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## **Briefing Note for West Bridgford Colts FC: Heading a football**

M.H.

### **1 Summary**

The implications of concussion are becoming increasingly well understood and documented. And major sporting bodies are reacting by putting clear guidelines and protocols in place to protect players.

However the effects of “lesser head impacts” (sub-concussive impacts) (including the heading of a football) are not so well understood. There is growing, vocal<sup>1</sup> concern that heading a football is extremely dangerous and research is slowly gathering pace. This includes the PFA itself calling on a ban of Under 10s heading the ball in December 2016.<sup>2</sup>

This reaction from the PFA follows;

- guidelines in the United States that now prevent young children from heading the ball
- a new study by the University of Stirling that indicated memory impairment after heading the ball
- and what experts have called the “frightening” anecdotal evidence of former players suffering with serious brain conditions.

This short briefing paper has been written to pull together some structured thoughts on the subject to look at what data is out there.

I am not at all qualified on the subject. I’m a dad of a kid and I’m a coach of a team, and I am confused and frustrated that more research hasn’t been done on the subject. I have reached out to a friendly pediatric consultant who has helped me decipher some of the research.

I have tried to be as objective and factual as possible in this note, and have called out personal opinions when they have crept in. Having spent the time to create this briefing note, I am increasingly concerned about the impacts of heading a football and increasingly keen to do something about it.

*In the original paper (v2.0) I made some personal recommendations, but these have been removed in v3.0 of this paper as it will be more widely distributed – and my personal views don’t necessarily reflect those of the club.*

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<sup>1</sup> The Telegraph is a particularly loud voice in this space, and I’ll reference their material widely in this briefing note. This includes their “Football’s Silent Shame” campaign.

<sup>2</sup> <http://www.telegraph.co.uk/football/2016/12/29/pfa-urges-fa-consider-ban-heading-children-10/>

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## 2 Definitions

Let’s start with some definitions;

Concussion	<p><b>Concussion is the sudden but short-lived loss of mental function that occurs after a blow or other injury to the head. It is the most common but least serious type of brain injury.</b></p> <p>The medical term for concussion is minor traumatic brain injury.</p> <p><a href="#">Symptoms of concussion</a> include brief:</p> <ul style="list-style-type: none"> <li>• loss of consciousness after the head injury</li> <li>• periods of memory loss</li> <li>• disturbances in vision, such as "seeing stars" or blurry vision</li> <li>• a period of confusion, a blank expression, or a delay in answering questions immediately after the head injury</li> </ul>
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	If a brain scan is carried out, concussion is only diagnosed if the scan is normal – for example, there is no bleeding or swelling of the brain. <sup>3</sup>
Sub-concussive	A blow to the head that is below the threshold of concussion.
CTE	Chronic Traumatic Encephalopathy (CTE), a neurodegenerative disorder that causes depression, anxiety, and cognitive deficits

### 3 First, a brief discussion on Concussion

In the past 10 years, lots of research has been done to understand the effects of Concussion.

#### 3.1 NFL

Perhaps the most famous here is the experience and evolution of the NFL's view towards concussion.

Concussions and other types of repetitive play-related head blows in American football have been shown to be the cause of chronic traumatic encephalopathy (CTE), which has led to player suicides and other debilitating symptoms after retirement, including memory loss, depression and dementia.<sup>4</sup>

Various highlights in the research include;

- Kevin Guskiewicz, Director of the Center for the Study of Retired Athletes in the Department of Exercise and Sport Science at the University of North Carolina, analyzed data from a 2007 study of nearly 2,500 former NFL players. He found about 11 percent of the study participants suffered from clinical depression, with **a threefold increased risk** in former players who had a history of three or four concussions.
- The following year, the NFL commissioned the University of Michigan Institute for Social Research to conduct a study involving more than 1,000 former NFL players. The results reported that Alzheimer's disease or similar diseases appear to have been diagnosed in former NFL players vastly more often than in the general population **at a rate of 19 times the normal rate** for men ages 30 through 49. The NFL responded to these results at the time by claiming the study was incomplete.
- On September 30, 2014, researchers with Boston University announced that in autopsies of 79 brains of former NFL players, 76 had tested positive for CTE. As of January 2017, that number had grown to 90 out of 94.

The real story here is about how ex-players, scientists and lawyers have fought the NFL to finally get this problem recognised. And with this recognition have come huge sums of compensation (circa \$1 billion) and new protocols for players.

There is a huge amount more that can be read on the subject, or watched as it was recently the subject of the film imaginatively called "Concussion".

<sup>3</sup> Source: NHS. <http://www.nhs.uk/conditions/concussion/pages/introduction.aspx>

<sup>4</sup> [https://en.wikipedia.org/wiki/Concussions\\_in\\_American\\_football#Federal\\_NFL\\_Concussion\\_Litigation](https://en.wikipedia.org/wiki/Concussions_in_American_football#Federal_NFL_Concussion_Litigation)

### 3.2 Boxing

There appears to be so much evidence linking boxing to long-term chronic brain injury, that modern articles focus on (in my mind) peripheral issues.

Research has long shown that head trauma— something no boxer cannot avoid over the years—puts one at risk for permanent brain damage. Brain cells generally cannot repair themselves (as can cells elsewhere in the body), so damaged neurons stay damaged. The American Medical Association and British Medical Association have both called for a ban on boxing, citing statistics of brain damage in professional boxers.<sup>5</sup>

### 3.3 Rugby and Football in the UK

Rugby in the UK (in my opinion) has been slow to react, but it has now introduced new head injury protocols. And The FA has also recently issued protocols on Concussion in November 2015.

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<sup>5</sup> <http://www.livescience.com/1519-boxing-brain-damage.html>

## 4 Is there evidence that heading the ball is damaging?

### 4.1 Academic research and potential biases in the press

A search of medical academic published articles for the term “soccer heading” returned a surprisingly high result – of 95 articles with some connection to the subject.

These ranged from studying the mechanics of heading a ball to the potential impacts.

#### 4.1.1 A review of all academic literature

One or two of the articles described themselves as a review of all relevant literature. At first site I thought that these might be perfect, saving the time it would take someone to read all 95 pieces of research..

Their findings are largely that “there is no conclusive evidence of detriment”. At first glimpse this looks really encouraging.

However, my medical friend warned me that often when you review the collective work of many experiments and pieces of research it is very difficult to draw powerful conclusions as the research has all been conducted in different ways. So he stressed that “no conclusive evidence of detriment”, is not the same as “evidence that it doesn’t cause detriment”.

#### 4.1.2 Possible biases in the Press

I have found four pieces of recent relevant research that have stimulated significant press coverage;

- Radiological Society of North America - published 2013
- Purdue University, Indiana, US – published 2015
- University of Stirling – published October 2016
- Swansea University and University College London – published February 2017

It is a subtle point but worth making; ie those studies that have powerful recommendations tend to be the ones that get the coverage. I’m not stating that the people conducting the research bias their results. But if there are lots of pieces of the research, then the ones that journalists will write about will be the ones with powerful conclusions rather than those with indifferent conclusions. We should be a little wary of this.

### 4.2 Radiological Society of North America (Sept 2013)

#### **Soccer Heading Is Associated with White Matter Microstructural and Cognitive Abnormalities<sup>6</sup>**

One of the first academic articles on heading a ball, was published in the medical journal for the RSNA in September 2013. The abstract for the article is in the appendix and the full article is linked in the footnotes.

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<sup>6</sup> <http://pubs.rsna.org/doi/abs/10.1148/radiol.13130545>

This study was based on 39 amateur players, average age 31 years old. It looked at their history of concussion and last 12 months history of heading a ball (ie it was a paper survey rather than a scientific measurement one).

Having read the article, my conclusions are;

- it discovered that Fractional Anisotropy (FA) and Cognitive abilities were significantly negatively impacted by those subjects who had headed a ball around 1000 – 1800 times per year. (Confession – I didn't understand the Fractional Anisotropy bit)
- The research did not find that concussion itself was a predictor of this detriment (but rather sub-concussive impacts were a predictor).

### 4.3 Purdue University, Indiana (2015) – Constant heading of lightweight balls can cause lasting brain damage

#### Scientific study on women footballers in the US has shown that constant heading of modern lightweight footballs can cause lasting brain damage

Credit for this article goes to Sean Ingle, Guardian. (1/11/2015)<sup>7</sup>

As I've taken (pretty much) the whole article, I've dropped it into a table. I have highlighted what I think are the most important bits;

“We are all aware some old-time players – most notably and tragically Jeff Astle, the former West Bromwich centre-forward – suffered degenerative brain disease from repeatedly heading leather balls. **But while modern footballs are lighter and more waterproof, research by scientists at Purdue University in Indiana suggests they may not negate the dangers from heading hard shots and high punts.**

The researchers focused on women's football, which is known to have the highest concussion rates among female athletes – although, somewhat paradoxically, little is known about the number and magnitude of head impacts.

Eric Nauman, the director of the Human Injury Research and Regenerative Technologies Laboratory at Purdue University, along with his colleagues Tom Talavage and Larry Leverenz, sought to change that by tracking two high school teams and one collegiate level squad over a season. At every training session and match players wore an xPatch sensor behind their right ears, allowing the academics to monitor not only the G-force of every impact to the head but the rotational acceleration of the brain after every impact greater than 20g. The researchers' thoroughness didn't end there. They also monitored each session to see what types of impacts were causing the most force – and took MRI scans before, during, and after the season, to track changes in each player's brain.

Several discoveries startled them. First, **the forces generated by heading back goal-kicks and goalkeeper's punts were much higher than expected. Some registered at between 50g and 100g – similar to American Football players crashing into each other or punches thrown by boxers.** What's more, as Nauman explains: “The percentages of 100g hits was effectively the same between women's college soccer and American Football, which really surprised us. And while American Football players tend to take more hits overall in a given

<sup>7</sup> <https://www.theguardian.com/football/blog/2015/nov/01/football-heading-brain-damage>

practice session and game, the college soccer players were getting hit every day and so it evened out.”

Their results – some of which have recently been published in the Journal of Biomechanics – also showed college players experienced impacts of greater than 20g an average of 4.59 times every time they trained or played, more than double the figure for high schoolers. Because college players tend to head a football on most days they, in Nauman’s words “took blow after blow and absorbed a lot more energy in their brains”.

Of greater significance still are the results of the MRI scans on these women’s players, which are currently under peer review. As Nauman explains: “We looked at how the blood vessels responded to these headers, and the players who were in the top half for hits taken you could see their vasculature was damaged. These are things that can heal, but they need rest.”

**And that is the key. Rest. A football shouldn’t necessarily be dangerous. But if you head away thunderbolt shots or goalkeeper’s clearances regularly there is a risk that the brain can suffer several sub-concussive injuries – those impacts with no readily observable symptoms that can cause injury to the brain.**

These can even be more serious than heavy collisions which leave players foggy and groggy. As Nauman explains, **“If you actually compare the brains of people who have taken lots of sub-concussive hits to ones that have taken a single big hit, the sub-concussive brains often look worse. I don’t think people appreciate that yet.”**

**Worryingly, some of the college soccer players had brain injuries as bad as the American footballers that the Purdue University team have studied. That should be a wake-up call to sceptics who can’t imagine that a lightweight football can cause significant damage.**

What next? First and foremost, the academics believe there needs to be much more research in this area. Few would dispute we need a better understanding of these risks from junior level, where brains are growing, to the professional game.

And greater awareness too. A major problem is that with sub-concussive injuries people don’t realise they have damaged their brains. And so they keep going. “You can bruise any other part of your body and it feels sore,” says Nauman. “But when the same thing happens to your brain it doesn’t have the pain receptors to tell you to ease off for a few days. That is enough to really cause problems.”

Nauman also would love to put sensors on a Premier League team to judge the effects. “I’m willing to bet that if a Premier League keeper kicks it out and a player heads it back they could be pushing 150g or 160gs,” he says. Would that potentially be more dangerous? Probably not, he says, because men’s necks are stronger and therefore can absorb the extra force. But Nauman would like to make sure. “After all, our study on women’s soccer players altered our preconceptions. And with soccer it’s clear we’re only scratching the surface.”

#### 4.4 University of Stirling (October 2016) – “Heading a football causes instant changes to brain”

The published academic article is called: “Evidence for Acute Electrophysiological and Cognitive Changes Following Routine Soccer Heading”.

This was then summarized in a piece that appeared on the University of Stirling website. As I am quoting below significant text from that piece<sup>8</sup>, I’ve dropped the whole text into the following table:

##### Heading a football causes instant changes to brain

24<sup>th</sup> October 2016

Researchers from the University of Stirling have explored the true impact of heading a football, identifying small but significant changes in brain function immediately after routine heading practice.

The study from Scotland’s University for Sporting Excellence published in EBioMedicine<sup>9</sup> is the first to detect direct changes in the brain after players are exposed to everyday head impacts, as opposed to clinical brain injuries like a concussion.

Football players headed a ball 20 times, fired from a machine designed to simulate the pace and power of a corner kick. Before and after the heading sessions, scientists tested players’ brain function and memory.

Increased inhibition in the brain was detected after just a single session of heading. Memory test performance was also reduced by between 41 and 67 percent, with effects normalising within 24 hours.

Played by more than 250 million people worldwide, the ‘beautiful game’ often involves intentional and repeated bursts of heading a ball. In recent years the possible link between brain injury in sport and increased risk of dementia has focused attention on whether football heading might lead to long term consequences for brain health.

Cognitive neuroscientist Dr Magdalena Ietswaart from Psychology at the University of Stirling said: “In light of growing concern about the effects of contact sport on brain health, we wanted to see if our brain reacts instantly to heading a football. Using a drill most amateur and professional teams would be familiar with, we found there was in fact increased inhibition in the brain immediately after heading and that performance on memory tests was reduced significantly.

“Although the changes were temporary, we believe they are significant to brain health, particularly if they happen over and over again as they do in football heading. With large numbers of people around the world participating in this sport, it is important that they are aware of what is happening inside the brain and the lasting effect this may have.”

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<sup>8</sup> <https://www.stir.ac.uk/news/2016/10/heading-a-football-causes-instant-changes-to-brain/>

<sup>9</sup> Full academic article can be found at: [http://www.ebiomedicine.com/article/S2352-3964\(16\)30490-X/fulltext](http://www.ebiomedicine.com/article/S2352-3964(16)30490-X/fulltext)

Dr Angus Hunter, Reader in Exercise Physiology in the Faculty of Health Sciences and Sport, added: "For the first time, sporting bodies and members of the public can see clear evidence of the risks associated with repetitive impact caused by heading a football.

"We hope these findings will open up new approaches for detecting, monitoring and preventing cumulative brain injuries in sport. We need to safeguard the long term health of football players at all levels, as well as individuals involved in other contact sports."

Dr Letswaart and Dr Hunter were supported in the research by Stirling neuropsychologist Professor Lindsay Wilson and PhD student Tom Di Virgilio, consulting with leading Glasgow University Medical School Neuropathologist Dr Willie Stewart and a wider multi-disciplinary team.

In the study, scientists measured levels of brain function using a basic neuroscience technique called Transcranial Magnetic Stimulation (TMS). The findings from this National Institute of Health Research-funded study are the first to show the TMS technique can be used to detect changes to brain function after small, routine impacts.

This raises lots of questions..

How old were the participants in this study? They were 19-25 years old.

Does that matter? WB Colts needs to decide whether they are focused on just youth policies or entire club...

Is there any link between short term memory degradation and longer term seriously clinical illnesses? Not sure we know this.

#### 4.5 Swansea University and UCL (February 2017) – Postmortem Examinations

In February 2017, research from Swansea University and University College London linked chronic, repetitive head impacts with chronic traumatic encephalopathy (CTE) and dementia in deceased players.

Researchers at University College London found evidence of chronic traumatic encephalopathy (CTE), a potential cause of dementia, in four out of six former players following postmortem brain examinations. Helen Ling and Huw Morris at UCL's Institute of Neurology had been tracking 14 retired footballers with dementia who were referred to the old age psychiatry service in Swansea between 1980 and 2010.<sup>10</sup>

Although the sample size was small, researchers said the incidence of CTE among footballers exceeded the 12 per cent population average seen in previous studies.

Rather than the result of a severe concussion, the damage had been done by decades of "subconcussions" from heading the ball, clashing with other players or colliding with the goalpost. The ex-footballers whose brains were studied had played regularly for an average of 26 years.

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<sup>10</sup> <https://www.ft.com/content/8100124e-f2ca-11e6-95ee-f14e55513608>

#### 4.6 University of Glasgow – Retired rugby players not significantly affected

Here is the brief article as summarized in the Telegraph by Sarah Knapton<sup>11</sup> in October 2016;

Retired rugby players do not appear to suffer major brain problems in later life even if they suffer multiple concussions playing the game, a new study has shown.

Fifty-two former Scotland rugby stars were recruited for the study at the University of Glasgow, which sought to gather more evidence about the health and wellbeing consequences later in life for athletes.

Concussions suffered in sport have been linked to neurodegenerative disease and chronic traumatic encephalopathy, a progressive degenerative disease of the brain.

The 52 men, who had sustained an average of 14 concussions each, were analysed alongside 29 control volunteers.

Researchers "found that they only displayed some mild memory effects" in contrast to the volunteers.

They also reported no significant effects on daily life overall.

I included this article to demonstrate balance. But I also struggle with this particular press coverage in the Telegraph – mainly that there does seem to be some small detriments but the author spins it as a positive.

### 5 Some highly publicised case studies...

The research into heading a football is gathering pace (as highlighted in previous section). In addition, there are a number of high profile cases that it may be worth me briefly laying out below.

#### 5.1 Case Study: Jeff Astle – died of “industrial disease” from playing football

Suspicion that heading the ball may cause long-term damage to the brain emerged more than a decade ago after the death of Jeff Astle in 2002 (the former England and West Bromwich Albion striker). Astle died of a degenerative brain disease and the coroner said the cause of death had been due to repeated minor injuries to the brain.

Dr Willie Stewart is the consultant and lead neuropathologist at the Southern General Hospital in Glasgow. His name comes up in a number of different places on this subject. He was involved in the University of Stirling study already covered. But 3 years ago, he also reexamined Jeff Astle’s brain.

Stewart had been asked to re-examine Astle’s brain after a first post-mortem had concluded he died through playing football. What he found was more like the brain of an 89-year-old

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<sup>11</sup> <http://www.telegraph.co.uk/science/2016/10/07/rugby-players-do-not-suffer-major-brain-problems-in-later-life/>

than a 59-year-old and, even in the context of his past examinations of boxers, among the worst cases he had seen.

Stewart was then also part of a study last year by the University of Stirling that found temporary short and long-term memory impairment in footballers after routine heading practice. "It struck me in two ways," he told The Telegraph. "One, that such a low level insult [blow to the brain] could change what was happening and, secondly, that it is nearly 2017 and nobody has done this kind of work before. Nobody had looked at what heading might do to the brain."

Stewart is strenuous in not overstating the science or the findings of any study but he is emphatic about the need for more wide-ranging research.

## 5.2 Case Study: England 1966 World Cup Winning Team

In May 2016, The Telegraph reported that 4 of the remaining 8 outfield players are suffering from significant memory problems. Ray Wilson, Martin Peters and Nobby Stiles were diagnosed with Alzheimer's in their sixties while Jack Charlton has been struggling with memory loss since his late seventies.

The Alzheimer's Society has published that the number of men suffering from dementia in the wider national population between the ages of 65 and 69 is one in 75, which only rises to around one in 10 from 80 to 84.

The sample size is small, but that would **suggest football increases the chances of Alzheimer's by 20-30x** (which is similar to the NFL finding).

## 5.3 Case Study: US Soccer has banned heading for young players

In November 2015, the US Soccer Federation banned heading for children under 11 and limited the heading that 12-13 year olds would do – following pressure from a lawsuit.

In August 2014, a group of parents and players had filed a class-action lawsuit in the United States District Court of California against Fifa, US Soccer and the American Youth Soccer Organisation with negligence in treating and monitoring head injuries, although this was later amended to a complaint against US Soccer after a judge ruled that the case against Fifa had no standing.

The lawsuit sought no financial damages but only rule changes, and the lawyer who brought the case, Steve Berman, has confirmed that there will not be an appeal against the resolution as the intentions of the group have been accomplished.

"With the development of the youth concussion initiative by U.S. Soccer and its youth members, we feel we have accomplished our primary goal and, therefore, do not see any need to continue the pursuit of the litigation," Berman said in a statement.

I am finding it hard to find out how much evidence was actually presented, as this would be fascinating....

In the appendix is information on how the practice sessions and the matches are actually now run in practical terms.

## 6 What are the governing bodies doing?

### 6.1 Football Association

The Telegraph has been pushing the UK's governing bodies to act, calling it "Football's Silent Shame" and likening it to the tobacco companies' record on research and clarity on health issues.

The Telegraph launched a campaign in May 2016 urging the football authorities to commission independent research with a large sample of former players into whether football increases the risk of degenerative brain diseases.

The Professional Footballers' Association and the Football Association responded by promising to examine what research could be done both collaboratively and with other sports. A meeting was then held between Dawn Astle and Charlotte Cowie, the FA's head of performance medicine. Astle was also invited onto the FA's expert panel on head injuries. PFA chief executive Gordon Taylor said that he would be "disappointed" if research has not started by the end of year but, as yet, no details of any PFA or FA-funded project have emerged. The FA also promised to send research questions to Fifa.

In December 2016, the Telegraph reported that Dr Lisa Hodgson, the medical education lead at the Football Association, said the governing body hopes to finalise support for at least one major research project "within the next few months".

The statement will be received cautiously by campaigners, given that it is nearly 15 years since the FA and Professional Footballers' Association promised research following the Astle inquest. Stewart is amazed the anecdotal accounts of how so many former professionals are suffering has not mobilised the PFA into facilitating even relatively simple and low-cost research

Update: On 5<sup>th</sup> March 2017, Martin Glenn, CEO of FA announced that a "six-figure sum" would be invested in research into the area. He said a study would be jointly commissioned with the PFA by an unnamed university. He said: "The research that we're scoping out is really to look at one simple thing -- is the incidence of dementia greater in professional footballers, or former professional footballers, than it is in the population as a whole? You need lots and lots of data on that."

### 6.2 Why is the basic research not being done?

Our friend Dr Willie Stewart<sup>12</sup> has some basic views on this which I personally agree with;

"The question, 'Is the incidence of dementia in football higher than the general public?' could be answered by people in football, particularly the PFA, very quickly," says Stewart. "They have a list that goes on for pages of former footballers.

"All they need to do is arrange for that to be made available to researchers. They could then look at health records and see what conditions they had and what they died of. You can already do this in an amateur sense just by looking at football teams from the 1950s and

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<sup>12</sup> <http://www.telegraph.co.uk/football/2016/12/29/footballs-dementia-scandal-15-years-since-jeff-astle-no-forward/>

1960s. If you do that through Wikipedia, and through anecdotal evidence, you find a remarkable number of teams where four, five or six former footballers from the team have dementia. That's stunning.

"You would expect maybe one or two but to find four, five or six in team after team makes you think this really needs to be pursued. And yet, coming up for 15 years after Jeff Astle, we are still no further forward."

The families of many former footballers have become suspicious at the lack of action. "The PFA have people employed on phenomenal salaries and, as the footballers' union, could and should have answered this a decade or more ago," says Stewart.

"They should have numbers by now that say perhaps there's no difference in the dementia numbers of former players. Or, actually the dementia rate in former footballers is twice, three, four times what it is in the population. Or, maybe the rate of dementia is twice as high as the population but the cardiovascular health and other aspects are better so actually they have lived longer.

"It is astonishing how they cannot find the small sum to divert into what seems a reasonably simple study into the rate of dementia in former footballers. It defies my understanding."

## 7 Conclusion: West Bridgford Colts – what next?

As this note has laid out, we are operating in a world of imperfect information. This is especially the case when the largest bodies in world football (FIFA, UEFA, The FA) are (potentially) not the most objective and impartial judges or sponsors of new research.

It is my personal opinion that it would be extremely easy to do quantitative research using the vast numbers of ex-players. However that isn't the role of WB Colts!

### 7.1 What can we take away from the various bits of research that have been done?

So what can we conclude at this stage from the various research and articles that have been published?

1. This is not solely about Concussion. Sub-concussive blows to the head (similar to those received from heading a ball) can cause short term damage (up to 24 hours of reduced memory ability from only 20 headers - Stirling), and longer term damage (seen 12 months later – RSNA).
2. This is not about heavy leather balls from the 1960s. Recent studies have shown that the modern, lighter ball can still cause significant sub-concussive injuries.
3. Experts suggest that high frequency of heading a ball can be as damaging as a single large blow to the head.
4. Experts suggest that in younger brains, supported by weaker necks, the impacts can be worse than in adults.

For concussion, it seems that medical science has proven the link between concussion and long term degenerative brain diseases.

I don't know (having read what I've found) that there is yet a proven link between high frequencies of heading a ball as a youngster and long term degenerative disease – as I don't think that academic research has been done yet. However, there is strong anecdotal evidence (e.g. Jeff Astle, 1966 team) that there is a linkage between adult players and long term problems.

But do we need to wait to have a proven link between heading a modern ball and long term degenerative disease? There seems to be a short term detriment.

Are the four statements above enough to make us want to put some basic protections in place until this is better understood?

## 7.2 What could/should WB Colts FC do?

This isn't an exhaustive list, but here are some potential actions that the club could take;

- 1) Wait for the FA to make a country wide ruling on youth football
- 2) Drive a consultation with parents and coaches
- 3) Put some guidelines in place to restrict heading in practice sessions (perhaps using a sponge ball to teach technique)
- 4) Talk to YEL, other local clubs (and referees etc) about changing the rules for young players in our competitive games, potentially to adopt the practices of US Soccer.
- 5) Leave it up to parents and coaches to make up their own minds

*In the original paper (v2.0) I made some personal recommendations, but these have been removed in v3.0 of this paper as it will be more widely distributed – and my personal views don't necessarily reflect those of the club.*

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## 8 Appendix – further reading

In the course of writing this paper, I've come across other material or notes which needed a dumping ground but got in the way of the "briefing note" so that has gone here.

### 8.1 RSNA - Abstract

The first is the full Abstract for the article mentioned above from the Radiological Society for North America;

#### **Purpose**

To investigate the association of soccer heading with subclinical evidence of traumatic brain injury.

#### **Materials and Methods**

With institutional review board approval and compliance with HIPAA guidelines, 37 amateur soccer players (mean age, 30.9 years; 78% [29] men, 22% [eight] women) gave written informed consent and completed a questionnaire to quantify heading in the prior 12 months and lifetime concussions. Diffusion-tensor magnetic resonance (MR) imaging at 3.0 T was performed (32 directions; *b* value, 800 sec/mm<sup>2</sup>; 2 × 2 × 2-mm voxels). Cognitive function was measured by using a computerized battery of tests. Voxelwise linear regression (heading vs fractional anisotropy [FA]) was applied to identify significant regional associations. FA at each location and cognition were tested for a nonlinear relationship to heading by using an inverse logit model that incorporated demographic covariates and history of concussion.

#### **Results**

Participants had headed 32–5400 times (median, 432 times) over the previous year. Heading was associated with lower FA at three locations in temporo-occipital white matter with a threshold that varied according to location (885–1550 headings per year) ( $P < .00001$ ). Lower levels of FA were also associated with poorer memory scores ( $P < .00001$ ), with a threshold of 1800 headings per year. Lifetime concussion history and demographic features were not significantly associated with either FA or cognitive performance.

#### **Conclusion**

Heading is associated with abnormal white matter microstructure and with poorer neurocognitive performance. This relationship is not explained by a history of concussion.

## 8.2 US Soccer – new rules of the game

Given that the US has banned heading the ball for U11s and limited it for 12-13 year olds, I thought I'd share the following guidelines that explain how they now run the practice sessions and the games;

**The Federation is recommending, and US Club Soccer is requiring immediately, new rules as it relates to heading, as follows:**

- Players in U-11 programs and younger shall not engage in heading, either in practices or in games.
- Limited heading in practice for players in U-12 and U-13 programs. More specifically, these players shall be limited to a maximum of 30 minutes of heading training per week, with no more than 15-20 headers per player, per week.
- Clubs should be aware of circumstances in which individual consideration is needed. For example:
  - A 10 year old playing at U-12 or older should not head the ball at all.
  - An 11 or 12 year old playing at U-14 or older should abide by the heading restrictions in practice.
- Referees should enforce these restrictions by age group according to the specified rules. Referees will not be assessing the age of individual players on the field; they will enforce the rules for the age group.
- **Leagues and organizations are free to set their own standards, as long as the minimum requirements outlined above are met.**
- **In adherence to these new requirements, referees have been instructed by U.S. Soccer of the following rule addition:** *When a player deliberately heads the ball in a game, an indirect free kick (IFK) should be awarded to the opposing team from the spot of the offense. If the deliberate header occurs within the goal area, the indirect free kick should be taken on the goal area line parallel to the goal line at the point nearest to where the infringement occurred.*

**Modified substitution rules also took effect Jan. 1, 2016, as follows:** *Any player suspected of suffering a head injury may be substituted for evaluation without the substitution counting against the team's total number of allowed substitutions during the game.*