Response to Questions

Produced in response to letter received by email from Mr. Gordon Thomson dated 24 September 2022.

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Dear Mr Thomson,

Thank you for your letter received via email on 24/09/22 requesting my opinion on matters arising following your reading of my review document concerning female concussions in rugby. You are correct; I did examine a very large volume of information prior to preparation of the document. This included not only formal academic papers, but also an extensive volume of documentation relating to current World Rugby protocols, IOC documentation relating to four yearly discussions of concussion in sport, as well as numerous uncited research papers and media articles. I additionally viewed a number of very informative web-based videos from leading experts in the field worldwide.

It should be stated for clarity that a large proportion of concussion injuries are comparatively minor, respond well to appropriate treatment and from which a full recovery is made over a short period of time, usually measured in days or a few weeks. A single mild concussion that settles swiftly should not be a major risk to brain health over the longer term. The following comments primarily relate to the smaller proportion of more severe concussions which result in more significant, intrusive and long-lasting symptoms. These and multiple episodes of head trauma are the issues about which we should be concerned.

1. Regarding the question of concussions in rugby generally, there is a large volume of documentation available, but it is noteworthy that very little of this is female centric. Nevertheless, there does appear to have been a significant amount of work on the subject of sport related concussions, especially over the last decade. Whilst any and all research is to be encouraged in the interests of player welfare of both sexes, I remain concerned that there is, or would appear to be, a very significant disparity in the level of medical care and review available to the small cohort of elite players compared to the much larger cohort of club and amateur players, particularly the younger school age group. It should be borne in mind that those of junior and high school age are at the highest risk of the most severe consequence of head injuries, this being Second Impact Syndrome with catastrophic brain swelling and frequently resulting in fatalities.

As ever, attitudes towards various types of injury and their potential seriousness are usually driven by the position of elites and “trickle down” to lower levels of participation. As a doctor, player welfare and future health has to be the principal consideration for sports participants. Consequently, it is my view that it is incumbent on World Rugby and the various Rugby Unions worldwide to encourage reporting and speak out about the risk of concussions to encourage higher awareness at more junior levels.

I am particularly troubled that the last time that there was any discussion of female concussion risk at the International IOC symposium was in 2012, fully a decade ago. At that time it was deemed that there was "insufficient evidence" to categorise a higher risk of concussion in the female cohort. Even more troubling, at the most recent IOC symposium on concussion in sport held in 2016, there was absolutely zero re-examination of the female position. Consequently, there has been no consideration of any sex differentiation in the last decade, despite a large volume of emerging evidence in the medical field firmly supporting the view that there should be a heightened awareness of concussion and its potentially more long-lasting effects in female players.

Given the amount of research documentation from the last 15 years, a considerable volume of which the various contributors to the IOC Conference in 2016 must surely have been aware, I find this situation completely inexplicable from a medical point of view.

2. The next area which simply cannot be supported on medical grounds is the allowance of Head Injury Assessment (HIA) and a potential return to play in the same match in International competition. Whilst I appreciate that all Unions would wish to see their best players on the pitch, any return to play on the same day after a mild traumatic brain injury or suspected mild traumatic brain injury flies in the face of general medical opinion. The best medical minds worldwide are effectively unanimous: -"when in doubt, sit them out!" This applies to all head injured individuals and there can be no rationale for a return to play in the same match, just because this is an International. Player welfare and long-term health must be the principal concern whether at junior or amateur level or at the pinnacle of Test rugby.

Whilst loss of consciousness, no matter how brief, and post-traumatic amnesia are normally taken to be definitive indicators of a concussion, many concussions do not demonstrate obvious loss of consciousness or amnesia and are therefore subjectively difficult to assess and grade at pitch side. It is also widely accepted that the severity of a concussion does not necessarily correlate with the apparent severity of the observed head trauma, with some individuals experiencing significant concussional symptoms after what appears to be comparatively minor head trauma and others showing little or no sign of a significant minor traumatic brain injury after major impacts.

The progress of concussional symptoms may also show significant worsening in the initial minutes and hours following the trauma sustained, allowing the situation where an individual may pass an initial head injury assessment but subsequently develop much more significant neurological issues as time progresses. I think it is fair to say that we have all seen some instances of this during televised matches.

I can also think of a number of instances where players have obviously been rendered unconscious but then allowed to play on without even having to undergo a head injury assessment. Those suffering from concussional symptoms also tend to demonstrate decreased cognitive thinking, balance and spatial awareness and are more at risk of further head trauma in the highly competitive arena of International sport. As a consequence, it is impossible to support any allowance of return to play on the same day after a concussion or suspected concussion. Whilst International rugby players are unquestionably elite athletes, no amount of training makes their brain cells more resilient to damage than the rest of the population.

In the interests of both short-term health and long-term brain health and wellbeing of the athlete after cessation of competitive play, anything that elevates their risk of significant brain injury is unacceptable from a medical point of view.

This is something that I feel World Rugby will have to consider further on an urgent basis. From the medicolegal point of view, if an International player was to suffer a suspected concussion in an International match and then be allowed to return to play in the same game before subsequently suffering another concussion, they would have very strong grounds for litigation as the International protocol does not follow best medical practice.

3. Despite my criticisms at the International level, I do feel that the most recent World Rugby guidelines are, in general, well-structured and reasonable for the majority of players, particularly with regard to return to play protocols. However, these really only cover the more general pattern of post-concussional symptoms. They do not address the more subtle issue of diminished neuropsychological and neurocognitive debility that may persist substantially beyond the timeframe in which the individual player may feel that they have made a full recovery in line with current testing methods and return to play protocols. If there are still neurocognitive and neuropsychological issues ongoing, these mean that the player is not, in fact, fully recovered back to their baseline level and remain at increased risk of further head injury and late sequelae. For this reason, I strongly support the idea of pre-season neuropsychological testing to establish a player's baseline level. If they then suffer a traumatic brain injury they should not be allowed to return to play until their neuropsychological tests return to a level as good as, or better than, their baseline.

This would mean that very few individuals were allowed to return to play after minor TBI's before they have effectively made a <u>full</u> recovery both from more obvious initial post head injury symptoms and the later and more subtle neuropsychological issues and slow recovery of full functional memory.

As yet, this area has not been extensively researched and this needs to be done as a matter of considerable urgency to enhance our understanding of ultimate head injury recovery. I am personally of the view that differences in recovery times between individuals of the same sex and certainly between males and females are likely multifactorial. There may well be an underlying genetic component, but there seems little doubt that subtle neuropsychological issues persist substantially beyond "cruder" subjective measures of concussion recovery. It is these that we need to make sure are fully recovered before we allow players to risk further head trauma. If this involves further refinement of the World Rugby protocols, so be it.

4. Concussion awareness is an area that needs close scrutiny. The majority of the population appear to consider concussion a comparatively "minor" injury of short-lived duration. This is indeed the case for the majority of concussions, although I do note from the world literature that there is a range of timeframes to recovery offered, ranging from "a few days" to "up to a month". Nevertheless 85-90% of concussions are indeed of comparatively low grade with individuals making a swift recovery to an apparent normal level of functioning without any objective or subjective symptoms.

What we need to worry about is the 10-15% of concussions that cause more protracted symptoms which may be severe, causing significant diminution of quality of life and neurological function. The medical community considers any form of brain injury to be a serious issue and this does not appear to be fully appreciated, both by players and the coaching and sport hierarchies.

Whilst elite players unquestionably have excellent medical and ancillary support, it is my view that even these are not perhaps giving sufficient attention to the subtle neuropsychological effects of concussions which may have a significant effect on player wellbeing and quality of life. This is an area in which much further research is needed, but definitely is an area where evidence is growing incrementally that there may be as yet unquantified issues that need additional support and input to help resolve. Obviously, at Club and Amateur level it is likely that an individual who has sustained a concussion, but not a quantifiable head injury such as a skull fracture or intracranial bleed, is simply going to be discharged from an Accident & Emergency Department, if they even attend one, with advice to rest, utilise appropriate analgesia or anti-inflammatories and to attend their General Practitioner if they have continuing issues.

In turn, the vast majority of General Practitioners have little or no experience of dealing with acute head trauma or significant post-concussional presentations.

Certainly they are unlikely to be intimately familiar with the neuropsychological issues that may be experienced after concussions which act as identifiers of more severe or likely more prolonged injuries. The "index of suspicion" of post-concussional difficulties needs to be raised in General Practice. It is our General Practitioners on whom the burden of continued care and identification of individuals with significant issues after a concussion will fall and they must be aware of the full spectrum of potential difficulties and have effective guidelines for onward specialist referral. This is an area in which enhanced General Practitioner education and training should be easy to attain through co-operation with the various Rugby Unions and ongoing General Practice training and development through annual CPD (Continuous Professional Development). This is mandatory for all medical practitioners.

5. With regard to pre-season baseline testing, a number of authors and eminent practitioners in the field of neurology and neuropsychology have already suggested that pre-season baseline testing should be mandatory.

Whilst I accept that for now this may well be beyond the financial means of school and small club structures, emerging computer-based testing is improving exponentially and is likely to be widely available online in the near future. The reason for baseline testing is to allow individuals after they have sustained a concussion to have their neurocognitive and neuropsychological function compared to their pre-season and uninjured status. Otherwise, tests of neuropsychological and neurocognitive function after an injury cannot be compared to a meaningful baseline, a view with which I would concur. I note from the worldwide literature that several authors suggest that until an individual reaches a stage where these parameters are equal to or better than their pre-season baseline, they should not be allowed to return to play. This may well be a better ultimate indicator of brain health than the current return to play protocols which are much more subjective and lacking sensitivity for ongoing subtle neurocognitive and neuropsychological dysfunction. The influence of persistent neuropsychological sequelae after minor traumatic brain injuries is an area requiring urgent study and is likely to yield a significant amount of valuable data. This would be extremely helpful in initial assessment and may in future offer a significant benchmark of a return to "full brain health".

6. You ask what Club and Elite rugby should be doing to improve its care for concussed players. Firstly, the most important consideration must always be player welfare. Avoidance of concussional injuries would be the ideal, but this of course is going to be impossible to achieve in any contact sport. Rugby must therefore work to mitigate risk. I have already dealt with the question of a return to play on the same day in International matches. The next risk reduction factor is to firmly embrace and implement the "if in doubt, sit them out" mantra that is effectively accepted universally in the medical field. Whilst obvious head injuries on the pitch will normally be easy to identify, concussion type injuries without loss of consciousness or gross neurological deficit are more problematic.

Rugby players on the whole wish to participate in team sports and "don't want to let the team down". This can result in under-reporting of symptoms as players wish to remain on the pitch, even although this may not be in their best interests.

A further issue is potential bias in favour of return to play amongst coaching and ancillary staff who do not wish to have their "best players" off the pitch and lower the chances of winning the game. Rugby is, after all, a competitive sport. This attitude however is not in the best interests of the player, particularly regarding long term brain health and I would advocate that increased weight is given to medical opinion. Essentially, to prevent any intentional or unintentional bias, players who have obviously or potentially suffered a concussive head injury should be immediately removed from the field and not allowed to return to play whether or not they believe that they are fit to do so, as per World Rugby guidelines.

Additionally, I find myself very strongly in support of the American system where all individuals involved with American Football, be they players, coaches, ancillary staff and indeed parents are required to have mandatory education into concussion and second impact syndrome. This allows the potential seriousness of concussional injuries to be understood by all involved in the game and additionally brings in the "early warning system" of family members, partners etc. who are good at identifying changes in mood, personality and social engagement in injured players, which may be indicators of a more significant level of post-concussional injury. These are subtle changes that may not be noted by healthcare providers who are not intimately acquainted with the individual. Dr James Kelly, an eminent American Neurologist, feels that familial input is vital in identifying subtle neuropsychological changes that the patients themselves may not be aware of. Legislation currently in place in all 50 states of the US was first enacted in Texas as long ago as 2007 after a fatal second impact syndrome incident during high school football training and was subsequently adopted nationwide more than a decade ago. A similar legislated requirement for awareness training would be invaluable in the UK and would undoubtedly help to direct those with persistent post-concussional symptoms to appropriate expert care, especially if coupled to increased GP awareness of potential post head injury sequelae.

7. The final area you ask me to cover is the question of Chronic Traumatic Encephalopathy. This is an extremely topical subject with multiple recent publications in the media concerning large group actions both in England and a progressively growing group action in Scotland. This is an area of great potential significance for all Rugby Unions and ultimately World Rugby. The knowledge base concerning Chronic Traumatic Encephalopathy has grown exponentially in recent years, assisted considerably by pioneering neuropathology work, both here in the United Kingdom and in the United States involving examination of the brains of deceased football (soccer) players and players in the NFL in

America. It should be borne in mind that the brains examined were donated by players showing signs of neurodegenerative change in life. After death, autopsy examination of the brains showed a very high level of the presence of Chronic Traumatic Encephalopathy, particularly in the elite NFL players, where 99% of players are reported to have shown signs of CTE.

The one common factor for all is their exposure to multiple head blows over a long period of sports participation. Whilst the precise neuropathological process between repeated head blows and formation of abnormal proteins within the brain of sufferers of CTE has not been identified, there are a number of current working hypotheses under investigation. Doubtless we will see the fruition of these efforts over the coming decades. However, experts in the field including Professor Willie Stewart here in Glasgow are of the opinion that a balance of probabilities consensus has already been reached that CTE does result as a consequence of multiple head blows in the course of contact sports. Whilst there may be some ongoing argument as to whether head blows only cause Chronic Traumatic Encephalopathy or may be responsible for a wider spectrum of mixed neurodegenerative changes including Alzheimer's disease and Parkinson's, the end point is the same. This results in a progressive neurodegenerative pattern with very significant consequences for the individual in terms of neurological function, personality and emotional lability, inhibited memory and ultimately very serious issues regarding quality of life, not only of the sufferer but also their extended family. It should additionally be borne in mind that as things currently stand, costs of late care will the burden of society in general and the NHS, as well as the affected individuals and their family.

The current state of medical knowledge is that we don't know whether Chronic Traumatic Encephalopathy only follows concussional injuries or whether this is more due to repetitive and much more frequent sub-concussive head blows.

There is, however, emerging evidence particularly from studies in football that retired football players demonstrating CTE have suffered many minor sub-concussive injuries but only one or two documented concussions. This is particularly of relevance in rugby where the number of head blows per player per game seems to be significantly higher than in other comparable contact sports.

Probably the most serious issue for the Rugby Unions if they chose to try and defend the question of "Is CTE sports related?" is the outcome of a group action against the NFL in America. This has been brought by several thousand former NFL players suffering from neurocognitive deficits, first staring as long ago as 2006 and then pursuing a complex course through the Courts in the US.

Ultimately it was judged that neurocognitive deficits were indeed as a consequence of repeated head trauma and that compensation was payable to the affected players. Whilst there was some further negotiation regarding the ultimate cost to the NFL, the final settlement in 2016 was of compensation worth $1.1 billion to be paid to the affected individuals over coming decades. I feel that there has been a lot of further information made available since this landmark judgement, all of which is supportive of a positive link between CTE and repeated head injuries. Consequently I believe that it is unlikely in the extreme, should the same question be examined in the UK Courts, that any other viewpoint would be reached.

We are only now starting to see significant numbers of male rugby players presenting with symptomatology in keeping with CTE and as yet, there has been no similar cohort in female rugby. It is highly likely that this is due to only comparatively recent expansion and participation in the women's game and that the presentation of a cohort of CTE sufferers of female sex will be forthcoming over time. Robert Stern, Professor of Neurology at Boston University, where the principal US brain bank is located, responded to the question of whether there is any noted sex difference between male and female sports players in the context of CTE by saying that he had "no idea" as the brains of women with a history of contact sports participation had not as yet been examined. He did however comment that with increased female sports participation in the US over more recent years, cases should now be "popping up".

Whilst it has not as yet been possible to undertake full post mortem neuropathological examination of a representative sample of female brains, it is reasonable to assume that a proportion of female contact sports players are indeed going to go on to develop CTE.

As regards this likelihood, Professor Stern states, very reasonably, "We can't wait until adequate data are compiled 30 to 60 years from now when a group has been followed through their entire lives to prove that head impacts cause CTE. We must combine common sense with the growing body of evidence". This is an entirely reasonable and balanced viewpoint inferring that <u>immediate</u> action within rugby to mitigate the risk of CTE cases in future is of vital importance.

Considering all the issues outlined above and accepting that the point has now been reached where women should be considered at higher risk for concussions and their late sequelae, I would suggest that the following actions are necessary on the part of those in control of policy at the SRU:-

IMMEDIATE ACTIONS

Accepting that a balance of probability has been reached supporting the view that women suffer more concussions and potentially have longer lasting symptomatology, any current female players and any new players to the sport, irrespective of age, must be made aware of their enhanced risk status. This awareness must be transmitted to the legal guardians of minors who are starting to play. This would allow informed consent of potential risks of participation going forward and be a robust defence should such individuals subsequently raise legal proceedings on the basis of concussions or their long-term sequelae.

The second immediate action would be to initiate a process of widespread education across players of both sexes regarding concussion risk in the game, plus ancillary education of support and coaching staff to greater appreciate the seriousness of potential concussive injuries, their likely long-term sequelae and the implications of inappropriate actions as concerns concussion management.

MEDIUM TERM OBJECTIVES

As the burden of diagnosis and care in persistent concussive presentations will fall out-with the elite sector, primary healthcare pathways will be involved. Normally this will involve the patient's General Practitioner and for reasons outlined previously this is an area where short to medium term improvement is undoubtedly achievable. The best method would be through General Practice enhanced awareness and education on the immediate and potential sequelae of concussional injuries.

This would best be achieved as part of their mandatory annual CPD education, supported by the Royal College of General Practitioners, the Scottish Rugby Union and, potentially, the Scottish Government. This would allow formal high-level education of primary care givers, particularly with regard to the emerging subtle differentiators of persistent head injuries such as neuropsychological and neurocognitive disorders. Such an initiative would rapidly, over the space of only a few years, exponentially increase the number of General Practitioners with much more expert skill levels when assessing players, both in the immediate post-injury phase and whilst assisting in return to play and activity protocols.

A further area that requires addressing in the short to medium term would be a change of "cultural appreciation" of concussional injuries. This refers to the current structure of team

coaching and interaction with supportive healthcare professionals involved in the game. At present, it would appear that in many instances the opinion of senior coaching staff is regarded as the ultimate arbiter of play and participation even when healthcare staff are in attendance. This may not be the case universally, but a change to openness in players discussing potential post-concussive symptoms and heeding the opinion of healthcare providers as regards player welfare must be considered, with greater emphasis always placed on the best interests of player welfare and brain health. This, in my opinion, will require specifically targeted education and role definition for coaches and ancillary club and school staff.

MEDIUM TO LONG TERM RESEARCH

Having examined all the information available to me, it is quite clear that there are major knowledge gaps as well as, perhaps, a refusal in certain quarters to acknowledge the evidence presented in peer-reviewed papers of the last decade. We do not as yet know with surety the precise structural injuries within the brain that cause post-concussive symptoms, although it is generally accepted that the most commonly involved areas are the frontal and temporal lobes and inter-hemispheric white matter. Greater precision in terms of brain imaging is undoubtedly required to help manage traumatic brain injury and there are exciting developments in this area which require research support. Other potential questions arise, such as hormonal influence, differential brain structure and especially differing neuropsychological responses to minor traumatic brain injury. There is no doubt that there is much further research to be done.

At present we know what happens and what the ultimate outcome is, but we do not necessarily have good understanding of the precise nature of mild traumatic brain injury at the cellular level and the neuropsychological and neurohormonal pathways that lead to the ultimate outcome.

The analogy would be that we know the start point, i.e. a concussive head injury and we know the end point i.e. post-concussional symptoms or CTE, but we do not necessarily know the route from one to the other and where in that chain there are opportunities for treatment or mitigation of symptoms. Further research needs to be undertaken in a number of fields, preferably in such a way that there is cross-reference and pooling of knowledge between the individual specialisms involved.

With regard to Chronic Traumatic Encephalopathy, research is likely to take decades to fully elucidate the causal pathway given the slowly progressive nature of the disease. It did strike me however that there is an excellent opportunity to try and understand if there is any

common gene prevalent in the current cohorts that have clinical symptoms but are not yet deceased. Establishment of any common gene in sufferers might be extremely helpful in ongoing neurodegenerative research and potentially assist genetic medical treatments in the longer term. This is an opportunity we should not pass up and I would hope that the SRU would be in favour of such an initiative if they wish to promote long term player welfare.

Research allowing precise identification of differential occurrences between males and females, investigation of hormonal variance and investigation of neuropsychological aspects of head injuries are the areas most likely to be achievable in the short to medium term and these goals should be pursued as soon as possible. Additionally, the emerging role of progressively more and more advanced imaging techniques, particularly for early identification of mild traumatic brain injury, are also worthy of urgent research input and support.

I took the opportunity to discuss the structure of a potential multifactorial investigation going forward into the medium to longer term with retired Professor Emeritus of Neurosurgery Sir Graham Teasdale, co-author of the Glasgow Coma Scale. Our collaboration resulted in the following outline for potential research going forward:-

AN INVESTIGATION OF HEAD INJURIES IN SPORT WITH EMPHASIS ON FEMALE RUGBY PLAYERS

The perspective envisaged for the programme would be broad and multi-disciplinary, covering the various aspects of the problem in-depth and in a complementary way.

The fields of research are likely to include epidemiology of injury, biomechanics, biochemistry, imaging, clinical severity, complications and early and late outcome.

Cohorts are likely to be studied prospectively including trials of therapeutic interventions.

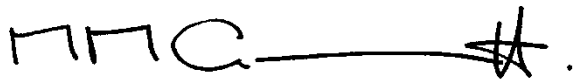
Outputs are expected to include:-

- Delineation of the pattern of occurrence of head injuries, defined clearly and uniformly.
- Delineation of the nature of sequelae of a head injury, defined consistently after different injuries.
- Whether the foregoing are influenced by gender, by age, by management.

The success of a programme of the scale and ambition envisaged calls clearly for the leadership of an experienced investigator with high academic standing and an International reputation.

As you will see from my various comments, there are multiple areas of considerable interest arising from my general research. I note your intention to transmit my original paper and this further discussion to the Board of the SRU which I would welcome, as these are important questions relating to player safety and wellbeing, both in the short and long term. Whilst there would appear little doubt that there are differences between males and females, players of both sexes deserve the highest level of protection and care, both during their playing careers and extending beyond. I would be happy to discuss any further matters arising with members of the Board as individuals or collectively going forward.

Yours sincerely,



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I have taken the liberty of attaching a list of further reading for those interested. This contains a significant number of further relevant research papers which collectively influenced my review document and this current response. Also included are a group of media articles likely to show the level of background knowledge on the subject of CTE and concussions available to most lay individuals. Recommended video articles are outlined.

RESEARCH ARTICLES

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ADDITIONAL VIEWING

Brainline video series 1 – 5, Professor James Kelly, Professor of Neurology, Denver, Colorado. This is an excellent series providing insight into mTBI from one of the World's foremost authorities and is extremely accessible and informative.