

# Rugby Codes Research Group

## e-Magazine

Issue 10 (April) 2022

Uthoff, A., Hume, P.A., King, D., Hind, K. Editors.

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Rugby Codes Research Group (RCRG) website:

<https://sprinz.aut.ac.nz/areas-of-expertise/interdisciplinary-research/rugby-codes>



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AUT MILLENNIUM

e-Magazine Editors welcome .....	2
updates and links.....	3
World Rugby Player Welfare and Laws Symposium.....	3
New member's profiles .....	4
Dr Danielle Salmon PhD.....	4
Associate Professor Simon Walters.....	5
Associate Professor Chris Whatman.....	6
Updated member profiles .....	8
Professor Richard Ma, MD, FAAOS, FAOA.....	8
Project updates.....	9
UK Rugby Health Research update by Dr Karen Hind's team.....	9
Swansea Rugby Research team update.....	9
AUT Traumatic Brain Injury Network Update.....	12
Professor Alice Theadom - Director of TBIN.....	12
Australian and New Zealand CTE Biobanks Update .....	13
A concussion management strategy: Community rugby in New Zealand.....	14
Dylan Cleaver – NZ Journalist perspective article .....	17
The Paul McCrory and Concussion in Sport Group (CISG)22	
Repercussion Group .....	25
Infographics .....	26

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**RCRG e-Magazine aim:** To communicate advances in evidence-based knowledge and its practical application to the wider support network of rugby codes.

The RCRG is an international network with over 150 members from 10 countries who focus their research on performance improvement and injury reduction in the rugby codes (union, league, football). We aim to provide the latest evidence-based knowledge informing best practice within rugby codes taking a comprehensive account of all supporting factions.

### RCRG aims

- Bring together expertise that integrates areas of sport research (injury prevention, strength & conditioning, sport technology, coaching, psychology, physiology, performance analysis, leadership, management, epidemiology, pathology, engineering).
- Offer leading edge design and development solutions to rugby organisations, teams, and players around the world.

For more information including membership forms, see <https://sprinz.aut.ac.nz/areas-of-expertise/rugby-codes>

## E-MAGAZINE EDITORS WELCOME

Welcome to issue 10 of the Rugby Codes Research Group (RCRG) e-Magazine.

The RCRG aims to share information for teaching and research. As examples, in this edition of the RCRG eMagazine you will see project updates from UK Rugby Health Research, Swansea University, AUT Traumatic Brain Injury Network, and a concussion management strategy for New Zealand Rugby. You will also see new and updated members' profiles, a perspective piece by NZ journalist, Dylan Cleaver, on the issues related to a retired professional prop and potential brain health issues, an update on the ongoing saga pertaining to the allegations of plagiarism by former chair of Concussion in Sport Group, Paul McCrory, and the Repercussion Group's call for a new process for the development of TBI consensus guidelines.

**RCRG e-Magazine contributions can be sent to:** [aaron.uthoff@aut.ac.nz](mailto:aaron.uthoff@aut.ac.nz)

## ANNOUNCEMENTS AND LINKS

### World Rugby Player Welfare and Laws Symposium

The World Rugby Player Welfare and Laws Symposium sessions were recorded and are now available on <https://www.world.rugby/the-game/player-welfare/conferences/player-welfare>

### Connectivity Online Concussion Short Course

Dr Lindy Fitzgerald is excited to notify you of the Connectivity Traumatic Brain Injury Australia's free online Concussion Short Course. The goal of the Concussion Short Course is to raise awareness of best practices for concussion recognition and management for people who encounter concussion in their work, home, or sporting lives.

In this FREE online course, you will learn the essentials of concussion including:

- What to do if you suspect someone has suffered a concussion
- The signs and symptoms
- When to seek medical attention
- Recovery processes and timeframes
- Returning to normal life activities such as work, school, study, or sport

To access the Concussion Short Course, please click the link below:

### [Join Concussion Short Course](#)

Please note, this link will take you to the Wicking Dementia Research Education Centre at the University of Tasmania. You will need to create an online account to access the course.

## NEW MEMBER'S PROFILES

### Dr Danielle Salmon PhD



**Research specialization:** Injury rehabilitation, surveillance, and prevention with a specialization in concussions and neck strength.

**Experience:** Danielle is currently employed as a Research Scientist with New Zealand Rugby with a particular focus on the area of concussion. In this role she leads a community rugby concussion education, awareness and management strategy through RugbySmart, developed and conducted an injury surveillance program for Super Rugby, coordinated and implements the Otago Head Impact Detection Study and is a member of the NZR Medical and Science Advisory panel. She completed her PhD from the University of Otago looking at *An Examination of Functional Neck Strength and Endurance and its Relationship to Neck Injury and Self-Reported Neck Pain in Professional Rugby Players*. She also completed her Masters in Canada from the University of Regina in the field of kinesiology and health sciences looking at the Efficacy of Exercise Therapy in Reducing Neck Pain and Fatigue in CH-146 Helicopter Aircrew.

**Research overview:** As illustrated by my work experience and academic background my research passion is the design and implementation of injury prevention programs. My work to date in this field has been primarily with the military or at the professional sport level. However, in my role as Research Scientist I have been able to implement and evaluate a concussion education and management strategy in a number of high schools and clubs across NZ. The opportunity to work in the community rugby space has been a very rewarding experience and I feel the potential to affect positive behavioural changes towards concussion disclosure at the community level to ensure player welfare and make the game safer has been a major motivator for my work in this area.

#### Research publications:

- Salmon D, Chua J, Sullivan SJ, Whatman C, Brown J, Register-Mihalik J, Walters S, Clacy A, Keung S, Sole G, Kerr ZY, Rasmussen K, England M, Murphy I. Baseline concussion assessment performance of community-based senior rugby players: a cross-sectional study. *Brain Injury*, accepted 23<sup>rd</sup> August 2021.
- Salmon, D.M., Romanchuk J., Sullivan J., Walters S., Clacy A., et al. Concussion knowledge, attitude and reporting intention in rugby coaches and high school rugby players. *Int J or Sport Sci & Coach*. 2020;16(1):54-69.
- Salmon, D.M., Romanchuk J., Murphy I., Sullivan J., Walters S., Whatman C., et al. Infographic. New Zealand Rugby's concussion management pathway. *Br J Sports Med*. 2020;54(5):298-9.
- Salmon D.M., Sullivan S.J., Romanchuk J., Murphy I., Walters S., Whatman C., et al. Infographic. New Zealand rugby's community concussion initiative: keeping kiwi communities RugbySmart. *Br J Sports Med*. 2020;54(5):300-1.
- Salmon D.M., McGowan J., Sullivan S.J., Murphy I., Walters S., Whatman C., et al. What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. *J Sports Sci*. 2020:1-10.
- Salmon D.M., Sullivan S.J., Murphy I., Register Mihalik J.K., Dougherty B., McCrory G. Square peg round hole - Time to customise a concussion assessment tools for primary care: The New Zealand experience? A call for a GP-SCAT. *Brain Inj*. 2020:1-2.
- Hoeta T.J., Oldershaw S.A., Young S.M., Salmon, D.M., Sullivan, J.S. First aid in rugby (FAIR) training: The Otago experience. *The New Zealand Journal of Sports Medicine*. 2020;47(1):20-6.
- Quarrie K., Gianotti S., Murphy I., Harold P., Salmon D.M., Harawira J. RugbySmart: Challenges and Lessons from the Implementation of a Nationwide Sports Injury Prevention Partnership Programme. *Sports Med*. 2020;50(2):227-30.
- Salmon, D.M., Sullivan SJ, Handcock P, Rehrer NJ, Niven B. Neck strength and self-reported neck dysfunction: what is the impact of a season of Rugby Union? *J Sports Med Phys Fitness*. 2018;58(7-8):1078-89.
- Salmon, D.M., Handcock, P., Sullivan, S.J., Rehrer, N.J. & Niven, B. Can neck strength be measured using a single maximal contraction in a simulated contact position. *J Strength Cond Res*. 2017; Epub ahead of print. (Impact Factor = 1.858, 29/81, ISI Sport Sciences)
- Neary, J.P., Salmon, D.M., Dahlstrom, B.K., Casey, E.J. & Behm, D.G. Effects of an inverted seated position on single and sustained isometric contractions and cardiovascular parameters of trained individuals. *Hum Mov Sci*. 2015; 40(0):119-133. (Impact factor = 2.027, 22/81, ISI Sport Sciences)
- Salmon, D.M., Handcock, P., Sullivan, S.J., Rehrer, N.J. & Niven, B. Reliability of repeated isometric neck strength and endurance testing in a simulated contact posture. *J Strength Cond Res*. 2015; 29(3): 637-646. (Impact Factor = 1.858, 29/81, ISI Sport Sciences)
- Salmon, D.M., Neary, J.P. & Harrison, M.F. Neck pain in military helicopter aircrew and the role of exercise therapy. *Aviat Space Environ Med*. 2013; 82(9): 1-10. (Impact Factor = 0.782, 105/151, ISI Medicine General & Internal)

## Associate Professor Simon Walters



**Research specialization:** Sports coaching, coach development, youth development.

**Experience:** Simon is an Associate Professor at Auckland University of Technology where he leads sports coaching courses in the Bachelor of Sport and Recreation Coaching major and the Master of Sport Exercise and Health Coaching specialization. He received a Master of Science in Sociology of Sport at the University of Leicester and completed his Doctor of Philosophy at Auckland University of Technology. He has coached football predominantly at a community level, and athletics, mountain running and orienteering working with athletes from junior level through to senior and national level.

**Research overview:** A focus on enhancing the experiences of all young people participating in organized sport. A lot of my work draws upon qualitative methodologies with an emphasis on representing participant voice. Current projects include an international collaborative project led by New Zealand Rugby designing, implementing and evaluating a concussion management pathway for community rugby in New Zealand. A further related project is the development of a rugby concussion management guidelines for high schools. Previous rugby-related research has explored secondary school first XV rugby players' perceptions of their coaching environment.

**Postgraduate supervision:** Currently 5 PhD & 5 Masters students

### Recent research publications (2020->)

- Salmon, D. M., Badenhorst, M., Walters, S., Clacy, A., Chua, J., Register-Mihalik, J., . . . Whatman, C. (2021). The rugby tug-of-war: Exploring concussion-related behavioural intentions and behaviours in youth community rugby union in New Zealand. *International Journal of Sports Science & Coaching*. doi:[10.1177/17479541211047661](https://doi.org/10.1177/17479541211047661)
- McGowan, J., Walters, S., & Whatman, C. (2021). 10,000 hours and Early Specialization: Short term Gains or Long term Pain?. In A. Whitehead, & J. Coe (Eds.), *Myths of Sport Coaching*. Sequoia Books.
- Salmon, D., Chua, J., Sullivan, J. S., Whatman, C., Brown, J., Register-Mihalik, J., Murphy, I., Walters, S., . . . England, M. (2021). Baseline concussion assessment performance of community-based senior rugby players: A cross-sectional study. *Brain Injury*. doi:[10.1080/02699052.2021.1972452](https://doi.org/10.1080/02699052.2021.1972452)
- Bradbury, T., Walters, S., Lucas, P., Minjares, V., Lenton, A., Spencer, K., & Spencer, S. (2021). The industry-academic nexus: A case study of collaboration. *Managing Sport and Leisure*. doi:[10.1080/23750472.2021.1918018](https://doi.org/10.1080/23750472.2021.1918018)
- Wilson, O. W. A., Walters, S. R., Naylor, M. E., & Clarke, J. C. (2021). Physical activity and associated constraints following the transition from high school to university. *Recreational Sports Journal*, 45(1), 52-60. doi:[10.1177/1558866121995138](https://doi.org/10.1177/1558866121995138)
- Woolliams, D., Spencer, K., Walters, S., & Krägeloh, C. (2021). Resolving uncertainties of the factor structures of the Coach-Athlete Relationship Questionnaire (CART-Q). *Australian Journal of Psychology*, 73(2), 212-222. doi:[10.1080/00049530.2021.1882275](https://doi.org/10.1080/00049530.2021.1882275)
- Salmon, D. M., Romanchuk, J., Sullivan, S. J., Walters, S., Clacy, A., Register-Mihalik, J. K., . . . Keung, S. (2021). Concussion knowledge, attitude and reporting intention in rugby coaches and high school rugby players. *International Journal of Sports Science & Coaching*, 16(1), 54-69. doi:[10.1177/1747954120961200](https://doi.org/10.1177/1747954120961200)
- Tomsofsky, L., Reid, D., Whatman, C., Fulcher, M., & Walters, S. (2020). Futsal FastStart: The development of a futsal specific warm-up. *New Zealand Journal of Sports Medicine*, 47(1), 15-19.
- Lees, A. B., Walters, S., & Godbold, R. (2021). Variation in ethics review for tertiary-based educational research: An international and interdisciplinary cross-sectional review. *Journal of Academic Ethics*, 19, 517-540. doi:[10.1007/s10805-020-09382-1](https://doi.org/10.1007/s10805-020-09382-1)
- Reid, D., Hume, P., Whatman, C., Theadom, A., Walters, S., Hardaker, N., & Fulcher, M. (2020). Knowledge, attitudes, and behaviours of New Zealand physiotherapists to sports-related concussion. *New Zealand Journal of Physiotherapy*, 48(1), 19-28. doi:[10.15619/NZJP/48.1.03](https://doi.org/10.15619/NZJP/48.1.03)
- Salmon, D. M., McGowan, J., Sullivan, S. J., Murphy, I., Walters, S., Whatman, C., . . . Romanchuk, J. (2020). What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. *Journal of Sports Sciences*, 38(14), 1585-1594. doi:[10.1080/02640414.2020.1749409](https://doi.org/10.1080/02640414.2020.1749409)
- Walters, S., Rogers, A., & Oldham, A. (2020). A competency-based approach to coach learning: The Sport New Zealand Coach Developer program. In B. Callary, & B. Gearity (Eds.), *Coach education and development in sport: Instructional strategies* (pp. 154-165). New York, NY: Routledge.
- McGowan, J., Whatman, C., & Walters, S. (2020). The associations of early specialisation and sport volume with musculoskeletal injury in New Zealand children. *Journal of Science and Medicine in Sport*, 23(2), 139-144. doi:[10.1016/j.jsams.2019.09.002](https://doi.org/10.1016/j.jsams.2019.09.002)
- Salmon, D., Sullivan, J., Romanchuk, J., Murphy, I., Walters, S., Whatman, C., . . . Van Der Vis, K. (2020). Infographic. New Zealand rugby's community concussion initiative: Keeping kiwi communities RugbySmart. *British Journal of Sports Medicine*, 54(5), 300-301. doi:[10.1136/bjsports-2019-100949](https://doi.org/10.1136/bjsports-2019-100949)

# AUT

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## Associate Professor Chris Whatman



**Research specialization:** Injury prevention in youth sport with special interest in neuromuscular training, early specialisation, and the impact of growth and maturation.

**Experience:** Originally a sports physiotherapist for 10 years before becoming an academic. Involved in research related to injury prevention in youth sport for the last 10 years. Senior research member of the AUT Millennium Sports Performance Research Institute and former leader of the Sports Kinesiology and Injury Prevention (SKIP) research group. Published >50 peer-reviewed journal articles and made 30 plus conference presentations. International Advisory Board member, Physical Therapy in Sport. Editor New Zealand Journal of Sports Medicine.

**Research overview:** Focus on reducing injuries in youth sports and promoting positive youth sport experiences. Most recently investigating benefits of neuromuscular warm-up (collaboration with Netball NZ and NZ Football) and appropriate player development pathways (specialisation versus diversification) and the impact of growth and maturation. Additionally, a collaborator on projects with New Zealand Rugby developing a secondary school concussion management pathway and ACC investigating knowledge, attitudes and behaviours to concussion in secondary school sports.

**Postgraduate supervision:** 11 Masters and 5 PhD students supervised to completion and currently supervising 4 Masters and 3 PhD students.

### Recent research publications (2020->)

- Salmon, D. M., Badenhorst, M., Walters, S., Clacy, A., Chua, J., Register-Mihalik, J., . . . Whatman, C. (2021). The rugby tug-of-war: Exploring concussion-related behavioural intentions and behaviours in youth community rugby union in New Zealand. *International Journal of Sports Science & Coaching*. doi:[10.1177/17479541211047661](https://doi.org/10.1177/17479541211047661)
- Zoellner, A., Whatman, C., Read, P., & Sheerin, K. (2021). The association between sport specialisation and movement competency in youth: A systematic review. *International Journal of Sports Science & Coaching*, 16(4), 1045-1059. doi:[10.1177/1747954121998456](https://doi.org/10.1177/1747954121998456)
- Belcher, S., Whatman, C., Brughelli, M., & Borotkanics, R. (2021). Short and long versions of a 12-week netball specific neuromuscular warm-up improves landing technique in youth netballers. *Physical Therapy in Sport*, 49, 31-36. doi:[10.1016/j.ptsp.2021.01.016](https://doi.org/10.1016/j.ptsp.2021.01.016)
- Tomsofsky, L., Reid, D., Whatman, C., Borotkanics, R., & Fulcher, M. (2021). The effect of a neuromuscular warm-up on the injury rates in New Zealand amateur futsal players. *Physical Therapy in Sport*, 48, 128-135. doi:[10.1016/j.ptsp.2020.12.015](https://doi.org/10.1016/j.ptsp.2020.12.015)
- Salmon, D. M., Romanchuk, J., Sullivan, S. J., Walters, S., Clacy, A., Register-Mihalik, J. K., . . . Keung, S. (2021). Concussion knowledge, attitude and reporting intention in rugby coaches and high school rugby players. *International Journal of Sports Science & Coaching*, 16(1), 54-69. doi:[10.1177/1747954120961200](https://doi.org/10.1177/1747954120961200)
- Tomsofsky, L., Reid, D., Whatman, C., & Fulcher, M. (2020). Futsal: The nature of the game, injury epidemiology and injury prevention - a narrative review. *New Zealand Journal of Sports Medicine*, 41(1), 8-14.
- Tomsofsky, L., Reid, D., Whatman, C., Fulcher, M., & Walters, S. (2020). Futsal FastStart: The development of a futsal specific warm-up. *New Zealand Journal of Sports Medicine*, 47(1), 15-19.
- Sommerfield, L. M., Whatman, C. S., Harrison, C. B., Maulder, P. S., & Borotkanics, R. J. (2021). The effect of a school based injury prevention program on physical performance in youth females. *International Journal of Sports Science and Coaching*, 16(1), 81-90. doi:[10.1177/1747954120952211](https://doi.org/10.1177/1747954120952211)
- Sommerfield, L. M., Harrison, C. B., Whatman, C. S., & Maulder, P. S. (2020). A prospective study of sport injuries in youth females. *Physical Therapy in Sport*, 44, 24-32. doi:[10.1016/j.ptsp.2020.04.005](https://doi.org/10.1016/j.ptsp.2020.04.005)
- Reid, D., Hume, P., Whatman, C., Theadom, A., Walters, S., Hardacker, N., & Fulcher, M. (2020). Knowledge, attitudes, and behaviours of New Zealand physiotherapists to sports-related concussion. *New Zealand Journal of Physiotherapy*, 48(1), 19-28. doi:[10.15619/NZJP/48.1.03](https://doi.org/10.15619/NZJP/48.1.03)
- Salmon, D. M., McGowan, J., Sullivan, S. J., Murphy, I., Walters, S., Whatman, C., . . . Romanchuk, J. (2020). What they know and who they are telling: Concussion knowledge and disclosure behaviour in New Zealand adolescent rugby union players. *Journal of Sports Sciences*, 38(14), 1585-1594. doi:[10.1080/02640414.2020.1749409](https://doi.org/10.1080/02640414.2020.1749409)
- Sommerfield, L. M., Harrison, C. B., Whatman, C. S., & Maulder, P. S. (2020). Relationship between strength, athletic performance, and movement skill in adolescent girls. *Journal of Strength and Conditioning Research*. doi:[10.1519/JSC.0000000000003512](https://doi.org/10.1519/JSC.0000000000003512)
- Whatman, C., Toomey, C., & Emery, C. (2020). Visual rating of movement quality in individuals with and without a history of intra-articular knee injury. *Physiotherapy Theory and Practice*, 37(12), 1474-1480. doi:[10.1080/09593985.2019.1703229](https://doi.org/10.1080/09593985.2019.1703229)



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**Chris Whatman (PhD)**

Associate Professor

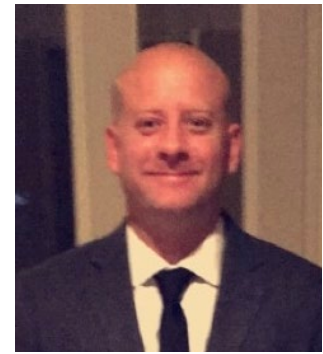
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## Dr Lee Bridgeman

**PhD, MSc, BSc (Hons), PGCE, SFHEA**



**Research specialisation:** Eccentric training, post-activation performance enhancement, and the use of microtechnology in rugby union.

**Experience:** Lee graduated from Chichester University in 2007 with a BSc (Hons) in sport science. Upon graduating, Lee took up a lecturing role in Portsmouth and completed a teaching qualification (PGCE) at Portsmouth University. While lecturing, Lee also completed an MSc in strength and conditioning at St Mary's University.

In 2013 Lee left the UK to complete a PhD in Strength and Conditioning at Auckland University of Technology in New Zealand. Lee's research in New Zealand focused on accentuated eccentric loading during plyometric activities and exercise-induced muscle damage.

During his time in New Zealand, Lee worked with a range of Olympic sports in a sports science consultancy role and worked in professional rugby union as a sports scientist and strength and conditioning coach. In 2017 Lee returned to the UK to take up his current role at Solent University. In 2020 Lee was awarded Senior Fellowship by the Higher Education Academy.

### Research overview:

Lee's PhD focused on the effects of accentuated eccentric overload on strength, power speed and exercise-induced muscle damage. More recently, he has been working with GB Speedway to produce research on the physiological characteristics of elite Speedway riders. However, Lee's primary focus is research investigating the use of microtechnology such as GPS and HR monitoring in rugby union. He is currently working on several projects in this area.

### Research publications:

Bridgeman, LA & Gill, ND 2021, 'The Use of Global Positioning and Accelerometer Systems in Age-Grade and Senior Rugby Union: A Systematic Review', *Sports Medicine Open*, vol. 7, 15. <https://doi.org/10.1186/s40798-021-00305-x>

Fisher, JP, Ravalli, S, Carlson, L, Bridgeman, LA, Roggio, F, Scuderi, S, Maniaci, M, Cortis, C, Fusco, A & Musumeci, G 2020, 'The "Journal of Functional Morphology and Kinesiology" Journal Club Series: Utility and Advantages of the Eccentric Training through the Isoinertial System', *Journal of functional morphology and kinesiology*, vol. 5, no. 1. <https://doi.org/10.3390/jfmk5010006>

Bridgeman, LA, McGuigan, MR, Gill, ND & Dulson, DK 2018, 'Relationships between concentric and eccentric strength and countermovement jump performance in resistance trained men' *Journal of Strength and Conditioning Research*, vol. 32, no. 1, pp. 255-260. <https://doi.org/10.1519/JSC.0000000000001539>

Bridgeman, LA, McGuigan, MR, Gill, ND & Dulson, DK 2017, 'The effects of accentuated eccentric loading on the drop jump exercise and the subsequent postactivation potentiation response' *Journal of Strength and Conditioning Research*, vol. 31, no. 6, pp. 1620-1626. <https://doi.org/10.1519/JSC.0000000000001630>

Bridgeman, LA, Gill, ND, Dulson, DK & McGuigan, MR 2017, 'The effect of exercise-induced muscle damage after a bout of accentuated eccentric load drop jumps and the repeated bout effect' *Journal of Strength and Conditioning Research*, vol. 31, no. 2, pp. 386-394. <https://doi.org/10.1519/JSC.0000000000001725>

Bridgeman, LA, McGuigan, MR, Gill, ND & Dulson, DK 2016, 'Test-retest reliability of a novel isokinetic squat device with strength-trained athletes' *Journal of Strength and Conditioning Research*, vol. 30, no. 11, pp. 3261-3265. <https://doi.org/10.1519/JSC.0000000000001410>

Brown, SR, Brughelli, M & Bridgeman, LA 2016, 'Profiling isokinetic strength by leg preference and position in rugby union athletes' *International Journal of Sports Physiology and Performance*, vol. 11, no. 4, pp. 500-7. <https://doi.org/10.1123/ijspp.2015-0241>

Bridgeman, L, McGuigan, M & Gill, N 2015, 'Eccentric exercise, exercise induced muscle damage and the repeated bout effect: A brief review' *Journal of Australian Strength and Conditioning*, vol. 23, no. 3, pp. 74-84.

Bridgeman, L, McGuigan, M & Gill, N 2015, 'Eccentric exercise as a training modality' *Journal of Australian Strength and Conditioning*, vol. 23, no. 5, pp. 52-66.

Bridgeman, L & Blagrove, R 2014, 'The effect of an exercise induced muscle damage protocol on the postactivation potentiation response' *Journal of Australian Strength and Conditioning*, vol. 22, no. 5, pp. 73-75.

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## UPDATED MEMBER PROFILES

### Professor Richard Ma, MD, FAAOS, FAOA

**Research specialization:** Sports injury epidemiology, anterior cruciate ligament (ACL) injury and healing, musculoskeletal repair and regenerative therapies.

**Experience:** Dr. Ma is an U.S. orthopaedic surgeon specializing in treatment of sports medicine injuries. He is the Chief of the Division of Sports Medicine and the Endowed Gregory L. and Ann L. Hummel Distinguished Professor at the Missouri Orthopaedic Institute and the University of Missouri. He serves as a Team Physician for the University of Missouri Tigers. Dr. Ma completed a two-year Clinician-Scientist Orthopaedic Sports Medicine and Shoulder Surgery Fellowship Program at the Hospital for Special Surgery. He was the recipient of the NIH Musculoskeletal Tissue Repair and Regeneration Research Fellowship during his orthopaedic surgery training at the University of Virginia. He has received grants and awards from various organizations including the Orthopaedic Research Education Foundation, National Football League, American Orthopaedic Society for Sports Medicine, and the National Operating Committee on Standards for Athletic Equipment. Dr. Ma was also selected as a 2020 American Orthopaedic Association/Japanese Orthopaedic Association Traveling Fellow. Dr. Ma is currently Co-Director of the Rugby Research and Injury Prevention Group (RRIPG).

**Research overview:** Dr. Ma's research focuses are currently in: 1) Epidemiology and biomechanism of injuries in sports; 2) ACL injuries and the biology of ACL healing after surgery; 3) Application of novel orthobiologics for musculoskeletal repair. As a Clinician Scientist, Dr. Ma conducts his translational research at the University of Missouri's Thompson Laboratory for Regenerative Orthopaedics ([thompsonlab.missouri.edu](http://thompsonlab.missouri.edu)). He collaborates with RRIPG and Rugby Codes Research Group members on U.S. Rugby-7s research initiatives.

**Postgraduate supervision:** Dr. Ma mentors PhD students, orthopaedic residents, and undergraduate and graduate students. Topics have revolved around ACL biology and healing after surgery. Through RRIPG, Dr. Ma works with researchers at varying levels of training on understanding the injury risk of playing amateur Rugby in the U.S.

**Research publications:** Examples representative of Dr. Ma's ongoing work include:

Cardona-Ramirez S, Stoker AM, Cook JL, [Ma R](#). Fibroblasts from common ACL tendon grafts exhibit different biological responses to mechanical strain. *AM J SPORTS MED*. 2021. 49(1):215-225. DOI: 10.1177/0363546520971852.

Cook JL, Rucinski K, Crecelius C, Ma R, Stannard JP. Return to sport after large single surface, multisurface, or bipolar osteochondral allograft transplantation in the knee using shell grafts. *ORTHOP J SPORTS MED*. 2021 Jan 22;9(1):2325967120967928. DOI: 10.1177/2325967120967928.

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[Ma R](#), Lopez V, Jr., Weinstein MG, Chen JL, Black CM, Gupta AT, Harbst JD, Victoria C and Allen AA. Injury profile of American women rugby-7s. *MED SCI SPORTS EXERC*. 2016; 48(10):1957-66. DOI: 10.1249/MSS.0000000000000997.



RUGBY RESEARCH  
& INJURY PREVENTION GROUP, INC.



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## PROJECT UPDATES

### UK Rugby Health Research update by Dr Karen Hind's team

Dr Karen Hind has been awarded Northern Accelerator funding for a pilot clinical trial of a new treatment for post-concussion syndrome in collaboration with Dr Paul Chazot, Biosciences and Dr Suresh Komati, Tyne and Wear NHS Trust.

Dr's Paul Chazot and Karen Hind (Durham University) have started a new funded research project with UK company, Conka Elite, investigating the tolerability and efficacy of a natural food-based supplement for brain health in contact sports athletes. An additional industry funded research project with My Sports Wellbeing, will evaluate a new app for self-reporting of concussion and the efficacy of a clinical cognitive test as add-on information to support return to play.

We welcome Dr Daniel Glassbrook, Post Doctoral Research Associate, who will be supporting the above projects over the next 6 months starting from November 2021. Dr Glassbrook is a former AUT graduate and member of SPRINZ.

We also welcome Lewis Williams, Strength and Conditioning coach at Newcastle Falcons RUFC, who has recently started his PhD with our team to explore global markers of fatigue in professional rugby union, with a focus on rugby player welfare.

#### *Publications*

1. Entwistle, I., Hume, P., Francis, P. and Hind, K. (2021). Vertebral anomalies in retired rugby players and the impact on bone density calculation of the lumbar spine. *Journal of Clinical Densitometry*, 24(2): 200-205.
2. McHugh C, Hind K, Davey D, Farrell G, Wilson, F (2021). Body Mass and Body Composition Changes over 7 Years in a male Professional Rugby Union Team. *International Journal of Sports Medicine*. DOI: 10.1055/a-1403-2906.

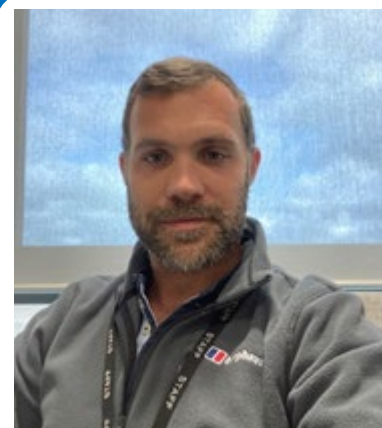
### Swansea Rugby Research team update

#### **Dr. Mark Waldron**

Mr. Luke Woodhouse, supervised by Dr. Mark Waldron, has had the second study of his PhD published.

**Woodhouse, L.N., Tallent, J., Patterson, S.D., Waldron, M. (2022) International Female Rugby Union Players' Anthropometric and Physical Performance Characteristics: A Five-Year Longitudinal Analysis by Individual Positional Groups. *Journal of Sport Sciences*, 40(4), 370-378.**

Longitudinal changes in anthropometric and physical performance characteristics of International female rugby union players were evaluated across 5-seasons, according to field position. Sixty-eight international female rugby union players from a top 2 ranked international team, undertook anthropometric and physical performance measurements across five seasons. Anthropometric and physical performance changes occurred, with skinfolds decreasing between 2015 and 2017 and body mass increasing between 2017 and 2019. Single-leg isometric squat (SL ISO), 0–10 m momentum (0–10 Mom) and 20–30 m momentum (20–30Mom) were higher in 2018 and 2019 than all years. Front-row players were characterised by greater SL ISO and 1-RM bench press than inside and outside backs, with higher skinfolds and lower endurance levels than all positions. Between 2017 and 2019, front-row players had larger decreases and increases in endurance and one repetition maximum (1-RM) bench press, respectively, compared to all other positions. Forwards had the highest 0–10Mom and 20–30Mom, and scrum-half the lowest, while outside backs had faster 0–10, 30–40, and 40 m (TT40 m) times, and greater peak velocity (Vmax) compared to forward positions. These longitudinal findings show that physical performance has increased, with anthropometric and performance characteristics becoming more distinctive between positions, among elite female rugby union players.



Mr. Erwan Izri, supervised by Dr. Mark Waldron, Dr. Rowan Brown and Prof. Liam Kilduff, has completed his programme of work, co-sponsored by Welsh Government and Sports & Wellbeing Analytics, investigating the role of instrumented mouthguards in elite rugby. Erwan will be attending the European Congress of Sports Sciences (ECSS) to present some of his work in September 2022.

### Professor Neil Bezodis

James Wild, supervised by Neil Bezodis, has recently published a paper looking at the sprint acceleration techniques of professional rugby union backs.

**Wild, J.J., Bezodis, I.N., North, J.S., Bezodis, N.E. (2022) *Characterising initial sprint acceleration strategies using a whole-body kinematics approach*. Journal of Sports Science, 40(2), 203-214.**

Sprint acceleration is an important motor skill in team sports, thus consideration of techniques adopted during the initial steps of acceleration is of interest. Different technique strategies can be adopted due to multiple interacting components, but the reasons for, and performance implications of, these differences are unclear. 29 professional rugby union backs completed three maximal 30 m sprints, from which spatiotemporal variables and linear and angular kinematics during the first four steps were obtained. Leg strength qualities were also obtained from a series of strength tests for 25 participants, and 13 participants completed the sprint protocol on four separate occasions to assess the reliability of the observed technique strategies. Using hierarchical agglomerative cluster analysis, four clear participant groups were identified according to their normalised spatiotemporal variables. Whilst significant differences in several lower limb sprint kinematic and strength qualities existed between groups, there were no significant between-group differences in acceleration performance, suggesting inter-athlete technique degeneracy in the context of performance. As the intra-individual whole-body kinematic strategies were stable (mean CV = 1.9% to 6.7%), the novel approach developed and applied in this study provides an effective solution for monitoring changes in acceleration technique strategies in response to technical or physical interventions.



Neil Bezodis was co-author on a recent paper investigating the technique of place kickers in rugby union as they approach the ball during their run-up.

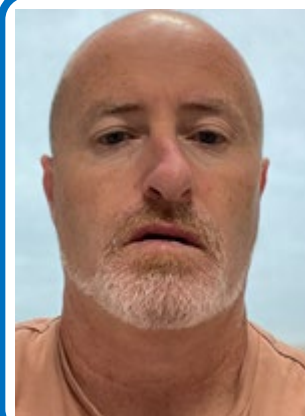
**Atack, A.A., Trewartha, G., Bezodis, N.E. (2022) *The approach towards the ball, rather than the physical characteristics of the kicker, limits accurate rugby place kicking range*. Journal of Sport Science, 40(1), 104-115.**

The aim of this study was to understand how a place kicker's range is limited by their approach to the ball and their physical characteristics. Thirty-three kickers performed maximal place kicks and vertical jumps in a laboratory. Whole-body motion and ground reaction forces during the approach phase of the kicks, jump performance and anthropometric measurements of those whose predicted maximum distance was limited by range ( $n = 17$ ) rather than accuracy were analysed. Principal component analysis (PCA) reduced the number of variables considered before stepwise regression analyses assessed variance in place kick maximum distance and associated criteria. Four components, explaining 94% of the variance in maximum distance, were extracted from the PCA: width of approach, anterior-posterior body position, centre-of-mass height and lower limb strength. Lower limb strength was a significant predictor of both kicking foot velocity ( $R^2 = 0.55$ ,  $p = 0.001$ ) and ball velocity magnitude ( $R^2 = 0.57$ ,  $p < 0.001$ ). However, maximum distance was determined by body position during the approach (antero-posterior position,  $R^2 = 0.52$ ,  $p = 0.001$  and centre-of-mass height,  $R^2 = 0.12$ ,  $p = 0.049$ ). This highlights the importance of considering three-dimensional motion of the kicker alongside their physical capabilities to understand place kicking range.

**Professor Liam Kilduff**

Hall, E.C.R.,...Kilduff, L.P., et al. (2022) [Genetic Polymorphisms Related to VO<sub>2</sub>max Adaptation Are Associated With Elite Rugby Union Status and Competitive Marathon Performance](#). *International Journal of Physiology and Performance*, 16(12), 1858-1864.

**Purpose:** Genetic polymorphisms have been associated with the adaptation to training in maximal oxygen uptake (V'O<sub>2</sub>max). However, the genotype distribution of selected polymorphisms in athletic cohorts is unknown, with their influence on performance characteristics also undetermined. This study investigated whether the genotype distributions of 3 polymorphisms previously associated with V'O<sub>2</sub>max training adaptation are associated with elite athlete status and performance characteristics in runners and rugby athletes, competitors for whom aerobic metabolism is important. **Methods:** Genomic DNA was collected from 732 men including 165 long-distance runners, 212 elite rugby union athletes, and 355 nonathletes. Genotype and allele frequencies of PRDM1 rs10499043 C/T, GRIN3A rs1535628 G/A, and KCNH8 rs4973706 T/C were compared between athletes and nonathletes. Personal-best marathon times in runners, as well as in-game performance variables and playing position, of rugby athletes were analyzed according to genotype. **Results:** Runners with PRDM1 T alleles recorded marathon times ~3 minutes faster than CC homozygotes (02:27:55 [00:07:32] h vs 02:31:03 [00:08:24] h,  $P = .023$ ). Rugby athletes had 1.57 times greater odds of possessing the KCNH8 TT genotype than nonathletes (65.5% vs 54.7%,  $\chi^2 = 6.494$ ,  $P = .013$ ). No other associations were identified. **Conclusions:** This study is the first to demonstrate that polymorphisms previously associated with V'O<sub>2</sub>max training adaptations in nonathletes are also associated with marathon performance (PRDM1) and elite rugby union status (KCNH8). The genotypes and alleles previously associated with superior endurance-training adaptation appear to be advantageous in long-distance running and achieving elite status in rugby union.



Antrobus., M.R., Brazier, J., Stebbins, G.K., Day., S.H., Heffernan, S.M., Kilduff, L.P., et al. (2021) [Genetic Factors That Could Affect Concussion Risk in Elite Rugby](#). *Sports (Basel)*, 9(2), 19.

Elite rugby league and union have some of the highest reported rates of concussion (mild traumatic brain injury) in professional sport due in part to their full-contact high-velocity collision-based nature. Currently, concussions are the most commonly reported match injury during the tackle for both the ball carrier and the tackler (8-28 concussions per 1000 player match hours) and reports exist of reduced cognitive function and long-term health consequences that can end a playing career and produce continued ill health. Concussion is a complex phenotype, influenced by environmental factors and an individual's genetic predisposition. This article reviews concussion incidence within elite rugby and addresses the biomechanics and pathophysiology of concussion and how genetic predisposition may influence incidence, severity and outcome. Associations have been reported between a variety of genetic variants and traumatic brain injury. However, little effort has been devoted to the study of genetic associations with concussion within elite rugby players. Due to a growing understanding of the molecular characteristics underpinning the pathophysiology of concussion, investigating genetic variation within elite rugby is a viable and worthy proposition. Therefore, we propose from this review that several genetic variants within or near candidate genes of interest, namely APOE, MAPT, IL6R, COMT, SLC6A4, 5-HTTLPR, DRD2, DRD4, ANKK1, BDNF and GRIN2A, warrant further study within elite rugby and other sports involving high-velocity collisions.

# AUT TRAUMATIC BRAIN INJURY NETWORK UPDATE

## Professor Alice Theadom - Director of TBIN

For further information see [TBI Network - TBI Network - AUT](#)

### TBIN Public Forum

**Our next public forum will be on Friday 1<sup>st</sup> July at 10:30 am**

**Zoom link:** <https://aut.zoom.us/j/94283174663>

We ask those attending to remember that this forum is to help connect our researchers with clinicians and the general public to help improve knowledge and care for those experiencing a TBI and their whānau.



These forms are not for promoting private services or to seek individual clinical advice, thank you.

### Influence of alcohol on cognitive functioning and brain structure following concussion in sport

High levels of alcohol use have been associated with increased risk of dementia and cognitive decline in the general population. Alcohol is also thought to be involved in the link between sport and increased risk of dementia. World rugby recently identified alcohol as one of 12 risk factors for dementia.

To investigate the evidence for this Tara Munro (one of our Honours students) recently completed a systematic review of the evidence between alcohol and longer term neurocognition and neuropathology specifically in sports athletes who had experienced repeated concussion. A high number of papers talked about the link between high use of alcohol and later life brain health, but only five studies presented people's data. There was no strong evidence of a link between high alcohol use and later life cognitive functioning. Only one study showed higher rates of alcohol use were found in people diagnosed with CTE.


<https://bit.ly/3wHHzal>

**MALE?  
HAVE YOU EXPERIENCED A  
CONCUSSION? READ ON...**

Researchers at AUT want to learn more about you and your whānau's experience accessing concussion care - what worked, what didn't, who helped you recover and how we can make things better. We also want to involve you along the research journey, ka mura, ka muri.

If you're **male** & 16 years or older, please contact Jason Chua at [jason.chua@aut.ac.nz](mailto:jason.chua@aut.ac.nz) or call/ text 027 3968 384.




### Are interviews really better than questionnaires to understand functioning after TBI? (Rhodes et al., 2021)

The Glasgow Outcome Scale – Extended (GOS-E) is a measure that is frequently used to determine impact of TBI. Interview administration of the GOS-E is currently considered the gold standard method of assessing global functional outcomes. The CENTER-TBI study compared the findings on the GOS-E between an interviewer rated version and questionnaires completed by the person or their caregiver. Data was available for both types of assessment for 994 adults at 3 months after injury and 628 adults at 6 months after injury. All severities of TBI (mild, moderate, and severe) were included.

There was good agreement between the two ways of measuring functioning at both time points. This suggests that the GOS-E is measured can be decided based on the needs of the context it will be used.

See link for the full paper here: <https://bit.ly/37W9OaR>

### Explaining difference in recovery after mild TBI between males and females (Mikolic et al., Online ahead of print)

A previous CENTER-TBI study found that women had lower functional outcomes after mild TBI than males. This CENTER-TBI study aims to find out some of the reasons for this.

Data was collected for adults who presented to an emergency department after a mild TBI and 6 months later using the GOS-E. Data was available for 842 men and 1022 women (16+). The team looked at whether the person was admitted to hospital after injury or discharged home, if there was a psychiatric history or not, whether the person lived alone or not, education and their employment status.

The found that poorer outcomes in females were only partly explained by treatment, living status, psychiatric history, education, and employment. This suggests that other factors are likely to have more influence on outcomes. The authors suggest future studies should explore other potential influences such as gender roles and biological factors to see if they explain gender differences in outcomes.

See link for the full paper here: <https://doi.org/10.1089/neu.2021.0116>

## AUSTRALIAN AND NEW ZEALAND CTE BIOBANKS UPDATE

### Australian CTE Biobank co-launches with New Zealand CTE Biobank

A national Australian CTE biobank to collect information and test samples relating to repeated traumatic brain injuries was launched on the 22<sup>nd</sup> March, with New Zealand announcing its intention to establish a similar clinic and biobank. The Biobanks will initially focus on those with possible or probable traumatic encephalopathy syndrome (TES) and increased risk of chronic traumatic encephalopathy (CTE). Current clinical testing does not reach sensitivity and specificity for diagnosing CTE during life, and the disease can only be conclusively diagnosed by examining the brain after death. The two biobanks will work together and seek to gather quality data across blood sampling, neuroimaging, and neuropsychology testing, with stored blood samples over the long term that can be reanalysed in the future.

Macquarie University neurologist and Australian CTE Biobank (ACB) Director DR Rowena Mobbs says patients and their families are desperate for more support from the community, and the clubs for whom they played. "CTE is a devastating condition for patients and families. Our hope is to see blood screening alongside advanced neuroimaging for CTE internationally within five years, just as we see on the horizon for Alzheimer's and other forms of dementia."

Professor Maurice Curtis and Professor Lynette Tippett will co-direct the NZ CTE Biobank, two of NZ's leading neuroscientists in the field of brain research. Maurice says "Momentum has been building towards the formation of the NZ CTE Research Biobank alongside other researchers on both sides of the Tasman. The work done here in New Zealand will complement that of our Australian colleagues and other leading groups around the world in this critical area of brain research."

If you are interested in learning more about the Australian CTE Biobank go to [ctebiobank.org](https://ctebiobank.org) and for more on the New Zealand CTE Biobank contact [m.curtis@auckland.ac.nz](mailto:m.curtis@auckland.ac.nz)

For more information see <https://www.aut.ac.nz/traumatic-brain-injury-tbi-network>

## A concussion management strategy: Community rugby in New Zealand

Excerpts extracted by Professor Patria Hume, with permission (6/12/2021), from the report (08/10/2021) by Dr Danielle Salmon and Manu Albert (NZ Rugby). A copy of the full report can be obtained from New Zealand Rugby.

See also: Salmon, D., Romanchuk, J., Murphy, I., Sullivan, J., Walters, S., Whatman, C., . . . Van Der Vis, K. (2020). Infographic. New Zealand Rugby's concussion management pathway. *British Journal of Sports Medicine*, 54(5), 298-299. doi:[10.1136/bjsports-2019-100950](https://doi.org/10.1136/bjsports-2019-100950)

The impetus for this project arose from existing challenges in community rugby to operationalise World Rugby's "Recognise, Remove, Refer and Recovery" recommendations for concussion management. The purpose of this project was to develop a system to support player welfare by improving the identification and management of concussion injuries in community rugby. This process was examined through two primary objectives:

1. To document and evaluate the implementation of the NZ Rugby concussion management pathway (NZR CMP) and its associated supporting technologies.
2. To solicit and gain a deeper understanding of stakeholder perceptions and contextual considerations (local rugby environment) for the optimal implementation of the NZR CMP.

### NZR Research Advisory Team

NAME	ROLE
Dr Danielle Salmon	New Zealand Rugby Research Scientist
Dr Ian Murphy	Former New Zealand Rugby Medical Director
Karen Rasmussen	New Zealand Rugby Medical Manager
Dr Mike England	New Zealand Rugby Medical Advisor
Joe Harawira	New Zealand Rugby Injury Prevention Programme Manager
Dr John Sullivan	Retired Professor, School of Physiotherapy at University of Otago
Assoc. Prof Gisela Sole	School of Physiotherapy at University of Otago
Dr Chris Whatman	Head of Department, Sport and Exercise Science, Auckland University of Technology
Dr Amanda Clacy	Research Fellow School of Law & Society, University of the Sunshine Coast, Maroochydore, Australia
Dr Simon Walters	Associate Professor in the School of Sport and Recreation at Auckland University of Technology
Asst Prof Zachary Kerr	Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A. Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A. Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A.
Asst Prof Johana Register-Mihalik	Matthew Gfeller Sport-Related Traumatic Brain Injury Research Center, Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A. Injury Prevention Research Center, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A. Department of Exercise and Sport Science, University of North Carolina at Chapel Hill, Chapel Hill, NC 27705, U.S.A.
Dr James Brown	The Institute of Sport and Exercise Medicine, Stellenbosch University, Cape Town, South Africa
Janelle Romanchuk, Dr Jason Chua, Jody McGowan, Christina Sutherland & Ashton Tourell,	NZR Research Assistant Team
Dr Marelise Badenhorst	Post-Doctoral Qualitative Research fellow, Sport and Exercise Science, Auckland University of Technology
Manu Albert	New Zealand Rugby Injury Prevention Project Manager

### New Zealand Rugby Concussion Management Pathway

The NZR CMP includes an electronic health record-based Clinical Decision Support Tool (CDST) designed to streamline the concussion management process for all stakeholders, from identification of a suspected concussion through to diagnosis and treatment. The CDST consists of two components:

1. NZR Concussion Application (NZR App)
2. NZR Concussion Portal (web-based)

The NZR Concussion App allows the user (team physiotherapist, manager, other) to complete the modified SCAT5 baseline assessment and to log suspected concussions as they happen during trainings or match play, which takes them through a process that replicates the internationally recognised Concussion Recognition Tool. The logging of the suspected concussion in the App also generates automated emails that inform the relevant stakeholders of the injury. In the email notification to the player and the parent, an access code is provided that gives their general practitioner (GP) access to the NZR concussion assessment pathway (NZRCAP) and the player's pre-season baseline scores, which is contained with the NZR Concussion Portal. The NZR Concussion portal allows healthcare providers

(HCP) to view players baseline scores, provides guidance for concussion diagnosis and medical clearance, and contains NZR concussion regulations and GRTP and GRTL guidelines. When the player believes they are ready to return to contact training or when they have completed the stand-down period, they then return for a medical clearance assessment where the doctor decides whether it is safe for the player to return to contact. The GP portal then sends out automated notifications to the relevant stakeholders to let them know that the player is either able or not able to return to contract training to close the communication loop. If a player was not cleared at their medical clearance assessment, a follow-up appointment is then made, or the player is referred on for additional medical specialist support.

### *What did we do?*

The NZR CMP was piloted over three seasons (2019-2021) in three provincial unions (PUs) in NZ. Over each season the number of suspected concussions and training data were tracked. Once a player entered the CMP their healthcare touchpoints (GP and/or Nurse assessments) were tracked through the engagements with the CDST and follow-up with players and associated stakeholders. At the end of the 2019 season, 118 formal interviews were conducted with a range of stakeholders to better understand the factors that facilitated their recovery journey from concussion and the barriers they encountered.

In 2019 a total of 1837 community rugby players from 61 clubs and schools were invited to participate; 79% (n=1454) of players consented to be involved and completed a baseline test (males n= 1273; females n=181; high school players n=885; senior club players n= 569). Of the 201 suspected concussions that were reported during the season 69% (n=138) were logged using the App. The suspected concussion rate was 12.4 concussions per 1000 player match hours, the concussion rate for the logged concussions was 8.5 per 1000 player match hours. At the end of the season, we mapped out each player's journey through the CMP to measure compliance with the pathway. We captured who they saw, when, and if they sought medical clearance before returning to play. There were 27 unique pathways that players took following their concussion diagnosis and subsequent recovery period. Following a suspected concussion 80% (n=109) of those players with a logged concussions were reviewed by a GP for a diagnosis assessment post-injury. For the recovery stage, 98 players obtained a medical clearance from a GP prior to returning to contact training, resulting in a compliance rate of 71%.

The implementation of the CMP pathway during the 2020 season was complicated by Covid-19; despite this, a total of 2033 players from 59 clubs and schools were invited to participate. Of those that were invited 70% (n= 1417) of players consented to be involved and completed a baseline assessment. Of the 131 suspected concussions that were reported post-season, 95% (n=124) were logged using the App. The suspected concussion rate was 17.3 concussions per 1000 player match hours, the concussion rate for the logged concussions was 14.2 per 1000 player match hours. Following a suspected concussion 94 players attended a diagnosis assessment with a GP, resulting in an overall compliance rate of 76%. At the recovery stage, 100 players obtained a medical clearance from a GP prior to returning to contact training, resulting in a compliance rate of 81%.

For the 2021 season, we are still collating data but currently, 248 concussions have been logged in the 3 participating provincial unions (PUs). For those concussions that have been logged 212 players have attended a medical diagnosis assessment and 188 have been medically cleared to return to contact training. The team is still finalising these data and awaiting the government's decision around the return of rugby following the most recent lockdown, so will be able to provide an update on this once we know more. When we compare these results to date to the 2018 Blue Card statistics, the NZR CMP has substantially improved compliance with the community management guidelines, through the documentation and notification of critical steps in the concussion management process. It has also provided the respective PUs and NZR with oversight of how players are progressing through their concussion journey so that they can confidently say that for those teams that were involved in 2020 80% of players who sustained a concussion were formally cleared by a GP before they returned to contact.

The structure provided by the CMP gives stakeholders the "authority" to manage concussions following the recommended guidelines or to encourage others to follow these guidelines. Looking at some of the interview data one of the biggest themes to emerge from the physiotherapist's interviews, is that the CMP provides support to 'back them up' against stakeholders who may resist or have unfavourable attitudes/beliefs around concussion management. Stakeholders reported that the CMP helped to mitigate the unfavourable behaviours. This theme was also present in the interviews and focus groups that examined stakeholder perspectives of the CMP and the role of the baseline assessment. By encouraging compliance with the NZR CMP stakeholders were contributing to changing attitudes, enhancing knowledge and making good concussion management the norm, not the exception.

Stakeholders involved in the CMP were learning by 'doing' instead of engaging in passive forms of concussion education.

### *What did we learn?*

The key insight we have taken away from this project is the importance of flexibility within the concussion management pathway to that it can be adapted based on the level of support and resource within each team. The landscape and the level of support for a senior men's premier club team (highest level of men's community rugby) and that of an under-15 high school girls' team are very different. However, the guidelines for the management of a concussion are the same; "Recognise, Remove, Refer and Recovery". Therefore, we needed a system that had the flexibility to allow different levels of engagement depending on the capacity of the team, but at the same time still met the critical requirements for the safe management of a concussion at the community level (stakeholder notifications when a concussion was logged, diagnosed and medically cleared).

This project has undergone various iterations and modifications during each season from 2019 through to 2021, according to feedback received and the experiences from the utilisation of the CMP in the community. We have made concerted efforts to ensure a collaborative review process with all involved stakeholders at the end of each season. The modification of the pathway and the technology has been informed by those stakeholders who sustained a concussion and those individuals that have supported the management of the concussed player from pitch side through to the return to play.

## DYLAN CLEAVER – NZ JOURNALIST PERSPECTIVE ARTICLE



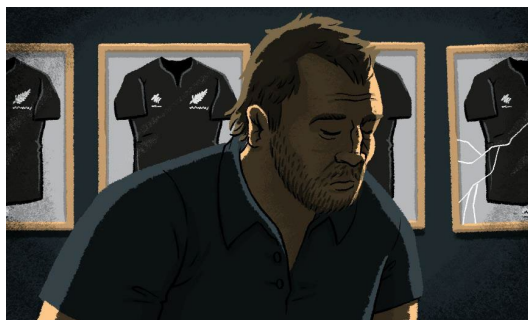
Dylan Cleaver, from The Bounce, is a leading journalist in NZ, and led the OIA request that profiled the NZ Rugby Health study that gained international media attention on the issue of retired player health and potential brain health issues.

This article originally published Wednesday, 3 November 2021 5:30 AM is reproduced with permission by Dylan.

**From:** Dylan Cleaver from The Bounce <[dylancleaver@substack.com](mailto:dylancleaver@substack.com)>

### Carl Hayman doesn't want to forget

He played close to 450 games of professional rugby and is now suing World Rugby and the RFU. Hayman, 41, tells Dylan Cleaver his story for the first time.



*Illustration by Toby Morris for The Spinoff*

Carl Hayman was once estimated to be the highest-paid player in rugby. Now, less than six years after the end of his playing days, he has spoken of the disorientation he felt as his career was winding down, the ceaseless headaches that plagued him and sent him into a spiral of alcohol abuse and frequent suicidal thoughts, culminating in a suspended prison sentence in France after admitting to charges of domestic violence.

"I spent several years thinking I was going crazy. At one stage that's genuinely what I thought. It was the constant headaches and all these things going on that I couldn't understand," Hayman says.

The 41 year old, once regarded as the finest tighthead prop in the world, now has an explanation. He received a shocking diagnosis after extensive testing in England that included a brain scan that can identify changes in the brain's white matter. He has been diagnosed with early-onset dementia and probable chronic traumatic encephalopathy, or CTE. It's a progressive brain condition which has been strongly associated with former NFL players and boxers and the "probable" refers to the fact that it can only be properly diagnosed in post mortem.

CTE has a profound effect on its sufferers and has been associated with many premature deaths in the US, including NFL superstars Junior Seau, Dave Duerson and Aaron Hernandez, the latter committing suicide in prison while serving a life sentence for murder. There has been no confirmed cases of CTE among former All Blacks, though the New Zealand Herald has reported links between rugby and high incidences of Alzheimer's disease in [specific teams](#).

Now living in New Plymouth with partner Kiko and their young daughter, Hayman has joined the lawsuit being prepared on behalf of 150 former professional rugby players, including England's World Cup-winning hooker Steve Thompson, former Wales No8 Alix Popham, and Michael Lipman, who played 10 tests as a flanker for England. The landmark suit claims rugby's governing bodies, including World Rugby, failed to protect players from the risks caused by concussions and sub-concussions, despite being armed with the knowledge and evidence to do so.

World Rugby has consistently declined to comment on the lawsuits but has responded in the past with a broad statement: "While it would be inappropriate to comment on possible legal proceedings, everyone in World Rugby has utmost respect for the wellbeing of all our players, including former players.

"Player welfare is our top priority and, along with our unions, we are unwavering in our commitment to evidence-based injury prevention strategies, in particular in the priority area of concussion education, management and prevention."

Hayman, a father of four, said he agonised over the decision.

"I um'd and ah'd for about 12 months about whether I'd do anything about it and find out if something was wrong with me, or whether I would just get on with life and hope for the best. I went to the doctors here before I went to the UK but the process seemed like it was going to take a long time and I was getting to the point where I needed answers," he says.

"It would be pretty selfish of me to not speak up and talk about my experience when I could help a guy in New Zealand perhaps who doesn't understand what's happening to him and has no support network to lean on."

He joined the action in part to get access to the testing and is also keen to trial any new treatments that might become available in a bid to slow down the ravages of dementia. “The other side is to hope that players of the future don’t fall into the same trap I did – that they’re not treated like an object and are looked after better,” he says. “These younger aspiring players need to know what they’re getting into and there needs to be more support and monitoring around head injuries and workloads if they do decide to play professionally. I’ve even come across people who have been affected having just played school and university-level rugby, so it’s a conversation that needs to be happening with parents and teenagers at the very start.”

#### 441 games and 150,000 knocks

Hayman has joined the claim as he played extensively in England and France after his All Black career ended with the World Cup quarter final defeat in 2007.

*Carl Hayman's last test as an All Black - the 2007 RWC quarter-final - was an unhappy experience. Photo / Getty Images*



There is no legal avenue to take action against New Zealand Rugby, due to our ACC law that offers no-fault insurance for personal injury and removes the right to sue.

New Zealand Rugby CEO Mark Robinson was a former teammate of Hayman’s.

“My thoughts are first and foremost with Carl and his whānau,” Robinson said in a [written statement](#). “It’s certainly sad to hear about anyone in our rugby community who is struggling - for whatever reason.

“It’s important to continue to stress that player safety and welfare is New Zealand Rugby’s number one priority. In particular, we are focused on contributing to the development of world leading policies and research on the complex problem of concussion.”

Hayman emphasised that it was not concussion, but the sheer volume of subconcussive hits that most concerned him.

The former Highlanders stalwart played close to 450 first-class or professional games in a 17-year professional career, a body of work he is “100 percent” certain has contributed to his illness. “There’s no doubt. We’re talking about more than 400 games of professional rugby and that doesn’t include training,” Hayman says. “From the age of 15 when I made the New Zealand Under-16s, I’ve played a phenomenal amount of rugby and taken a phenomenal amount of knocks to the head. CTE isn’t about concussions but about the ongoing knocks in games and trainings.”

Wales forward Popham estimated he had taken 100,000 subconcussive blows in his 300-game career. A simple exercise in extrapolation would put Hayman’s total closer to 150,000. Richard Boardman of Rylands Law, representing the players, has claimed there is a “ticking time bomb” of players who are developing symptoms from as young as their mid-20s and are subsequently diagnosed with epilepsy, Parkinson’s Disease, dementia, Motor Neuron Disease and post-concussion syndrome as they reach their 40s. A recent [Drake study](#) shows the potential scale of this issue in the game as 23 percent of elite rugby players tested – with a mean age of just 25 – had brain damage.

Boardman says it’s not just rugby union facing this, but all contact sports: “There’s currently a coroner’s inquest in Australia looking into the suicide last year of Shane Tuck, an AFL player, who died at the age of 38 and was found to have CTE. We all know the stories out of the NFL [and] I represent an additional 65 former rugby league players in England with brain damage.

“Across the sporting world, you have retired athletes with serious brain damage left to contemplate an uncertain retirement undiagnosed with little support. The sports can celebrate the core physicality of game day, but do much more around that to look after those participating.”

Hayman said he remains frustrated by the refusal to make fundamental changes to the sport’s calendar. “When I first started playing pro rugby I remember having a Players’ Association meeting and the conversation was all about having a global window and a shorter season. We’re still having the same conversations about rugby now. There’s a number of changes we can and have to make to help protect the players of the future.

“I look at the NFL again and they have a 17-game season across four-to-five months with the possibility of a couple of playoff games. You compare that to rugby with a 10-month season.

“There needs to be a discussion about what constitutes an acceptable volume of rugby.”

### The French connection

In France's Top 14, the country's premier competition, forwards can be made to feel like useful slabs of meat. Hayman loved living in France, and playing for Toulon he racked up a staggering 156 matches in five years. This followed a three-year stint at Newcastle where he played 64 games as the sport's biggest earner.

"Basically, if I was fit and available, I was on the field," he says. "There were times that I probably shouldn't have played but it was expected – like when I had a root nerve anti-inflammatory injection in my neck during the week and was back on the pitch at the weekend. They worked us hard and I never complained. It was my job and I was paid well, but I doubt it did any favours."



*Carl Hayman and Jonny Wilkinson bask in Toulon's 2013 Heineken Cup victory. Photo / Getty Images*

He loved the club and the club loved him. They declined to comment on his condition but noted memories of "an extraordinary player with extraordinary physical abilities and playing intelligence, making him a natural leader who captained the team to the European title in 2015".

Toulon would fight each year on two fronts, the French competition and the European competition.

"In hindsight, as much as I enjoyed it at the time, I don't think doing that week after week for 10 months of the year did much good for me. At the time I felt indestructible. I never got injured, I trained bloody hard. I literally felt that I was indestructible, but if I knew then what I know now, I don't think I would have played post the [2007] World Cup. I think I would have stopped playing," Hayman says.

"I'm 41, I've still got a massive part of my life ahead of me and when you live with something like this it certainly makes every day a challenge."

Hayman's career remained a source of fascination for New Zealanders because he left the country at the peak of his powers in 2007. There were frequent rumours that he would return to the black jersey, but it never eventuated. He left, he says, because he had literally had enough. "Leading up to the World Cup I gave everything I could."

Hayman did not have a big history of concussion, though there was one wrenching occasion during a 2006 Bledisloe Cup test at Eden Park, when he clashed heads with Wallaby loose forward Wycliff Palu.

Hayman tried to stand up and run, but twice fell over. As fate would have it, the Wallabies intercepted a pass near where he was being treated and there was the tragi-comic sight of the big prop, still clearly groggy, trying to chase down flying wing Lote Tuqiri.

"Apart from that I never really had a history of concussion, but my issue is the sheer number of repetitive head knocks – subconcussions – I took during my career."

'I've forgotten my son's name'

By the time his playing days were winding down at Toulon, Hayman had started to experience frequent episodes of déjà vu on the field, which he found bizarre and unsettling. He didn't know it at the time, but that would have been of great concern to a neurologist, as chronic déjà vu can be a symptom of dementia.

It was when he stopped playing and joined Pau, another French club, as forwards coach in 2016 that his life started to spiral. "The headaches were the start, and they were something that kept getting worse over time. Waking up daily with a constant headache at various levels that never really goes away," he says.

"I started having substantial memory issues. I was trying to get a passport for my son and I couldn't remember his middle name, which was a significant moment. I was searching around for it in my mind for a good 25 seconds and had to go, 'I'm really sorry, I've forgotten', to the person on the phone trying to do the passport. 'I've forgotten my son's name'.

"I had temper issues, definitely, and then at this point of my life, it led down the track to what I'd consider alcohol abuse. I always enjoyed a beer with the boys but at this point I began drinking more. I didn't know what was going

on and the drinking brought a little bit of an escape for a certain amount of time. It would temporarily alleviate the symptoms somewhat but then, as you can imagine, the next day things would be back to how they felt before, if not worse. It was a vicious cycle I got caught in.”

Although he was not diagnosed, Hayman was in the midst of a serious bout of depression. There were days when all he wanted to do was sleep so he didn’t have pain. There were regular suicidal thoughts. “One hundred percent I did [think about suicide]. For a while on a daily basis.”

His marriage was collapsing under the strain.

“At my lowest point, my relationship with my ex-wife Natalie had broken down and I was involved in a physical incident with her that went to court. I don’t want to minimise the harm I did and I don’t want to make any excuses because I should never have put myself in that situation, but I have so much regret because that’s just not who I am. I’m not an angry person but I was in a deep, dark place and unfortunately I will have to carry that with me forever.

“As time has gone on it has become more apparent what the symptoms are that are related to the CTE injuries: memory loss, anxiety, anger, depression and alcohol abuse. Recently I have had head spins, and get tongue-tied and find it difficult to find the right words in the first place.”

Due to Auckland’s lockdown status, we are speaking over the phone. While Hayman is a thoughtful subject, the frequent pauses as he assembles his sentences are noticeable. On at least one occasion he starts answering a question but mid answer switches to responding to a previous question he’s already answered.

“I get a foggy head,” he says, by way of explanation. “Tiredness and stress really exacerbate the symptoms so it’s important that I manage my time well, exercise and keep fit and do things which I feel comfortable with. Kiko and my friends and family who know me well, are also important for keeping my brain health on track.”

*Photo / Getty Images*

Hayman writes down anything important now, though he jokes that Kiko is in charge of telling him where his wallet and phone are.

Kiko Matthews met Hayman just as he was finishing his ill-fated coaching stint in Pau, a role that would end in controversy after he had an altercation with his players. She took an immediate liking to him but noticed a lot of what she described as “unnecessary” drinking.

“I put it down to his recent split from his wife and leaving his career. There was obviously a lot going on [and] I wanted to work with and help him to see what the cause of the drinking was as he was a lovely guy. Further down the line, after various conversations, it made sense to try and to work out the fogginess and the headaches,” she says.

No stranger to medical trauma of her own – she nearly died after developing two tumours on her pituitary gland (and celebrated her recovery by breaking the trans-Atlantic solo rowing record) – Matthews set about learning as much about her partner’s dementia as she could, to help him manage the symptoms.

“It is confronting but... we can now plan for the future with this diagnosis in mind and it’s important that Carl, who has worked very hard for 20 years and now has a serious injury as a result, gets to enjoy his life. It’s sad to think that you work really hard for your team and country and then end up permanently and progressively brain damaged,” she says.

“We can plan our life. We can say it’s going to get to 10 years before it gets to the point where we need to be in a stable home and where we don’t need to have a stressful work life. We’ve got to think about these sorts of things a bit earlier than most people our age, but we’re thinking about how we live our life now and what we can get from our life now.”

The couple is hopeful that advancements in medical science and therapies will slow down dementia’s inexorable march. Hayman no longer drinks. Instead he trains for ironman events – he has completed two – and manages his work-life balance as the owner of a small charter boat company in New Plymouth.

For a long time, he didn’t know whether he needed the complication of a high-profile lawsuit in his life, but ultimately Hayman believes the battle for rugby’s future is urgent. The way the sport is structured and administered needs to change, and if legal action provides some impetus for it, then he’d be letting the side down if he stood on the sidelines of this fight.



Likewise, he wrestled whether to go public but decided his message was too important not to share. “There will be a lot of guys out there who haven’t come forward. We need to let them know they’re not alone.”



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See also:

The Bounce, ‘The CTE sports wall of denial is crumbling’ <https://bit.ly/3iCDCeR>

## THE PAUL MCCRORY AND CONCUSSION IN SPORT GROUP (CISG)

Professor Paul McCrory resigned from the Concussion in Sport Group (CISG) following allegations of plagiarism in relation to concussion papers he authored. The CISG quadrennial Concussion in Sport conference has been sponsored by major federations including World Rugby and FIFA. This Concussion in Sport conference undertook reviews of research including concussion management and helped define consensus to assist sports with their policy-making.

Some of the papers now under review include:

Cosgrave, C., C. Fuller, A. Franklyn-Miller, E. Falvey, C. Beirne, J. Ryan and P. McCrory (2018). "Concussion in adolescent rugby union players: comprehensive acute assessment protocol and development of the SSC concussion passport to monitor long-term health." *BMJ Open Sport Exerc Med* **4**(1): e000455.

**Introduction:** Sports-related concussion (SRC) can be challenging to diagnose, assess and manage. Much of the SRC research is conducted on adults. The assessment of SRC should aim to identify deficits using a detailed multimodal assessment; however, most studies investigating the effects of SRC use diagnostic tools in isolation. It is likely that a combination of diagnostic tests will improve diagnostic accuracy. In this study, we aim to investigate how concussion affects adolescent rugby players and how a variety of diagnostic tools interact with each other as participants recover from their injury. The study will also determine the logistics of recording an individual's concussion history on a virtual 'Concussion Passport' that would remain with the individual throughout their sporting career to allow monitoring of long-term health. **Methods and analysis:** All rugby players (n=211) from the Senior Cup Teams of five schools in Dublin, Ireland will be invited to participate in the study. Baseline testing will be performed at the Sports Surgery Clinic, Dublin (SSC) before the rugby season commences. Participants will be followed up over the course of the rugby season. At baseline and at each postconcussion visit, participants will complete the following: Questionnaire, Sports Concussion Assessment Tool 3, Balance Error Scoring System, Computerised Neurocognitive Testing, Vestibulo-ocular assessment, King Devick test, Graded exercise test, Blood tests, Neck strength, FitBit. **Ethics and dissemination:** Ethical approval was obtained from the Sports Surgery Clinic Research Ethics Committee (Approval number: SSC 0020). On completion of the study, further papers will be written and published to present the results of the various tests. Trial registration number: NCT03624634.

Davis, G. A., M. Makdissi, P. Bloomfield, P. Clifton, C. Cowie, R. Echemendia, E. C. Falvey, G. W. Fuller, G. A. Green, P. Harcourt, J. Hill, K. Leahy, M. P. Loosemore, P. McCrory, A. McGoldrick, W. Meeuwisse, K. Moran, S. Nagahiro, J. W. Orchard, J. Pugh, M. Raftery, A. K. Sills, G. S. Solomon and A. B. Valadka (2020). "Concussion Guidelines in National and International Professional and Elite Sports." *Neurosurgery* **87**(2): 418-425.

The Berlin statement on sport-related concussion was published in 2017 using evidence-based recommendations. We aimed to examine (1) the implementation of, distribution and education based on the Berlin recommendations, and the development of sport-specific protocols/guidelines among professional and elite sports, (2) the implementation of guidelines at the community level, (3) translation of guidelines into different languages, and (4) research activities. Senior medical advisers and chief medical officers from Australian Football League, All Japan Judo Federation, British Horseracing Authority, Cricket Australia, Federation Equestre Internationale, Football Association, Gaelic Athletic Association, International Boxing Association, Irish Horseracing Regulatory Board, Major League Baseball, National Football League, National Hockey League, National Rugby League, and World Rugby completed a questionnaire. The results demonstrated that all 14 sporting organizations have published concussion protocols/guidelines based on the Berlin recommendations, including Recognize, Removal from play, Re-evaluation, Rest, Recovery, and Return to play. There is variable inclusion of Prolonged symptoms. Prevention and Risk reduction and Long-term effects are addressed in the guidelines, rules and regulations, and/or sport-specific research. There is variability in education programs, monitoring compliance with guidelines, and publication in other languages. All sporting bodies are actively involved in concussion research. We conclude that the Berlin recommendations have been included in concussion

protocols/guidelines by all the sporting bodies, with consistency in the essential components of the recommendations, whilst also allowing for sport- and regional-specific variations. Education at the elite, community, and junior levels remains an ongoing challenge, and future iterations of guidelines may consider multiple language versions, and community- and junior-level guidelines.

Davis, G. A., M. Makdissi, P. Bloomfield, P. Clifton, R. J. Echemendia, E. C. Falvey, G. W. Fuller, G. Green, P. Harcourt, T. Hill, N. McGuirk, W. Meeuwisse, J. Orchard, M. Raftery, A. K. Sills, G. S. Solomon, A. Valadka and P. McCrory (2019). "International consensus definitions of video signs of concussion in professional sports." *Br J Sports Med* **53**(20): 1264-1267.

**BACKGROUND:** The use of video to assist professional sporting bodies with the diagnosis of sport-related concussion (SRC) has been well established; however, there has been little consistency across sporting codes with regards to which video signs should be used, and the definitions of each of these signs. **AIM:** The aims of this study were to develop a consensus for the video signs considered to be most useful in the identification of a possible SRC and to develop a consensus definition for each of these video signs across the sporting codes. **METHODS:** A brief questionnaire was used to assess which video signs were considered to be most useful in the identification of a possible concussion. Consensus was defined as >90% agreement by respondents. Existing definitions of these video signs from individual sports were collated, and individual components of the definitions were assessed and ranked. A modified Delphi approach was then used to create a consensus definition for each of the video signs. **RESULTS:** Respondents representing seven sporting bodies (Australian Football League, Cricket Australia, Major League Baseball, NFL, NHL, National Rugby League, World Rugby) reached consensus on eight video signs of concussion. Thirteen representatives from the seven professional sports ranked the definition components. Consolidation and refinement of the video signs and their definitions resulted in consensus definitions for six video signs of possible concussion: lying motionless, motor incoordination, impact seizure, tonic posturing, no protective action-floppy and blank/vacant look. **CONCLUSIONS:** These video signs and definitions have reached international consensus, are indicated for use by professional sporting bodies and will form the basis for further collaborative research.

Davis, G. A., M. Makdissi, P. Bloomfield, P. Clifton, R. J. Echemendia, E. C. Falvey, G. W. Fuller, G. Green, P. R. Harcourt, T. Hill, N. McGuirk, W. Meeuwisse, J. W. Orchard, M. Raftery, A. K. Sills, G. S. Solomon, A. Valadka and P. McCrory (2019). "International study of video review of concussion in professional sports." *Br J Sports Med* **53**(20): 1299-1304.

**BACKGROUND:** Video review has become an important tool in professional sporting codes to help sideline identification and management of players with a potential concussion. **AIM:** To assess current practices related to video review of concussion in professional sports internationally, and compare protocols and diagnostic criteria used to identify and manage potential concussions. **METHODS:** Current concussion management guidelines from professional national and international sporting codes were reviewed. Specific criteria and definitions of video signs associated with concussion were compared between codes. Rules and regulations adopted across the codes for processes around video review were also assessed. **RESULTS:** Six sports with specific diagnostic criteria and definitions for signs of concussion identified on video review participated in this study (Australian football, American football, world rugby, cricket, rugby league and ice hockey). Video signs common to all sports include lying motionless/loss of responsiveness and motor incoordination. The video signs considered by the majority of sports as most predictive of a diagnosis of concussion include motor incoordination, impact seizure, tonic posturing and lying motionless. Regulatory requirements, sideline availability of video, medical expertise of video reviewers and use of spotters differ across sports and geographical boundaries. By and large, these differences reflect a pragmatic approach from each sport, with limited underlying research and development of the video review process in some instances. **CONCLUSIONS:** The use of video analysis in assisting medical staff with the diagnosis or identification of potential concussion is well established across different sports internationally. The diagnostic criteria used and the expertise of the video review personnel are not clearly established, and research efforts would benefit from a collaborative harmonisation across sporting codes.

Fuller, G. W., A. Gardner, R. Tucker, M. Douglas, C. Readhead, W. McDonald, I. Murphy, M. Saco, M. Raftery and E. Falvey (2021). "Expansion of cognitive testing for off-field concussion screening in elite rugby players: A cohort study." *J Sci Med Sport* **24**(12): 1204-1210.

**OBJECTIVES:** Current off-field concussion screening instruments have sub-optimal accuracy and additional testing domains may be necessary to detect the full spectrum of concussion presentations. This study aimed to determine if additional cognitive tests add utility to off-field screening for sport-related concussion. **DESIGN:** Reproducibility and diagnostic accuracy cohort studies were performed in the 2017 and 2018 seasons of the Super Rugby competition, conducted in Argentina, Australia, Japan, New Zealand, and South Africa. **METHODS:** Abridged versions of Stroop (score, time), Spatial Memory (score, failed trials), and Trail Making Trial-B (time, errors) cognitive tests, modified for off-field use, were examined. Players performed baseline testing prior to each season. Cases undergoing off-field screening as part of the World Rugby Head Injury Assessment Process underwent evaluation with the same cognitive tests during competition matches. Agreement between repeated pre-season baseline measurements, and the diagnostic accuracy of off-field testing against a clinical reference standard of concussion, was evaluated. **RESULTS:** Data were available for repeated preseason baseline testing in 644 players, and 100 cases undergoing off-field concussion screening. There was little individual agreement across pre-season baseline assessments for all tests (Lin's correlation and Gwets AC1 coefficients ranging between 0.2 and 0.3). There was significantly worse performance for the time taken to complete the modified Stroop Test in concussed players undergoing off-field screening, compared to non-concussed players (median time 21.1 v 18.4s,  $p < 0.01$ ; area under the receiver operating characteristic curve 0.7 (95% CI 0.5-0.8)). Other cognitive measures did not discriminate between injured and un-injured players, with no-statistically significant differences in distribution medians ( $p = 0.6-0.9$ ) and AUROC values close to 0.5. **CONCLUSIONS:** The time taken to perform a modified Stroop Test may provide additional diagnostic accuracy if added to current off-field concussion screening tools. Abridged Spatial Memory and Trail Making Trial-B tests did not discriminate between concussed and non-concussed players.

Patricios, J. S., C. L. Ardern, M. D. Hislop, M. Aubry, P. Bloomfield, C. Broderick, P. Clifton, R. J. Echemendia, R. G. Ellenbogen, E. C. Falvey, G. W. Fuller, J. Grand, D. Hack, P. R. Harcourt, D. Hughes, N. McGuirk, W. Meeuwisse, J. Miller, J. T. Parsons, S. Richiger, A. Sills, K. B. Moran, J. Shute and M. Raftery (2018). "Implementation of the 2017 Berlin Concussion in Sport Group Consensus Statement in contact and collision sports: a joint position statement from 11 national and international sports organisations." *Br J Sports Med* **52**(10): 635-641.

The 2017 Berlin Concussion in Sport Group Consensus Statement provides a global summary of best practice in concussion prevention, diagnosis and management, underpinned by systematic reviews and expert consensus. Due to their different settings and rules, individual sports need to adapt concussion guidelines according to their specific regulatory environment. At the same time, consistent application of the Berlin Consensus Statement's themes across sporting codes is likely to facilitate superior and uniform diagnosis and management, improve concussion education and highlight collaborative research opportunities. This document summarises the approaches discussed by medical representatives from the governing bodies of 10 different contact and collision sports in Dublin, Ireland in July 2017. Those sports are: American football, Australian football, basketball, cricket, equestrian sports, football/soccer, ice hockey, rugby league, rugby union and skiing. This document had been endorsed by 11 sport governing bodies/national federations at the time of being published.

## REPERCUSSION GROUP

There has been a call by the **Repercussion Group** for a new process for the development of TBI consensus guidelines.

Traumatic brain injury consensus guidelines for prevention and care, based on scientific and clinical evidence, must be developed by transparent processes and have broad disciplinary and participant inclusion.

Preparing consensus guidelines on concussion and other brain injuries in sports is a task demanding the assumption of a considerable duty of care from medical societies, conference participants, authors of final reports, and the editors of journals bringing them to the public. All must understand that the goals of such documents are to prevent brain injuries, inform on the timely identification and optimal management of these injuries, and to assist athletes with injuries to their brains so that they get the care they need. Accordingly, a consensus guideline should assimilate what evidence there is for both prevention and care. Where there is minimal evidence or none, guidance should be weighted towards player safety and informed consent.

No one should be naïve about the intense pressures that exist in sporting environments. Athletes, parents, coaches, medical professionals, and sporting authorities must have clear eyes about those pressures. For this reason, consensus documents on concussions and other brain injuries in sports must possess unimpeachable integrity, be informed by scientific and clinical evidence, but also be wary of the tension between sports' short-term aims and athletes' long-term needs. All concerned must understand the immediate and long-term risks of their injuries. How athletes, coaches, and sporting authorities are likely to respond to that knowledge should have little bearing on the evidence-based guidance and recommendations offered.

Given the unique environment of sport, we recommend that consensus conferences and the documents they produce maximize transparency and participant inclusion. No one attending these consensus conferences, or participating in producing the final product, should expect or even desire privacy related to potential conflicts of interest. Broad disciplinary and participant inclusion should be a core value informing the crafting of such a consensus. Patients, caregivers and survivors living with the consequences of head impacts, brain injuries, or fatal outcomes should have representation and roles. Beyond that, consensus guidelines must provide an extensive register of authors' conflicts of interest and how they will be managed by the group. There should be strict criteria on selection of an independent chair who will have additional influence on the direction conversations and decisions take. Ideally, authors should have no potential conflicts to register within the last decade. Beyond these safeguards, how evidence is identified, selected, and interpreted needs to be transparent and publicly available to enable continuous rigorous peer review. Any embargoed data should be released.

There should be a change in focus from trying to 'prove cause and effect' to following the ethical principle of 'first do no harm'. As was the case for smoking and lung cancer, proving a causal link may not be entirely possible and conclusions need to be drawn from the evidence that is available. Strong associative links must be acted upon when the potential implications are life-threatening and life-debilitating. If evidence is missing, calls need to be put out to address that area of need through research. We suggest the following actions need to be implemented by a new concussion in sport group:

- Selection of an independent chair with previous experience in the creation of widely used and respected guidelines, definitely from a different field of study altogether to avoid bias.
- Group membership by roles (e.g. pathologists, physiatrists, neurologists, sports physicians, psychologists, player representatives, player caregiver representatives, and/or lay members) needed rather than specific individuals. Wide international representation would be ideal.
- Transparent processes for the key questions to be posed, selection of literature, criteria for review, results found and how they were interpreted.
- Terms of reference that ensure an athlete health focus, not a sports organization focus.
- Clear process for registering and managing conflicts of interest.
- An open process where disagreement (non-consensus) on issues is publicly recorded.

## Infographics

- Salmon, D., Sullivan, J., Romanchuk, J., Murphy, I., Walters, S., Whatman, C., . . . Van Der Vis, K. (2020). Infographic. New Zealand rugby's community concussion initiative: Keeping kiwi communities RugbySmart. *British Journal of Sports Medicine*, 54(5), 300-301. doi:[10.1136/bjsports-2019-100949](https://doi.org/10.1136/bjsports-2019-100949)
- Salmon, D., Romanchuk, J., Murphy, I., Sullivan, J., Walters, S., Whatman, C., . . . Van Der Vis, K. (2020). Infographic. New Zealand Rugby's concussion management pathway. *British Journal of Sports Medicine*, 54(5), 298-299. doi:[10.1136/bjsports-2019-100950](https://doi.org/10.1136/bjsports-2019-100950)