

SCRIMMAGE for Brain Health in the NRL (Studying Contact Replays: Investigating Mechanisms, Management, and Game Exposures in the Australasian National Rugby League): A protocol for a database design

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Supplementary Table 1. Changes to the number of clubs and match rounds per year in the NRL since 2017.

Year	Number of clubs	Number of rounds (bye weeks)
2024	17	27 (3)
2023	17 [^]	27 (3)
2022	16	25 (1)
2021	16	25 (1)
2020*	16	20 (0)
2019	16	25 (1)
2018	16	25 (1)
2017	16	25 (1)

*Season impacted by COVID-19; [^]Dolphins joined as new club.

Supplementary Table 2. Variables and descriptions for event and tackle-based features for NRL player head contact.

Variable number	Variable Description <ul style="list-style-type: none"> Response options <i>Additional details</i>
Player Characteristics	
#1	The position of the impacted player <ul style="list-style-type: none"> Fullback Wing Centre Five-Eighth Halfback Lock Second Row Prop Hooker Interchange player (i.e., player is not in the starting lineup)
#2	The position of an opposing player who had a role in the impact <ul style="list-style-type: none"> Same options as #1.
#3	Role of impacted player at the time of event <ul style="list-style-type: none"> Ball carrier Tackler Neither
Game Play Characteristics	
#4	Specific match time in the game when impact event occurred Minutes played as 00:00
#5	Time of impact event as a category Game time broken down into quarters: <ul style="list-style-type: none"> 0-20mins 21-40mins 41-60mins 61-80mins 80-90 mins
#6	Match location for the impacted player <ul style="list-style-type: none"> Home Away Neutral
#7	The score at end of game Positive or negative integer representing difference in team scores <ul style="list-style-type: none"> Integer
#8	The score at time of impact Positive or negative integer representing difference in team scores <ul style="list-style-type: none"> Integer
#9	Tackle number What was the tackle number in the set when the event occurred? The position or order of a specific tackle within a set of tackles during the game. <ul style="list-style-type: none"> Number entered (0-6) <p><i>Note tackle zero category may be used to indicate that no tackles have occurred yet in the set (for instance, at the beginning of a set of tackles following a knock on from the opposition team).</i></p>
#10	Field location What location on the field was the player when the event occurred? <ul style="list-style-type: none"> Middle defence

Variable number	<p>Variable Description</p> <ul style="list-style-type: none"> • Response options <p><i>Additional details</i></p>
	<ul style="list-style-type: none"> • Side defence • Middle midfield defence • Side midfield defence • Middle midfield attack • Side midfield attack • Middle attack • Side attack <p><i>The field is split by length and breadth. The length of the field is broken into 4 x 20m sections. Awareness of the direction of play needed to identify if it is an attacking or defensive end.</i></p> <p><i>Defence: 20m defence line to the dead ball line</i> <i>Midfield defence: Halfway line to the 20m defence line</i> <i>Midfield attack: Halfway line to the 20m attack line</i> <i>Attack: 20m attack line to the dead ball line</i></p> <p><i>The breadth of the field is broken into three sections; the middle which goes between the two inside tram lines; and the two sides, which go from the inside tram lines to the touchline, on either side of the field.</i></p>
Pre-Contact Phase Characteristics	
#11	<p>Line speed What was the line speed immediately prior to contact?</p> <ul style="list-style-type: none"> • Off the ball contact/not applicable • Fast/aggressive/moving forward • Moderate/Moving forward backwards/sliding • Slow/defensive/passive/on the back foot/moving backwards/sliding • Not present/broken defensive line <p><i>Line speed refers to the defensive players movement on field in applying pressure to their attacking opponents</i></p>
#12	<p>Defender alignment The alignment or positioning of a defender during a specific observation in a rugby league match.</p> <ul style="list-style-type: none"> • Marker 1 • Marker 2 • A Defender (R) • A Defender (L) • B Defender (R) • B Defender (L) • C Defender (R) • C Defender (L) • Middles (back rowers in) • Edges (winger, centre, halves) • Kick off/kick chaser/hit up off restart • Fullback • Scrum <p><i>The defender is positioned at Marker 1, the first in position near the play-the-ball area.</i></p> <p><i>The defender is positioned at Marker 2, the second player from the play-the-ball area than Marker 1.</i></p>

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
#13	<p>Tackler deceleration</p> <p>Deceleration features of the tackler before contact made</p> <ul style="list-style-type: none"> • None • One step • Two steps • Three steps • Four steps <p><i>None. The player maintained constant speed prior to contact.</i> <i>One step pre-contact the player began to decelerate</i> <i>Two steps pre-contact the player began to decelerate</i> <i>Three steps pre-contact the player began to decelerate</i> <i>Four steps pre-contact the player began to decelerate</i></p>
#14	<p>Ball carrier arm side</p> <p>Arm side that ball is being carried in (by ball carrier)</p> <ul style="list-style-type: none"> • Right • Left • In both hands • Passed or kicked the ball
#15	<p>Tackler reaction to ball carrier</p> <p>Did the tackler react to the ball carrier moving position at last minute?</p> <ul style="list-style-type: none"> • Not applicable/ no change in movement • Could not react to the ball carrier change • Was able to react to the ball carrier change
#16	<p>Ball carrier evasive techniques</p> <p>Did the ball carrier use any evasive or impact techniques?</p> <ul style="list-style-type: none"> • None • Hand Fend • Forearm bumpers • Shoulder • Ball bump • Lean/bend • Twist/spin • Side on and lean • Lifted knee • Lead with head • Change direction • Footwork/Stepping • Dropped to ground/Surrendered • Stopped/propped
#17	<p>Tackle technique</p> <p>What technique was used in the tackle?</p> <ul style="list-style-type: none"> • Not a front-on, one-on-one tackle event or it is any "other" type event/contact • Illegal • Over the Ball NRL (Dominant tackle, upright, contact over the ball, upper torso) • Over the Ball Variation (Smother, Pop and lock, partially bent over, mid/upper torso) • Over the ball Hybrid/Grappling (hit, stick head into the neck of ball carrier, upper torso) • Under the Ball variation (partially bent, mid torso) • Under the Ball NRL (cheek to cheek, lower torso)
#18	<p>Defender rush</p> <p>Did a defender rush up out of the defensive line in the play prior to contact?</p> <ul style="list-style-type: none"> • No • Yes

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
#19	<p>Action at time of event What was happening (type of play) when the event occurred?</p> <ul style="list-style-type: none"> • Hit Up • Kick-off return • Line Drop Out return • Fullback/winger kick return • 20m restart • Penalty tap restart • Dummy half run • Hit Up off scrum • Contesting for loose ball • Kicking the ball • Broken play • Backline play • Initial contact and subsequent defender(s) in hits ball carrier high • Line Break/Breakaway • Clean up grubber kick, surrendered in tackle, on the ground etc. • Back of ball carrier's head slammed into playing surface • Aerial contest • Cross field runner • Late contact/ball passed and hit late • Kick pressure • Lifted in tackle head into the ground • Attempting to score a try, or scoring a try • Tacklers force ball carriers head into the ground during the tackle • Contact off the ball, unanticipated • Decoy runner contact • Tackler kicked in face by ball carrier • Ball carrier turned back on inside
Contact Phase	
Refer to "Table 2. Categorisation of the tackling instruction" in the manuscript, for additional details.	
#20	<p>Body part in tackle At what body height area/location was the tackle made?</p> <ul style="list-style-type: none"> • Head/Neck • Upper Torso • Mid Torso • Lower Torso and Upper Leg • Lower Leg <p><i>The stability of the injured player will be affected by the magnitude of moment (also known as a torque) that is applied by the opponent. Moment is calculated by force multiplied by the moment arm. Moment arm is the distance from the external force applied relative to the axis of rotation. That is for the same magnitude of external force applied to the affected player, a higher moment/torque can be create by the opponent simply applying the external force further away from the axis of rotation (i.e., the location of the centre of gravity of the body). This 'principle of moment' will mean that a tackler with the same magnitude of external force can create a higher magnitude of moment from an upper torso contact location as opposed to lower torso by increasing the moment arm.</i></p>
#21	<p>Head position of tackler Head position of the tackler relative to the body of the ball carrier</p> <ul style="list-style-type: none"> • In-front • Beside

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <p><i>Additional details</i></p>
	<ul style="list-style-type: none"> • Behind • Above
#22	<p>Foot position of the tackler Foot position of the tackler relative to the body of the ball carrier at the time of contact</p> <ul style="list-style-type: none"> • Split Stance right foot in front • Split Stance left foot in front • Together under hips/shoulders <p><i>There are six main factors of stability.</i></p> <ol style="list-style-type: none"> 1. <i>Width of the base of support.</i> 2. <i>Height of the centre of gravity.</i> 3. <i>Position of the centre of gravity in relation to the base of support</i> 4. <i>Mass of the body</i> 5. <i>Friction</i> 6. <i>“Principle of moments”</i> <p><i>This should be taken in context in relation to the shoulder side preference of the tackler. That is a right shoulder tackle should have a split stance with the right foot in front. Width of the base of support is defined as the area bound by outermost regions of contact between body and support surface(s). A split stance width base of support will only be more stability IF the external force applied by the affected player is from a front on tackle. Note, that stability of a player can also be altered moving their centre of gravity to the edge of the base of support that is closest to their opponent. This increases the distance that the centre of gravity has to move before it moves outside the base of support and the player becomes unstable.</i></p>
#23	<p>Foot width (stance) of the tackler The width will be affected as to the direction of the external force applied to the injured player.</p> <ul style="list-style-type: none"> • Shoulder Width • Narrower than shoulder width • Wider than shoulder width <p><i>A narrow base of support will be the less stable base of support. A wide than shoulder width base of support will only be more stability IF the external force applied by the affected player is from the side on tackler as opposed to a front on tackle.</i></p>
#24	<p>Body part of contacted player Which body part of the contacted player was struck?</p> <ul style="list-style-type: none"> • Unknown • Head • Top of head • Face • Back of head • Neck • Shoulder • Chest • Back
#25	<p>Opposition/teammate body part or field feature struck by impacted player If contact was involved, which body part of another player or field feature (i.e., object) was struck by impacted player?</p> <ul style="list-style-type: none"> • Unknown • Head • Shoulder • Hip • Forearm • Elbow • Arm

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
	<ul style="list-style-type: none"> • Hand/Wrist • Torso • Knee • Boot • Playing surface • Buttocks • Back • Ball • Goal posts • Lower leg
#26	<p>Body position of tackler What was the body position of the player that was performing a tackle at the time of contact?</p> <ul style="list-style-type: none"> • Upright • Partially bent • Bent at waist • Diving • Leaping/Jumping • Flopping/tackling player on ground • Lying on ball carrier • Slipping/Falling • Return to feet • Bent at knees <p><i>The position of the centre of gravity in relation to the base of support will affect a player's stability.</i></p>
#27	<p>Body position of ball carrier What was the body position of the ball carrier at the time of contact?</p> <ul style="list-style-type: none"> • Upright • Partially bent at waist • Bent at waist • Falling/Diving • Kicking • On ground • Jumping\ • Bent at knees
#28	<p>Average speed ball carrier What was the average speed of the ball carrier just prior to when impact occurred?</p> <ul style="list-style-type: none"> • Stationary • Walking • Jogging • Running • Running High speed • Sprinting <p><i>Stationary- the ball carrier is still or remains in the same location on the court.</i> <i>Walking - The ball carrier is walking</i> <i>Jogging- The ball carrier runs in a slow jog at a constant speed</i> <i>Running- The ball carrier runs in a moderate running speed with both feet off the ground (i.e., flight phase) at times, and includes curvilinear running.</i> <i>Running High speed - The ball carrier is running at a faster pace than running, but not at maximal running speed.</i> <i>Sprinting - The ball carrier is running at or near maximal running speed</i></p>
#29	Average speed of tackler

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
	What was the average speed of the tackler just prior to when impact occurred? <ul style="list-style-type: none"> • Stationary • Walking • Jogging • Running • Running High speed • Sprinting <i>Stationary-The tackler is still or remains in the same location on the court.</i> <i>Walking-The tackler is walking</i> <i>Jogging-The tackler runs in a slow jog at a constant speed</i> <i>Running-The tackler runs in a moderate running speed with both feet off the ground (i.e., flight phase) at times, and includes curvilinear running.</i> <i>Running High speed-The tackler is running at a faster pace than running, but not at maximal running speed.</i> <i>Sprinting - The tackler is running at or near maximal running speed</i>
#30	Tacklers head contact with opposition/teammate body part or field feature If tackling, was the tacklers head potentially in contact with a body part of another player or field feature? <ul style="list-style-type: none"> • Unknown • Head • Shoulder • Hip • Forearm • Elbow • Arm • Hand • Torso • Thigh • Knee • Boot • Playing surface • Buttocks • Back • Lower Leg
#31	Tackle contact direction From which direction was the tackle contact made? <ul style="list-style-type: none"> • Front • Side • Behind
#32	Head contact direction From which direction was head contact made? <ul style="list-style-type: none"> • Front • Side • Back • Top • No head contact
#33	Secondary head contact direction If there was a secondary impact, which direction was this? <ul style="list-style-type: none"> • Blank (not coded): no secondary impact seen • Front • Side • Back

Variable number	Variable Description <ul style="list-style-type: none"> Response options <i>Additional details</i>
	<ul style="list-style-type: none"> Top <i>e.g. player initially contacted on side of head while upright and then secondary impact on back of head when falling to ground.</i>
#34	Head contact region On which part of the impacted player's head was contact made? <ul style="list-style-type: none"> Frontal (R) Frontal (L) Frontal/Parietal (R) Frontal/Parietal (L) Parietal/Temporal (R) Parietal/Temporal (L) Occipital (R) Occipital (L) Unclear Frontal Occipital Top of head No head contact
#35	Positioning of the torso (the tackler) <ul style="list-style-type: none"> Neutral Flexion (30-60 degrees) Flexion (>60 degrees) <i>Torso is defined as rigid segment of between the tackler's hips and shoulder, and is the combination of the lower, mid and upper torso.</i>
#36	Head Flexion (of the tackler) <ul style="list-style-type: none"> Extension (30-60 degrees) Neutral Flexion (30-60 degrees) Flexion (>60 degrees)
#37	Spinal Posture (tackler) <ul style="list-style-type: none"> Neutral Slight kyphotic Kyphotic Lordosis
#38	Ball carrier's foot position In what position (stance) were the ball carrier's feet? <ul style="list-style-type: none"> Split stance right foot in front Split stance left foot in front Together under hips/shoulders
#39	Ball carrier's foot width In what position (width) were the ball carrier's feet? <ul style="list-style-type: none"> Shoulder width Narrower than shoulder width Wider than shoulder width
#40	Tackler eye position Eye position of the tackler <ul style="list-style-type: none"> Straight/forward Down
#41	Tackler shoulder side Shoulder side of the tackler

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
	<ul style="list-style-type: none"> • Right • Left • Chest/midline, no shoulder, arms/hands
#42	Did contact come from players own teammate? <ul style="list-style-type: none"> • No • Yes
Post-Contact Phase	
#43	Post contact meters Integer (positive or negative) representing the distance in meters between contact and play the ball) <ul style="list-style-type: none"> • Number entered
#44	Ball carrier's body position after impact occurred? The outcome or result of an attempt to tackle or bring down an athlete during the observed play. <ul style="list-style-type: none"> • On back • On backside/crusher tackle • On front/elbows/knees • On side • Stayed upright • Missed tackle • Offload • Scored try/no further progress • Kicking • Lost possession • Not a tackle contest (The athlete lost possession of the ball during the play)
#45	Was the offending player injured? <ul style="list-style-type: none"> • No • Yes • Unknown
#46	Number of defender(s) Number of the defender involved in the tackle <ul style="list-style-type: none"> • Number entered
#47	Total defenders Total number of defenders in the tackle <ul style="list-style-type: none"> • Number entered
#48	Dual contact tackle Did the tackle involve dual contact? <ul style="list-style-type: none"> • Not Dual Contact • Dual Contact • 3rd tackler in
#49	Dual contact successful Was the dual contact tackle successful? <ul style="list-style-type: none"> • No • Yes
#50	Missed Tackle <ul style="list-style-type: none"> • No • Yes • Not applicable
#51	Offload The ball carrier successfully or unsuccessfully passed or "offloaded" the ball to a teammate during the observed play. <ul style="list-style-type: none"> • No • Yes

Variable number	Variable Description • Response options <i>Additional details</i>
	<i>No - The ball carrier did not execute an offload; they did not pass the ball to a teammate during the play. Yes - The ball carrier successfully executed an offload; they passed the ball to a teammate during the play</i>
#52	Lost Ball/knock on/possession lost • No • Yes
#53	Foul play Was there any suspected foul (illegal) play involved? • No • Yes
#54	Did the contacted player anticipate the contact? Did the contacted player anticipate the contact? • No • Yes
#55	Height differential What was the height differential between the contacted player and other player involved? • Equal • Taller • Smaller <i>Equal: The affected player and the non-impact player have similar height. Taller: The affected player is taller than the non-impacted player. Smaller: The affected player is shorter than the non-impact player.</i>
#56	Weight differential What was the body mass differential between the contacted player and non- impacted players involved? • Equal • Heavier • Lighter <i>Linear momentum is defined as body mass multiple by speed. The variables body mass differential and speed differential will contribute to the linear mass and provide an indicator of impact force on players. Conservation of linear momentum will provide information as to which direction the outcome of the tackle. For example, similar body mass and speed of two opposing players will lead to the players maintaining similar position during the contact phase. Equal: The affected player and the non-impact player have similar body masses. Heavier: The affected player has a higher body mass than non-impact player body mass. Lighter: The affected player has a lower body mass than non-impact player body mass.</i>
#57	Ball carrier leg drive after contact Was there leg drive by the ball carrier after contact? • Absent • Moderate • Strong
#58	Tackler leg drive after contact Was there leg drive by the tackler after contact? • Absent • Moderate • Strong

Variable number	Variable Description <ul style="list-style-type: none"> • Response options <i>Additional details</i>
#59	Tackler head into neck Did the tacklers wrestle their heads into the ball carriers' necks? <ul style="list-style-type: none"> • No • At contact • Post contact
#60	Speed differential What was the speed differential between the player who was impacted and the tackler? Calculated as speed of injured player minus speed of the injury-causing player. <ul style="list-style-type: none"> • Stationary • Slow • Fast
#61	Player lifted in tackle Was the player lifted (off ground) in the tackle? <ul style="list-style-type: none"> • No • Yes
#62	How removed from play How did the player leave the field? <ul style="list-style-type: none"> • Jogged off • Walked off unassisted • Walked off accompanied by trainer • Walked off accompanied by two trainers • Walked off assisted by trainer • Walked off assisted by two trainers • Medicab • End of Half/Game • Unknown • Stretcher
#63	Immediately removed Was player immediately removed from field? <ul style="list-style-type: none"> • No • Yes
#64	Time to leave How long did it take for the player to leave the field? <ul style="list-style-type: none"> • Minutes and seconds reported. 00:00

Supplementary Table 3. Categorisation of the tackling instruction.

Tackle Information	Over the Ball Tackle (i.e., over the ball) (upper body)			Under the Ball Tackle (i.e., under the ball) (Lower Body)	
Tackle Type	<i>Over the Ball NRL (TackleReady [1])</i>	<i>Over the Ball, Pop & Lock</i>	<i>Over the Ball Hybrid/Grappling</i>	<i>Under the Ball, Torso & Stick (Tahu Lower pop/Midtorso)</i>	<i>Under the Ball NRL</i>
Tackle objectives	Prevent the ball carrier offloading the ball and/or wrap up the ball and ball carrier together to (i) prevent the ball carrier using his forearm/ball as a defensive strategy to bump off the tackler and (ii) control the ball carrier when taking the tackle to the ground to slow the play the ball.		By leading with the head into the tackle, then tackler places their head tight into the neck of the ball carrier to create neck pressure to control the ball carrier's upper body and reduce their ability to offload and/or halt their forward momentum.	By placing ball carriers on their back, it enables the defensive team a longer duration to get back onside for next play. This tackle also aims to move the ball carrier laterally instead of driving the ball carrier backwards to allow defensive teammates to assist in the tackle.	By placing ball carriers on their back, it enables the defensive team longer duration to get back onside for the next play. This tackle also aims for the tackler to dip under the ball carrying side of the attacker and drive the attacker backwards to be Under the Ball in the tackle.
Contact area on the ball carrier as defined by Tierney & Simms, 2018. [2] 13/09/2024 13:57:00	Upper torso (base of chest/pectorals to line of the shoulders)	Mid-Upper torso (base of chest)	Upper torso (base of chest/pectorals to line of the shoulders)	Mid torso (top of pelvis and base of chest/pectorals)	Hip area (base of pelvis to the top of pelvis)
Tackler makes contact with:	Shoulder	Chest/Pectoral region	Leads with head/shoulder	Shoulder	Shoulder
Tackler torso position (in the sagittal plane) as defined by Stokes et al, 2021. [3]	Upright/partially bent at waist* (*dependent on the vertical height of ball carrier and tackler, and where the ball	Partially bent at waist.	Upright/partially bent* (*dependent on the vertical height of ball carrier and tackler, and where the ball carrier is).	Partially bent at waist.	Fully bent at waist.

	carrier is holding the ball).				
Tackle engagement description	Tacklers use their chest and wrap both arms around the ball carrier as defined by Fuller et al, 2010. [4]	Tacklers use their pectoral on the ball carrier's forearm and ball to wrap up both the arms around the ball carrier (i.e., tackler right pectoral, ball carrier's right forearm/ball).	Leads with head into the tackle to take control of the wrestle with the ball carrier and uses hooks and levers to maintain body contact and control. The tackler maintains head contact with ball carrier by tucking their head into the ball carriers neck to maintain control of the tackle.	Tacklers use their shoulder to engage in contact with the ball carrier's abdomen (i.e., mid torso; tackler right shoulder, ball carrier's non-ball carrying side).	Tacklers use their shoulder to engage in contact with the ball carrier's lower torso.
Tackler's impact objective	Tacklers position themselves underneath the height of the ball and or elbow, and then come up over the top of the ball to execute the tackle.	Tacklers lower the vertical height of their body position and then perform a vertical 'pop up' action to reorient the motion of the ball carrier into an upward direction.	Tackler positions their head on ball carriers' neck to get control of ball carrier body movement– this is a wrestling and grappling technique to control the opponent.	Tackler moves the ball carrier in a <i>backward and upward</i> direction during the tackle and places the ball carrier on his back at the completion of the tackle.	Tackler moves the ball carrier in <i>backward</i> direction during the tackle and places the ball carrier on his back at the completion of the tackle as defined by King et al, 2012. [5]
Tackler head position	Tacklers position their heads <i>within</i> the ball carrier's shoulder when engaging in contact and may not avoid the ball carrier using his forearm/ball to bump the tackler away.	Tacklers position their heads <i>outside</i> the ball carrier's shoulder when engaging in contact.	Tacklers position their heads <i>within</i> ball carriers shoulder and aims to get their head in contact with the neck of the ball carrier to control the tackle outcome with their head pressure and control.	As the tackle is executed on the non-ball carrying side, the tackler's head is away from the ball carrier's forearm, which avoids the ball carrier using his forearm/ball to bump the tackler away.	Tacklers duck their heads prior to contact and may end up beside or in front of the ball carrier depending on the movement of the ball carrier prior to the contact.
Gaze Direction as per	Up and forward, gaze focused on ball carrier.	Up and forward, gaze focused on ball carrier.	Down, gaze pointing towards the ground (not the ball carrier) as the	Up and forward, gaze focused on ball carrier.	Down, gaze pointing towards the ground (not

Hendricks et al, 2020. [6]			player is trying to get control of ball carrier and tackle with head positioning into the ball carriers neck.		the ball carrier)
When to employ tackle (ball carrying side)	Not specified	Ball carrier is holding ball on same side as tackler (i.e., ball in right hand of ball carrier, tackler is to the left side with respect to the ball carrier, and performs the tackle with his right side)	Not specified	Ball carrier is holding ball on the opposite side as tackler (i.e., ball in left hand of ball carrier, tackler is to the left side with respect to the ball carrier and performs the tackle with his right side)	Not specified
Traffic Light System defined by Tackle Safe Program [1]	Red zone.	Amber/Red zone.	Red zone.	Amber zone.	Green zone.
Revised Traffic Light System –	Orange zone – Tackler. Orange zone – Ball carrier.	Green zone – Tackler. Red zone – Ball carrier.	Orange zone – Tackler. Orange zone – Ball	Green – Tackler. Orange zone – Ball carrier.	Red zone – Tackler. Green zone – Ball carrier.
Cues	Dip and drive	Pop and lock	Lead with head/head in tight	Head above hip, back, and up	Dip and drive, Cheek to cheek.

Supplementary Table 4. Variable number, issue and recorded responses for visible signs of injured player following head contact.

Variable Number*	Description[^]
#65	Lying motionless Lying without purposeful movement on the playing surface for longer than two seconds. Does not appear to move or react purposefully, respond or reply appropriately to the game situation.
#66	Motor incoordination Appears unsteady on feet (including losing balance, staggering/stumbling, struggling to get up, falling) or in the upper limbs (including fumbling). May occur when rising from the playing surface or in the motion of walking or running.
#67	Impact seizure Involuntary clonic movements that comprise periods of asymmetric and irregular rhythmic jerking of axial or limb muscles.
#68	Tonic posturing Involuntary sustained contraction of one or more limbs (typically upper limbs), so that the limb is held stiff despite the influence of gravity or the position of the player. The tonic posturing could involve other muscles such as the cervical, axial and lower limb muscles.
#69	No protective action – floppy Falls to the playing surface in an unprotected manner (i.e., without stretching out hands or arms to lessen or minimise the fall) after direct or indirect contact to the head. The player demonstrates loss of motor tone (which may be observed in the limbs and/or neck) before landing on the playing surface.
#70	Blank or vacant look Player shows no facial expression or apparent emotion in response to the environment.
#71	Clutching or shaking head Player holds or grasps head or face Player is shaking their head like they are attempting to clear something.
#72	Distressed appearance Grimacing/wincing or scrunching up face, or any other facial feature considered to be a sign of distress or discomfort.
#73	Slowed movements Player is moving unusually slowly back to position (e.g., short or shuffled steps), no sense of urgency in their movement.

#74	Duration for loss of responsiveness or lying motionless Recorded in minutes and seconds 00:00.
#75	Possible motor incoordination Suspicion of Motor Incoordination but not certain or clear, so it is considered “possible.”
#76	Suspected facial fractures Any video evidence that suggests a possible fracture (e.g., indentation in bone structure, severe swelling).
#77	Slow to return to feet Player remains on the ground (does not return to their feet), and they are not attended to by team staff, for ≥ 20 s

Note. *Variables #65 to ##70 are from the consensus definitions with summary from Table 1 Davis et al [7], # 71 to #77 are from a study of NRL players.[8]; ^ Yes, no or unknown is recorded for all variables unless otherwise stated.

References

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