

# The Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5)

Gavin A Davis,<sup>1,2</sup> Laura Purcell,<sup>3</sup> Kathryn J Schneider,<sup>4,5,6</sup> Keith Owen Yeates,<sup>7</sup> Gerard A Gioia,<sup>8,9</sup> Vicki Anderson,<sup>1</sup> Richard G Ellenbogen,<sup>10</sup> Ruben J Echemendia,<sup>11</sup> Michael Makdissi,<sup>2,12</sup> Allen Sills,<sup>13</sup> Grant L Iverson,<sup>14</sup> Jiri Dvorak,<sup>15</sup> Paul McCrory,<sup>2</sup> Willem Meeuwisse,<sup>16</sup> Jon Patricios,<sup>17,18</sup> Christopher C Giza,<sup>19</sup> Jeffrey S Kutcher<sup>20</sup>

For numbered affiliations see end of article.

## Correspondence to

Professor Gavin A Davis, Suite 53 - Neurosurgery, Cabrini Medical Centre, Malvern, Victoria, Australia; [gavin.davis@me.com](mailto:gavin.davis@me.com)

Accepted 9 January 2017

## ABSTRACT

This article presents the Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5). The Sport Concussion Assessment Tool was introduced in 2004, following the 2nd International Conference on Concussion in Sport in Prague, Czech Republic. Following the 4th International Consensus Conference, held in Zurich, Switzerland, in 2012, the SCAT 3rd edition (Child SCAT3) was developed for children aged between 5 and 12 years. Research to date was reviewed and synthesised for the 5th International Consensus Conference on Concussion in Sport in Berlin, Germany, leading to the current revision of the test, the Child SCAT5. This article describes the development of the Child SCAT5.

## INTRODUCTION

The Sport Concussion Assessment Tool (SCAT) was introduced in 2004, following the 2nd International Conference on Concussion in Sport in Prague, Czech Republic.<sup>1</sup> The aim was to 'create a standardised tool that could be used for patient education as well as for physician assessment of sports concussion', by combining eight existing tools into one. However, the SCAT was not age-specific and was not appropriate for younger concussed children. The 3rd International Conference on Concussion in Sport, held in Zurich, Switzerland, in 2008, introduced the SCAT2 and recommended its use for athletes aged  $\geq 10$  years.<sup>2</sup> The 4th International Consensus Conference, held in Zurich, Switzerland, in 2012, examined the evidence for the assessment of the child athlete and determined that a child-specific tool was required. Thus, the Child SCAT3 was developed for children aged between 5 and 12 years.<sup>3</sup> Based on the available evidence, the Child SCAT3 incorporated several components that differed from the SCAT3. First, the Maddocks questions were modified to include questions more appropriate to children engaged in both organised and playground sport. Second, the Symptom Evaluation was changed from the adult version of the Post-Concussion Symptom Scale to the Health and Behavior Inventory, which is a validated symptom list for both child-reported and parent-reported symptoms.<sup>4</sup> Third, the Orientation assessment did not include the time question because most young children cannot answer this question. Fourth, the Digits Backwards introduced a two-digit string because

many younger children could not perform this task with three-digit strings. Fourth, the Months in Reverse Order was changed to Days of the Week because many young children could not recite the months in order. Fifth, the Balance Examination removed the single-leg stance because many younger children were unable to perform this task. Finally, Return to School information was provided for the child athlete. To date, very few studies have been published using the Child SCAT3.<sup>5-8</sup>

## METHODS

The 5th International Consensus Conference on Concussion in Sport, held in Berlin, Germany, in 2016, followed a consensus development process, which incorporated systematic reviews to address specific questions, and the results of the reviews were presented at the meeting in an open forum. Full methods of the 5th International Consensus Conference on Concussion in Sport are published elsewhere.<sup>9</sup> Poster abstracts, as well as audience questions and feedback, were included in the expert panel's deliberations following the meeting in Berlin.

A systematic review of the SCAT3 and Child SCAT3 was performed<sup>10</sup> and the evidence was synthesised to inform the expert panel convened to improve these tools. The panel unanimously agreed that a child-specific version of the SCAT is required. A subgroup of the Berlin Expert Panel met on a separate day to develop a revised version of the tool, the Child SCAT5. *The version number (5) was chosen to align the version number with the consensus meeting number and, therefore, there is no Child SCAT4.*

## RESULTS

Based on the systematic reviews, conference discussions and panel deliberations, we made several modifications to the Child SCAT3 to create the Child SCAT5. These modifications are set out in [box 1](#). The format of the Child SCAT5 is consistent with the SCAT5. The panel sought to minimise the changes to test elements that have demonstrated validity and are complemented by published normative data. We modified components that did not meet these criteria, as needed.

The Child SCAT5 is a tool for evaluating injured children (aged 5–12 years) suspected of having suffered concussion and is designed



CrossMark

**To cite:** Davis GA, Purcell L, Schneider KJ, et al. *Br J Sports Med* Published Online First: [please include Day Month Year]. doi:10.1136/bjsports-2017-097492

## Consensus statement

## Box 1 Modifications of the Child SCAT3 for the Child SCAT5.

- ▶ The Potential Signs of Concussion Box was replaced with a 'Red Flags' Box in the initial assessment to highlight the potential of a structural brain injury that may require neurosurgical intervention.
- ▶ Declaration that the complete Child SCAT5 cannot be appropriately completed in less than 10–15 min.
- ▶ The modified Maddocks questions were removed because of the questionable reliability and usefulness in young children.
- ▶ The Symptom Evaluation is recommended to be performed with the child in a resting state.
- ▶ Neck pain was added to the list of child-reported and parent-reported symptoms.
- ▶ An overall rating of functioning (0-10) has been included for the Child Report and a rating (0-100) has been included for the Parent Report.
- ▶ The Orientation questions were removed because of their doubtful usefulness in young children.
- ▶ The Immediate Memory word lists include two additional five-word lists and optional 10-word lists are provided for older children in whom a ceiling effect is identified with the five-word lists. All six versions of the Standardised Assessment of Concussion word lists are now presented and they should be administered by choosing one at random for baseline testing and then using them serially post-injury.
- ▶ The time at completion of the third trial of the word list is recorded and the Delayed Recall is not to proceed <5 min from completion of the Immediate Recall.
- ▶ Digits Backwards has been modified to include two additional digit lists and has been formatted to assist with administration of this test, in which a correct response from one string length advances to the next string length, but an incorrect response requires a second trial at the same string length. Administration of different digit lists should be randomised at baseline and serially post injury.
- ▶ The Balance Examination includes the single-leg stance for children aged 10–12 years.
- ▶ The Neck Examination and Coordination Examination have been removed and incorporated into a new section, the Rapid Neurological Screen (RNS).
- ▶ The RNS includes assessment of balance and gait, ocular function, coordination and reading (assesses cognitive function, cranial nerves [acuity, diplopia], dysphasia, dysarthria and response time). Younger children who cannot read are asked to describe what they see in a photograph.
- ▶ The Return to School information has been modified to inform the student that prolonged school absence is not recommended and that appropriate accommodations should be made, in consultation with the medical team, teachers and parents/caregivers. The Return to School section includes a stepwise table that allows for symptom-limited cognitive activity.<sup>13</sup>
- ▶ The Return to Sport information has been modified to inform the student that a symptom-limited activity programme should be followed with healthcare professional guidance.<sup>13</sup>

for use by medical professionals. The SCAT5, for athletes aged  $\geq 13$  years, is published separately.<sup>11</sup> A separate tool, the Concussion Recognition Tool 5, has been developed for

non-medically trained individuals for the identification and immediate management of suspected concussion and is also published separately.<sup>12</sup>

## DISCUSSION

The Child SCAT5 is consistent with the previous version—it provides a standardised approach to the evaluation of suspected concussion that includes measures and methods valid for detecting sport-related concussion. The Child SCAT5 incorporates changes that address some of the limitations identified in the systematic review<sup>10</sup> and provides additional evaluative tools (eg, RNS).

The diagnosis of concussion relies on a clinical synthesis of complex, non-specific and, at times, contradictory information. Accordingly, only healthcare professionals trained in the assessment and management of sport-related concussion should use the Child SCAT5. The Child SCAT5 is a tool to assist the qualified health professional with the clinical diagnosis of concussion and is not designed to be used in isolation to make or exclude the diagnosis of concussion.

The Child SCAT5 includes comprehensive instructions for the appropriate administration of the subscales that should be carefully studied and practised prior to clinical use. Future research on the reliability and validity of the Child SCAT5 will inform further improvement of this tool. We note that there are insufficient data on the use of the Child SCAT in athletes with disabilities and across different cultures and language groups. We recommended that a systematic approach be undertaken to translate and culturally adapt the Child SCAT5 into other languages. The Concussion in Sport Group encourages research; there is a need for a comprehensive set of norms in both sexes and across ages, language groups, sports and in people with disabilities.

The Child SCAT5 is available for free, unrestricted distribution for use in childhood sport-related concussion, provided that no modifications are made to the tool. The development of the tool is evidence-informed and we encourage its widespread distribution and use by medical professionals worldwide.

## Author affiliations

<sup>1</sup>Murdoch Childrens Research Institute, Melbourne, Australia

<sup>2</sup>Florey Institute of Neuroscience and Mental Health, Austin Campus, Melbourne Brain Centre, Heidelberg, Australia

<sup>3</sup>Department of Pediatrics, McMaster University, Hamilton, Ontario, Canada

<sup>4</sup>Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Alberta, Canada

<sup>5</sup>Alberta Children's Hospital Research Institute for Child & Maternal Health, Cumming School of Medicine, University of Calgary, Alberta, Canada

<sup>6</sup>Hotchkiss Brain Institute, University of Calgary, Alberta, Canada

<sup>7</sup>Department of Psychology, Alberta Children's Research Institute, Hotchkiss Brain Institute, University of Calgary, Calgary, Canada

<sup>8</sup>Division of Pediatric Neuropsychology, Children's National Health System, George Washington University School of Medicine, Washington, DC, USA

<sup>9</sup>Department of Pediatrics and Psychiatry & Behavioral Sciences, George Washington University School of Medicine, Washington, DC, USA

<sup>10</sup>Department of Neurological Surgery, University of Washington, Seattle, Washington, USA

<sup>11</sup>University Orthopaedic Center, Concussion Care Clinic, State College, PA, USA; University of Missouri-Kansas City, Kansas City, Missouri, USA

<sup>12</sup>Olympic Park Sports Medicine Centre, Melbourne, Australia

<sup>13</sup>Vanderbilt University Medical Center, Nashville, Tennessee, USA

<sup>14</sup>Center for Health and Rehabilitation Research, Department of Physical Medicine and Rehabilitation, Harvard Medical School, Charlestown, Massachusetts, USA

<sup>15</sup>Swiss Concussion Center, Schulthess Clinic Zurich, Switzerland

<sup>16</sup>Sport Injury Prevention Research Centre, Faculty of Kinesiology, University of Calgary, Canada

<sup>17</sup>Section Sports Medicine, Faculty of Health Sciences, University of Pretoria, Pretoria, South Africa

<sup>18</sup>Department of Emergency Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

<sup>19</sup>UCLA Steve Tisch BrainSPORT Program, Operation MEND TBI Program, Los Angeles, USA

<sup>20</sup>The Sports Neurology Clinic at the CORE Institute, Michigan, USA

**Competing interests** GAD is an honorary member of the Australian Football League Concussion Working Group and has attended meetings organised by sporting organisations including the NFL (USA), National Rugby League (Australia) and FIFA (Switzerland); however, he has not received any payment, research funding or other monies from these groups other than for travel costs. LP is an expert consultant to mdBriefcase in the development of an online concussion education module and has received speaking honoraria/travel expenses for presentations at scientific meetings. KJS has received speaking honoraria for presentations at scientific meetings. She is a physiotherapy consultant at Evidence Sport and Spinal Therapy in Calgary, Alberta, Canada, and for athletic teams. KOY has received grant funding from NIH and Canadian Institutes of Health Research and book royalties from Guilford Press and Cambridge University Press and has occasionally served as an expert witness in forensic cases; he is President-Elect of the International Neuropsychological Society and a member of the Expert Panel on Acute Diagnosis and Management of Mild Traumatic Brain Injury among Children and Adolescents convened by the Centers for Disease Control and Prevention. RGE is a volunteer co-chairman of the NFL Head Neck and Spine Medical Committee. RJE is a consultant to the NHL, Major League Soccer, US Soccer Federation and Princeton University. He has received financial remuneration for these consulting relationships. He has a clinical practice in sport neuropsychology and serves as an expert (neuropsychology, sport neuropsychology) in medico-legal cases involving traumatic brain injury. He at times has received honoraria and reimbursement of expenses to attend professional meetings. MM is Consultant Sport and Exercise Medicine Physician at Olympic Park Sports Medicine Centre, Team Doctor—Hawthorn football club (Australian Football League(AFL)). AFL research grant—funding for research program on concussion in AFL (collaboration between the AFL and the Florey Institute of Neuroscience & Mental Health). Shareholder—Olympic Park Sports Medicine Centre. IOC—travel and accommodation paid as part of Ad Hoc Committee to evaluate rule changes in boxing. FIFA—Travel and accommodation paid as part of International Concussion in Sport Group. AFL—support for travel to NFL concussion 'think tank' August 2014. CogState Pty Ltd—free access to computerised neuropsychological testing program for research purposes. AFL Doctors Association—paid role as executive officer. Honorary member of the Australian Rugby Union Concussion Advisory Group; World Rugby Concussion working group; Concussion in AFL working group; AFL Concussion Scientific Committee and Member and the International Olympic Committee ad hoc group to evaluate rule change in boxing. AS is an unaffiliated neurotrauma consultant, the NFL. GLI acknowledges philanthropic research support from the Mooney-Reed Charitable Foundation and ImPACT Applications, Inc. He has a medical-legal consulting practice, including expert testimony, in the area of neuropsychology and mild traumatic brain injury. PMCC is a co-investigator, collaborator, or consultant on grants relating to mild TBI funded by several governmental organizations. He is directly employed by the National Health & Medical Research Council of Australia and is based at the Florey Institute of Neuroscience and Mental Health. He is Co-Chair of the Australian Centre for Research into Sports Injury and its Prevention (ACRISP), which is one of the International University Research Centres for Prevention of Injury and Protection of Athlete Health supported by the International Olympic Committee (IOC). He is co-chair of the International Concussion in Sport Group and is a member of the scientific advisory boards of the International Concussion & Head Injury Research Foundation (London, UK) and the Sports Surgery Clinic (Dublin, Ireland). He has a clinical and consulting practice in general and sports neurology. He receives book royalties from McGraw-Hill and was employed in an editorial capacity by the British Medical Journal Publishing Group from 2001 to 2008. He has been reimbursed by the government, professional scientific bodies, and sporting bodies for travel costs related to presenting research on mild TBI and sport-related concussion at meetings, scientific conferences, and symposiums. He received consultancy fees in 2010 from Axon Sports (US) for the development of educational material (which was not renewed) and has received research funding since 2001 from CogState Inc. The Australian Football League funds research at the Florey Institute under a legal memorandum and Dr. McCrory does not receive any money from this industry funded

research. Dr. McCrory is a cofounder and shareholder in two biomedical companies (involved in eHealth and Compression garment technologies) but does not hold any individual shares in any company related to concussion or brain injury assessment or technology. He did not receive any form of financial support directly related to this manuscript. WM is Medical Director for the National Hockey League. JP is concussion consultant to South African Rugby's BokSmart injury prevention programme and a member of World Rugby's Concussion Advisory Group; both organisations have contributed honoraria towards conference expenses. GAG receives royalties as a test author from Psychological Assessment Resources, receives research funding from the CDC and NIH, receives speaking Honoraria for professional lectures, and is on the pediatric mild TBI guidelines panel of the CDC. CCG receives grants/research support from NIH, NCAA, DoD, Today's and Tomorrow's Children Fund, UCLA Brain Injury Research Center, UCLA Faculty Grants Program, UCLA Steve Tisch BrainSPORT program, Avair (research grant 2016-2017), NINDS Neural Analytics SBIR grant (2016-2018) Consultant: NFL-Neurological Care Program, NHLPA, Neural Analytics Inc (2015-16), is on the advisory panel of LoveYourBrain, MLS, NBA, NCAA, USSF, performs medicolegal work 1-2 cases annually, and speaks on the Medical Education Speakers Network. JSK provides consulting to National Basketball Association, National Football League Players' Association, National Hockey League Players' Association, EIMindA, Ltd. VA and JD have nothing to declare.

**Provenance and peer review** Commissioned; internally peer reviewed.

© Article author(s) (or their employer(s) unless otherwise stated in the text of the article) 2017. All rights reserved. No commercial use is permitted unless otherwise expressly granted.

## REFERENCES

- 1 McCrory P, Johnston K, Meeuwisse W, *et al*. Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004. *Br J Sports Med* 2005;39:i78-i86.
- 2 McCrory P, Meeuwisse W, Johnston K, *et al*. Consensus statement on concussion in sport: the 3rd international conference on concussion in sport held in Zurich, November 2008. *Br J Sports Med* 2009;43 (Suppl 1):i76-i84.
- 3 McCrory P, Meeuwisse WH, Aubry M, *et al*. Consensus statement on concussion in sport: the 4th international conference on concussion in sport held in Zurich, November 2012. *Br J Sports Med* 2013;47:250-8.
- 4 Ayr LK, Yeates KO, Taylor HG, *et al*. Dimensions of postconcussive symptoms in children with mild traumatic brain injuries. *J Int Neuropsychol Soc* 2009;15:19-30.
- 5 Brooks A, McGuine T, Kebisek J, *et al*. Establishing the psychometric properties of the child sport concussion assessment tool (Child SCAT3). *Clin J Sport Med* 2015;25:214.
- 6 Glaviano NR, Benson S, Goodkin HP, *et al*. Baseline SCAT2 assessment of healthy youth student-athletes: Preliminary evidence for the use of the Child-SCAT3 in children younger than 13 years. *Clin J Sport Med* 2015;25:373-9.
- 7 Jennings D, Sells P, Allison J, *et al*. Effects of a season of subconcussive contact on child- SCAT3 scores in 8-12 year-old male athletes. *Int J Sports Phys Ther* 2015;10:667.
- 8 Nelson LD, Loman MM, LaRoche AA, *et al*. Baseline performance and psychometric properties of the child sport concussion assessment tool 3 (Child-SCAT3) in 5- to 13-year-old Athletes. *Clin J Sport Med* 2016:1.
- 9 Meeuwisse W, Schneider K, Dvorak J, *et al*. The Berlin 2016 process: a summary of methodology for the 5th international consensus conference on concussion in sport. *Br J Sports Med* 2017 .
- 10 Echemendia RJ, Broglio SP, Davis GA, *et al*. What tests and measures should be added to the SCAT3 and related tests to improve their reliability, sensitivity and/or specificity in sideline concussion diagnosis? *A systematic Review Br J Sports Med* 2017.
- 11 Echemendia RJ, Meeuwisse W, McCrory P, *et al*. The Sport Concussion Assessment Tool 5th Edition (SCAT5). *British Journal of Sports Medicine* 2017.
- 12 Echemendia RJ, Meeuwisse W, McCrory P, *et al*. The Concussion Recognition Tool 5th Edition (CRT5). *Br J Sports Med* 2017.
- 13 Davis GA, Anderson V, Babl FE, *et al*. What is the difference in concussion management in children as compared to adults? A systematic review. *Br J Sports Med* 2017.



## The Child Sport Concussion Assessment Tool 5th Edition (Child SCAT5)

Gavin A Davis, Laura Purcell, Kathryn J Schneider, Keith Owen Yeates, Gerard A Gioia, Vicki Anderson, Richard G Ellenbogen, Ruben J Echemendia, Michael Makdissi, Allen Sills, Grant L Iverson, Jiri Dvorak, Paul McCrory, Willem Meeuwisse, Jon Patricios, Christopher C Giza and Jeffrey S Kutcher

*Br J Sports Med* published online April 26, 2017

---

Updated information and services can be found at:

<http://bjsm.bmj.com/content/early/2017/05/09/bjsports-2017-097492>

---

*These include:*

### References

This article cites 7 articles, 2 of which you can access for free at:

<http://bjsm.bmj.com/content/early/2017/05/09/bjsports-2017-097492>  
#BIBL

### Email alerting service

Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

---

### Notes

---

To request permissions go to:

<http://group.bmj.com/group/rights-licensing/permissions>

To order reprints go to:

<http://journals.bmj.com/cgi/reprintform>

To subscribe to BMJ go to:

<http://group.bmj.com/subscribe/>