

Introducing the Sport Concussion Office Assessment Tool 6 (SCOAT6)

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BACKGROUND AND RATIONALE

Since 2004, the Concussion in Sport Group (CISG) has produced the Sport Concussion Assessment Tool (SCAT),¹ the most recent iteration of which is the SCAT6. The SCAT has greatest utility in assessing acute concussions in the first 72 hours (3 days) following injury.²⁻⁴ Sport-related concussions (SRC) are complex pathophysiological processes manifesting in varying ways across different clinical domains. Serial, multimodal clinical evaluation is recommended to identify areas for potential intervention and monitor recovery. As part of the 6th International Consensus Conference on Concussion in Sport, the author group was tasked with developing a clinical tool better suited to evaluating and managing SRC in the days and weeks after the acute (first 72 hours) period postinjury. The Sport Concussion Office Assessment Tool 6 (SCOAT6), for use in athletes 13 years and older, is the product of the 6th International Consensus Conference on Concussion in Sport aimed at assisting Health Care Professionals (HCPs) in an office-based, multimodal assessment of SRC. A child version for use in children ages 8–12 years is described separately in this issue.⁵ Consistent with the principles of previous consensus conference outputs, the Sport Concussion Office Assessment Tool 6 (SCOAT6) will be freely available.

PROCESS FOR DEVELOPMENT

Specific to the search for the systematic review informing the development of the SCOAT6 was the diagnostic accuracy of

clinical tests to: (1) establish the diagnosis or predict the prognosis of concussion and (2) affect clinical subdomains related to impairment and function of the patient in the subacute phase of injury (3–30 days).⁶ The results of the search informed a draft paper forwarded to the Expert Panel before the conference, and the key outcomes were presented by the lead author at the meeting. These outcomes were voted on and approved by the expert panel and the format of the SCOAT6 further deliberated on by a dedicated group that met at a workshop to discuss the tools on the final day of the conference. Between November 2022 and January 2023, the SCOAT6 was then developed and refined by a clinical subgroup of the systematic review authors.

CONTENT OF THE SCOAT6

The systematic review synthesised results across 12 prespecified clinical domains including: (1) global symptom scales, (2) cognition, (3) vestibulo-ocular, (4) cervical assessment, (5) neurological examination (6) autonomic dysfunction, (7) paediatric-specific, (8) balance assessment/postural stability, (9) sleep assessment, (10) depression/anxiety, (11) exercise stress test and (12) emerging technologies for office assessment. Apart from the diagnostic accuracy, the appropriateness of tests for an office environment was also considered as well as accessibility, time to complete and cost.

The expert panel approved the following recommendations for inclusion in the SCOAT6:

- ▶ Word recall and digit backwards tests: The 10-word immediate recall and digit backwards tests should be used; should the athlete find the word recall task too easy (eg, exhibits a ceiling effect), a 15-word list may be used.

- ▶ Measurement of systolic and diastolic blood pressure as well as heart rate in the supine position (after 2 min rest) followed by repeat measures after 1 min standing, accompanied by the recording of any symptoms (eg, lightheaded, dizzy) associated with postural change.
- ▶ Evaluation of the cervical spine.
- ▶ A neurological examination.
- ▶ Timed tandem gait as a single task and a more complex dual task with the addition of a choice among three cognitive tasks.
- ▶ The modified Vestibular-Ocular Motor Screen.
- ▶ Delayed word recall a minimum of 5 min after completion of the verbal list learning and memory tests.

Computerised neurocognitive test batteries (such as ANAM, Axon and ImPACT), where available, may also add value.

Due to the potential for sleep disturbances associated with SRC, anxiety related to the injury, and the overlap of depression and anxiety symptoms with SRC, inclusion of optional validated sleep screening tool and mental health screening tools was recommended.⁷⁻¹⁰

HOW TO USE THE SCOAT6

The SCOAT6 is a multimodal clinical management tool to be used in the serial evaluation of athletes postconcussion. It has evolved from the SCAT6 and aligns with the domains validated since the creation of the SCAT. While remaining true to the systematic process that led to the determination of which diagnostic tests are most appropriate to include in the SCOAT6, it also needs to be acknowledged that such a tool requires flexibility to deal with variations in clinical context, HCP skill sets and time constraints. Hence, components of the SCOAT6 have been colour coded as follows: black—need only be completed at the first consultation; green—recommended components and orange—optional components.

Moreover, although the inclusion criteria of the systematic review specified clinical tests used 3–30 days postconcussion, it is expected that clinicians will continue to use a similar clinical evaluation beyond this period when needed to monitor athletes and guide management. With time, as with the four previous iterations of the SCAT, the SCOAT requires evaluation, validation and refinement.

The SCOAT6 is freely available and the tool will be accompanied by an extensive and freely-accessible supplement that

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details each of the components of the SCOAT6. An important corollary to more widespread use of the SCOAT6 is that more athlete-specific assessments should promote better individualised care. As with the SCAT6, the aim is to culturally adapt the SCOAT6 into many languages.

The SCOAT6 is a new product of the concussion consensus process. As a multi-modal tool designed to assist HCPs in the management of SRC in the subacute phase, the SCOAT6 should complement HCPs' clinical skills to allow greater consistency in the evaluation and treatment of SRC.

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Contributors JP conceptualised the initial draft of the editorial describing the process of developing the sports concussion office assessment tool (SCOAT6). Initial versions of the manuscript were aligned with the process for the SCAT6, lead author RJE and the Child SCAT6, lead author GAD. All clinician coauthors of the SCOAT6 systematic review were invited to contribute to this editorial and align it with their input into the development of the SCOAT6. All coauthors provided edits through three rounds of review before agreeing on the final version. JP submits on behalf of all authors and takes accountability for the editorial's content.

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Competing interests JP Editor BJSM (honarium) Member of World Rugby Concussion Advisory Group (unpaid) Independent Concussion Consultant for World Rugby (fee per consultation) Medical consultant to South African Rugby (unpaid) Co-chair of the Scientific Committee, 6th International Conference on Concussion in Sport (unpaid) Board member of the Concussion in Sport Group (unpaid) Scientific Board member, EyeGuideTM (unpaid). GAD is a member of the Scientific Committee of the 6th International Consensus Conference on Concussion in Sport; an honorary member of the AFL Concussion Scientific Committee; Section Editor, Sport and Rehabilitation, NEUROSURGERY; and has attended meetings organised by sporting organisations including the NFL, NRL, IHF, IOC and FIFA; however, has not received any payment, research funding or other monies from these groups other than for travel costs. OHA is a senior physiotherapist at University Hospitals Dorset NHS Foundation Trust (England) and is Para Football Physiotherapy Lead/Para Football Classification Lead at the Football Association (England). He also works on a consultancy basis with the Football Association as the squad physiotherapist to the England Cerebral Palsy Football squad, and teaches on the Football Association's Advanced Trauma and Medical Management in Football course on a consultancy basis. He has a Visiting Senior Lecturer position at the University of Portsmouth, England (unpaid). He sits on several disability sport committees including Para Football Foundation as Medical Unit Co-Lead (unpaid), the International Federation of Cerebral Palsy Football as Medical and Sports Science Director (unpaid) and the International Blind Sports Association as Medical Committee member (unpaid). He has Associate Editor positions at the British Journal of Sports Medicine (unpaid) and BMJ Open Sports NCAA-CARE-DoD 2.0, ended 2020. Have received honoraria and reimbursement for travel for speaking and conferences. Have written chapters for UpToDate, and received royalties for the Neerer's Sports Medicine textbook. Have provided work as an expert for cases involving concussion, team physician and other sports medicine topics. GMS is an owner of a multidisciplinary practice (managing patients with MSK pain disorders). He is a board member of Hockey Calgary (Calgary, AB, Canada)

and Chair of the Alberta Association of Physiotherapy. He received funding for the administrative aspects of the writing of two of the systematic reviews that informed the consensus process. Dr. SAH is co-founder and senior advisor, The Sports Institute at UW Medicine (unpaid)Centers for Disease Control and Prevention and National Center for Injury Prevention and Control Board Pediatric Mild Traumatic Brain Injury Guideline Workgroup (unpaid)Concussion in Sport Group (travel support)NCAA Concussion Safety Advisory Group (unpaid)Team Physician, Seattle MarinersFormer Team Physician, Seattle SeahawksOccasional payment for expert testimony. Travel support for professional meetings has received grant funding from the Canadian Institutes of Health Research, National Football League Scientific Advisory Board, International Olympic Committee Medical and Scientific Research Fund, World Rugby, Mitacs Accelerate, University of Calgary) with funds paid to her institution and not to her personally. She is an associate editor of BJSM (unpaid) and has received travel and accommodation support for meetings where she has presented. She is coordinating the writing of the systematic reviews that will inform the 6th International Consensus on Concussion in Sport, for which she has received an education grant to assist with the administrative costs associated with the writing of the reviews. She is a member of the AFL Concussion Scientific Committee (unpaid position) and Brain Canada (unpaid positions). She works as a physiotherapy consultant and treats athletes of all levels of sport from grass roots to professional. MT is employed full-time as the CEO and Medical Director of ICHIRF—a paid post he has held since April 2015. Hon Medical Adviser to the Professional Riders Insurance Scheme (PRIS)—discretionary honorarium Member of the Premier League Head Injury Advisory Group (HIAG)—no remuneration Director of ICHIRF Ireland—no remuneration Honorary Medical Adviser to the Concussion Foundation—no remuneration Member of the expert panel for the Dept of Digital, Culture, Media and Sport review into concussion in amateur sport—no remuneration Attendance at conferences or meetings as a guest speaker—reimbursement of travel expenses, complimentary registration and payment of hotel accommodation and meals by the organising committee. No stocks or options in any concussion-related company. No consultancies, board or editorial positions related to concussion. Jvl is the founder of R2P Concussion Management. NW Chair, British Paralympic Association (voluntary) IPC Medical Committee Member (voluntary) Concussion in Para Sports (CIPS), founding member (voluntary) BJSM Editorial Board member (voluntary) Sports Horizon, Board of Directors—equity share—see <https://www.sportshorizon.co.uk> KOY is editor-in-chief of the journal Neuropsychology and receives an editorial stipend from the American Psychological Association. He is an unpaid consulting editor for the journals Archives of Clinical Neuropsychology and Journal of Head Trauma Rehabilitation. He is an unpaid member of the Scientific Advisory Committee for Brain Injury Canada. He is the chair of the Canadian Concussion Network, which is funded by a grant from Canadian Institutes of Health Research (CIHR) to his institution; he is principal applicant on the grant but receives no income from it. He is a principal investigator on another grant from CIHR from which he derives no income. He is a coinvestigator on research grants from CIHR, the US National Institutes of Health (NIH), Brain Canada Foundation and National Football League Scientific Advisory Board; he derives income only from the grant from NIH. He serves as a member of a CIHR grant review panel for which he receives a small honorarium. He receives book royalties from Guilford Press and Cambridge University Press. He has received travel support and honorarium for presentations to multiple organisations. He has served or serves on the following committees/boards for which he receives honorarium:

1. Independent Data Monitoring Committee (IDMC), Care for Post-Concussive Symptoms Effectiveness (CARE4PCS-2) Trial, National Institute for Child Health and Human Development 2. Observational Study Monitoring Board (OSMB), Approaches and Decisions in Acute Pediatric TBI (ADAPT) Trial, National Institute of Neurological Disorders and Stroke National Research Advisory Council, National Pediatric Rehabilitation Resource Center, Center for Pediatric Rehabilitation: Growing Research, Education, and Sharing Science (C-PROGRESS), Virginia Tech University.

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REFERENCES

- 1 McCrory P, Johnston K, Meeuwisse W, *et al.* Summary and agreement statement of the second International Conference on concussion in sport, Prague 2004. *Phys Sportsmed* 2005;**33**:29–44.
- 2 Echemendia RJ, Meeuwisse W, McCrory P, *et al.* The concussion recognition tool 5th edition (crt5): background and rationale. *Br J Sports Med* 2017;**51**:870–1.
- 3 Echemendia RJ, Thelen J, Meeuwisse W, *et al.* Testing the hybrid battery approach to evaluating sports-related concussion in the National hockey

League: a factor analytic study. *Clin Neuropsychol* 2020;**34**:899–918.

- 4 Downey RI, Hutchison MG, Comper P. Determining sensitivity and specificity of the sport concussion assessment tool 3 (scat3) components in University athletes. *Brain Inj* 2018;**32**:1345–52.
- 5 Davis PJ, Purcell L, *et al.* The child sports concussion office assessment tool 6 (child SCOAT6). *Br J Sports Med* 2023;**57**:632–5.
- 6 Patricios JS, Schneider G, *et al.* [A1] Beyond acute concussion assessment to office management. A systematic review informing the development of a Sport Concussion Office Assessment Tool (SCOAT6) for adults and children. [A1]I don't think the SCOAT requires that this is a re-evaluation. Many of the clinicians who will use the SCOAT6 will be seeing the patient for the first time. Is this needed? Happy to be overruled.. *Br J Sports Med* 2023;**57**:737–48.
- 7 Spitzer RL, Kroenke K, Williams JBW, *et al.* A brief measure for assessing generalized anxiety disorder. *Arch Intern Med* 2006;**166**:1092.
- 8 Kroenke K, Spitzer RL, Williams JB. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 2001;**16**:606–13.
- 9 Bender AM, Lawson D, Werthner P, *et al.* The clinical validation of the athlete sleep screening questionnaire: an instrument to identify athletes that need further sleep assessment. *Sports Med Open* 2018;**4**:23:23.
- 10 Gouttebauge V, Bindra A, Blauwet C, *et al.* International Olympic Committee (IOC) sport mental health assessment tool 1 (SMHAT-1) and sport mental health recognition tool 1 (SMHRT-1): towards better support of athletes' mental health. *Br J Sports Med* 2021;**55**:30–7.