Return to Sports Following Sports-Related Concussion in Collision Sports: An Expert Consensus Statement Using the Modified Delphi Technique

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Purpose: To perform a Delphi consensus for return to sports (RTS) following sports-related concussion (SRC). Meth- ods: Open-ended questions in rounds 1 and 2 were answered. The results of the first 2 rounds were used to develop a Likert-style questionnaire for round 3. If agreement at round 3 was S80% for an item, if panel members were outside consensus or there were >30% neither agree/disagree responses, the results were carried forward into round 4. The level of agreement and consensus was defined as 90%. Results: Individualized graduated RTS protocols should be used. A normal clinical, ocular and balance examination with no more headaches, and asymptomatic exertional test allows RTS. Earlier RTS can be considered if athletes are symptom free. The Sports Concussion Assessment Tool 5 and vestibular and ocular motor screening are recognized as useful tools to assist in decision-making. Ultimately RTS is a clinical decision. Baseline assessments should be performed at both collegiate and professional level and a combination of neurocognitive and clinical tests should be used. A specific number of recurrent concussions for seasondor career-ending decisions could not be determined but will affect decision making for RTS. Conclusions: Consensus was achieved for 10 of the 25 RTS criteria: early RTS can be considered earlier than 48 to 72 hours if athletes are completely symptom-free with no headaches, a normal clinical, ocular and balance examination. A graduated RTS should be used but should be individualized. Only 2 of the 9 assessment tools were considered to be useful: Sports Concussion Assessment Tool 5 and vestibular and ocular motor screening. RTS is mainly a clinical decision. Only 31% of the baseline assessment items achieved consensus: baseline assessments should be performed at collegiate and professional levels using a combination of neurocognitive and clinical tests. The panel disagreed on the number of recurrent concussions that should be season- or career-ending. Level of Evidence: Level V, expert Opinion.

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Sports-related concussions are known to potentially have short-term effects on cognitive processes but also can affect memory, executive, and psychomotor function with evidence of poorer cognitive health in retired athletes with a history of concussion.[1] A significantly greater prevalence in adverse mental health, sleep disruptions, anger, and irritability were observed in former elite and amateur rugby players who had a history of 5 or more concussions.[2]

Early return to sports can potentially cause worse clinical outcomes, but the current evidence only shows modest evidence for an association.[3] Before the introduction of standardized graduated return to play guidelines in 2011, 27% of rugby union players returned to play in <6 days, which decreased to 7% after the 2014 season despite a significant increase in the number of concussed athletes.[4] A similar return to sports postconcussion was observed in the National Football League from 2015 through 2020, with a median return to sports of 9 days reported.[5]

The National Athletic Trainers Association recommended no activity until the athlete no longer reports concussion-related symptoms, has a normal clinical examination, and performs at preconcussion levels on all objective concussion assessments.[6] This is followed by light exercise, sports-specific activities, noncontact training, unrestricted training, and return to play.[6] The National Athletic Trainers Association statement also specifies if any activity results in return of symptoms, it should be immediately stopped and restarted at a minimum of 24 hours.[6] The 2016 Berlin Consensus also recommends a graduated stepwise approach to rehabilitation and return to sports.[7] Following an initial period of rest (24-48 hours), symptom-limited activity below physical and cognitive threshold can be begun and progression to the next level depends on resolution

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The authors report the following potential conflicts of interest or sources of funding: P.B. reports personal fees from the National Rugby League, Rugby League Players Association, World Rugby, Manly Sea Eagles (rugby league team), and eo, and other from PolarCap, outside the submitted work. R.E. reports other from the National Hockey League, International Concussion Consensus Conference, and South African Sports Medicine Association, outside the submitted work. L.G. reports personal fees from World Rugby, outside the submitted work. M.M. reports personal fees from the Australian Football League, Olympic Park Sports Medicine Centre, Cabrini and Epworth Health, World Rugby, Hawthorn Football Club, and AFL Doctors Association, outside the submitted work. He has received travel support from the Australian Football League, FIFA (Fédération Internationale De Football Association), and the International Olympic Committee to present at international conferences. He is an honorary member of the Scientific Committee for the 6th International Conference on Concussion in Sport, the International Concussion in Sport Group, and the Australian Rugby Union Concussion Advisory Group. J.P. reports grants from World Rugby, personal fees from British Journal of Sports Medicine, and nonfinancial support from the International Olympic Committee, UEFA, and Isokinetic Conference, outside the submitted work. M.P. is a consultant and Chief Medical Officer for Major League Soccer. She serves as a team physician for U.S. Soccer and is also on their Medical Advisory Committee. She is a senior advisor for the National Football League (NFL) Head Neck & Spine Committee and a member of the NFL General Medical Committee. She is a member of the FA Research Task Force, United States Olympic & Paralympic Committee Mental Health Committee, the International Olympic Committee Mental Health Working Group, the National Operating Committee on Standards for Athletic Equipment Scientific Advisory Committee, the Centers for Disease Control and Prevention Concussion Committee, and is a member of the Concussion in Sport group. She has been an expert witness, written several chapters, and been an editor of the Netter's Sports Medicine Handbook. She has also received travel reimbursement and for travel and expenses for committee work. Full ICMJE author disclosure forms are available for this article online, as supplementary material.

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of concussion-related symptoms.[7] The graduated return to sports strategy involves 6 steps from symptom limited activity to light aerobic exercise, sports-specific exercise, noncontact training skills, full contact practice, to return to sports.[7]

The authors of the 2016 consensus statement also acknowledged that the consensus needs to be modified to accommodate new knowledge.[7] Here, a structured expert consensus approach such as the Delphi method allows experts with clinical expertise in a specific field to provide answers where evidence-based medicine cannot provide a clear guideline or is limited by biases, poor study quality, or the inability to reach valid conclusions.[8,9] Therefore, the purpose of this study was to perform a Delphi consensus for the return to sports assessment following sports concussion. It was hypothesized that would be reached consensus for all items.

Methods

The Delphi panel technique was used as previously described.[9] In principle, 4 rounds of questions are required. For this study, the first round of questions was developed by the steering committee based on submissions from the selected panel. The steering committee then compiled the questions for round 1. On completion of round 1, a written summary was provided to the panel and based on the responses from round 1, a second round with open questions was e-mailed to the panel. For round 3, a Likert style questionnaire was developed and again e-mailed to the panel. A 4-round approach was selected for this study. For all items where consensus could not be reached, panel members who were outside consensus, were asked to reconsider their answer or justify their response. Previous recommendations for consensus were suggested to a level of agreement of 80%.[10,11] However, the steering committee believed that very high consensus would reliably reduce bias and achieve solid and valid recommendations and defined consensus as a minimum level of agreement of 90%.[12]

Question Development

The steering group consisted of 2 experienced researchers who were not content experts and 2 experienced sports physicians with extensive experience in the field of sports-related head injuries. For question development the clinical guideline published in *Arthroscopy* was used, and the current controversies highlighted in the guideline were identified.[13]

Panel Selection

To select suitable panel members, the current literature was searched on Medline using the search terms "concussion," "head injury," and "sports concussion." Relevant publications were screened, and the senior authors were contacted and invited to participate as panel members. To achieve a broader perspective and increase the generalizability of the consensus state- ment, personal contacts to sports physicians involved with national and international contact sports were used and these contacts were asked to nominate their experts for sports concussion. The steering committee then invited 20 panel members. Of the 20 invited panel members, 3 declined participation. One potential panel member declined, explaining that he was currently too busy with other projects; 1 potential panel member felt that he was no expert in the field; and 1 potential panel member was not allowed to participate by his employer (professional sporting association based in the United States). The panel therefore consisted of recognized and well-published experts in the field, from diverse aca- demic background and of experienced sports physicians who served as team physicians of professional clubs at national and international level.

Table 1. Round 1 Open Questions: RTS Assessment of Sports-Related Concussion

[1] What are your return to sports criteria and how do you determine whether players are ready to return?
[2] Do you use any assessment tools such as SAC, SCAT, MACE, symptoms test such as ACE, PCSS or computerized neurocognitive tests such as ImPACT, C3 Logix, Cogstate, or others? Please outline why you prefer your approach.
[3] Is there a need for baseline assessments and, if yes, which one is your preferred tool? How often should these tests be repeated?
[4] If the athlete has a recurrent concussion/head injury, would this change your approach to RTS for this player?
[5] What is the minimum period of rest before a player can return to play and what are your criteria?
[6] For RTS, should the protocols/guidelines be time-specific or level-specific and do individual symptoms and severity of concussion play a role?
[7] At what point are second opinions from independent specialists required and what specific qualifications should they have?
[8] Do you use a specific concussion treatment/management strategy?
[9] Do you believe that baseline assessments are useful for RTS decision-making?
[10] Do multiple concussions or the severity of a concussion influence your timeline for return to sports? What are your criteria to recommend no further contact sport (within season and general)?
[11] Does the sporting code or level of professionalism make a difference when deciding on return to sports?
[12] Is there a role for biomarkers both for on-field assessment and RTS assessment?
[13] What would you consider prolonged or chronic concussion syndrome?
[14] If there is evidence of postconcussion syndrome what is your preferred investigation?
[15] Graduated return to sports: what do you use to determine suitability to graduated RTS?

ACE, acute concussion evaluation; ImPACT, immediate post-concussion assessment and cognitive testing; MACE, Military Acute Concussion Evaluation; PCSS, Post-Concussion Symptom Scale; RTS, return to sport; SAC, standardized assessment of concussion; SCAT, Sports Concussion Assessment Tool.

Rounds 1 and 2

In round 1, the 11 open questions were electronically delivered to the panel (Table 1). For the first round, the panel was asked to provide open-ended questions which they believed were critical for diagnosis and initial on-field management. The steering panel then summarized all responses and compiled 15 initial open- ended questions. The panel was asked to answer the questions in a narrative fashion and argue their case as specifically as possible, using current guidelines or recently published literature if required. Sports physi- cians who are involved with national and international sporting codes also were asked to base their responses on their specific association or country's guidelines. The results of round 1 were summarized and the contro- versies and agreements from the first round were highlighted.

Based on these responses, a further 9 open and semi-open-ended questions were developed (Table 2). In addition, the panel was asked to rank the importance of return-to-sports criteria to determine which of these variables were considered essential. The questions were again delivered to the panel via e-mail.

Rounds 3 and 4

Based on the responses from rounds 1 and 2, controversies and potential agreements were analyzed, and a summary was emailed to the panel members. Likert-style questions were then developed for round 3 (Table 3). Similar to a previous Delphi study,[13] the questions were grouped under subheadings to facilitate easier answering. In round 4, panel members who were outside consensus in round 3 were contacted, asked to reassess their responses, and the re-rank their agree- ment for each item outside the 90% consensus level of agreement. If the panel member did not change their assessment, they were asked to provide justification. If consensus was not reached because there were more than 30% of "neither agree nor disagree" responses and the responses were equally distributed between the "strongly agree/agree" and "disagree/strongly disagree" options, panel members who voted "neither agree nor disagree" were asked to commit to an either agree or disagree vote.

Table 2. Round 2 Questions: Return to Sports Assessment of Sports-Related Concussion

[1] Can you please rate the importance of the below return to sports criteria. [1 ¼ not important to 10 ¼ very important].
[2] Can you comment further on the need for baseline assessment for all players involved in contact sports. Please differentiate between school, college, and professional players. A clear yes/no is sufficient.
[3] If yes, which assessment tool should be used?
[4] Would you argue that we need a standard tool and which would you suggest?
[5] How many concussions per season for an athlete to be removed from play for the season and how concussions would you consider are enough to recommend to an athlete to retire from contact and collision sports?
[6] If there was one protocol/guideline that would be implemented for contact sports which one would you select?
[7] Some panel members commented that despite the lack of clinical symptoms, neurocognitive tests are still positive. Would you recommend compulsory neurocognitive testing for all concussions?
[8] Which test would you use? Please select only one.
[9] Similar to [8], please select one test for baseline assessments

Statistical Analysis

The results of rounds 3 and 4 were described as calculated percentiles. Consensus was defined if a minimal level of agreement of 90% was achieved. If there was consensus against a specific item, the results were reported as consensus to disagree.

Results

All 17 panel members completed the first 3 rounds, and all 17 panel members were also required to participate in a fourth round. Twelve of the panel members were registered sports physicians and 4 were employed full-time by an academic institution. Two panel members were neurologists with a focus on concussion and both had academic affiliations. Two panel members were psychologists who specialized in concussion and both were employed full-time by an academic institution. One panel member was an orthopaedic sports medicine fellowship-trained surgeon who is an active team physician for various professional and collegiate collision sports teams. All 17 panel members were engaged with professional sporting codes or were the Chief Medical Officer of the code (U.S. Soccer, FIFA [Fédération Internationale De Football Association], National Rugby League Australia, Australian Rules Rugby, South African Rugby, Rugby 7s, U.S. National Football League, National Hockey League, World Netball). Fifteen of the 17 panel members were actively involved in collision sports as team physicians for various sporting teams and codes at high-school, collegiate, national, and international level.

Round 1

The responses for the first round suggested 6 clinical signs, 6 different assessment tools, and 2 different approaches for a graduated return to sports. The Sports Concussion Assessment Tool 5 (SCAT 5), computerized neurocognitive tests (ImPACT [immediate post-concussion assessment and cognitive testing), Cogstate], vestibular and ocular motor screening (VOMS), the Post-Concussion Symptom Scale checklist, and clinical evaluation of cognition and performance were considered to be acceptable tools for assessment. Baseline assessment was considered to be useful and SCAT 5 and Cogstate were mentioned to be performed at the beginning of the season to be repeated annually for

Table 3. Consensus Round 3 and 4

	SA	A	N	D	SD	Consensus 3	Consensus 4
What are the RTS criteria							
No more headaches	9	5	1	2		82	94
Normal clinical examination	11	4	2			88	88
Normal ocular and balance examination	11	5		1		94	94
Normal SCAT 5	9	8				100	100
Normal VOMS	8	7	2			88	88
Normal Exertional Test	9	8				100	100
Normal neurocognitive tests such as Cogstate, Cognigram, or others	5	9	2			82	88
Always graduated RTS as stated by Berlin Consensus and others	13	2	2			88	88
The minimum time for recovery for a sports-related concussion should always be 1 week	4	6	4	2	1	59	70
Earlier RTS (48-72 hours) can be considered if symptom free	1	2		8	6	82	100
Earlier RTS (48-72 hours) can only be considered if symptom free and no history of previous concussions	2		1	9	5	82	94
For children and adolescents, 1 week of rest followed by 1 week of graduated return to play is strongly suggested	5	4	2	2	4	53	53
Time-based protocols are not helpful; it is more important to assess RTS on an individual basis	7	2	4	3	1	53	58
All protocols should be flexible and should be tailored to the individual athlete	7	5	2	2	1	70	82
Time-based protocols are only helpful as a guide for inexperienced physicians	4	4	4	5		47	58
Severity of concussion rather than time combined with an individual RTS protocol are more appropriate	3	7	3	4		59	70
Individual protocols should be developed and based on symptoms, recurrence, age, level of professionalism	8	4	2	2	1	70	76
RTS is also dependent on available resources (experience and training of medical team, neuroimaging and neurocognitive testing)	7	7	1	1	1	82	88
Ultimately clinical assessment by an experienced physician well trained in the management of concussion is the most important step	11	4		2		88	88
Graded Return to Sports Protocol is a good protocol for RTS	10	7				100	100
RTS must be individualized and tailored to the sporting code	9	7		1		94	94
RTS must be individualized and level of play, age, resources, and player history must be considered	11	5	1			94	94
RTS can be staged according to the Berlin and now the updated Amsterdam guidelines	12	4	1			94	94

Useful assessment tools to assists with deciding RTS are	SA	A	N	D	SD	Consensus 3	Consensus 4
SCAT 5	9	6	2			88	94
ImPACT	5	10	1	1		88	88
Cogstate	3	10	2	1	1	76	76
PCSS checklist	8	5	4			76	82
VOMS	5	11	1			94	94
Cognigram	1	8	7		1	53	53
Paper and pencil test		10	7			59	82
Sway	1	5	11			N 65	N 60
mBESS	4	9	3	1		76	76
RTS is a clinical decision	8	8	1			94	94
Validated tools should always be used	8	9				100	100

Baseline assessment	SA	A	N	D	SD	Consensus 3	Consensus 4
Baseline assessment tests should be performed at professional level	13	4				100	100
Baseline assessment tests should be performed at college level	10	6	1			94	94
Baseline assessment tests should be performed at amateur level	6	4	5	2		59	70
Baseline assessment tests should be performed preseason but annually at a minimum	7	6	2	1	1	76	82
For adolescents and children, baseline assessment tests should be performed every 6 months		4	6	6	1	D 41	D 47
Helpful but will not aid in diagnosis of concussion		3	1	10	3	76	82
Helpful but will not aid in RTS decision-making		1	2	10	4	82	82
Some athletes will present with positive findings on baseline assessment and can be allowed to play	2	13	1	1		88	88
Positive baseline tests do not allow return to collision sports until the test is normal		5		8	4	70	94

(continued)

Table 3. Continued

Baseline assessment	SA	A	N	D	SD	Consensus 3	Consensus 4
Baseline assessment necessary as it provides objective and reproducible data	3	6	5	2	1	53	70
Neuropsychological testing should be part of baseline assessment	2	10	3	2		70	70
A combination of neurocognitive computer based, and clinical tests will be more insightful for concussion screening	7	9	1			94	94
Software applications must be more readily used in concussion decision-making	1	8	5	3		53	76
Recurrent concussion and return to sports	**SA**	**A**	**N**	**D**	**SD**	**Consensus 3**	**Consensus 4**
The total number of concussions do not influence RTS decision-making, normal RTS criteria still apply		4	1	7	5	70	82
The total number within season concussions do not influence RTS decision-making, normal RTS criteria still apply		1	1	7	8	88	88
Recurrent concussions (2 and more per year) require at least a 4-week break from collision sports	1	4	5	5	2	D 41	A 50 e D 50
Recurrent concussions (2 and more per year) require at least a 3-month break from collision sports	2	2	5	6	2	D 47	58
A total of 5 lifetime concussions requires at least a 4-week break from collision sports		2	6	7	2	53	76
A total of 5 lifetime concussions requires at least a 3-months break from collision sports	1	2	7	5	2	N 41	D 64
The number of lifetime concussions affect long-term sequelae	5	5	4	3		59	76
Two or more concussions per year are season ending	1		6	7	3	59	76
Five or more lifetime concussions are season ending		2	5	6	7	76	76
Two or more lifetime concussions are career ending			4	6	7	76	D 94
Five or more lifetime concussions are career ending		3	5	4	5	53	D 88
Current knowledge provides an accurate predictive expectation on long term concussion sequelae risk		1	2	9	5	82	83
Current research allows prediction of long-term concussion sequelae		1	3	8	5	76	82
Repeated concussions have a poor long-term prognosis	3	7	3	2	2	59	64
The number of concussions does not affect decisions to return to impact sport		4		7	6	76	D 94
At professional or elite level neuro-imaging and/or full neuro-cognitive tests should be employed before RTS decision-making	5	1	4	7			D 52
At amateur level neuro-imaging and/or full neurocognitive tests should be employed before RTS decision-making	2	1	3	9	2	65	70
Conventional neuroimaging is not very helpful in return to sport decision making after repeated concussion	5	5	3	3	1	59	70
Children or adolescents should undergo neuro-imaging and/or full neurocognitive tests before RTS decision-making	1	2	4	9	1	59	64
Presentation of current symptoms are more important than the number of concussions	4	8	1	4		70	70
Neuropsychological testing should be part of RTS decision-making	2	8	2	5		59	59
Neurocognitive tests are important to guide RTS decisions	1	13	1	2		82	94
Player informed consent should be part return to sport decision-making	9	8				100	100
Medicolegal principles in informed consent are important for players at risk of concussion	8	8	1			94	94
The presence of athlete anxiety is part of repeated concussion sequelae for long-term decision-making	6	6	5			70	82

Bold values indicate the item where consensus was reached in round 3 respectively round 4.

A, agree; D, disagree; ImPACT, immediate post-concussion assessment and cognitive testing; mBESS, modified balance error scoring system; N, neutral; PCSS, Post-Concussion Symptom Scale; RTS return to sport; SA, strongly agree; SCAT 5, Sports Concussion Assessment Tool 5; SD, strongly disagree; VOMS, vestibular/ocular motor screening.

adults and every 6 months for children. The minimum period before return to sports was generally 7 days. The protocols should be flexible, graduated, and based on individual assessments. Athletes with persistent symptoms should be referred to a neurologist. Multiple concussions and the severity should be considered when making return to sports recommendations. Sporting code or level of professionalism does not play a major role in return to sports recommendations, but more caution is advised in youth sport. Biomarkers may be helpful in the future but are not widely available yet and lack application and validation. Chronic or post-concussion syndrome was considered when athletes had persistent symptoms and the timer interval ranged from 2 weeks to 3 months. Magnetic resonance imag- ing, neuropsychological assessment, sleep studies, and a complete neurological assessment should be performed if there is evidence of persisting symptoms and post-concussion syndrome. Finally, return to sports should be graduated with no clinical symptoms and an initial

rest period of 24-48 hours. A summary of the round 1 responses is shown in Appendix Table 1, available at www.arthroscopyjournal.org.

Round 2

Only 64% of the panel believed that baseline assessment should be performed for all athletes involved in contact sports. Ninety-four percent of the panel agreed that SCAT 5 is the most useful tool. The panel agreed (88%) that there is no specific number of concussions that should result in removal of play for the game and season. There was no single guideline that can be used for return to sports agreement, and multiple guidelines are available than can be used: World Rugby Guidelines, Berlin, and updated Amsterdam Consensus and Concussion in Sport Group Consensus. Only 50% of the panel believed that compulsory neurocognitive testing for all concussions should be performed. The Impact test was suggested as a suitable tool. The panel ranked the importance of return criteria as follows (maximum of 10 points): graded return to sports 9.41, no more headaches and normal neurologic examina- tion 8.76, Berlin/Amsterdam Consensus 8.37, normal ocular and balance examination 8.29, fully asymp- tomatic at rest 8.23, graduated return to play with a minimum rest period of 7 days 8.17, normal exertional tests 7.82, normal SCAT 5 assessment 7.35, normal computerized neurocognitive tests 7.29, normal VOMS 7.17, and graduated return to sports 6 days for pro- fessionals and adults but 2 weeks for children 6.53

Round 3

Of the 23 return-to-sports criteria, consensus was reached for 7 items (Table 3): normal ocular and balance examination, normal SCAT 5/6 assessment, normal exertional test, graduated return to sports; return to sports must be individualized and tailored to the sporting code, level of play, age of player, history of player, and available resources; and return to sports can be staged according to the Berlin/Amsterdam guidelines. Of the 11 potentially useful assessment tools to decide on return to sports, consensus was reached for 3 items (Table 3): VOMS is a useful tool, return to sports is a clinical decision, and validated tools should always be used.

Of the 13 items assessing the need for baseline assessments, consensus was reached for 3 items (Table 3): baseline assessments should be performed at professional and college level and a combination of neurocognitive computer-based and clinical tests will be more insightful for concussion screening.

Of the 23 items that assessed recurrent concussions and return to sports, consensus was reached for 2 items (Table 3): player informed consent should be part of return to sports decision-making and medicolegal principles in informed consent are important for players at risk of concussion.

Round 4

In round 4, the panel reached consensus for 2 addi- tional items with regards to return-to-sports criteria (Table 3): earlier return to sports (48-72 hours) can be considered if symptom free and earlier return to sports can be considered if symptom free and there is no history of previous concussions.

For the useful assessment tools that can assist with decision making in return to sports section, the SCAT assessment tool reached consensus (Table 3). One panel member reported that he made an accidental mistake, which he corrected in round 4.

For the baseline assessment section, the panel reached consensus, the panel reached consensus for 1 more item (Table 3): positive baseline tests do not allow return to sports until the test is normal.

Three more items reached consensus for the recurrent concussion and return to sports section (Table 3): 2 or more lifetime concussions are career-ending (disagreement), the number of concussions does not affect decisions to return to sports (disagreement), and neurocognitive tests are important to guide return-to-sport decisions (agreement).

Discussion

In this Delphi Expert Panel Consensus exploring return to sports following sports-related concussion, 4 different areas were explored. Of the 23 return-to-sports criteria that were assessed, only 10 criteria (43%) reached consensus. The ocular and balance examination and exertional tests should be normal, athletes should have no headaches, and the SCAT tool score should be normal. The panel recommended graduated return to sports that should be individualized to level of play, age, resources, player history, and tailored to the sporting code. The recommendations of the 2016 Berlin consensus and updated Amsterdam guidelines should be considered. The panel disagreed that earlier return to physical activity within 48 to 72 hours could be considered if athletes were symptom free and had no history of previous concussions. However, the panel could not agree on minimum rest for 1 week in both adults and children/adolescents and were divided as to whether time-based protocols are useful. Of the 11 assessment tools to assist with return to sports assessment that were offered for consider- ation, only 2 tools were considered to be helpful: SCAT and VOMS. The panel unanimously animinously agreed that validated tools should always be used. Ul- timately, return to sports is a clinical decision. Baseline assessment could be quite useful when deciding whether athletes are ready for return to sports.[14] Of the 13 items in this section, the panel only agreed on 4 items: baseline tests should be performed at both college and professional level and a combination of neurocognitive computer-based and clinical tests are more

insightful for concussion screening. The panel agreed that positive findings on baseline tests do not allow return to sports. The section on recurrent concussion and return to sports offered 25 items and the panel could only agree on 5 items: 94% disagreed that 2 or more lifetime concussions are career-ending and that the number of concussions do not affect decision making. When deciding return to sports, players should be involved and informed consent should be obtained. Medicolegal principles should be taken into consideration when players are at risk of concussion.

The return-to-sports criteria is still a controversial topic and there is insufficient evidence to recommend a specific protocol.[7] The Berlin guidelines suggest a graduated return to sports after an initial rest of 24 to 48 hours with progression to the next stage if the concussion-related symptoms have completely resolved.[7] The guidelines also outline that the time frame for return to sports should consider player age, history, level of sports, and individualized management. The results of this Delphi are in strong agreement with the 2016 consensus. The Centers for Disease Control and Prevention have stated that return to sports should be assessed by a health care provider and 6 steps should be followed.[15] The 6 steps were divided into back to regular activities, light aerobic activity, moderate activity, heavy noncontact activity, practice, and full contact and competition.[15] Similar to the Berlin consensus, athletes should only progress to the next stage if the concussion-related symptoms have resolved, and if there is any recurrence, the athlete should drop back to the previous asymptomatic level.[7,15] The American Medical Society for Sports Medicine position statement proposed a very similar protocol.[16] Wiebe et al.[17] investigated return to sports using the Ivy LeagueeBig Ten Epidemiology Concus- sion Study and reported a median time of 8 days for symptom resolution and 9 days to full exertion with a 5-stage return to sports protocol. The authors noted that only 70% had an initial physical and cognitive rest of 24 to 48 hours and took longer until their symptoms resolved. Wait et al. performed a systematic review and included 65 studies.[18] The median return to play was 21 days.[18] Although the graduated return to sports pro- tocol has been accepted by the medical profession as the standard of care, the guidelines are not supported by prospective randomized studies and validation of the existing return to sports protocols are needed.[19] In addition, the quality of evidence is rather poor and most studies limited by serious and critical risk of bias, poor study quality and heterogeneity.[18]

The panel agreed that SCAT 5/6 and VOMS are useful tools to assist with deciding the timing of return to sports. SCAT 5 has 2 major components and includes an immediate/on-field concussion assessment and an off-field assessment.[20] Testeretest reliability varied between 0.40 and 0.85 with considerable differences for the SAC (standardized assessment of concussion) and mBESS (i.e., modified balance error scoring system) scores.[21] In addition, 50% of athletes reported at least one baseline symptom (fatigue, low energy, neck pain) which may limit the application.[21] The SCAT tool is also influenced by sex, health, depression/anxiety, and sports type.[22] The SCAT tool may therefore not a comprehensive neuropsychological test and cannot be used alone.[23] In contrast the VOMS tool is reliable and highly accurate and could be used in combination with SCAT for a comprehensive assessment.[24-26]

The panel determined that baseline assessment using a combination of clinical and neurocognitive tests should be performed at both professional and collegiate level. This is in contrast to the 2016 Berlin guidelines that concluded that mandatory baseline or preseason testing was not required but may add useful information.[7] It appears that the panel felt that baseline assessment is useful for comparison if athletes present with a suspected concussion. Unfortunately, this consensus does not appear to be supported strongly by the current evidence. Petit et al.[22] could clearly show that students athletes in a “healthy state” reported symptoms during preseason baseline testing. Katz et al.[27] assessed 15,681 NCAA student-athletes and reported that student-athletes endorsed an average of 3 symptoms. Normative and reference values may therefore be needed to allow reliable and valid comparisons between baseline assessment and acute concussion assessment.[22,28] However, the effect sizes on baseline tests are very small and are most likely not clinically meaningful.[28] Familiarity with test application may theoretically introduce error. Tucker et al.[29] have shown that these changes are small and unlikely to have clinical significance but advised that clinicians should be mindful. The SCAT 5 has been shown to be stable with retesting at 1 year for all SCAT 5 subcom- ponent metrics supporting the use of SCAT for repeated testing.[30]

Only 5 of the 25 items to evaluate the panel’s opinion on recurrent concussion and return to sports reached consensus. They disagreed on the number of recurrent concussions that would affect return to sports or should be considered to be season- or career ending. Nearly 25 years ago, Cantu[31] and Kelly and Rosenberg[32] have developed guidelines for removal of play for recurrent concussion. Cantu[31] suggested that a history of 3 concussions independent of severity should be season-ending. Kelly and Rosenberg[32] believed that a fourth concussion for a grade 1 concussion, a third concussion for a grade 2 concussion and a second for a grade 3 concussion should be season terminating. The current evidence is conflicting and this is reflected in the lack of consensus for this subsection. Currie et al.[33] have performed a paired comparison of athletes sustaining a

first-time concussion to athletes with recurrent concussion and found similar symptom resolution times. Hannah et al.[34] showed that athletes with a history of repeated concussion had no significant impact on acute neurocognitive recovery. In a large cross-sectional study including more than 5,000 high school players, Brooks et al.[35] demonstrated that foot- ball players with multiple past concussions performed the same on cognitive testing as those with no prior concussions. However, these studies only investigated short-term-effects and recurrent concussions may have long term consequences. Pearce et al.[36] showed significantly slower reaction times, poorer cognitive performance and neurophysiological alterations in retired rugby players 20 years after repeated head trauma when compared to an age-matched group with no history of concussion. Decq et al.[37] reported greater rates of major depressive-, mild cognitive disorders and headaches in retired rugby players more than 20 years after retirement when compared to other age-matched retired sportsmen. The number of concussions may obviously have a cumulative effect and it appears that the issue of recurrent concussion with regards to return-to-play criteria and season- or career-ending decision-making requires more attention.

Limitations

This consensus study has inherent limitations. Consensus only reflects agreement at a specific point in time, and consensus may change in the future if new evidence is published. Selection of panel members is a crucial aspect and unfortunately standard criteria do not exist.[38] Homogeneity should be avoided and it should be aimed for a diverse panel.[8,9,38] The panel consisted of 17 members of which 9 members (53%) were associated with rugby. This could have caused bias in favor of rugby-related concussion diagnosis and management. The majority of the panel members were sports physicians and only 2 neurologists and 2 psy- chologists were included. This could have also resulted in bias. In cases in which the current evidence is con- flicting, medical professionals tend to rely on their own experience, interpret the literature subjectively confirming their own biases when making recommendations and these processes can be flawed.[39-41]

Conclusions

Consensus was achieved for 10 of the 25 return-to- sport criteria: early return to sport can be considered earlier than 48 to 72 hours if athletes are completely symptom-free with no headaches, a normal clinical, ocular and balance examination. A graduated return to sport should be used but should be individualized. Only 2 of the 9 assessment tools were considered to be use- ful: SCAT 5 and VOMS. Return to sport is mainly a clinical decision. Only 31% of the baseline assessment items achieved consensus: baseline assessments should be performed at collegiate and professional levels using a combination of neurocognitive and clinical tests. The panel disagreed on the number of recurrent concussions that should be season- or career-ending.

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