factors, with the best possible measurement of each factor should be explored. The researcher hopes that these integrated RTP guidelines for rugby union will form the basis of further endeavours in the research of safe return-to-rugby and the potential reduction of re-injuries.

6.5 References

ASKLING, C.M.; NILSSON, J. & THORSTENSSON, A. 2010. A new hamstring test to complement the common clinical examination before return to sport after injury. *Knee Surgery, Sports Traumatology, Arthroscopy: Official Journal of The ESSKA,* 18(12): 1798 – 1803.

BEAM, J.W. 2002. Rehabilitation including sport-specific functional progression for the competitive athlete. *Journal of Bodywork and Movement Therapies*, 6(4): 205–219.

BEARDMORE, A.L.; HANDCOCK, P.J. & REHRER, N.J. 2005. Return-to-play after injury: practices in New Zealand rugby union. *Physical Therapy in Sport*, 6(1): 24–30.

BROOKS, J.H.M.; FULLER, C.W.; KEMP, S.P.T. & REDDIN, D.B. 2005. A prospective study of injuries and training amongst the England 2003 Rugby World Cup squad. *British journal of sports medicine*, 39(5): 288–293.

CREIGHTON, D.W.; SHRIER, I.; SCHULTZ, R.; MEEUWISSE, W.H. & MATHESON, G.O. 2010. Return-to-play in sport: a decision-based model. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 20(5): 379–85.

CROISIER, J.; GANTEAUME, S.; BINET, J. GENTY, M. & FERRET, J. 2008. Strength imbalances and prevention of hamstring injury in professional soccer players: a prospective study. *The*

American journal of sports medicine, 36(8): 1469–75.

CUSIMANO, M.D.; NASSIRI, F. & CHANG, Y. 2010. The effectiveness of interventions to reduce neurological injuries in rugby union: a systematic review. *Neurosurgery*, 67(5):1404–1418.

DEUTSCH, M.U.; KEARNEY, G.A. & REHRER, N.J. 2007. Time-motion analysis of professional rugby union players during match-play. *Journal of sports sciences*, 25(4): 461–472.

DREZNER, J.A. 2003. Practical management : Hamstring muscle injuries. *Clinical Journal of Sports Medicine*, 13(1): 48–52.

EATON, C. & GEORGE, K. 2006. Position specific rehabilitation for rugby union players. Part II: Evidence-based examples. *Physical Therapy in Sport*, 7(1): 30–35.

EITZEN, I.; HOLM, I. & RISBERG, M.A. 2009. Preoperative quadriceps strength is a significant predictor of knee function two years after anterior cruciate ligament reconstruction. *British Journal of Sports Medicine*, 43(5): 371–376.

FULLER. C.W.; RAFTERT, M.; READHEAD, C.; TARGETT, S.G.R. & MOLLOY, M.G. 2009. Impact of the International Rugby Board ' s experimental law variations on the incidence and nature of match injuries in southern hemisphere professional rugby union. *South African Medical Journal,* 99(4): 232–237.

FULLER, C.W.; SHEERIN, K. & TARGETT, S. 2013. Rugby World Cup 2011: International Rugby Board injury surveillance study. *British journal of sports medicine*, 47(18): 1184–91.

FULLER, C.W.; SHEERIN, K. & TARGETT, S. 2013. Rugby World Cup 2011: International Rugby Board injury surveillance study. *British journal of sports medicine*, 47(18): 1184–91.

GARRAWAY, W.M.; LEE, A.J.; HUTTON, S.J.; RUSSEL, E.B.A.W. & MACLEOD, D.A.D. 2000. Impact of professionalism on injuries in rugby union. *British journal of sports medicine*, 34(6): 348–351.

GHANE, A.; HUYNH, H.P.; ANDREWS, S.E.; LEGG, A.M.; TABUENCA, A. & SWEENY, K. 2014. The relative importance of patients' decisional control preferences and experiences. *Psychology & health*, 29(10): 1105–1118.

HAMILTON, B. 2011. Return to Play Criteria Following Anterior Cruciate Ligament Surgery. Unpublished disssertation. Utah State University.

HARTWIG, T.B.; NAUGHTON, G. & SEARL, J. 2008. Defining the volume and intensity of sport

participation in adolescent rugby union players. *International journal of sports physiology and performance*, 3(1): 94–106.

HASELER, C.M.; CARMONT, M.R. & ENGLAND, M. 2010. The epidemiology of injuries in English youth community rugby union. *British journal of sports medicine*, 44(15): 1093–1099.

HENDRICKS, S.; LAMBERT, M.I.; BROWN, J.C.; READHEAD, C. & VILJOEN, W. 2014. An evidence-driven approach to scrum law modifications in amateur rugby played in South Africa. *British journal of sports medicine*, 48(14): 1115–1119.

HERRING, S.A.; KIBLER, W.B. & PUTUKIAN, M. 2002. The team physician and return-to-play issues: a consensus statement. *Medicine and science in sports and exercise*, 34(7): 1212–1214.

KERSSEMAKERS, S.P.; FOTIADOU, A.N.; DE JONGE, M.C.; KARANTANAS, A.H. & MAAS, M. 2009. Sport injuries in the paediatric and adolescent patient: a growing problem. *Pediatric radiology*, 39(5): 471–484.

KRABAK, B. & KENNEDY, D.J. 2008. Functional rehabilitation of lumbar spine injuries in the athlete. *Sports medicine and arthroscopy review*, 16(1): 47–54.

LAM, M.; FONG, D.T.P.; YUNG, P.S.H.; HO, E.P.Y.; CHAN, W.Y. & CHAN, K.M. 2009. Knee stability assessment on anterior cruciate ligament injury: Clinical and biomechanical approaches. *Sports medicine, arthroscopy, rehabilitation, therapy & technology*, 1(1): 20-29.

LEE, A.J., GARRAWAY, W.M. & ARNEIL, D.W. 2001. Influence of preseason training, fitness, and existing injury on subsequent rugby injury. *British journal of sports medicine*, 35(6): 412–417.

LISTON, K.; REACHER, D.; SMITH, A. & WADDINGTON, I. 2006. Managing Pain and Injury in Non-elite Rugby Union and Rugby League: A Case Study of Players at a British University. *Sport in Society*, 9(3): 388–402.

MARSHALL, S.W.; LOOMIS, D.P.; WALLER, A.E.; CHALMERS, D.J.; BIRD, Y.N.; QUARRIE, K.L. & FEEHAN, M. 2005. Evaluation of protective equipment for prevention of injuries in rugby union. *International journal of epidemiology*, 34(1): 113–118.

McMANUS, A. & CROSS, D.S. 2004. Incidence of injury in elite junior Rugby Union: a prospective descriptive study. *Journal of science and medicine in sport / Sports Medicine Australia*, 7(4): 438–445.

MURTHY, A.M.; DWYER, J. & BOSCO, J.A. 2012. Ethics in sports medicine. *Bulletin of the NYU hospital for joint diseases*, 70(1): 56–59.

ORCHARD, J.; BEST, T.M. & VERRALL, G.M. 2005. Return to play following muscle strains. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 15(6): 436–441.

PETERSEN, W. & ZANTOP, T. 2013. Return to play following ACL reconstruction: survey among experienced arthroscopic surgeons (AGA instructors). *Archives of orthopaedic and trauma surgery*, 133(7): 969–977.

POULIS, I. 2012. Approaches to conflicts between treatment recommendations and patients' decisions in physiotherapy: a case study. *Physical Therapy Reviews*, 17(3): 184–189.

QUARRIE, K.L.; HOPKINS, W.G.; ANTHONY, M.J. & GILL, N.D. 2013. Positional demands of international rugby union: Evaluation of player actions and movements. *Journal of Science and Medicine in Sport*, 16(4): 353–359.

REID, L.C.; COWMAN, J.R.; GREEN, B.S. & COUGHLAN, G.F. 2013. Return to play in elite rugby union: application of global positioning system technology in return-to-running programs. *Journal of sport rehabilitation*, 22(2): 122–129.

REURINK, G.; GOUDSWAARD, G.J.; TOL, J.L.; ALMUSA, E.; MOEN, M.H.; WEIR, A.; VERHAAR, J.A.N.; HAMILTON, B. & MAAS, M. 2014. MRI observations at return to play of clinically recovered hamstring injuries. *British journal of sports medicine*, 48(18): 1370–1376.

SHULTZ, R.; BIDO, J.; SHRIER, I.; MEEUWISSE, W.H.; GARZA, D. & MATHESON, G.O. 2013. Team clinician variability in return-to-play decisions. *Clinical journal of sport medicine : official journal of the Canadian Academy of Sport Medicine*, 23(6): 456–461.

TJONG, V.K.; MURNAGHAN, M.L.; NYHOF-YOUNG, J.M. & OGILVIE-HARRIS, D.J. 2014. A qualitative investigation of the decision to return to sport after anterior cruciate ligament reconstruction: to play or not to play. *The American journal of sports medicine*, 42(2): 336–342.

TOL, J.L.; HAMILTON, B.; EIRALE, C.; MUXART, P.; JACOBSEN, P. & WHITELEY, R. 2014. At return to play following hamstring injury the majority of professional football players have residual isokinetic deficits. *British journal of sports medicine*, 48(18), pp.1364–1369.

WIKSTROM, E.; TILLMAN, M.D.; CHMIELEWSKI, T.L. & BORSA, P.A. 2006. Measurement and evaluation of dynamic joint stability of the knee and ankle after injury. *Sports medicine (Auckland, N.Z.)*, 36(5): 393–410.

Chapter 7

Reflections on the Research

7.1 Introduction

7.2 The Research Topic

7.2.1 Personal Obstacles

7.2.2 Interpersonal Obstacles

7.2.3 Theoretical Obstacles

7.2.4 Practical Obstacles

7.3 The Way Forward

7.4 Final Thoughts

7.1 Introduction

The intention of study is to firstly improve oneself, and also, if possible, to advance the subject of study. The purpose of this Chapter is thus to describe not only my attempt to add value to my profession, but also to reflect upon the personal growth that took place during and as a result of this study. One should always strive for self-development, self-empowerment and the advancement of self-knowledge. It is when one is faced with demands greater than what one thought oneself capable of, that real growth can take place. Or as it is often said: one's comfort zone is a beautiful place, but nothing grows there.

7.2 The Research Topic

In light of the limited research available surrounding the research topic, several obstacles arose throughout the study. These included, but were not limited to personal, interpersonal, theoretical and practical obstacles.

7.2.1 Personal Obstacles

As a practising Biokineticist and owner of a Biokinetics practice, time for study was somewhat limited. In the world of service provision, one will often help others before helping one self. I found that the time I allocated for working on my thesis, was often put in jeopardy. This happened when patients from out of town suddenly required appointments, when the practice was very busy or when there was just no other time available to go to the shop for the proverbial milk and bread. Since my only means of income is my practice, in my mind, it is also justified that the practice and patients enjoy first priority. I limiting my time for study to after hours (and Biokineticists 'after hours' are quite late!) and weekends. Towards the end of my study I, however, had to force myself to take more time out of a week in order to finish the momentous task at hand.

That being said, I knew that further study was always something that I wanted to do. It was something that I had now chosen to do, and giving up was never part of my make-up. Sticking to your guns and surrounding yourself with the right people, having patience and diligence and keeping the bigger picture in mind has always helped me through rough patches in life. This brings me to the next obstacle, namely, interpersonal obstacles.

7.2.1 Interpersonal Obstacles

'*We look up at the stars and see such different things*' – *George R.R. Martin*

Realising that at some point one should stop lending one's ears to everyone and start listening to oneself and maybe one other person, helped me a great deal in finishing this thesis. At the start of any research, it is imperative to gain as much insight as possible and I am grateful to have had some very strong and knowledgeable people influence the direction of my thoughts and planning. However, later on in the study, the different opinions and instructions only

added to my confusion and had a demoralising effect on me. This resulted in great time loss and very little progress in the overall study.

It takes a fair amount of time and much wisdom eventually to recognize that one can hear everyone, but one can choose whom to listen to.

7.2.3 Theoretical Obstacles

As mentioned above, very little research in the holistic nature of RTP decision-making in rugby union is available. This research project is thus, in some ways, ground-breaking. Many articles have been published on each of the factors that could influence RTP decision-making, but since no standardized RTP protocol for rugby union is available, the process cannot easily be evaluated. The hope of this study is rooted in the development of such a RTP decision-making model for rugby union, so that it can form the basis of further research in the field. The main reason for the research is the high incidence of re-injuries in rugby union. There is also a massive upward curve in for the severity of rugby union injuries. It is believed by some researchers, including myself that standardized RTP guidelines could potentially help reduce re-injuries in rugby union or decrease the severity of the re-injuries.

Great emphasis has been placed on the incidence of injuries in rugby union; there is currently great emphasis on the positional demands of rugby union and a massive amount of research is being conducted in the field of musculoskeletal rehabilitation. The risks of rugby union are known, the demands which injured players will have to face upon return are known, and the best information regarding rehabilitation of these injuries is known. The time is now ripe for the focus to shift towards producing a detailed RTP model for rugby union that will incorporate all the existing knowledge, aimed at making rugby union a safer sport.

7.2.4 Practical Obstacles

Practically, I think time was the greatest challenge. As already mentioned under personal obstacles, my own time was not always my own. Adding to this, an e-Delphi is a time-consuming method of research. With each round of the e-Delphi questionnaires, time had to be allowed for the participants to complete the questionnaires. Being part of the medical

team of a rugby union (as all of the participants were) meant that one travels often, and sometimes for extended periods of time. This made it difficult for participants to respond quickly. The other difficulty faced when conducting an e-Delphi is that one is reliant on other people, people whose main focus has little to do with the completion of one's study project. Reminders had to be sent to all the participants, at least twice and sometimes even for a third or fourth time.

7.3 The Way Forward

The research that I undertook is of a somewhat broad and general nature. The ultimate goal was always to create a basis which can later serve as a framework for further research. Each factor included in the RTP guidelines for rugby union should be investigated to such an extent that specific tests or measurable results can be obtained to clarify and objectify RTP. Something like functional testing, developing a battery of tests to assess an injury for all the positional demands of the player could become a reality. It will be necessary to create different tests for each of the positions in rugby union. The injury should not be the deciding factor in RTP but rather the ability of the injury to withstand the demands placed upon it. In other words, rehabilitation should focus on the injury while RTP decision-making should focus on the ability of the player (and subsequently the injury) to meet the demands of the game.

I believe that through combining the literature surrounding RTP with the knowledge, expertise and experience of the rugby unions' medical teams, the basic framework for RTP decision-making has now been established. Only once the framework has been properly coloured-in, so to speak, will it be possible to evaluate the effectiveness of such a model for RTP decision-making in rugby union. This will, however, be the ultimate step, this study being only the first of many steps towards achieving the ultimate goal.

Another shortcoming of this study was that it only included South African franchises and per implication South African healthcare professionals. It would be interesting to see how the potential differences in education and training could influence the results of the study.

7.4 Final Thoughts

In summary, I have gained immense wisdom, learned that I am able to do much more than I thought I could and that time management is really of the essence. I have grown within my profession – being a Biokineticist is something that I am very passionate about. In the words of Robert T. Kiyosaki: '*You become what you study'*. I feel that I have contributed to my profession in a positive and practical way. I would also like to encourage educational systems and practitioners to assist one another in conducting similar studies so that the breach between University and practice can be bridged. Our profession is still a young one and the proverbial tree should be bent while it is still young. Promoting collaboration between theory and practice should be pursued from both sides, resulting in the advancement and expansion of our field.

'It always seems impossible,

until it is done' – Nelson Mandela

Appendix A

ECUFS Ethical Approval

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS
UV

Research Division
Internal Post Box G40
☎(051) 4052812
Fax (051) 4444359

E-mail address: EthicsFHS@ufs.ac.za

2014-09-22

REC Reference nr 230408-011
IRB nr 00006240

MS CM WALL
C/O MS S VAN DER MERWE
DIVISION OF SPORTS MEDICINE
UFS

Dear Ms Wall

ECUFS NR 142/2014
PROJECT TITLE: AN INTEGRATED MODEL FOR RETURN TO PLAY AFTER INJURY IN RUGBY UNION.

1. You are hereby kindly informed that at the meeting on 16 September 2014 the Ethics Committee approval the above project after all the conditions have been met when all the concerns of the reviewer was addressed adequately.

2. Committee guidance documents: Declaration of Helsinki, ICH, GCP and MRC Guidelines on Bio Medical Research. Clinical Trial Guidelines 2000 Department of Health RSA; Ethics in Health Research: Principles Structure and Processes Department of Health RSA 2004; Guidelines for Good Practice in the Conduct of Clinical Trials with Human Participants in South Africa, Second Edition (2006); the Constitution of the Ethics Committee of the Faculty of Health Sciences and the Guidelines of the SA Medicines Control Council as well as Laws and Regulations with regard to the Control of Medicines.

3. Any amendment, extension or other modifications to the protocol must be submitted to the Ethics Committee for approval.

4. The Committee must be informed of any serious adverse event and/or termination of the study.

5. All relevant documents e.g. signed permission letters from the authorities, institutions, changes to the protocol, questionnaires etc. have to be submitted to the Ethics Committee before the study may be conducted (if applicable).

6. A progress report should be submitted within one year of approval of long term studies and a final report at completion of both short term and long term studies.

7. Kindly refer to the **ETOVS/ECUFS** reference number in correspondence to the Ethics Committee secretariat.

Yours faithfully

PROF WH KRUGER
CHAIR: ETHICS **COMMITTEE**

Cc Dr L Holtzhausen

Appendix B

Letter of Support from SARU

SOUTH AFRICAN RUGBY UNION

SARU House | Tygerberg Park | 163 Uys Krige Drive | Plattekloof | Cape Town 7500

P.O. Box 15929 | Panorama 7506

Tel: +27 (0)21 928 7000 | www.sarugby.co.za

: springboks | : @bokrugby

Dear Christine

Your research proposal and request were discussed by the SARU Internal Research Review Committee. Please note the following:

1. We support your research proposal to scientifically establish whether an "Integrated model for return to play after injury in rugby union" can be established. We believe that this is an area that needs to be addressed but can prove challenging and therefore are encouraged by your proposed study.

2. SARU, has indicated their support of the study in writing, and encourages all Provincial Rugby Unions that are approached to participate in the study to please consider getting involved in the study and to contribute in a meaningful way. A model to assist medical professionals in decision making regarding return to play will be of huge value to the medical professional, the player and the union.

3. Unfortunately we cannot force any of the provincial unions to participate if they are not willing to do so.

4. Please note that SARU does not provide any financial assistance.

Thank you once again for your interest in the game of rugby.

Regards

Dr Jakoet

SOUTH AFRICAN RUGBY UNION (an incorporated association of persons)

President: OPM Hoskins Deputy President: MA Alexander Vice President: JY Stoffberg Chief Executive Officer: JW Roux

Appendix C

Letter of Communication

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA

UFS UV

School for Allied Health Professions (SAHP),
UV/UFS
Bloemfontein
9300

8 July 2016

Dear

Research Project: AN INTEGRATED MODEL FOR RETURN TO PLAY AFTER INJURY IN RUGBY UNION (ECUFS 142/2014)

Dear Dr De Wet

There is a lack of standardized, quantifiable guidelines for return to play (RTP) decision-making after injury at all levels in rugby union. To address this need, I embarked upon developing a RTP decision-making model for rugby, as a PhD study at the University of the Free State, Bloemfontein, South Africa. Ethical clearance has been obtained from the Ethics Committee, Faculty of Health Sciences, University of the Free State (ECUFS 142/2014).

The study will be conducted in the following manner:

1. A literature review of all aspects relevant to RTP decision-making in rugby union and in general will be conducted.
2. A document analysis of RTP guidelines used by the top 10 countries in World Rugby as well as the senior Currie Cup teams.
3. From the literature and guidelines of the top rugby unions and Currie Cup teams, a preliminary model for RTP will be constructed.
4. The model will then be evaluated and scrutinized by team doctors and physiotherapists of the eight premier South African teams competing in the top South African domestic competition, the Currie Cup Premier Division by means of a panel discussion.
5. Finalising the RTP model for rugby union.
6. Make the model available via publication in peer-reviewed journals, and to all participating rugby unions.

Your name has been provided to us by the South African Rugby Union, as Medical representative of the Free State Rugby Union.

In order to develop this important instrument for rugby, we kindly request that you share any of your Union's RTP guidelines or other documentation in this regard, with us. This includes guidelines for all levels of play. Please e-mail copies or links to christine@marynawessels.co.za or fax to +2751 444 5283. Alternatively, I can be reached at +27 82 811 1371.

I would also greatly appreciate it, if we could schedule an appointment to discuss your RTP documents as well as to answer a brief questionnaire which I have developed based on the RTP model presented by Creighton et al.

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

School for Allied Health Professions (SAHP),
UV/UFS
Bloemfontein
9300

If you need more information or have questions, you are welcome to contact me or my supervisor. Our contact details are:

Investigator:

Christine Wall	E-mail:	christine@marynawessels.co.za
	Phone:	+27 82 811 1371
	Fax:	+27 51 444 5283

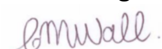
Supervisor:

Prof Derik Coetzee	E-mail:	CoetzeeF@ufs.ac.za
	Phone:	+27 51 401 2323

I also attach a more detailed description of the study for your perusal. An informed consent document has also been attached as well as a copy of Creighton's model for RTP.

Your time and involvement is greatly appreciated and any comments and suggestions are welcomed.

Kindest regards



Christine Wall

Appendix D

Information Document

UNIVERSITY OF THE
FREE STATE
UNIVERSITEIT VAN DIE
VRYSTAAT
YUNIVESITHI YA
FREISTATA

UFS·UV
HEALTH SCIENCES
GESONDHEIDSWETENSKAPPE

Information Document

Research Project: AN INTEGRATED MODEL FOR RETURN TO PLAY AFTER INJURY IN RUGBY UNION (ECUFS 142/2014)

I am currently a Biokineticist (Rehabilitation Specialist) in a private practice, in Bloemfontein, South-Africa. I deal mainly with the rehabilitation of Sports injuries and other orthopedic problems. I have started a PhD degree in Biokinetics through the University of the Free State (Student number: 2007054279), with the title: **AN INTEGRATED MODEL FOR RETURN TO PLAY AFTER INJURY IN RUGBY UNION.**

My supervisor for the degree is:

Prof F. Coetzee
Head of Department: Exercise and Sport Sciences
University of the Free State
Bloemfontein, SOUTH AFRICA

As indicated by the title of the thesis, the **purpose** of my study is to develop an integrated model for decision-making regarding return to play (RTP) in rugby union. The subject matter was chosen due to the lack of an available, standardized, scientifically based model to assist in the decision-making process for RTP in rugby union. Due to the high injury and re-injury prevalence associated with rugby union, on all levels of play, measures need to be put in place to reduce the risk of re-injuries. Literature on the demands of rugby union, rehabilitation and return to play are readily available, it is thus possible to use the science to develop a model for RTP decision-making.

The **problem** that has to be addressed is thus the lack of a scientifically based RTP decision-making model for rugby union in particular. As injuries in professional sport has great impact, not only on the player, but also on the team, management and sponsors, decisions surrounding RTP are often more difficult. This brings the need for a **model** by which these decisions can be made.

The overall **goal** of the study will be to provide quality, publishable research on return to play decision-making; presenting a scientifically developed model for RTP in rugby union, evaluated by an expert panel.

The **aim** of the study is to develop an integrated model for RTP in rugby union. The model will be based on literature, available guidelines from rugby playing countries and practical experience of an expert panel.

To achieve this aim, the following **objectives** will be pursued:

1. To do a literature review on aspects relating to RTP decision-making.
2. To analyze RTP guidelines used in professional international rugby unions as well as provincial teams, and
3. From the above, to develop a preliminary integrated model for RTP in rugby union
4. Present the model to an expert panel for evaluation of the validity and usefulness of the RTP model
5. Finalize the RTP model.

The **methods** for conducting the study will include a comprehensive literature study of all aspects of RTP decision-making process. Thereafter, a document analysis will be done of guidelines used in the top 10 professional rugby unions. A preliminary model will then be developed based on the literature and document analysis. This new model will be sent to the South African Currie Cup Premier Division's doctors and physiotherapists for evaluation. Numerical weights will be ascribed to all the factors within the proposed model to discern the importance of each factor according to the doctor and physiotherapist. After the numerical weights have been assigned and processed, each Currie Cup team doctor and physiotherapist will evaluate by means of individual assessment as well as a panel discussion, the necessity and possible value it could have in this kind of decision-making process.

The **value** of the research will be to create a model for assisting medical professionals in decision-making regarding RTP in rugby union. The lack of such a model is evident in literature and practice and is seen as a contributing factor for high re-injury rates in rugby union.

My contact details:

Telephone: +2751 444 5283 Fax: +2751 444 5283

Cellular phone: +2782 811 1371 E-mail address: cmwall21@gmail.com

Postal address: PO Box 27983
Danhof
9310

Thank you for taking the time to read this communication. I will greatly appreciate your contribution to the project.
Sincerely,

Christine Wall
Doctorate student, University of the Free State, Bloemfontein, South Africa

Appendix E

Informed Consent

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

School for Allied Health Professions (SAHP),
UV/UFS
Bloemfontein
9300

CONFIDENTIAL

INFORMED CONSENT

General information regarding the project:

1. **The title**: An Integrated model for Return to Play after Injury in Rugby Union

2. **Aims of the project:**
    1. To do a literature review on aspects relating to RTP decision-making.
    2. To analyze RTP guidelines used in professional international rugby unions as well as provincial teams, and
    3. From the above, to develop a preliminary integrated model for RTP in rugby union
    4. Present the model to an expert panel for evaluation of the validity and usefulness of the RTP model
    5. Finalize the RTP model.

3. **Procedures:**

- **Quantification of RTP decision-making model**

Through Chapters 1 and 2, evidence from the literature and current practices will be integrated into a conceptual model for RTP decision making in rugby union. The model will be based on what is found in literature, and include components such as health status, participation risk factors and decision modifiers. Other components identified during the course of the literature revision could be added to the model.

The model will be presented to the Currie Cup team doctors and physiotherapists to award numerical values to each step within the decision-making model according to its importance. Through this process, each factor in the RTP model will be quantified.

- **Evaluation or testing of the RTP decision-making model**

The testing will be done through a questionnaire filled in by the team doctors and physiotherapists. After completing the evaluation of the decision-making model, the doctor of physiotherapist will then have to indicate whether the model would be useful with the actual decision-making process and whether or not it could influence their decision.

4. **Benefits of this study:**

To create a model for assisting medical professionals in decision-making regarding RTP in rugby union. The lack of such a model is evident in literature and practice and is seen as a contributing factor for high re-injury rates in rugby union.

UNIVERSITY OF THE FREE STATE
UNIVERSITEIT VAN DIE VRYSTAAT
YUNIVESITHI YA FREISTATA
UFS UV

School for Allied Health Professions (SAHP),
UV/UFS
Bloemfontein
9300

To the person signing the consent:

Participation in the project described above, is not compulsory. If you choose to participate, the following general principles must be kept in mind:

- Participation is voluntary
- You are free to withdraw from the project at any stage without giving a reason for the withdrawal. We would, however, request that you consider your decision thoroughly before withdrawing as it may have an effect on the project's results.
- Feel free to ask questions at any stage regarding the project or the procedures
- We require that you indemnify the University from any liability due to detrimental effects of treatment by University staff or students or other subjects to yourself or anybody else. We also require indemnity from liability of the University regarding any treatment to yourself or another person due to participation in this project, as explained above. Lastly it is required to abandon any claim against the University regarding treatment of yourself or another person due to participation in this project.

Consent:

Title of the project: An Integrated model for Return to Play after Injury in Rugby Union

I, the undersigned ....(full names) read all the information on the project and I declare that I understand the information. I had the opportunity to discuss aspects of the project with the leader and I declare that I participate in the project as a volunteer. I hereby give my consent to be a subject in this project.

I indemnify the university, also any employee or student of the university, of any liability against myself, which may arise during the course of the project.

I will not submit any claims against the University regarding personal detrimental effects due to the project, due to negligence by the University, its employees or students, or any other subjects.

.... (Signature or subject)

Signed at .... on ....

Witnesses: 1. ....

2. ....

Signed at .... on ....

Department of Exercise and Sport Sciences / Departement Oefen- en Sportwetenskappe
Tel.: +27(0)51 401 2323,
205 Nelson Mandela Drive/Rylaan, Park West/Parkwes, Bloemfontein 9301, South Africa/Suid-Afrika
P.O. Box/Posbus 339, Bloemfontein 9300, South Africa/Suid-Afrika, T: +27(0)51 401 9111, www.ufs.ac.za

Appendix F

Article: Return-to-Play in Sport: A Decision-based Model

(Creighton *et al*., 2010)

Return-to-Play in Sport: A Decision-based Model

David W. Creighton, MS, Ian Shrier, MD, PhD,† Rebecca Shultz, PhD,**
*Willem H. Meeuwisse, MD, PhD,‡ and Gordon O. Matheson, MD, PhD**

Objective: Return-to-play (RTP) decisions are fundamental to the practice of sports medicine but vary greatly for the same medical condition and circumstance. Although there are published articles that identify individual components that go into these decisions, there exists neither quantitative criteria nor a model for the sequence or weighting of these components within the medical decision-making process. Our objective was to develop a decision-based model for clinical use by sports medicine practitioners.

Data Sources: English literature related to RTP decision making.

Main Results: We developed a 3-step decision-based RTP model for an injury or illness that is specific to the individual practitioner making the RTP decision: health status, participation risk, and decision modification. In Step 1, the *Health Status* of the athlete is assessed through the evaluation of *Medical Factors* related to how much healing has occurred. In Step 2, the clinician evaluates the *Participation Risk* associated with participation, which is informed by not only the current health status but also by the *Sport Risk Modifiers* (eg, ability to protect the injury with padding, athlete position). Different individuals are expected to have different thresholds for "acceptable level of risk," and these thresholds will change based on context. In Step 3, *Decision Modifiers* are considered and the decision to RTP or not is made.

Conclusions: Our model helps clarify the processes that clinicians use consciously and subconsciously when making RTP decisions. Providing such a structure should decrease controversy, assist physicians, and identify important gaps in practice areas where research evidence is lacking.

Submitted for publication May 10, 2010; accepted July 22, 2010.
From the *Division of Sports Medicine, Department of Orthopaedic Surgery, Stanford University School of Medicine, Palo Alto, California; †Centre for Clinical Epidemiology and Community Studies, Lady Davis Institute for Medical Research, Jewish General Hospital, McGill University, Montreal, Quebec, Canada; and ‡Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Calgary, Alberta, Canada.
The authors report no conflicts of interest.
This publication represents work done by members of RAISEM (Research Alliance in Sport and Exercise Medicine). RAISEM undertakes group research projects on sport injury prevention, clinical treatment, and return to play. The members of the group include clinicians, content experts, epidemiologists, biomechanists, and physiologists, with associated members collaborating on specific projects.
Reprints: Ian Shrier, MD, PhD, Centre for Clinical Epidemiology and Community Studies, SMBD-Jewish General Hospital, 3755 Cote Ste-Catherine Rd, Montreal, QC H3T 1E2, Canada (e-mail: ian.shrier@mcgill.ca).
Copyright © 2010 by Lippincott Williams & Wilkins

Key Words: return to play, medical decision making, sport participation, injury, preparticipation physical examination

(*Clin J Sport Med* 2010;20:379–385)

INTRODUCTION

Previous injury is associated with up to a 4-fold increase in the risk of reinjury,[1] and the treatment of all injuries includes advice on when it is safe to resume sport participation. For this reason, return-to-play (RTP) decisions are critical to the practice of clinical sport medicine. In general, previous research related to RTP decision making has focused on conditions with serious long-term morbidity or potential mortality such as concussion,[2–12] spinal cord injuries,[13–17] and cardiovascular abnormalities.[18–27] Even though musculoskeletal trauma represents the majority of injuries in sports medicine, there is little original RTP research for them. In the absence of clear scientific evidence, RTP decisions lack standardization[28–30] and can be a source of confusion and disagreement for physicians, athletes, coaches, and administrators.[31,32] More importantly, the RTP process may be open to influence by those not trained or experienced in medical decision making.[33,34] Practices such as game-day injections to mask pain and deviations from the typical medical approaches to allow full healing have become commonplace in sports medicine practice, leading to questions among bioethicists,[35,36] media,[37,38] legal professionals,[39] and medical professionals.[40–44]

In 2002, the American College of Sports Medicine issued a "consensus statement" on RTP to help team physicians "make an informed decision as to whether an injured or ill athlete may safely return to practice or competition."[45] Although it includes a list of the various elements involved in RTP, the consensus statement fails to describe how or why those elements influence the medical decision-making process. Indeed, the statement reflects the difficulties and complexities in RTP medical decisions:

- *This statement is not intended as a standard of care, and should not be interpreted as such. This statement is only a guide, and as such is of a general nature consistent with the reasonable and objective practice of the healthcare professional. Individual decisions regarding the return of an injured or ill athlete to play will depend on the specific facts and circumstances presented to the physician. Adequate insurance should be in place to help protect the athlete, the sponsoring organization, and the physician.*

The purpose of this article is to synthesize the available literature concerning RTP and to propose a model for RTP decision making in sports medicine. We believe that this model

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

helps clarify the processes that clinicians use consciously and subconsciously when making RTP decisions. Providing such a structure provides a logical rationale for the RTP process with the hope that it will decrease controversy, assist physicians, and identify important gaps in practice areas where research evidence is lacking. The model is applicable for emergent, urgent and nonurgent decisions, although the weighting of individual components will differ with the context partly because of importance and partly because it may not be possible to obtain all the information when decisions need to be made rapidly—but a decision still has to be made nonetheless.

RETURN-TO-PLAY DECISION MAKING: THE DECISION-BASED RTP MODEL

In clinical practice, RTP may refer to "full return without restrictions," "partial return," "allowed to practice," and so forth. The model proposed in this article is applicable to any of these definitions, but for clarity, we will use the following RTP definition for our examples: "medical clearance of an athlete for full participation in sport without restriction (strength and conditioning, practice, and competition)."

The most common type of decision-making model is the rational decision model,[46–48] in which individuals weigh the advantages and disadvantages of decision "A" (eg, allowing an athlete to compete) against the advantages and disadvantages of decision "B" (eg, restricting an athlete from participation). In the medical context of RTP, the issue is more complex because the physician is actually making a decision that affects someone else. There are additional factors and influences (medical and otherwise) that must be considered.

Figure 1 shows the decision-making model for RTP using an influence diagram.[49] In an influence diagram, the *states of nature* elements (the circumstances under which a decision is made) are illustrated with circles. *Decision* elements are usually illustrated with squares (we have used a rectangle in our diagram), and arrows are used to illustrate when information from one element contributes information to another element. The model integrates and sequences the many factors mentioned in the published literature and shows how they interact and at what point they should be considered in the RTP decision-making process. We first describe the model globally and then explain each component in subsequent sections of the article.

OVERVIEW

The first step in the decision-making process is the *Evaluation of Health Status* of the athlete. Evaluating health status requires an assessment of the athlete's recovery from a biological, psychological, and functional standpoint and is done by considering several *Medical Factors*. In essence, it is an evaluation of how much healing has occurred and how close to "normal" the previously injured tissue is. This is essential because tissue that has not healed is generally weaker or less functional than it was before the injury and therefore more likely to be reinjured.

Evaluation of Health Status (Step 1) is the most important piece of information that clinicians have for the *Evaluation of Participation Risk*. However, there are several other factors associated with the sport or activity (*Sport Risk Modifiers)* that, although not directly related to the evaluation of health status, have the capacity to substantially increase or decrease the participation risk for a given health status. For example, a swimmer with a medial collateral ligament injury to the knee may have a different risk than a football player (different sports), a first baseman with rotator cuff disease may have a different risk than a pitcher (different positions), and a recreational field hockey player may have a different risk related to a stress fracture than an Olympian (different competitive levels).

Evaluation of *Participation Risk* (Step 2) is essential in the rational decision-making model because a high reinjury risk represents the main disadvantage of allowing RTP (Decision A). However, there are additional factors that also represent disadvantages or advantages for Decision A (or similarly for Decision B of not allowing participation). We have called these factors *Decision Modifiers* (Step 3) because they may change the decision that would have been made if *Participation Risk* had been considered alone. Although it might be argued that the health of the athlete should be the only concern, all activity is associated with risk. Therefore, the clinician's role is to help determine what is an acceptable level of risk, and this evaluation must occur within the context of the *Decision Modifiers* present in a given situation. There are 3 important points related to decision modifiers. First, unlike *Participation Risk*, these factors are not restricted to the athlete. For example, family, coaches, and even the doctor may benefit or be harmed if the athlete is allowed to RTP or is prevented from RTP. Second, some clinicians may not consider all the factors listed as appropriate (eg, a physician in a conflict of interest may risk losing employment), but the factors are included because we believe that they are currently being considered in clinical practice today. Third, *Decision Modification* is set aside from the other steps because *Participation Risk* does not contribute information about *Decision Modification*, and *Decision Modification* cannot be used to determine RTP except in the context of knowing participation risk.

The next section discusses each of the components in greater detail. The main purpose of this article is to make note of what the literature defines as the individual components that make up the RTP medical decision. The actual value of each of these components with respect to contribution and weight in the decision-making process may or may not be quantifiable, but the value of RTP guidelines lies in the consideration of all such components before making an important decision.

SPECIFIC CONSIDERATIONS FOR RTP DECISION MAKING

Evaluation of Health Status: Step 1

Although estimates of biological healing time can be considered in the *Evaluation of Health Status*,[14,30,50–53] a complete evaluation of the health status for any particular injury or illness based on history, symptoms, signs, laboratory tests, and functional testing is preferable. We recognize that this is a developing clinical science. For example, plain

© 2010 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

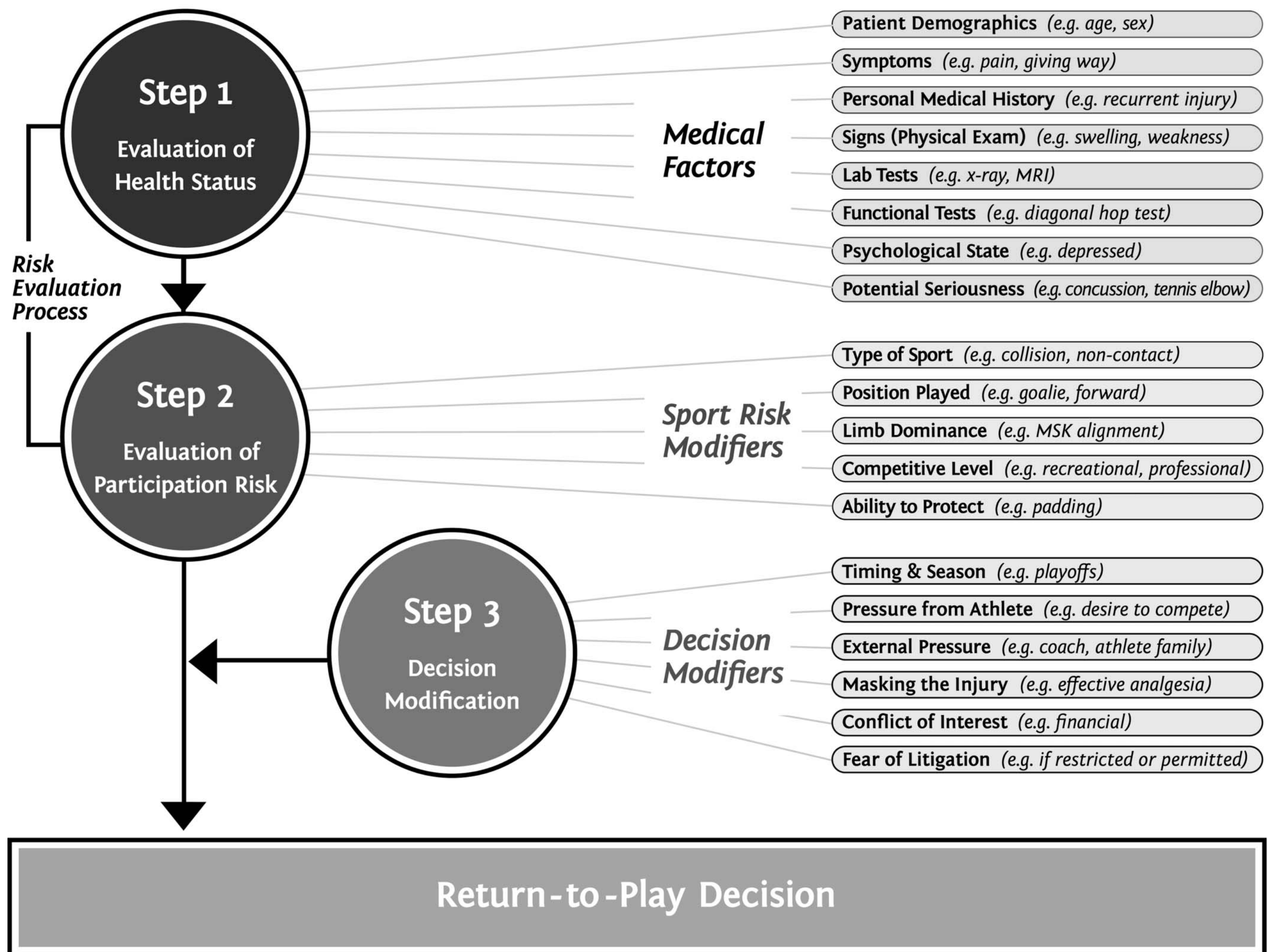


FIGURE 1. Decision-based RTP model. The decision-based RTP model for an injury or illness is specific to the individual practitioner making the RTP decision. The large black circles represent the states of nature elements (the circumstances under which a decision is made). The RTP square represents the final decision that actually results in an action being taken. The texts on the far right are individual factors or components identified from the literature that contribute information to the states of nature. These factors are grouped into *Medical Factors*, *Sport Risk Modifiers*, and *Decision Modifiers* and are on the left because they represent the general concepts the clinician should focus on when making a decision (the details are provided on the right). In Step 1, the health status of the athlete is assessed through the evaluation of *Medical Factors*. For example, symptoms, signs, and testing provide information on how much healing of the injury or illness has occurred. In Step 2, the clinician evaluates the risk associated with participation. For example, the health status is usually heavily weighted when the known reinjury and long-term sequelae risks are high (eg, if an athlete participates with only partial healing). However, there are *Sport Risk Modifiers* that also affect the risk associated with participation. For example, it may be possible to protect the injury with padding or to minimize risk by changing the position of the player. Although the RTP decision is fundamentally based on the risk associated with participation, decision making in all fields is based on a risk–benefit balance. There may be benefits to an athlete that affect what is considered an acceptable risk. For example, play-off competitions may result in significant financial and nonfinancial gains. Accounting for these *Decision Modifiers* (Step 3) is the final step in the process that leads to the actual RTP decision. *Decision Modification* is set aside from the other steps because Participation risk does not contribute information about *Decision Modification*, and *Decision Modification* cannot be used to determine RTP except in the context of participation risk. Finally, the process is recursive; decisions to not clear an athlete for participation are revisited as the healing process continues, and decisions that allowed an athlete to play are revisited if symptoms or signs recur or if the status of any of the *Sport Risk Modifiers* or *Decision Modifiers* are changed.

© 2010 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

radiographic or magnetic resonance findings lag behind the physiological healing of bone after a stress injury.[54,55]

- Patient demographics: Sex and age[50,56–59] influence the health status because of hormonal and age-related factors that can affect tissue regenerative abilities.
- Symptoms: History of the present illness provides very important information in the evaluation of an athlete's health status. Pain is considered an essential factor in the evaluation by most authors,[14,16,30,51,52,56–69] presumably because it is indicative of incomplete healing. Other symptoms that are often used by clinicians, such as stiffness or sensation of joint stability, are not explicitly discussed in the literature.
- Personal medical history: The literature emphasizes some aspects of the history that are related to the current injury.[58,62,70] For example, authors have distinguished between first-time injuries versus recurrent injuries.[13,15,50,71,72] Family history and medical history can predispose an athlete to other medical conditions or injuries, and the medical history provides the physician with a context in which to evaluate the health status.
- Signs: Like symptoms, the presence or absence of signs on physical examination have been used by some authors to propose RTP recommendations based solely on these criteria. These recommendations are summarized in Table 1. Of these signs, muscular strength and joint range of motion (ROM) are most frequently mentioned. Most authors suggest that muscular strength should be at or near preinjury levels (often measured compared with the uninvolved limb) before returning an athlete to sports.[14,30,51–53,56–61,65,67,68,71,73–79] However, the acceptable range for near normal is 70%[53] to 100%,[58] and these recommendations seem to be based on opinion and clinical experience, most likely because of the paucity of good scientific evidence. Similar criteria have been proposed for ROM,[13,14,17,30,51–53,56–61,64,65,67,68,72,73,75–80] and others have added criteria that ROM should be pain free.[30,52,57,72] In addition, some authors suggest that the injury site should be functionally stable[13,15,28,52,53,61,62,71,72,81] and nontender,[51,66,69,82] and joints should be without swelling[30,61,62,80] or effusion.[30,60] Although girth has been mentioned,[30] no specific criteria have been provided.
- Laboratory tests: Imaging techniques such as plain radiographs,[13,15,30,63,65,66,72,82] magnetic resonance imaging,[13,15,29,58–60,63,66,72] computed tomography,[13,52,63,66,82] bone scan,[63] and ultrasound[58] can provide objective evidence of tissue healing and detect some of the structural and physiologic abnormalities that suggest incomplete healing.[13,17,65,72,79] Laboratory tests are also of value in recovery from illness and some injuries.
- Functional tests: At times, an injured tissue may be healed biologically, but deficits remain that are secondary to the injury. Functional testing allows the clinician to assess the status of the athlete with respect to function by testing exercise maneuvers that simulate sport-specific actions. An appropriately designed battery of functional tests helps assess the integration of muscular strength, ROM, proprioception, endurance, and confidence,[28,60,77,83] and each individual test within the battery should mimic the forces and stresses that will be experienced by that athlete in a competitive situation.[14,28,30,45,52,56,57,62,68,84,85] In general, authors recommend that RTP should occur when there is no pain,[30] no instability,[30] normal kinematics,[14,30] and near symmetrical performance compared with the contralateral limb.[30,53,74]
- Psychological state: Authors have recently emphasized the importance of psychological "readiness" or "confidence" before RTP.[45,50,57,86,87] Apprehension, fear, and anxiety are associated with a higher risk of reinjury[86] in addition to negative effects on performance.
- Potential seriousness: Finally, the health status is related to the particular tissue injured, its extent, and the propensity for healing.[15,29,34,50,58,59,62] For example, the evaluation of health status is very different for a concussion versus an ankle sprain. This is an important field for further research because short-term and long-term effects of participation after injury can substantially affect health after retirement from sport.

Like symptoms, the presence or absence of signs on physical examination has been used by some authors to propose RTP recommendations based solely on these criteria, without accounting for other factors affecting risk or the decision-modifying factors.[69,79] Although some authors have suggested that RTP should only be allowed after complete resolution of symptoms,[17,30,69,78,79] the proposed model clearly demonstrates why these individual components cannot be considered in isolation. Although they are considered before the *Evaluation of Participation Risk* and *Decision Modification*, they remain only the first step in the RTP process. Further, the model helps us to understand why providing general recommendations without describing any of the specific symptoms is of limited value.

TABLE 1. General Recommendations for Each of the Physical Signs Used by Clinicians to Evaluate Whether an Athlete Should Be Allowed to Return to Play

Sign	General Recommendation	References
Strength	At or near pre-injury levels or symmetrical with unaffected side	14,30,51–53,56–61,65,67,68,71,73–79
Range of motion	At or near pre-injury levels or symmetrical with unaffected side	13,14,17,30,51–53,56–61,64,65,67,68,72,73,75–80
Joint stability	No instability	13,15,28,52,53,61,62,71,72,81
Tenderness	Injury site should be nontender	51,66,69,82
Inflammation or swelling	No swelling or inflammation	30,61,80
Effusion	No effusion	30,60
Girth	No specific recommendation provided	30

© 2010 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

Evaluation of Participation Risk: Step 2

- Type of sport: Participation in collision sports (eg, football and rugby) generally poses a higher risk of acute injury compared with participation in contact sports (eg, basketball), which poses a higher risk compared with participation in noncontact sports (eg, swimming).[15,30,50–52,56–60,62,64,78,82,88,89] However, high velocity sports (eg, alpine skiing) without collision or contact are also associated with high risks.[15,89] Noncontact sports may not present a high risk for acute injury, but RTP decisions may need to be conservative because disabling overuse injuries do occur in some activities[60] (eg, femoral stress fracture in a long-distance runner and patellar tendinopathy in a football lineman).
- Position played: Different positions within a sport are exposed to different forces and stresses and therefore different risks.[30,50,56–58,90] For example, an acromioclavicular sprain in a quarterback is repeatedly stressed during the throwing motion but receives much less stress in a field goal kicker.
- Limb dominance: An athlete's hand (or foot) dominance affects whether an injury is likely to be repeatedly stressed during activity (eg, a baseball pitcher with an injury to the dominant vs nondominant shoulder).[30,59]
- Competitive level: In general, greater size, speed, and strength in the more competitive athlete mean that these athletes will experience greater forces and greater stresses on the body. Furthermore, competitive athletes may be more likely to push themselves beyond the levels of noncompetitive athletes in an attempt to win. Therefore, for the same health status, higher levels of competition are associated with higher health risk.[50,57,58,64,66,91]
- Ability to protect: For some injuries, taping, bracing, splinting, or padding may reduce the risk for the same level of tissue healing.[30,45,52,61,62,81,82] A related consideration should be whether the piece of equipment poses a higher risk of reinjury to other athletes,[45,88] but this is usually governed by the rules of the sport.

Decision Modification: Step 3

- Timing and season: During the off-season, there may be less benefit to the athlete to return sooner. Allowing an athlete to participate in the play-offs may carry significant benefits in the form of bonus payments, scholarships, and so forth. Furthermore, the risk of reinjury in this situation may include only short-term disability but no long-term consequences. Therefore, for the same level of risk, the balance of advantages and disadvantages changes with respect to the timing and season involved.[14,17,32,50,57,58,63,66,81]
- Pressure from athlete: In most jurisdictions, the clinician must make the legal decision for RTP, although disagreement does exist about the extent to which the athlete should be involved in the decision.[17,29,32,41,59,73,74,92,93] In brief, the primary decision is left to the clinician because it is often difficult to determine if the athlete is in a position to provide informed consent because of the nature of the injury (eg, concussion) or if she/he is being coerced by "handlers" or "superiors" (eg, coach) or family members. Within this context, the clinician's assessment of what constitutes an acceptable risk may contradict the athlete's assessment.[41,74] Although the clinician has more experience evaluating the absolute level of injury risk, the athlete may (or may not) be in a better position to evaluate other risks, such as job security, potential scholarships, contract offers, and endorsements, and any of the athlete's other goals within sport.[14,16,32,41,50,81,90]
- External pressure: In the context of both competitive amateur and professional sport, many different groups of people stand to benefit (in a variety of ways) from a timely return of the athlete to competition, including coaches, teammates, relatives, team administrators, agents, sponsors, league officials, fans, and media.[14–16,32,34,41,50,88] Some of these groups may provide valuable additional information for the evaluation of risks and benefits, and some may provide misinformation and undue pressure related to their focused concern. Within an overall complex matrix of decision making, all the groups have the potential to influence the RTP decision. Although the immediate reaction of some clinicians may be to suggest these all be discounted, an athlete may consider the hopes and dreams of family members (or team members) as valid and important factors that need to be considered when balancing risks and benefits.
- Masking the injury: The use of cortisone injections, local anesthetics, and analgesics is very common in sport medicine[34] because it can increase function and allow injured players to participate. This factor could be considered under either *Evaluation of Participation Risk* or *Decision Modification* or both. For example, if someone has an acromioclavicular sprain and is able to return to play because it was injected with lidocaine, they may be at increased risk of worsening the pathology and prolonging the disability. To keep the decision-based RTP model as simple as possible, we have chosen to include it as only a *Decision Modifier* because there are other contexts where masking the injury has little effect on injury risk.
- Conflict of interest: Although it is the ethical obligation of the clinician to be an advocate for the athlete,[34,41] clinicians also have obligations to the team if they are paid employees. Potential conflicts of interest arise when the team's best interests and the athlete's best interests are not aligned.[33,41,88,93] In this context, advocating too strongly for the athlete means that the clinician may enter into a conflict with coaches or risk losing his or her job, including all of the perks, status, and money associated with it.[41] In essence, the clinician should be transparent with the athlete about dual roles and responsibilities so that the athlete is properly informed (analogous to informed consent). How often this occurs is difficult to determine because clinicians are subject to the same frailties as the general public, and it must be considered as a potential modifying factor for RTP decisions.
- Fear of litigation: This is actually a special form of conflict of interest. Physicians are typically sued for damages that may result when an athlete is injured after an RTP decision that is deemed as too early or if an athlete is deemed inappropriately restricted from returning to play with consequent financial or nonfinancial loss.[93] Although this

© 2010 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

fear concerns only the clinician's welfare, the fear is based on the potential benefits and harm that the athlete may be exposed to. Furthermore, in other areas of medicine, this fear is tempered by providing informed consent. However, the concept of informed consent is weak in sport medicine. For example, although adult athletes are considered capable of making every other decision in their life including medical ones, RTP decisions have been considered the responsibility of the team physician and "informed consent" is not considered a general defense. That said, regardless of the RTP decision, clinicians need to fully inform athletes about the risk of RTP and properly document all instructions and restrictions given to the athlete should it need to be drawn on as evidence in the future.[29,34,41,61,88,92,93]

CONCLUSION AND RECOMMENDATIONS

We have outlined a 3-step decision-based model for RTP that provides the clinician with structure and transparency within a complex process. The model includes the major factors within the *Evaluation of Health Status* and *Evaluation of Participation Risk*, as well as factors involved in the *Decision Modification*.

Our hope is that each of these individual components will become topics for future research. Progress needs to be made quantifying the importance of each of the individual components of each step, and ethical constructs need to focus on the unique sports medicine environment.

The decision-based RTP model provides a foundation for research into the individual factors and components that, when integrated, provide clinicians with an evidence-based rationale for RTP decision making.

REFERENCES

1. Fuller CW, Bahr R, Dick RW, et al. A framework for recording recurrences, reinjuries, and exacerbations in injury surveillance. *Clin J Sport Med*. 2007;17:197–200.
2. Cohen JS, Gioia G, Atabaki S, et al. Sports-related concussions in pediatrics. *Curr Opin Pediatr*. 2009;21:288–293.
3. Congeni J. Management of the adolescent concussion victim. *Adolesc Med State Art Rev.* 2009;20:41–56, viii.
4. Ellemberg D, Henry LC, Macciocchi SN, et al. Advances in sport concussion assessment: from behavioral to brain imaging measures. *J Neurotrauma*. 2009;26:2365–2382.
5. Fait P, McFadyen BJ, Swaine B, et al. Alterations to locomotor navigation in a complex environment at 7 and 30 days following a concussion in an elite athlete. *Brain Inj*. 2009;23:362–369.
6. Lovell M. The management of sports-related concussion: current status and future trends. *Clin Sports Med*. 2009;28:95–111.
7. McCrory P, Meeuwisse W, Johnston K, et al. Consensus statement on concussion in sport, 3rd International Conference on Concussion in Sport, held in Zurich, November 2008. *Clin J Sport Med*. 2009;19:185–200.
8. Meehan WP III, Bachur RG. Sport-related concussion. *Pediatrics*. 2009; 123:114–123.
9. Parsons TD, Notebaert AJ, Shields EW, et al. Application of reliable change indices to computerized neuropsychological measures of concussion. *Int J Neurosci*. 2009;119:492–507.
10. Purcell L. What are the most appropriate return-to-play guidelines for concussed child athletes? *Br J Sports Med*. 2009;43(suppl 1):i51–i55.
11. Putukian M, Aubry M, McCrory P. Return to play after sports concussion in elite and non-elite athletes? *Br J Sports Med*. 2009;43(suppl 1):i28–i31.
12. Randolph C, Millis S, Barr WB, et al. Concussion symptom inventory: an empirically derived scale for monitoring resolution of symptoms following sport-related concussion. *Arch Clin Neuropsychol*. 2009;24: 219–229.
13. Jeyamohan S, Harrop JS, Vaccaro A, et al. Athletes returning to play after cervical spine or neurobrachial injury. *Curr Rev Musculoskelet Med*. 2008;1:175–179.
14. Krabak B, Kennedy DJ. Functional rehabilitation of lumbar spine injuries in the athlete. *Sports Med Arthrosc*. 2008;16:47–54.
15. Tator CH. Recognition and management of spinal cord injuries in sports and recreation. *Neurol Clin*. 2008;26:79–88, viii.
16. Burnett MG, Sonntag VK. Return to contact sports after spinal surgery. *Neurosurg Focus*. 2006;21:E5.
17. Dunn IF, Proctor MR, Day AL. Lumbar spine injuries in athletes. *Neurosurg Focus*. 2006;21:E4.
18. Anderson BR, Vetter VL. Return to play? Practical considerations for young athletes with cardiovascular disease. *Br J Sports Med*. 2009; 43:690–695.
19. Baptista CA, Foronda A, Baptista Lde P. Competitive sports for children and adolescents: should an electrocardiogram be required in the pre-participation physical examination? *Arq Bras Cardiol*. 2009; 93:188–195.
20. Link MS. Prevention of sudden cardiac death: return to sport considerations in athletes with identified cardiovascular abnormalities. *Br J Sports Med*. 2009;43:685–689.
21. Seggewiss H, Blank C, Pfeiffer B, et al. Hypertrophic cardiomyopathy as a cause of sudden death. *Herz*. 2009;34:305–314.
22. Sik EC, Batt ME, Heslop LM. Atypical chest pain in athletes. *Curr Sports Med Rep*. 2009;8:52–58.
23. Thiene G, Carturan E, Corrado D, et al. Prevention of sudden cardiac death in the young and in athletes: dream or reality? *Cardiovasc Pathol*. 2010;19:207–217.
24. Pelliccia A, Zipes DP, Maron BJ. Bethesda conference #36 and the European Society of Cardiology consensus recommendations revisited a comparison of U.S. and European criteria for eligibility and disqualification of competitive athletes with cardiovascular abnormalities. *J Am Coll Cardiol*. 2008;52:1990–1996.
25. Sofi F, Capalbo A, Pucci N, et al. Cardiovascular evaluation, including resting and exercise electrocardiography, before participation in competitive sports: cross sectional study. *BMJ*. 2008;337:a346.
26. Basavarajaiah S, Wilson M, Whyte G, et al. Prevalence and significance of an isolated long QT interval in elite athletes. *Eur Heart J*. 2007;28: 2944–2949.
27. Maron BJ. Hypertrophic cardiomyopathy and other causes of sudden cardiac death in young competitive athletes, with considerations for preparticipation screening and criteria for disqualification. *Cardiol Clin*. 2007;25:399–414, vi.
28. Lam MH, Fong DT, Yung P, et al. Knee stability assessment on anterior cruciate ligament injury: clinical and biomechanical approaches. *Sports Med Arthrosc Rehabil Ther Technol*. 2009;1:20.
29. Brukner P. Return to play—a personal perspective. *Clin J Sport Med*. 2005;15:459–460.
30. Miller MD, Arciero RA, Cooper DE, et al. Doc, when can he go back in the game? *Instr Course Lect*. 2009;58:437–443.
31. Clover J, Wall J. Return-to-play criteria following sports injury. *Clin Sports Med*. 2010;29:169–175.
32. McFarland EG. Return to play. *Clin Sports Med*. 2004;23:xv–xxiii.
33. Fuller CW, Walker J. Quantifying the functional rehabilitation of injured football players [discussion]. *Br J Sports Med*. 2006;40:151–157.
34. Verrall GM, Brukner PD, Seward HG. 6. Doctor on the sidelines. *Med J Aust*. 2006;184:244–248.
35. Dunn WR, George MS, Churchill L, et al. Ethics in sports medicine. *Am J Sports Med*. 2007;35:840–844.
36. Bernstein J, Perlis C, Bartolozzi AR. Normative ethics in sports medicine. *Clin Orthop Relat Res*. 2004;420:309–318.
37. Jenkins S. Not everything's clear when it comes to HGH, PRP. *The Washington Post*. May 20, 2010:D01.
38. Skolnick EJ. Taking shot at glory: Wade's decision to get 2 injections to play in do-or-die NBA playoff game raised questions. *Chicago Tribune*. June 26, 2005:Sports: 6.
39. Blackwell T, O'Connor J. Drug charges for MD to the stars. *National Post*. May 19, 2010:A1.
40. Dietzel DP, Hedlund EC. Injections and return to play. *Curr Pain Headache Rep*. 2005;9:11–16.
41. Tucker AM. Ethics and the professional team physician. *Clin Sports Med*. 2004;23:227–241, vi.

© 2010 Lippincott Williams & Wilkins

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

42. Johnson R. The unique ethics of sports medicine. *Clin Sports Med*. 2004;23:175–182.
43. Orchard JW. Is it safe to use local anaesthetic painkilling injections in professional football? *Sports Med*. 2004;34:209–219.
44. Bernstein J, Perlis C, Bartolozzi AR. Ethics in sports medicine. *Clin Orthop Relat Res*. 2000;378:50–60.
45. The team physician and return-to-play issues: a consensus statement. *Med Sci Sports Exerc*. 2002;34:1212–1214.
46. Ashby D, Smith AF. Evidence-based medicine as Bayesian decision-making. *Stat Med*. 2000;19:3291–3305.
47. Reyna VF, Rivers SE. Current theories of risk and rational decision making. *Dev Rev.* 2008;28:1–11.
48. Shakespeare TP, Gebski VJ, Veness MJ, et al. Improving interpretation of clinical studies by use of confidence levels, clinical significance curves, and risk-benefit contours. *Lancet*. 2001;357:1349–1353.
49. Howard RA, Matheson JE. Influence diagrams. *Decis Anal*. 2005;2:127–143.
50. Bauman J. Returning to play: the mind does matter. *Clin J Sport Med*. 2005;15:432–435.
51. Curl LA. Return to sport following elbow surgery. *Clin Sports Med*. 2004;23:353–366, viii.
52. Kovacic J, Bergfeld J. Return to play issues in upper extremity injuries. *Clin J Sport Med*. 2005;15:448–452.
53. Cascio BM, Culp L, Cosgarea AJ. Return to play after anterior cruciate ligament reconstruction. *Clin Sports Med*. 2004;23:395–408, ix.
54. Faber KJ, Dill JR, Amendola A, et al. Occult osteochondral lesions after anterior cruciate ligament rupture. Six-year magnetic resonance imaging follow-up study. *Am J Sports Med*. 1999;27:489–494.
55. Fowler PJ. Bone injuries associated with anterior cruciate ligament disruption. *Arthroscopy.* 1994;10:453–460.
56. Drake DF, Nadler SF, Chou LH, et al. Sports and performing arts medicine. 4. Traumatic injuries in sports. *Arch Phys Med Rehabil*. 2004;85:S67–S71.
57. McCarty EC, Ritchie P, Gill HS, et al. Shoulder instability: return to play. *Clin Sports Med*. 2004;23:335–351, vii-viii.
58. Orchard J, Best TM, Verrall GM. Return to play following muscle strains. *Clin J Sport Med*. 2005;15:436–441.
59. Park HB, Lin SK, Yokota A, et al. Return to play for rotator cuff injuries and superior labrum anterior posterior (SLAP) lesions. *Clin Sports Med*. 2004;23:321–334, vii.
60. Bowen TR, Feldmann DD, Miller MD. Return to play following surgical treatment of meniscal and chondral injuries to the knee. *Clin Sports Med*. 2004;23:381–393, viii–ix.
61. Saal JA. Common American football injuries. *Sports Med*. 1991;12:132–147.
62. Smurawa T, Congeni J. Return-to-play decisions in the adolescent athlete: how to decide. *Pediatr Ann*. 2007;36:746–748, 750–741.
63. Kaeding CC, Yu JR, Wright R, et al. Management and return to play of stress fractures. *Clin J Sport Med*. 2005;15:442–447.
64. Eck JC, Riley LH III. Return to play after lumbar spine conditions and surgeries. *Clin Sports Med*. 2004;23:367–379, viii.
65. Cantu RC. Cervical spine injuries in the athlete. *Semin Neurol*. 2000;20:173–178.
66. Diehl JJ, Best TM, Kaeding CC. Classification and return-to-play considerations for stress fractures. *Clin Sports Med*. 2006;25:17–28, vii.
67. Dimberg EL, Burns TM. Management of common neurologic conditions in sports. *Clin Sports Med*. 2005;24:637–662, ix.
68. Kuhn JE. Treating the initial anterior shoulder dislocation—an evidence-based medicine approach. *Sports Med Arthrosc*. 2006;14:192–198.
69. Lord J, Winell JJ. Overuse injuries in pediatric athletes. *Curr Opin Pediatr.* 2004;16:47–50.
70. Bolin D, Goforth M. Sideline documentation and its role in return to sport. *Clin J Sport Med*. 2005;15:405–409.
71. Weinberg J, Rokito S, Silber JS. Etiology, treatment, and prevention of athletic "stingers." *Clin Sports Med*. 2003;22:493–500, viii.
72. Cantu RV, Cantu RC. Current thinking: return to play and transient quadriplegia. *Curr Sports Med Rep*. 2005;4:27–32.
73. Beazell JR, Magrum EM. Rehabilitation of head and neck injuries in the athlete. *Clin Sports Med*. 2003;22:523–557.
74. Myer GD, Paterno MV, Ford KR, et al. Neuromuscular training techniques to target deficits before return to sport after anterior cruciate ligament reconstruction. *J Strength Cond Res*. 2008;22:987–1014.
75. Larrain MV, Mauas DM, Collazo CC, et al. Arthroscopic anterior cruciate ligament distal graft rupture: a method of salvage. *Arthroscopy.* 2004;20:757–760.
76. Paulos L, Noyes FR, Grood E, et al. Knee rehabilitation after anterior cruciate ligament reconstruction and repair. *J Orthop Sports Phys Ther.* 1991;13:60–70.
77. Bizzini M, Gorelick M, Drobny T. Lateral meniscus repair in a professional ice hockey goaltender: a case report with a 5-year follow-up. *J Orthop Sports Phys Ther.* 2006;36:89–100.
78. Eddy D, Congeni J, Loud K. A review of spine injuries and return to play. *Clin J Sport Med*. 2005;15:453–458.
79. Elias I, Pahl MA, Zoga AC, et al. Recurrent burner syndrome due to presumed cervical spine osteoblastoma in a collision sport athlete—a case report. *J Brachial Plex Peripher Nerve Inj*. 2007;2:13.
80. Myklebust G, Bahr R. Return to play guidelines after anterior cruciate ligament surgery. *Br J Sports Med*. 2005;39:127–131.
81. Shelton WR, Barrett GR, Dukes A. Early season anterior cruciate ligament tears. A treatment dilemma. *Am J Sports Med.* 1997;25:656–658.
82. Steinberg B. Acute wrist injuries in the athlete. *Orthop Clin North Am*. 2002;33:535–545, vi.
83. Greenberger HB, Paterno MV. Relationship of knee extensor strength and hopping test performance in the assessment of lower extremity function. *J Orthop Sports Phys Ther.* 1995;22:202–206.
84. Hopper DM, Strauss GR, Boyle JJ, et al. Functional recovery after anterior cruciate ligament reconstruction: a longitudinal perspective. *Arch Phys Med Rehabil*. 2008;89:1535–1541.
85. Hudson Z. Rehabilitation and return to play after foot and ankle injuries in athletes. *Sports Med Arthrosc*. 2009;17:203–207.
86. Glazer DD. Development and preliminary validation of the Injury-Psychological Readiness to Return to Sport (I-PRRS) scale. *J Athl Train*. 2009;44:185–189.
87. Langford JL, Webster KE, Feller JA. A prospective longitudinal study to assess psychological changes following anterior cruciate ligament reconstruction surgery. *Br J Sports Med*. 2009;43:377–378.
88. Best TM, Brolinson PG. Return to play: the sideline dilemma. *Clin J Sport Med*. 2005;15:403–404.
89. Morganti C, Sweeney CA, Albanese SA, et al. Return to play after cervical spine injury. *Spine (Phila Pa 1976)*. 2001;26:1131–1136.
90. Leach RE, Paul GR. Injury and disability in the professional athlete. *Clin Orthop Relat Res*. 1987:221:68–76.
91. Poulsen TD, Freund KG, Madsen F, et al. Injuries in high-skilled and low-skilled soccer: a prospective study. *Br J Sports Med*. 1991;25:151–153.
92. Mitten MJ, Mitten RJ. Legal considerations in treating the injured athlete. *J Orthop Sports Phys Ther.* 1995;21:38–43.
93. Maron BJ, Brown RW, McGrew CA, et al. Ethical, legal, and practical considerations impacting medical decision-making in competitive athletes. *Med Sci Sports Exerc*. 1994;26:S230–S237.

© *2010 Lippincott Williams & Wilkins*

Copyright © Lippincott Williams & Wilkins. Unauthorized reproduction of this article is prohibited.

Appendix G

e-Delphi Questionnaire: Round 1

Delphi Questionnaire

An integrated model for return to play after injury in rugby union

© No Part of this questionnaire may be reproduced, stored in a retrieved system, copied or transmitted in any form without the written consent of the author.

Please note that the questionnaire is for RTP decision-making as it is relevant to **musculo-skeletal** injuries in rugby union

Step 1: Evaluation of Health Status

Indicate the importance of each factor in RTP decision-making, by using the scale below:

Fully Agree	Must be considered in the RTP decision-making process
Partially Agree	Can be considered in the RTP decision-making process
Disagree	Should not be considered in the RTP decision-making process

Please feel free to comment on your choice in the available space.

	Factor	Level of agree-ment	Comment	Literature
1	**Patient demographics**			Sex and age can influence decision-making due to hormonal and age-related factors relating to tissue regeneration. It is however found to be of little importance in sports medicine (Creighton et al. 2010; Shultz et al. 2013).
2	**Symptoms**			
	a) pain			Pain is postulated as an essential indicator of presumed incomplete healing (Creighton et al. 2010). Pain is seen as a risk factor for recurrent muscle strain injuries (Orchard et al. 2005).
	b) instability			Clinical laxity tests alone con not provide reliable predictions for functional stability (Noyes in Kegerries 1983).
	c) swelling			There should be no visible swelling or effusion after performing sport-specific activities and with RTP (Petersen & Zantop 2013; Creighton et al. 2010).
3	**Pesonal medical history**			Family history and a player's medical history could predispose the player to other medical conditions or injuries (Creighton et al. 2010). Condition-specific medical history is essential in evaluation (Herring et al. 2002).
4	**Signs**			
	a) strength			Objective strength testing through isokinetic testing (Beam 2002), confirming strength of 90 – 95% of the uninjured or contra-lateral limb (Croisier et al. 2008; Croisier 2004;

	Factor	Level of agree-ment	Comment	Literature
	b) range of motion			Drezner 2003) Unrestricted range of motion (ROM) is advised for most injury types and sites (Askling et al. 2010; Petersen & Zantop 2013 Hamilton 2011)
5	**Laboratory tests**			Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI of CT scans (Creighton et al. 2010). electro-goniometer (Askling et al. 2010).
6	**Functional tests**			Interaction of muscular strength, ROM, endurance and proprioception should be tested through functional testing specific to the sport's demands (Creighton et al. 2010; Orchard et al. 2005). This adds to the psychological readiness of a player (Clanton et al. 2012).
7	**Psychological state**			Physical readiness does not always coincide with psychological readiness (Tjong et al. 2014). Unrealistic fear of re-injury could exacerbate an injury (Azadian et al. 2011).
8	**Potential seriousness**			Players and staff need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery (Wikstrom et al. 2006).
9	**Orthopaedic surgeon's opinion**			The team physician should coordinate and evaluate the player (Herring et al. 2002). Surgeons do not take into account muscle function, jump and alignment tests and proprioception when advising a player to RTP after surgery (Petersen & Zantop 2013).

Step 2: Evaluation of Participation Risk

Please make use of the scale to indicate your level of agreement in using each of the following factors in your RTP decision-making process

	Factor	Level of agree-ment	Comment	Literature
1	**Type of sport: Rugby**			RTP decision-making should be approached with a thorough understanding of the inherent demands of the activity being returned to, as the likelihood of an identical recurrent trauma is high (Kegerreis 1983).

2	**Position played**			Although great variations exist between the demands of forward and backline players, there are also unique demands between every positional group (Deutsch et al. 2007; Quarrie et al. 2013).
3	**Limb dominance**			Limb dominance plays a role in RTP decision-making as a dominant limb could be more prone to repeated stress during activities (Creighton et al. 2010).
4	**Competitive level**			Injury incidence has increased over all levels of play since the dawn of the professional era (Garraway et al. 2000).
5	**Ability to protect**			Taping, bracing splinting or padding has been indicated as supplementary in the reduction of risk of certain injuries (Creighton et al. 2010)

Step 3: Decision modification

Please make use of the same scale as above to indicate your level of agreement in using each of the following factors in your RTP decision-making process

	Factor	Level of agree-ment	Comment	Literature
1	**Timing and season**			Pre-season, it is rationalized that a player can be side-lined for an extra week, but that same rationale could lead to a player being played for an important final(Orchard 2014; Tol et al. 2014)
2	**Pressure from the player**			Due to the deeply rooted characteristics of players at all levels, players are often adamant to return prematurely(Liston et al. 2006). An elite athlete lives on the limits of physical pain and psychological constraint in order to achieve their goals (Poulis 2012).
3	**External pressure**			External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation (Creighton et al. 2010).
4	**Masking of the injury**			Local anaestheticsare often used to mediate such masking of injuries in sport medicine, as they allow injured players to participate(Herring et al. 2012; Creighton et al. 2010).
5	**Conflict of interest**			Conflict of interest can arise, as what is best for the team and best for the player are not

				necessarily aligned (Creighton et al. 2010).
6	**Fear of litigation**			Creighton defined this point as 'a special form of conflict of interest' as it focuses on the clinician's welfare, with the fear based on the possible benefits and harm the athlete may be subject to (Creighton et al. 2010).

Importance of a standardized RTP protocol for musculo-skeletal injuries in Rugby

Please indicate your level of agreement for the following statements. Also feel free to comment on your choice.

		Level of agree-ment	Comment	Literature
1	**A standardized RTP protocol for musculo-skeletal injuries in rugby is relevant**			Alarming and powerful re-injury statistics are indicated in rugby, presumably due to premature RTP (Beardmore et al. 2005).
2	**A standardized RTP protocol for musculo-skeletal injuries in rugby could potentially reduce the prevalence of injuries**			The high incidence of re-injury in rugby union could potentially be reduced through the use of standardised RTP assessment procedures (Beardmore et al. 2005).

Thank you for your time, involvement and interest in completing this questionnaire

Appendix H

e-Delphi Questionnaire: Round 2

Delphi Questionnaire

An integrated model for return to play after injury in rugby union

© No Part of this questionnaire may be reproduced, stored in a retrieved system, copied or transmitted in any form without the written consent of the author.

Please note that the questionnaire is for RTP decision-making as it is relevant to **musculo-skeletal** injuries in rugby union

Please note that questions highlighted in green has been resolved. Consensus has been reached. The question does not need to be answered again.

Step 1: Evaluation of Health Status

Indicate the importance of each factor in the RTP decision-making process by using the scale below:

Fully Agree	Must be considered in the RTP decision-making process
Disagree	Should not be considered in the RTP decision-making process

Please feel free to comment on your choice in the available space.

	Factor	Level of agree-	Comment	Literature
1	**Patient demographics**			Literature indicates that sex and age can influence decision-making in the RTP process due to hormonal and age-related factors relating to tissue regeneration. It is however found to be of little importance in sports medicine (Creighton et al. 2010; Shultz et al. 2013). As the questionnaire was filled out with relevance to muskulo-skeletal injuries in rugby union within the professional milieu of Currie Cup teams, it was found that only 46% of respondents saw the validity of patient demographics in RTP decision making.
2	**Symptoms**			
	a) pain			Pain is not only postulated as an essential indicator of presumed incomplete healing, but is also seen as a risk factor for recurrent muscle strain injuries (Creighton et al. 2010; Orchard et al. 2005). It is also evident in the empirical investigation as 92% of respondents saw pain as a definite guideline in RTP decision-making. Pain was noted as being the messenger from the injured area and therefore it should be seen as a definite consideration in the RTP process.
	b) instability			Clinical laxity tests alone con not provide reliable predictions for functional stability (Noyes in Kegerries 1983). Joints such as the ankle and the

		knee rely on dynamic restrains to maintain stability during functional tasks due to the lack of bony congruence (Wikstrom et al. 2006). Dynamic methods are therefore advocated to ensure more challenging and possibly more effective test in assessing joint stability for RTP (Wikstrom et al. 2006). Joint stability scored 82% amongst respondents in the RTP decision-making process, it was noted however that a joint should clinically be as close to fully stable as possible before RTP could be made. It was also noted that if a degree of laxity is present, then neuromuscular control becomes more important, but with frank instability, recurrent injuries or early onset of osteoarthritis is a probability. Furthermore it was noted that if the functional testing or sport specific testing was satisfactory, a certain degree of instability post injury can be accepted, e.g. MCL or ATFL
	c) swelling	Literature indicates that there should be no visible swelling or effusion after performing sport-specific activities and with RTP (Petersen & Zantop 2013; Creighton et al. 2010). It was however given only a 60.7% importance rating amongst the respondents. Players often return with little visible swelling, especially with contusions of chronic knee effusions. It is also noted that slight effusions may be evident in knees or ankles after heavy training days in the process of RTP. However, swelling or effusion is also named as a indicator of what is happening at the
2	**Pesonal medical history**	Family history and a player's medical history could predispose the player to other medical conditions or injuries (Creighton et al. 2010). Condition-specific medical history is essential in evaluation (Herring et al. 2002). Personal medical history was given 85.7%. An example of a patient with diabetes that could have decreased peripheral sensation was given.
3	**Signs**	
	a) strength	Objective strength testing through isokinetic testing (Beam 2002),

		confirming strength of 90 – 95% of the uninjured or contra-lateral limb (Croisier et al. 2008; Croisier 2004; Drezner 2003). An importance of 82% was given to strength in the RTP decision-making process. It was noted however that strength is not the be-all-and-end-all of decision-making as chronic neuroplaxia could return with 80% of strength and as it sometimes takes too long for 100% strength to return, the limb or demand of the position/role/sport should be assessed. Loss of strength could however also lead to underperformance, re-injury and overuse of other parts of the kinetic
	b) range of motion	Unrestricted range of motion (ROM) is advised for most injury types and sites (Askling et al. 2010; Petersen & Zantop 2013; Hamilton 2011). Range of motion was also given an importance of 82% as it is indicated that some injuries, like ACL reconstructions, might never gain full extension. It was however again indicated that a loss of ROM could potentially lead to underperformance, re-injury and overuse of other parts of the kinetic
4	**Laboratory tests**	Objective evidence regarding tissue healing can be obtained by laboratory tests such as MRI of CT scans (Creighton et al. 2010). electro-goniometer (Askling et al. 2010). Only 57% of respondents saw laboratory tests as useful in RTP decision-making. It was noted that some special tests can be misleading, but should be considered, as ultrasounds, CT scans and MRI's may asist in the assessment process. It was also indicated that the clinician or specialist involved in the decision-making process should be able to fully comprehend the test results to be of use. Radiologic evidence of healing in fractures is important but, for example with tendon overuse the 'ultrasound picture recovery' lags well behind the
5	**Functional tests**	Interaction of muscular strength, ROM, endurance and proprioception should be tested through functional

		testing specific to the sport's demands (Creighton et al. 2010; Orchard et al. 2005). This adds to the psychological readiness of a player (Clanton et al. 2012). Amongst the respondents, a very high 96% of importance was given to functional tests and it was also called the best indicator of readiness for specific demands
6	**Psychological state**	Physical readiness does not always coincide with psychological readiness (Tjong et al. 2014). Unrealistic fear of re-injury could exacerbate an injury (Azadian et al. 2011). Psychological readiness was given an importance of 89% amongst respondents. Indicating that not being psychologically ready can be just as harmful as not being physically ready. It was also noted that some players need a push or rather a reassurance that it is safe to return. If there are huge issues, it should be considered not to let the
7	**Potential seriousness**	Players and staff need to be guided and educated on recovery and the risk of permanent disability and chronic injuries associated with a lack of full recovery (Wikstrom et al. 2006). An agreeance of 92.8% was recorded as medical staff felt that the consequences need to be explained in order to guide players to make
8	**Orthopaedic surgeon's opinion**	The team physician should coordinate and evaluate the player (Herring et al. 2002). Surgeons do not take into account muscle function, jump and alignment tests and proprioception when advising a player to RTP after surgery (Petersen & Zantop 2013). Medical staff indicated a 75% agreeance as they feel that the specialist need to understand the demands and rehabilitation goals in order for them to have a say in RTP decision-making. It should also be a specialist in a joint and not a general orthopaedic surgeon. Furthermore evaluation should be dependent on the experience and interests of the orthopaedic surgeon. However, if there were a grafting of other procedures done by the surgeon, they

				should guide the player and medical staff as to when it is safe to participate in full training with the relevant exposures considered. They should not however make the decision when the athlete is ready for full practice with contact, as that will depend on

Step 2: Evaluation of Participation Risk

Please make use of the scale to indicate your level of agreement in using each of the following factors in your RTP decision-making process

	Factor	Level of agree-	Comment	Literature
1	**Position played**			Although great variations exist between the demands of forward and backline players, there are also unique demands between every positional group (Deutsch et al. 2007; Quarrie et al. 2013). There was a 92.8% concurrence noted. Again it is important to reason whether the injured site will be able to withstand
2	**Limb dominance**			Limb dominance plays a role in RTP decision-making as a dominant limb could be more prone to repeated stress during activities (Creighton et al. 2010). An agreement level of 67.8% was reported for limb-dominance. Limb- dominant readiness can potentially lead to further overload of the non-dominant limb.
3	**Competitive level**			Injury incidence has increased over all levels of play since the dawn of the professional era (Garraway et al. 2000). Again, only a 67.8% level of agreement was indicated. It was noted that the professional era could lead to irrational decisions, but also that RTP is better monitored since the dawn of the professional era.
4	**Ability to protect**			Taping, bracing splinting or padding has been indicated as supplementary in the reduction of risk of certain injuries (Creighton et al. 2010). Only 67.8% of respondents thought that the ability to protect should be considered in RTP decision-making. A reason given is that as it may help in the RTP process and also once the player has

				returned, it should not influence the

Step 3: Decision modification

Please make use of the same scale as above to indicate your level of agreement in using each of the following factors in your RTP decision-making process

	Factor	Level of agree-	Comment	Literature
1	**Timing and season**			Pre-season, it is rationalized that a player can be side-lined for an extra week, but that same rationale could lead to a player being played for an important final(Orchard 2014; Tol et al. 2014). 67.8% of respondents agreed that timing and season does play a role in the RTP decision-making process. It was indicated that it is a risk-versus-reward kind of situation and although the respondents does not like to admit it, timing and season
2	**Pressure from the player**			Due to the deeply rooted characteristics of players at all levels, players are often adamant about returning prematurely (Liston et al. 2006). An elite athlete lives at the limits of physical pain and psychological constraint in order to achieve their goals (Poulis 2012). Only 50% of respondents agreed that pressure from a player influences RTP decision-making. The inherent character of a player and the informed decision-making of a player are sometimes in conflict. It is however dependent on the player. One respondent was of opinion the that the decision should sometimes be left to the player if the consequences have been properly explained to the player. This will only, however, take place if
3	**External pressure**			External pressure from coaches, team mates, relatives, team-administrators, agents, fans and media can provide additional information for RTP, but also unnecessary pressure and misinformation (Creighton et al. 2010). Again only 53.6% of respondents saw external pressure as having a place in RTP decision-making. One respondent was very adamant that external

		pressure should play no role in RTP decision-making.
4	**Masking of the injury**	Local anaestheticsare often used to mediate such masking of injuries in sport medicine, as they allow injured players to participate(Herring et al. 2012; Creighton et al. 2010). Only 50% of respondents saw a role for masking an injury in RTP decision-making. Considerations indicated included the anatomical site of the injury as well as the severity of the injury. Another respondent felt that it was unethical and illegal. One other respondent felt that if the player fully understood the consequences and risks involved and was still willing to play, he would use a local anaesthetic, but only if it were unlikely to put the player at unnecessary risk.
5	**Conflict of interest**	Conflict of interest can arise, as what is best for the team and best for the player are not necessarily aligned (Creighton et al. 2010). A percentage of 64.3% was awarded for conflict of interest. It was reported that the player's welfare should firstly be taken into account followed by that of the team. It should also be considered that an unfit player is not always the best for the team. The onus should lie with the medical professional to keep a player who in his medical opinion
6	**Fear of litigation**	Creighton defined this point as 'a special form of conflict of interest' as it focuses on the clinician's welfare, with the fear based on the possible benefits and harm the athlete may be subject to (Creighton et al. 2010). 67.8% of respondents indicated that fear of litigation does play a role in RTP decision-making. Players should therefore make informed decisions and give written consent should there be disagreements. A respondent felt that if the player and coaching staff wish to overrule him, they have to sign a document to acknowledge that they are going against his advice and that they are taking the risk.

Importance of a standardized RTP protocol for musculo-skeletal injuries in Rugby

Please indicate your level of agreement for the following statements. Also feel free to comment on your choice.

	Level of agree-	Comment	Literature
1 **Standardized RTP guidelines for musculo-skeletal injuries in rugby is relevant**			Alarming and powerful re-injury statistics are indicated in rugby, presumably due to premature RTP (Beardmore et al. 2005). Amongst the respondents, 60.7% indicated that an RTP protocol could be relevant in rugby union. Reservations included that rugby has very unique demands, there should be guidelines rather than a fixed protocol, the guidelines should leave space for clinical reasoning depending on the experience and knowledge of the healthcare provider, there should not be a recipe approach and that it is relevant if it is standardized to injury, demographics, types of sport, position played etc.
2 **Standardized RTP guidelines for musculo-skeletal injuries in rugby could potentially reduce the prevalence of re-injuries**			The high incidence of re-injury in rugby union could potentially be reduced through the use of standardised RTP assessment procedures (Beardmore et al. 2005). There was a 67.8% agreement level amongst respondents that a standardized protocol could potentially reduce re-injuries. Again it was indicated that it should be guidelines rather than a protocol. A protocol was also indicated to be an important tool in the RTP decision-making toolbox as the healthcare provider is often faced with people's emotions. One respondent, however, felt that there is no space for a recipe

Thank you for your time, involvement and interest in completing this questionnaire