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PUBLISHER
SPORTS MEDICINE NEW ZEALAND
PO Box 6398, Dunedin
NEW ZEALAND
Tel: +64-3-477-7887
Fax: +64-3-477-7882
Email: smnznat@xtra.co.nz
Web: www.sportsmedicine.co.nz

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EDITOR
Dr Bruce Hamilton

ASSOCIATE EDITOR
Dr Chris Whatman

# CONTRIBUTORS

## Reflections on the past, the present and a glimpse into the future

### Chris Milne

*Chris Milne is a sports physician in private practice at Anglesea Sports Medicine in Hamilton, NZ. He has been Team Doctor for NZ Olympic and Commonwealth Games teams from 1990 to the present, and was Team Doctor for the Chiefs Super Rugby team from 1997 to 2003. A Past President of the Australasian College of Sports Physicians, he has also served as National Chairman of Sports Medicine NZ. He has been Medical Director of Rowing NZ since 2002, and is currently Chair of the Medical Commission for Oceania National Olympic Committees. He has a longstanding interest in medical writing, and is a previous Editor of the NZ Journal of Sports Medicine.*

### David Gerrard

*David Gerrard is a sports physician and Associate Professor of Sports Medicine at the Dunedin School of Medicine, University of Otago. He is a former Olympic Team physician, a New Zealand Chef de Mission, an Olympic swimmer and a Commonwealth Games gold medallist. His research interests include children in sport, bioethics and sports anti-doping, with over 70 peer-reviewed publications. He is currently Chair of the WADA TUE Expert Group, Vice-Chair of the FINA Sports Medicine Committee, Chair of the NZ Drowning Prevention Council and former Chair of Drug-Free Sport NZ.*

### Tony Edwards

*Tony Edwards is a sports physician in private practice at UniSports Sports Medicine, Auckland, NZ. He has been Team Doctor for NZ Olympic and Commonwealth Games teams from 1990 to 1996, and was Team Doctor for the Warriors Rugby League team from 1996-2000. He has been Medical Director of High Performance Sport NZ for the last 8 years until his resignation earlier this year, and he has been Medical Director of Hockey NZ since 1992. He has also served as National President of Sports Medicine NZ, and is a member of the FIFA Medical Committee representing Oceania since 2005.*

## The use of skinfold measurements to predict outcome of open-water swim attempts in Cook Strait

### Karen Bisley

*Karen Bisley is a sports physician working in Canberra at Sports Physicians ACT. She graduated through Otago Medical School. She is a Fellow of the Australasian College of Sports Physicians and Fellow of the Royal New Zealand College of General Practitioners. Karen is an experienced open water swimmer having competed in marathon swims both in New Zealand and Australia. She successfully conquered Cook Strait and has been the event doctor for a number of open water swims. With this experience, she has a good understanding of the technical difficulties involved. Karen still swims for fitness. Karen also has an interest in gymnastics and dance related medicine. Currently she is the ACT cycling doctor and has been doctor for the Canberra Marathon for five years.*

### Michael Marfell-Jones

*Mike Marfell-Jones, sport scientist and anthropometrist, is currently the Research Manager at the Open Polytechnic of New Zealand. He is the International Society for the Advancement of Kinanthropometry's most senior Criterion Anthropometrist and is based in Wellington, New Zealand, from where he travels internationally to teach ISAK courses and re-accreditation workshops. As well as his many other publications, he has co-authored all three editions of the ISAK Manual, the latest being the 2011 edition, and authored the ISAK Handbook which is the international textbook for all those Level 3 and Level 4 anthropometrists teaching ISAK courses.*

## *Comment*

### Kelly Sheerin

*Kelly Sheerin is a physiotherapist and sports scientist at AUT Millennium Institute. He is the Manager of the Running and Cycling Mechanics Clinic, and Deputy Director of the J.E. Lindsay Carter Kinanthropometry Clinic. Kelly is currently completing his PhD in gait biomechanics which involves the development of a mobile feedback system based on inertialsensors, aimed at modifying running mechanics.*

## The use of a trunk-mounted GPS/accelerometer system to measure vertical impacts for injury risk factor analysis in Australian Rules footballers: A feasibility study

### Craig Panther

*Craig Panther is a sports physician based in Auckland. He and his family have in recent years spent two-year periods in both London and Melbourne, where he worked as a club doctor with Fulham FC and Geelong FC respectively. He has recently completed a Masters in Medical Science through the University of Auckland, and the Fellowship of the Australian College of Sports Physicians. He has particular interests in football and sailing medicine and is currently the club doctor for Auckland City FC. He currently lives with his wife and son on the North Shore of Auckland and is based at Unisports Sports Medicine.*

### Chris Bradshaw

*Chris Bradshaw is a sports physician and partner at Olympic Park Sports Medicine, leading the medical team at the Geelong campus and is the Medical Director for Geelong Football Club. On returning from working in the UK with numerous teams and organisations, he has re-joined the ACSP Board of Censors, having served on the board from 1997-2000 and also sits on the ACSP Board of Examiners. Chris finished 5th in the 1990 Commonwealth Games Decathlon in Auckland.*

## *Comment 1*

### Mike McGuigan

*Mike McGuigan is a Professor of Strength and Conditioning at AUT University and an Adjunct Professor at Edith Cowan University. He is the Associate Editor-in-Chief for the Journal of Sports Science and Medicine and a Senior Associate Editor for the Journal of Strength and Conditioning Research. He is also currently the Research and Innovation coordinator for the Silver Ferns.*

## *Comment 2*

### Chris Hanna

*Chris Hanna is a sports physician working at UniSports Medicine in Auckland. His interests include hip and groin injuries, and pectoralis major ruptures. He is an honorary lecturer for the Postgraduate Diploma in Sports Medicine at the University of Auckland.*

# CONTRIBUTORS

## Sports medicine practitioners' assessment and management of upper respiratory illness in athletes

### Samantha Promroy

*Samantha Pomroy is currently an intern at the Canberra Hospital after completing a Bachelor of Medicine/Bachelor of surgery at ANU. Prior to this, Sam was a physiotherapist for 10 years, having a keen interest in sports, working with Sydney University Rugby, Sydney University Flames WNBL, NSW/ACT Under 16/18 AFL and suburban Sydney rugby and AFL teams. In the future, Sam is keen for application to the sports medicine program with particular interests in team and Olympic sports, as well as further research involvement.*

### David Pyne

*David Pyne is a sports scientist in the Department of Physiology at the Australian Institute of Sport (AIS). David has 25 years experience at the AIS and been involved with every Australian Olympic Swimming Team from Seoul, 1988 to London, 2012. He also has extensive experience with court and field-based team sports at the AIS and national levels. His work in exercise immunology has focused on relationships between exercise, training and immune function, epidemiology of illness in athletes, and nutritional interventions. David has published over 190 peer-reviewed papers and holds adjunct appointments at the University of Canberra, James Cook University, and Griffith University. He is a member of Sports Medicine Australia, and a Fellow of the American College of Sports Medicine.*

### Kieran Fallon

*Kieran Fallon is Associate Professor in the Faculty of Medicine at the Australian National University where his main responsibility is coordination of teaching of all aspects of musculoskeletal medicine. He spent 19 years at the Australian Institute of Sport, the last 11 as Head of Sports Medicine and recently downshifted to concentrate on medical education and pursuits that he had neglected for many years. Kieran graduated MBBS (Hons) from the University of Sydney and holds a Master of Sport and Exercise Science degree from that university. He gained his MD and a Masters degree in Higher Education from ANU and holds two medical fellowships. His main research interests have been in clinical haematology and biochemistry in elite athletes, ultramarathon running and mythbusting in sport and exercise medicine.*

### Peter Fricker

*Peter Fricker OAM is a sports physician currently employed as Chief Sports Medicine Advisor with the Aspire Zone Foundation in Qatar. Fricker spent 30 years with the Australian Institute of Sport, as Head of Sports Medicine, and then Executive Director from 2005-2011. He was a team doctor to several Australian Olympic and Commonwealth Games teams and travelled extensively with Australian gymnastics and basketball teams. His research and industry interests are numerous including groin pain, exercise immunology, and anti-doping strategies. He was a member of the Australian Sports Drug Medical Advisory Committee and the Anti Doping Research Panel from 2000 to 2005. He was President of the Australasian College of Sports Physicians from 1994 to 1996.*

## Reducing injury in elite sport - Is simply restricting workloads really the answer?

### Paul Gamble

*Paul Gamble is an author and strength and conditioning specialist. Paul is originally from the UK where he worked in high performance sports for a decade, beginning his career in professional rugby union with London Irish and latterly serving as National Strength and Conditioning Lead with Scottish Squash where he also oversaw sports medicine and sports science provision for players in the national programme. Since arriving in New Zealand in late 2011 Paul has continued to combine writing and training athletes: in 2012 he founded the Informed Practitioner in Sport website to develop and deliver online continuing education courses for practitioners, and is presently engaged with training track and field athletes.*

## Ethics in New Zealand Sports Medicine

### Lynley Anderson

*Lynley Anderson is a senior lecturer at the Bioethics Centre, University of Otago. She teaches ethics and professional issues to medical, physiotherapy, and other health professional students as well as post-graduate students at the University of Otago. Lynley's PhD explored the ethical issues facing NZ sports doctors working with elite athletes and teams through interviews with 16 sports doctors. As a result of this research Lynley was invited to write the Australasian College of Sports Physician's Code of Ethics. Since then she has written the NZ Physiotherapy Code of Ethics, and the NZ Sports Physiotherapy Code of Conduct. Lynley has a number of publications on sports medicine ethics.*

## How I Treat: Adhesive capsulitis

### Judith May

*Judith May is a sports physician who is currently working at Grace Sports Medicine in Tauranga. Her interests include female issues in sport and endurance sports. She is currently the Medical Director for Triathlon New Zealand. She is a Professional Practice fellow with Otago University teaching the Women in Sport paper for the postgraduate diploma in sport and exercise medicine.*

## *Comment 1*

### Chris Hanna

*Chris Hanna is a sports physician working at UniSports Medicine in Auckland. His interests include hip and groin injuries, and pectoralis major ruptures. He is an honorary lecturer for the Postgraduate Diploma in Sports Medicine at the University of Auckland.*

## *Comment 2*

### Margie Olds

*Margie is a physiotherapist who specialises in shoulder injuries. She works alongside Graeme White at Unisports Medicine, has a specialist shoulder practice in West Auckland, works at AUT on the post-graduate musculoskeletal programme and has developed a shoulder brace to prevent recurrent shoulder instability.*

### Graeme White

*Graeme White is a sports and manipulative physiotherapist with a special interest in overhead sports and shoulder injuries. He is a founding partner at UniSports Sports Medicine in Auckland and is a provider to High Performance Sport New Zealand.*

## IOC Advanced Team Physician Course, Saltsjobaden, Sweden

### Nat Anglem, *Ngai Tahu*

*Nat Anglem is a sports physician in Christchurch. His aim is to use models of high performance sport to improve the health and well-being of his patients, as well as their athletic success. He works for High Performance Sport New Zealand within the Wintersport programme.*

# Towards a "Grand Unifying Theory of Sports Medicine" (AKA "Guts Me")

The latter half of the twentieth century was a period of immense social, cultural and technical development. It was also the period in which our field of Sports Medicine was founded and grafted into the specialty that it is today. Fifty years on from when our founding members had the foresight to establish the NZ Federation of Sports Medicine seems a reasonable period (despite the fact that 50 years no longer seems as long a time period as it once did) to reflect on how Sports Medicine has evolved. Even before the Second World War, the foundations for a future sports medicine specialty were being established in Europe, Britain and the USA, with physicians and therapists recognising the unique challenges of caring for the athletic individual. Subsequently, and despite the post war conditions of the times, the 1950's saw the publication of multiple textbooks exploring topics such as injury surveillance, injury and illness prevention, and injury management – topics as relevant today as they were in the infancy of our field.[1,2] By the mid-1950's national and international sports medicine organisations were established and Sports Medicine was already being recognised as a profession in some eastern block countries. The 1960's saw expansion in both Sports Medicine research and the production of referenced textbooks, with the term "Sports Medicine" appearing in the title of a textbook for the first time in 1962.[3] Recently, historians comprehensively described the development of Sports Medicine in Britain,[4] in which they recognised three key historical components in the development of sports medicine as being: "prevention", "treatment" and "enhancement". These components were the cornerstones of a fledgling specialty, and while "enhancement" has evolved into a dirty word, prevention and treatment do remain fundamental to Sports Medicine. While the science supporting the specialty of Sports Medicine has clearly evolved over the last 50 years, other fields of science have undergone similar periods of academic evolution. How then, in comparison with other areas of scientific endeavour over this period, has the development of Sports Medicine knowledge fared?

It is perhaps (or hopefully) an interesting observation that if you were able to add the mass of all the individual atoms that you are composed of, the total would be less than what you will actually weigh on your bathroom scale. This is no mistake of your scales, but, rather confusingly, seems to reflect the fact that the sum of the parts is actually greater than the sum of the parts - a conundrum that perplexed physicists from the early 20th century. Remarkably, in an attempt to explain this anomaly and despite no actual evidence for their existence (and no way at the time of proving their existence), theoretical physicists in the mid-20th century postulated the existence of hitherto unknown subatomic particles. That is, additional particles that hang around with atoms, over and above the electrons, protons and neutrons that we were taught about at school or university. This theory of an unknown particle, ultimately known as the Higgs Boson (after Englishman Peter Higgs, one of the six theorists to postulate their existence in the form of a mathematical equation) was first proposed in 1964, one full year after the conception of the NZ Sports Medicine Federation. Proving the existence of these unknown particles, which ultimately were thought to relate to, and unify the theory of everything from the Big Bang to big surf (and, while not overtly stated in the literature, probably ACL ruptures), became the equivalent of the search for the Holy Grail, for 20th century experimental physicists. Almost 50 years of experimentation, international collaboration, controversy, fierce competition and billions (and billions) of dollars culminated in the "discovery" of the Higgs Boson by the Large Hadron Collider (LHC) at the European Council for Nuclear Research (CERN) in 2012. The LHC, looking remarkably like a James Bond villains lair, is a 27 kilometre underground circular tunnel capable of smashing particles into each other at almost the speed of light, while scientists sit back and watch what happens. Very cool. The 2012 discovery of the Higgs Boson, by an organisation founded in 1954 (the year of the 4 minute mile, the publication of the Lord of the Rings, and (unfortunately for my story, but close enough to include) two years after the formation of our British counterpart BAS(E)M), is considered to be one of the great scientific breakthroughs.[5]

At the time theoretical physicists were postulating the theory of subatomic particles and experimentalist were taking up the task, Sports Medicine internationally was in its infancy. However, in the last 20 years in particular, undergraduate and postgraduate education in our field has massively expanded, presumably enhancing our scientific base and the care of our athletic patient. Presumably - but how do we really know and what progress we have made? In the 50 years since physicists postulated and discovered the game-changing, impossible-to-fathom but unifying theory of everything Higgs Boson, what progress has Sports Medicine made – do we have a Sports Medicine equivalent of the Higgs Boson?

It would be inappropriate to suggest that the care we provide to Athletes has not improved over the last 50 years, as there has undoubtedly been some excellent research into each of the three traditional cornerstones of Sports Medicine – prevention, treatment and enhancement. However, I would contend that we lack a Sports Medicine equivalent of the Higgs Boson in terms of either a unified theory for soft tissue injury causality or management, or a robust ability to explore any underlying theory (should there be one). What we do have, are increasingly well-articulated clinical observations, for which we are slowly moving towards an understanding of the real challenges of "prevention" and "treatment". For most injuries, our understanding of the patho-aetiological and patho-physiological processes involved remains remarkably superficial; nor do we yet appear to have the means to adequately explore these challenges. For example, since the 1930's, injury surveillance has been both recognised and instigated in the field of sports injuries, and injury prevention as the natural extension of that surveillance was identified as a key function of Sports Medicine from our infancy.[6] Without doubt, injury surveillance, when applied, has become more structured and sensitive, but despite this, its application at all levels of sporting activity remains at best inconsistent and a logistical challenge for most sporting codes. To be balanced, as I would like to try to appear at least, both prevention and management have made substantial gains in some areas, with concussion and ACL prevention/management probably standing out. However, scratch the surface and there remains only a superficial understanding of many of the most fundamental aspects of the aetio-pathological processes underlying the majority of the (common) conditions we manage. Thus, it remains a challenge after all these years, to understand why one individual will suffer an injury and another not. In the time that the Higgs Bosun was postulated and hitherto unknown subatomic particles were identified, we have managed to describe the complexity of injury in athletes, but have made only toddler steps towards a deeper understanding of the phenomenon – without which effective prevention and treatment will remain speculative. This is not however, a diatribe against our underpaid, underfunded researchers who are working hard to resolve this situation. Nor is it a shot at the clinicians who are working with limited funds in challenging environments in which to perform research. It is however, as I will describe, a shot across the bow for those who appear to contrive to delay, potentially fatally for our field, the process of theory development and experimental evaluation.

Recently at a large international Sports Medicine conference, I was amazed to see seven different techniques for blood manipulation, for use in healing injuries, being vocally marketed in the exhibitors area. Reluctant to engage any of them in conversation, I hovered at the back of the crowds (literally) of physicians queuing to hear from these sales gurus. Quite apart from the frequent misrepresentation of the research, the best line I heard was (liberally paraphrased for effect but without impacting on the accuracy) "…this product will derive different concentrations of platelets for use in different conditions and locations, as we know different tissues need different concentrations for optimal effect… of course…this is still anecdotal, but we know this is the way to go". Listening to subsequent conversations, the impression one was left with was that the research will show this eventually, so you should start using it now, or your athletes will miss out. This is without even a clear or consistent understanding of the pathology we are treating (for example, what exactly is a "muscle strain"?), why this treatment should work or how it works, but worse, without any attempt to perform quality, quantitative clinical research to test any non-existent (or at best superficially appealing) theories. This approach, which unfortunately appears common within what is still the maturing field of Sports Medicine, may be our Achilles' heel. Often quoted from "the Descent of Man" (1871), Darwin famously said "False facts are highly injurious to the progress of science, for they often endure long; but false views, if supported by some evidence, do little harm, for everyone takes a salutary pleasure in proving their falseness". While there are a few ways one can interpret this statement, my overwhelming concern is that through repeated presentation of false (or at least unsubstantiated views), we are in danger of creating a specialty of damaging false facts. These self-sustaining inaccurate beliefs, touted by the modern "snake oil salesman" will not only delay the progression of science and patient care in our chosen field, but potentially destroy the profession before we really get going – if we let it. As the lesser quoted second half of Darwin's reference highlights, it is only when the falseness of the beliefs is proven that the "..path towards error is closed and the road to truth is … opened". This pathway to unsubstantiated beliefs is one that Sports Medicine must avoid if we are to survive and progress as a specialty.

Hence, while we may actually have a Higgs Boson-type challenge in trying to develop a grand unifying approach to injury prevention and management (and many other areas of Sports Medicine), there seems, unfortunately, only limited progress in the development of robust underlying theories, let alone high quality clinical research. Theory development, such as that exemplified by our Australian neighbours Jill Cook and Craig Purdam considering tendinopathy,[7] or our Norwegian colleagues on "everything else" should be embraced, encouraged and challenged experimentally. It is our remit in sports medicine to ensure this happens and while we may not need to split the atom or split into theoretical and experimental factions as our physics colleagues have done, we must support both robust theory development, collaborative investigation and excellence in clinical practice. Recycling of inaccurate, incomplete evidence, driven by vested interest and based on a poor theoretical and scientific approach will neither help our patients nor our profession. Let's not still be saying this in 50 years time.

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# Is the screen clear enough to see the road ahead?

On the cover of a recent edition of the British Journal of Sports Medicine (BJSM) it proclaimed "Sports injury prevention – mission possible". This was encouraging as I had recently started to wonder if this was in fact a mission even too tough for Tom Cruise! The journal reports on the encouraging success of a well-known Norwegian research team in reducing ACL injuries in handball. However while it appears there is growing evidence this type of injury prevention programme can be successful it seems we are still struggling to identify the athletes at most risk. We all agree that risk is multi-factorial and one factor that has received much attention recently is movement pattern (functional movement, movement competency) screening.

Many authors have for some time promoted the notion of screening athletes to identify dysfunctional movement patterns before pain or functional problems occur. All physiotherapists will be familiar with the work of Shirley Sahrmann who advocates assessment of the movement system, recently suggesting it should be checked as often as your teeth.[4] Movement pattern screening to identify athletes at greater risk for the likes of ACL injury and other lower extremity injuries (especially overuse injuries) is now widespread and considered a key strategy in all major sports. Studying the single leg squat (small knee bend, single limb mini squat or whatever your favourite term) as a screening test has been a popular topic for many research groups. The test seems reasonably reliable and some have shown it to be useful in identifying increased risk of patellofemoral dysfunction but there is a lack of prospective evidence.

I'm sure most involved in screening elite athletes in this country would agree that the initial attempts at screening protocols were over the top, too complex, with excessive numbers of items resulting in little useful information save for the summary comment in the conclusion. I am aware that recently there has been a lot of work done on refining the screening protocol in HPSNZ and for me this has resulted in a far better and hopefully more useful tool – some more evidence it helps identify those at greater risk of injury would be nice and hopefully this can be gathered in time! That said there is plenty of anecdotal evidence supporting the concept of movement pattern screening and in the view of many, good theoretical justification.[3]

A challenge to the concept of screening the movement system comes from biomechanists who advocate the value of increased movement variability. They have questioned the view that pain and dysfunction result from failure to attain a specific movement pattern. Several authors have suggested reduced movement variability may adversely affect joint health by causing systematic loading on the same areas of articular cartilage raising the risk of chondral damage and osteoarthritis.[2] While this is an interesting notion my impression is the variability they mention is very small in magnitude and while it may be beneficial it's probably not clinically measurable. Furthermore I doubt the term variability means the same to a clinician as it does to a biomechanist – it would be an interesting conversation! Perhaps there is an optimal movement pattern (appropriate relative motion between segments in a chain) within which some athletes may have increased micro variability and thus these two ideas are not necessarily at odds. My coaching colleagues also speak of the benefits of having variability in movement patterns during the game situation. Again I don't see this being at odds with the concept of trying to achieve optimal movement in some fundamental patterns. It does however highlight the need for various disciplines to communicate regularly – the multidisciplinary sports medicine, science and coaching conferences of the past seem a lost opportunity.

Disappointingly there is little quality prospective evidence available showing we are good at predicting those at greater risk based on movement pattern screening. Is this because the screen actually doesn't predict injury or are their other factors at play? There are likely many other factors and a couple were highlighted in the "mission possible" edition of BJSM. One is the role that genomics play in identifying those at risk of injury. A podcast with Professor Malcolm Collins from the University of Cape Town (freely available to all on the BJSM website) gave an interesting summary of his work showing there is increasing evidence genetic profile contributes to an athlete's susceptibility to tendon and ligament injury (genes contributing to the differences in the structure of collagen fibres for example). Most of the research has apparently focused on genetic markers for overuse tendon injuries and there are protective as well as harmful genes. There is no doubt a lot of work still needing to be done in this area including genetic profiles of different ethnic populations. Professor Collins was quick to correct the misconception that genetic profile will one day predict injury risk but rather that it could be used alongside other information to aid risk rating or identify how an athlete will respond to treatment – the environment is still important, movement screening still has a place!

Another factor of interest in the same edition of BJSM was the new tool for better recording of overuse injuries. Ronald Bahr and his team from Oslo have reported on a new questionnaire which appears far superior to traditional injury reporting mechanisms where overuse injuries are concerned.[4] Inappropriate tools for recording overuse injuries may be another factor why past studies have failed to show links between movement patterns and injury risk – particularly risk of overuse injury which is most relevant to movement screening. The use of this new tool in future studies may help and our group certainly has plans to use it. Tracking exposure suffers from much the same problem as injury definition and given the environment is still considered key this needs to be improved in future studies also.

So next time you see an athlete with a less than ideal movement pattern but a clean injury history – don't despair! It's likely this athlete is blessed with a combination of micro movement variability, good genes and exposure that allows him or her to fly under the radar. Thus when combined with other information you may still be able to see the more likely road many athletes are on by looking through the movement screen.

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INTERVIEW

CHRIS MILNE

# The Matt Marshall Interview

A warning to the unwary - this is no standard interview transcript. What follows is a few thoughts I have been able to cobble together following an approach to Matt Marshall based on our association over many years. I had put several questions to Matt and the response that follows is an admixture of his thoughts and my own interpretation and reflection.

### *Q1. What got you into sports medicine?*

The answer I got from Matt was that many doctors seemed to treat injuries but gave little thought to prevention or rehabilitation. From looking at the CV he sent me, a few things stand out. He arrived in New Zealand in 1957 and practised as a GP with an interest in sports medicine in Whangarei from 1957 to 1995. One suspects that he was in some ways a "Scottish refugee", seeking release from the summer-less Celtic north to the winterless north of New Zealand.

Having always been passionate about rugby, it is not surprising that by 1959 he had been appointed honorary doctor to the North Auckland Rugby Union. He continued in this role until 1995. Longstanding aficionados of our national game will note that his period of service incorporated the playing days of the incomparable Going brothers (Sid, Ken and Brian) whose deeds for North Auckland, the All Blacks and Maori All Blacks were legendary. In addition, he is an honorary member of the New Zealand Barbarians Rugby Football Club.

He served New Zealand sport with great distinction internationally, having been Director of Medical Services for Commonwealth Games teams in 1982 and 1986 and our Olympic team in Los Angeles in 1984. Subsequently he served on the Oceania National Olympic Committee's Medical Commission from 1984 to 2001.

Matt has had a lifelong interest in sports doping matters and was a member of the Hillary Commission Task Force on Drugs in Sport from 1990 to 1991. Subsequently he was appointed to the board of New Zealand Sports Drugs Agency from 1992 to 1999 and has served on the three-man Therapeutic Use Committee of that organisation from 2002 onwards.

He is well-recognised for his verbal ability, in particular an ability to reflect on experience via many humorous anecdotes over the years. It is no surprise that we have a named lecture, The Matt Marshall Lecture, at our annual conference which was inaugurated in 1996. Matt served as President of the Northland Branch of Sports Medicine from 1982 to 1989 and as National President of Sports Medicine New Zealand from 1983 to 1991. He was appointed a Foundation Fellow of Sports Medicine New Zealand in 1990 and awarded life membership of Sports Medicine New Zealand in 1996.

Dr Marshall receiving his SMNZ Life Membership Award, Wellington, 1996.

Outside our organisation he has had national recognition, being made an Officer of the New Zealand Order of Merit in 2006. He was appointed Patron of Sport Northland in March 2001 and was inducted as one of the Legends of Northland Sport in 2012.

### *Q2. What changes have you witnessed in sports medicine over the course of your career?*

Matt's career in sports medicine began when I was aged one, so was still in short pants. It spans some 45 years from that date.

[Editors Note: I think Chris is kidding himself here…]

From what I can see, the major change that has taken place in that time has been the increasing professionalism within sport and this has been accompanied by the need for increased professionalism of sports medicine clinicians. Initially the GP or physiotherapist with an interest and skills in sports medicine, who was largely self-taught, provided care to athletes at all levels. In the 21st century an increasing number of the clinicians providing services to our top athletes are specialist doctors or physiotherapists with additional qualifications in sports medicine. They in turn have been joined by nutritionists, podiatrists, psychologists and sport scientists, who collectively make up a team of skilled professionals. These people collaborate to provide optimal care for our elite athletes.

***First you must hone your skills to be an excellent general clinician. Then apply those skills to athlete care. Finally, take what opportunities you are offered because life is a journey of varied experiences, all of which can prove valuable in the future.***

On looking through his CV, the title "honorary" crops up repeatedly. In addition to being honorary doctor for the North Auckland Rugby Union, he has been honorary doctor for Northern Districts and Northland Cricket plus Northland Hockey and Swimming. For the uninitiated, honorary means unpaid. Matt donated copious hours of his own time, often at night and at weekends, to the service of athletes. The change from "honorary" to "contracted" is a significant momentum shift in the provision of services at the higher levels of sport. Nevertheless, there are still a huge number of members of Sports Medicine New Zealand who provide team care to clubs or education sessions on a voluntary basis.

### *Q3. I asked him to recall a couple of memorable moments.*

His response, "Needless to say, plenty has happened over my career. Some funny, some libellous. Easier to tell than commit to writing." How true. Those of us who have been in the organisation long enough to share a drink with Matt can testify to the huge store of anecdotes, many of which stem from a lifetime of service to sport and all delivered with an unmistakable Scottish dialect. As he said to me once, "I'm the one who can watch Taggart (Scottish TV show) without an interpreter."

One of his favourite moments happened at the Edinburgh Games. He was standing with one of the bowls team, Morgan Moffat, also a Scot. He was dressed in his blazer with a pocket emblazoned Director of Medical Services. He was approached by a reporter from the Edinburgh Evening times. "He asked me what I did in the team! I managed to keep a straight face and told him that I gave out medicines and also acted as an interpreter for the team, along with Mr Moffat. This gem of information appeared in the Evening Times that night. Needless to say, I was fined at the team meeting that night. Anyway, my accent is definitely Glaswegian." This will mean he will be right at home as an interpreter for the New Zealand team going to Glasgow in 2014.

### *Q4. Any advice he may have to offer to a young clinician contemplating a career in sports medicine.*

He provided no specific response to this, but from my interaction with him over many years I suspect his response would be similar to mine. First you must hone your skills to be an excellent general clinician. Then apply those skills to athlete care. Finally, take what opportunities you are offered because life is a journey of varied experiences, all of which can prove valuable in the future. In later discussion he made the point that it would be a help to any sports physician or other clinician if they study the intricacies and actions involved in each particular sport, as this would help steer the treatment in the correct direction.

### Statement of Interest

I should declare that Matt has been both an inspiration and a great supporter of my career in sports medicine. The same is true for several of our other senior clinicians. For young clinicians, if you are unsure of what to do in a given situation, seek advice as this will invariably provide you with a clearer way forward.

# Reflections on the past, the present and a glimpse into the future

The year 2013 marks the 50th anniversary of the founding of the New Zealand Federation of Sports Medicine, the forerunner of Sports Medicine New Zealand (11 March 1995SMN). It was February 11, 1963 when the first formal meeting of SMNZ was held in the Red Lecture Theatre of the Otago Medical School, to elect the "Foundation Officers". They comprised Dr Norrie Jefferson (President), Dr Jack Kilpatrick (Hon Secretary), and Dr John Heslop and Professor Phillip Smithells completing the inaugural Executive Committee.

The genesis of this meeting was perhaps a chance meeting between Dr Mayne Smeeton (Auckland) and Dr Jefferson, both of whom had an interest in sport and medicine, while serving in the Pacific during WWII. Subsequently, a meeting was arranged in Auckland in 1961 between Norrie Jefferson and Sir Arthur Porritt, while the latter was on a visit to New Zealand at the behest of the British Medical Association. Sir Arthur Porritt, a distinguished Otago Medical Alumnus, had previously represented New Zealand as an athlete in the 1924 "Chariots of Fire" Olympic Games and as Chef de Mission in 1936, where he mentored another Otago Medical student, the legendary Jack Lovelock. At that time Porritt postulated the formation of a New Zealand association of medical practitioners with an interest in sport, thereby laying the groundwork for the organisation of which we are members today. It is fitting to record that our inaugural President, Dr Norrie Jefferson, still resides in Dunedin, where he continues to take an interest in the proceedings of the sports medicine community.

These developments in New Zealand were not occurring in isolation. In the UK, BASEM had been formed in 1953 and Dr John Williams, who was a relatively junior orthopaedic surgeon at the time, published his first "Textbook of Sports Medicine", which was to be the forerunner of a later collaborative volume with Dr Peter Sperryn(who is well known to New Zealand audiences having lectured at our conference in 1983 and 1994). In the USA, Dr Don O'Donoghue had just published (1962) his landmark textbook entitled "Treatment of Injuries to Athletes" and J Cerney (1963) published the massive 872 page "Athletic Injuries: An Encyclopedia of Causes, Effects and Treatment". In Scandinavia, Per-Olaf Astrand was hard at work on his Textbook of Work Physiology which provided the basis for modern exercise physiology.

## So what was the state of the art back in the early 1960s?

At this stage, anterior cruciate ligament injuries were recognised as a significant contributor to knee instability but there were no reliable operative procedures for its reconstruction. Anterior knee pain was frequently treated by patellectomy, reflecting a limited understanding of the mechanics of the patellofemoral joint and the importance of non operative rehabilitation. Stress fractures, originally described as "march fractures" were recognised in military recruits, and it would be several years before Michael Devas would publish his early monograph in this topic.

*The pioneering work of Dr Philip Wrightson, neurosurgeon in Auckland, was carried out in the 1960s and 70s. His studies showed that there was definite cognitive decline after repeated head injuries and paved the way for later work by authors such as Paul McCrory, which have helped clarify our understanding of head injuries.*

Turning to cardiac issues, anyone suffering a myocardial infarct in the early 1960s was routinely prescribed six weeks of complete bed rest with instructions to avoid future strenuous activity. Early work in the 1950s by Professors Jerry Morris and Ralph Paffenbarger in the UK and USA respectively recognised that those habitually active in their workplace had a lower risk of cardiac events, yet this knowledge was slow to translate into cardiac rehabilitation.

Similarly, tendon injuries were relatively poorly understood. It was recognised that complete ruptures of major tendons such as the achilles tendon could be treated either in an equinus cast or with operative repair, but lesser degrees of tendon pathology in runners were often managed either by retirement from running or a complete change of sport. For example, John Davies, the 1500m bronze medallist at the 1964 Tokyo Olympics managed his achilles tendinitis by switching to cycling for a few years, before returning to a lower level of running as a club athlete.

Heat illnesses were poorly understood and remarkably, athletes were actively advised against drinking, at the risk of inducing the symptom euphemistically referred to as "stitch". Consequently many athletes from temperate countries succumbed to the effects of dehydration and overheating when they raced in major competitions held in warmer climes.

We knew very little about concussion in 1963, other than that some boxers were described as being 'punch drunk' and some even died after being knocked out. Rugby players of the era who owned up to having concussions were regarded as a 'bit soft'. The pioneering work of Dr Philip Wrightson, neurosurgeon in Auckland, was carried out in the 1960s and 70s. His studies showed that there was definite cognitive decline after repeated head injuries and paved the way for later work by authors such as Paul McCrory, which have helped clarify our understanding of head injuries.

On the rugby field the All Blacks, led by iconic captains Sir Wilson Whineray and Sir Brian Lochore, were the internationally dominant team throughout the 60s and 70s. Sir Colin (Pine Tree) Meads, regarded as a colossus of the game and All Black of the much closer scrutiny, stimulated by the amphetamine-induced deaths of Danish cyclist Knut Jensen in the 1960 Olympic road race and Britain's Tommy Simpson in the 1967 Tour de France. It was another three decades before the establishment of the independent World Anti Doping Agency (WADA).

Medical appointments to New Zealand teams were not formalised until 1964 when Dr Renton Grigor, an Auckland GP, was appointed to the Olympic Team for Tokyo. His credentials were a keen interest in treating athletes and a strong affiliation with the Mt Eden Swimming Club and the famous stable of athletes trained by legendary coach Arthur Lydiard. Renton Grigor became New Zealand's first official Olympic Team physician, followed in 1966 by Dr Mayne Smeeton, an Auckland anaesthetist and former NZ Universities high jumper, who accompanied the New Zealand team to the Commonwealth Games in Kingston, Jamaica. Subsequently, the current pathway for medical appointments to Olympic and Commonwealth Games teams resides with the New Zealand Olympic Committee.

## Pan forward to 2013

Sports Medicine New Zealand now has 600 members representing 10 regional branches, concentrated in the major centres. An enviable record of professional leadership and education has been established over the past 50 years through a single pan professional group representing all clinicians active in the field.

Historically, the former Hillary Commission was responsible for distributing Government funding to sport at the elite level and SMNZ, acknowledged as an important support service, received critical financial support. Today High Performance Sport New Zealand, formerly the New Zealand Academy of Sport, has emerged as the significant funder of elite athletes. The growth in professionalism within New Zealand sport, beginning with rugby in the 1990s, now allows athletes in major codes to make a living from their sport. Elite athletes pursuing concurrent academic qualifications are further assisted financially through the Prime Minister's Scholarships.

In Australia the kindred organisation is Sports Medicine Australia (also founded in 1963), and under the auspices of the Australasian College of Sports Physicians (ACSP)there has been the development of specialist training in sports medicine. New Zealanders have played their part in that organisation, with Chris Milne its first New Zealand president from 2006 to 2008. In the UK, the British Association of Sport and Exercise Medicine is the equivalent of SMNZ and the Faculty of Sport and Exercise Medicine is the equivalent body to the ACSP.

Further afield in the USA the American College of Sports Medicine, founded in 1954, has gone from strength to strength and its annual meetings now attract some 5000 delegates. This is the world's preeminent sports medicine meeting and if you have never been it is worth a look. In the early 21st Century, a European College of Sports Medicine was founded, and with an annual conference, continues to gain in strength and numbers year by year.

And what of the clinical issues?

Firstly, anterior cruciate ligament injuries are no longer the inevitable career-shortening or ending injury that they used to be. ACL reconstruction has been a reliable procedure for the last two decades, but the forces involved in rupturing the ligament still mean that there is a significant risk of post-traumatic arthritis in those who have sustained an ACL rupture. Anterior knee pain is now managed effectively with Jenny McConnell's taping and exercise regime plus attention to core stability exercises, particularly for the gluteus medius muscle, and provision of orthotics in those with over-pronation.

Our knowledge of stress fractures has improved immeasurably and modern methods of analysis of bone density, e.g. DEXA scanning, give us a good idea as to who needs to be managed the most actively. The role of energy deficit, particularly in those with eating disorders, has been increasingly emphasised in the last decade.

With regard to tendon rehabilitation, the Alfredson concentric then eccentric strengthening regime is well-established and effectively rehabilitates about 90% of those with midsection achilles tendinopathy or patellar tendinopathy, providing they are prepared to comply with Alfredson's protocol and adhere to a strict regimen of 90 repetitions per day. For the few people who do not respond to the Alfredson regime and who have hypervascular tendon change, a variety of adjunctive therapies have come along (although most lack critical levels of evidence). High volume local anaesthetic injections, blood injections and platelet rich plasma (PRP) injections all have their advocates and only time will tell which of these ultimately is established as the gold standard for adjunctive treatment. Certainly, surgery has been very much relegated to small print unless there is a complete rupture or a very high-grade partial tear that has not settled with non-operative means.

Our understanding of concussion has moved ahead in leaps and bounds, and a series of international consensus conferences have been held since 2001. These have enabled experts of various craft groups representing different organisations around the world to come together and hammer out some agreed protocols. There has also been the development of standardised methods of clinical assessment, e.g. the Sport Concussion Assessment Tool and monitoring of progress via paper or computerised testing.

Information technology has been the huge advance of the last 50 years and the internet provides all clinicians with resources at their desk, laptop or mobile phone that they could not have even dreamed of as little as 10 years ago. Most major journals have allowed at least some electronic access and athletes also have access to this material. Dr Google has become the most widely consulted clinician in the world, however we clinicians down here in New Zealand can offer what the internet cannot - a perspective rather than a tidal wave of unfiltered information.

In the sporting arena, the All Blacks are the current holders of the Rugby World Cup and Richie McCaw recently became the first All Black to play 100 tests. He is possibly the greatest All Black ever and hopefully his career has several years to run. In athletics the rise of the East Africans has meant that, apart from Nick Willis, New Zealand does not have a world-class middle distance athlete. However, the Polynesian migration to New Zealand in the last 50 years has led to competitors such as Valerie Adams making up for this deficit with great success in field events.

Rowing, cycling, yachting, canoeing and equestrian continue to carry the banner for New Zealand in Olympic events. Yachting deserves a special mention: through the application of high technology and Kiwi grit, Team New Zealand, under Peter Blake's inspired leadership, was able to win the America's Cup in 1995 and defend it in 2000. Currently they are pioneering a technique of foiling in catamarans and hopefully this will lead to the Cup returning to New Zealand later this year. Mark Todd continues to set the benchmark for equestrian competitors at the ripe old age of 56, and Bob Charles is a revered golfer, having won the British Open way back in 1963 and gone on to great success in recent years on the senior tour. Today, however, it's Lydia Ko, the teenage superstar of amateur golf, who sets the bar for golf in New Zealand.

While society in 2013 is full of conundrums and a much more diverse society than in 1963, as evidenced last year (2012) in London our elite athletes continue to excel on the world stage.. Paradoxically, the rise in non-communicable diseases such as type 2 diabetes and various metabolic illnesses reflects a sedentary lifestyle where we are too often transfixed by a television or computer screen. Cigarette sponsorship is a thing of the past, yet the promotion of alcohol remains a significant source of income for many sporting codes.

## And what of the future?

The next 50 years will present both opportunities and challenges. Organisations such as ours must have an on-going role in organising interdisciplinary meetings and promoting clinical collaboration. We must also preserve a voice as professional leaders and continue to express our opinion on matters of on-going importance in sport and exercise medicine. The future holds an opportunity for extended collaboration with our Australian colleagues and those further afield through electronic networking. In the future, audio/video interfacing will most likely become the preferred mode of communication.

Looking to the future in injury rehabilitation, one wonders about the development of techniques such as the LARS ligament. Will this be a winner or will it go the way of carbon fibre ACL reconstructions of the early 1980s that were subsequently consigned to the scrap heap. Bone stimulation has the potential to improve the healing rate of stress fractures, but is limited by cost to its use in professional sport only. While our ability to map the human genome rates as the scientific achievement of the century, its therapeutic potential is offset by the misuse of gene therapy to enhance athletic performance,

*For sport medicine professionals, the challenges are to maintain our competence and provide cost-effective care in the 21st century. Against rising public expectations and the increasing availability of high-tech imaging, this could present our most pressing challenge.*

On the sporting field New Zealand has the challenge of staying ahead of the pack in rugby and maintaining our excellence in rowing, canoeing, cycling, yachting and equestrian. The seemingly endless supply of elite East African middle and long distance athletes of 'pneumopod' stature will predictably prove unbeatable. Sadly, the Tokyo sight of two New Zealanders medaling in an Olympic 1500 metre race again is extremely unlikely. However, as was the case in Atlanta, we might well see two Kiwi equestrians once again mount the same Olympic podium.

For sport medicine professionals, the challenges are to maintain our competence and provide cost-effective care in the 21st century. Against rising public expectations and the increasing availability of high-tech imaging, this could present our most pressing challenge. When our medical system becomes high jacked by the attitude currently prevailing in America, where reckless over-investigation is driven by the fear of legal challenge, we run the risk of the New Zealand health system falling into the same fractious state. We must educate patients that clinical justification must always override their perceived desire for a costly investigation such as an MRI.

Finally, on a personal level, we should all attempt to maintain our own personal health and fitness and stave off the inevitable age-related decline in organ function. Keep turning up to meetings and socialising with your friends and remember that, after exercise, they are probably two of the best medicines we can take.

## JULY

The July issue included an editorial entitled 'Is lifelong exercise damaging to the heart'. Written by Matthew Wilson, who spoke at the SMNZ Conference in November, plus Greg Whyte, cardiologist from the UK, the article notes that regular endurance exercise training appears to slow the progressive decline in cardiac function. However, compared with age-matched secondary controls, a higher prevalence of subclinical cardiac disease has been reported in some veteran athletes. The authors have previously postulated that long repetitive bouts of endurance exercise may result in fibrotic replacement of the myocardium in susceptible individuals. This, in turn, can provide a pathological substrate for the development of arrhythmias. However, based on the evidence provided here, there is no need to change our recommendations to the average person; they have much more to gain than to lose from embarking on a lifelong exercise regime.


Hip arthroscopy is a procedure that has been performed with increasing frequency. An Australian group conducted a systematic literature review of 29 studies and report reduced pain and functional improvement in 14 studies up to 10 years post-surgery. Adverse effects were minimal and predominantly involved transient neuropraxia.

The treatment of proximal 5th metatarsal fractures is something of interest to all New Zealanders, particularly since our All Black captain Richie McCaw suffered this injury in the lead up to the 2011 Rugby World Cup. This Dutch group included 21 studies and concluded that all non-displaced avulsion fractures can be treated non operatively. Jones fracture and stress fractures in athletes are preferably treated surgically, given the better tendency to heal and a quicker return to sport. In non athletes they can be treated with operatively or non-operatively depending on individual patient characteristics.

Exercise in pregnancy is something that is being increasingly recommended. Barakat and co-authors from Madrid found that a moderate physical activity programme performed during pregnancy improved levels of maternal glucose tolerance.

Whiplash injury to the neck is a frequent problem in clinical practice. Does physiotherapy rehabilitation help in its management? Michaleff and Ferreira, two Sydney-based physiotherapists, looked at 21 trials but found only 12 studies involving 1395 participants could be included in their meta-analysis. Active physiotherapy interventions had small, short term effects in reducing pain and improving range of motion compared with provision of a cervical collar and GP care, but the long term data are minimal. These authors advocate high quality research evaluating the effectiveness of these interventions in the longer term.

Prohormones, e.g. dehydroepiandrosterone (DHEA), are marketed aggressively as "legal alternatives" to testosterone with similar anabolic effects. A recent major literature review found that such substances do not augment muscle size gains observed from resistance training alone, and their use may predispose people to serious health risks. These products remain banned under anti-doping codes and urine tests can pick up even minute amounts in the system.


## AUGUST

The August issue contains an important article detailing the seven best investments for physical activity. Based on the Toronto Charter for Physical Activity in 2010, the investments include the following:

1 Whole of school programmes
2. Transport priorities and systems that prioritise walking and cycling and public transport
3 Urban design regulations and infrastructure that provide for equitable and safe access for recreational physical activity
4 Physical activity and non-communicable disease prevention integrated into primary healthcare systems
5 Public education to raise awareness and change social norms on physical inactivity
6 Community-wide programmes in multiple settings and sectors
7 Sports systems and programmes that promote "sport for all" and encourage participation across the lifespan

This article provides an excellent summary of what needs to be encouraged in all societies.

Earlier in the same issue Viljoen and Patricios describe the implementation of a national rugby safety programme in South Africa. Entitled BokSmart, it is similar to the RugbySmart programme utilised in New Zealand. Thus far, BokSmart has trained 38,500 coaches and referees on the rugby safety course.

Core stability programmes are frequently used to prevent future episodes of chronic low back pain. A Norwegian group reported on a prospective study with a one year follow up involving 109 patients. They found improved transversus abdominus lateral slide among patients with a low baseline slide to be associated with clinically important long term pain reduction. It seems the exercises work, but the trick is getting people to comply with them in the longer term.

## SEPTEMBER

The September IOC issue included a 10-page IOC Consensus statement on thermoregulatory and altitude challenges for high level athletes. Although very wordy, this statement presents state of the art advice for athletes faced with these environmental challenges. It includes 99 references.

Altitude training is frequently used to increase exercise performance in elite athletes - but does it work? This Swiss group found that the widely used live high/train low protocol may increase exercise performance in some but certainly not all athletes, and that the potential response seems to be reduced in athletes with an already high red cell volume. Intermittent hypoxic training is thought not to be effective.

Travel illness is something that is of concern to many New Zealand representative teams, especially as we are a long way from major population centres in Europe and North America. An article studying Super 14 rugby players from five South African and three New Zealand teams was published in this issue. The authors found a higher incidence of illness in athletes following international travel to a foreign country where there was a >5 hour time difference. This incidence returned to baseline on return to the home country. The authors believe that destination factors including temperature, humidity, altitude, pollution and airborne pollens may be the cause of the higher incidence of illness.

Clinicians are frequently called on to provide advice for those who are exercising at moderate altitude. This includes people going trekking in the Himalayas or Andes. A review paper by Schommer and colleagues from Germany points out that at altitudes of <2500 metres, acute mountain sickness is mild, transient and affects <25% of the tourist population at risk; the higher one goes and the older one is, the more risks are increased. The altitude can exacerbate known cardiovascular or pulmonary disease, or lead to a first manifestation of undiagnosed illness in older people. This may be particularly relevant to coaching and other support staff for our winter sports athletes.

Among other topics, the September issue included a systematic review of the effects of eccentric training on lower limb flexibility. The conclusion was that eccentric training was an effective method of increasing lower limb flexibility. This was based on consistent strong evidence from six trials and three different muscle groups.

Sticking with lower limb muscles, a multinational group including Nicola Maffulli studied hamstring exercises for track and field athletes. Eccentric training has been consistently shown to be able to reduce hamstring injury rates. This article introduces exercise classification criteria to guide clinicians in designing prevention strengthening programmes adapted specifically for track and field. The photographs compliment the text description particularly well.

Shin splints (medial tibial stress syndrome) are the bane of many running athletes. Newman and co-authors describe two simple clinical tests for predicting the onset of this condition. These include the shin palpation test, which involves palpation of the distal two-thirds of the posteromedial lower leg, particularly the posteromedial border of the shin. The other test is the shin oedema test which involves sustained palpation for more than 5 seconds of the distal two-thirds of the medial surface of the tibia and is positive when signs of pitting oedema are noted. These are both tests that are in widespread use in routine clinical practice and it is good to see some evidence base for their continued use.


Proximal hamstring tendinopathy is a condition that frequently becomes chronic. An Italian group evaluated the validity and reliability of three pain modification tests. These included the Puranen-Orava test, which involves placing the foot up on a support just above knee height and actively stretching the hamstring muscles. The second test is the bent knee stretch test, where the patient is lying supine and the hip and knee of the symptomatic leg are maximally flexed. The examiner then slowly straightens the knee. The modified bent knee stretch test involves maximal flexion of the hip and knee and then rapid straightening of the knee of the involved leg. Likelihood ratios for a positive test were 4.2 for the Puranen-Orava test, 6.5 for the bent knee stretch test, and 10.2 for the modified bent knee stretch test. The authors recommend that these tests be used in conjunction with other objective measures such as MRI scanning. In practice, MRI scanning is not routinely used outside the professional sporting environment.

The final article in the September issues discusses supplements. Spirulina has been long recommended as a dietary supplement. It contains micro-algae belonging to the cyanobacteria class. There are precious few controlled trials available, but one involving moderately trained runners who received 6g/day of spirulina supplementation for four weeks showed increased fat utilisation, reduction in markers of antioxidant stress and increased endurance at high intensity exercise (95% VO2max).

Sucrose is ubiquitous in the Western diet as it is in most households as table sugar. Sucrose ingestion before and during exercise can prevent hypoglycaemia if the exercise is particularly prolonged. However, the frequent consumption of sugary drinks can increase the risk of tooth decay, so it is not all good news.

Once again the BJSM delivers a wide range of articles of interest to clinicians. Those I have included above are merely a selection that I believe hold widespread interest for our readers.

## OCTOBER

The October issue was a theme issue for the Australasian College of Sports Physicians and featured several articles of interest. Your editor, Bruce Hamilton, wrote an article entitled Hamstring muscle strain injuries: what can we learn from history. He compared the management strategy for these injuries in the past with present day management. Early recognition of the importance of warm up and of not pushing things too rapidly gave way to later scientific studies on issues such as core stability, which were recognised as early as 1958. Lloyd in that year recognised that the risk for all sports injuries may be minimised by what he termed an "alerted posture".

Also in the same issue was an article entitled Pistorius at the Olympics: the saga continues. This dealt with the scientific and ethical dilemma regarding this athlete and whether or not he had gained an advantage from using his blades. Events have rather overtaken the scientific discussion as he is now facing a charge of murder. Somewhat bizarrely, however, he has been permitted to travel overseas to compete in events, pending his trial.


Team doctors have a role in preventing sexual harassment and abuse in sport, and an article by Saul Marks, Margo Mountjoy and Madalyn Marcus provides some useful pointers. These authors talk about codes of conduct for those in positions of power in sport, e.g. coaches and administrators, as well as clinicians, e.g. doctors and physiotherapists. They include simple measures such as not sharing a hotel room at an event, not driving an athlete home after practice and not seeing an athlete socially except in a team setting.

Knee joint kinematics can be altered by balance and technique training and an article by David Lloyd and colleagues examine this issue. The authors recommend that sidestepping tasks are performed during biomechanical testing to assess the effectiveness of prophylactic training protocols.

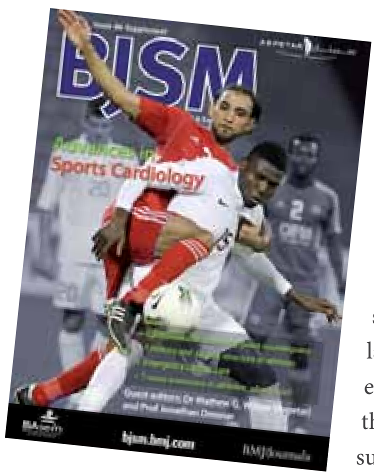
Later in this issue, Peter Harcourt and colleagues wrote about a strategy to reduce illicit drug use in elite Australian football. This again is very topical following the revelations from a recent report, and the Cronulla Sharks in particular have been implicated as a team with problems of drug abuse amongst their athletes. In general, there seems to be a differentiation between professional sport and Olympic sport, because money does tend to play a part in influencing athlete behaviour - surprise, surprise.

Bruce Forster and colleagues had an excellent pictorial essay on evaluating bone marrow oedema patterns in musculoskeletal injury. These can be very useful, particularly when the athlete has a poor recall of the exact events of their injury (this is the norm for most football players).

The supplement issue included an article on stacking, defined as the consumption of two or more supplements at the same time in an attempt to maximise results, written by Jeni Pearce, who has recently returned to take up the senior nutrition post within High Performance Sport New Zealand. Combining creatine with beta-alanine had an effect on delaying fatigue, whilst combining creatine with hydroxy-B methylbutyrate produced additive effects on lean body mass.

## NOVEMBER

The November issue celebrated London's very successful Olympic and Paralympic Games earlier in 2012.




Eric Hegedus provided an excellent review on which physical examination tests provide clinicians with the most value when examining the shoulder. He conducted a systematic review of 32 articles published since 2008 and commented that the use of any single physical examination test to make a pathognomonic diagnosis cannot be unequivocally recommended. Combinations of tests provide better accuracy but only marginally. He stresses the importance of providing a comprehensive clinical examination and taking due account of the history. All good sound advice.

Unrecognised ringside concussive injury in amateur boxers is a controversial topic. David Darby and colleagues from Melbourne studied 96 amateur boxers. Of these, 17 failed their first post-bout computerised cognitive assessment tool and 12 of these passed a repeat test. However, of the five remaining boxers there were two not suspected of a concussion after their bouts that showed evolving slowing in cognitive performance typical of a concussion. This is disturbing and may also apply in sports like rugby. Our own prolific researcher, Doug King, is looking into this matter and there was a recent item on a television news show discussing this. Watch the journals for an update once the article becomes available.

Diagnosing overreaching in team sports player is a controversial area. Sandor Schmikle and colleagues from the Netherlands found that resting growth hormone levels and ACTH levels after maximal exercise were reduced in players that were overreaching. Obviously this data should be used in combination with clinical symptoms such as fatigue, irritability and poor sleep.

In the dietary section there was mention of tryptophan, which has been prescribed for many years in the general community to alleviate depression. Two studies have claimed a beneficial effect of acute tryptophan supplementation on exercise capacity, but these results have not been borne out by subsequent studies. Furthermore, in the late 1980s there were cases of eosinophilia-myalgia syndrome that were linked to tryptophan supplements. I would advise athletes to steer clear of them.

Cardiology is one of the growth areas within sports and exercise medicine. Therefore, it was timely that a supplement of

BJSM in November was completely devoted to cardiology issues. Our editor, Bruce Hamilton, contributed an excellent editorial providing overview of the significant issues. One of the main ones is applying standardised criteria to athletes' ECGs to provide consistent interpretation. This work was pioneered in Italy and has been carried on in the USA by Jonathan Dresner and colleagues. The article on pages 6-8 should be required reading for all those who need to interpret athletes' ECGs.

There are significant differences in the way cardiac issues are managed in the USA versus Europe and a head to head debate, including some of the leading lights in the field, was published in this issue. It is also very useful reading.

In recent years ethnicity has been shown to be a significant risk factor for cardiac events; in particular, male athletes of Afro-Caribbean descent appear to be more at risk of developing cardiac events. We have no data on Maori and Pacific athletes and this is being gathered by clinicians in New Zealand at present. In the meantime, the article beginning on page 22 is worthy of study.

Atrial fibrillation is the commonest problem in endurance athletes and one that I have a particular interest in, having watched Rob Waddell and other leading athletes deal with it over the years and assisted where possible. The mechanism is still incompletely understood but the article on this issue is well worth a read. T-wave inversion can be a marker of serious pathology such as hypertrophic cardiomyopathy and I would recommend a good read of that article in this issue of the journal.


Performance enhancing drugs have potential cardiovascular risks and these are well covered later on in the November supplement. It is worth pointing out some of these risks to athletes who believe that they would be better off on performance enhancing drugs. It may not deter them completely, but may influence their decision making.

## DECEMBER

The December IOC issue included an editorial measuring the impacts of the first Winter Youth Olympic Games held in Innsbruck, Austria in 2012. It covers the medical services on offer at these first Winter Youth Olympic Games. There is also a very good article on course setting and selected biomechanical variables related to injury risk in alpine ski racing. Setting a course of appropriate difficulty is a significant responsibility. The memory of an athlete dying on the sliding course in Whistler in 2010 is etched in our recent memory. Clearly, less experienced athletes should be offered less demanding courses, and as their skill level rises so the difficulty of the course can be progressively increased.

In the regular December issue there was an article on ski helmet legislation, is this more effective than education. The authors commented that the impact of parental role modelling on ski helmet use is probably the single most important factor. The authors recommended non-legislative helmet promotion campaigns rather than a legislative approach.

Sudden cardiac arrest on the football field is a scary and potentially tragic event. Jiri Dvorak, medical director of FIFA, and colleagues provide an excellent, succinct summary of the topic. The emphasis is on prompt recognition of sudden cardiac arrest and early CPR plus application of the AED or manual defibrillator as soon as possible. Once the athlete's condition has stabilised, transport to a hospital facility capable of advanced cardiac life support should be undertaken as soon as is practicable.

Serious injury on the sports field is different to serious injury in a car crash. Jonathan Hanson and Brian Carlin discuss sport pre-hospital immediate care as a niche of general pre-hospital care, using the management of spinal injury as an illustration of the major differences between sport and road traffic trauma. They highlight the need to develop a sport specific pre-hospital evidence base and then apply that evidence to management of athletes.

The nutritional supplement series continued with articles on Vitamins A, C and E. These were discussed together, as all three have antioxidant properties. Hundreds of studies on antioxidant vitamin supplementation and exercise have been published but the quality of these articles is highly variable; whether or not athletes need higher dietary antioxidants than their less active counterparts remains under debate. For those athletes who wish to err on the side of caution, food based sources of antioxidant vitamins may be preferable to supplement based sources, in the opinion of these authors. This is because the possibility of toxicity is lower when foods are utilised.

My pick for the most valuable article in the latter half of 2012 goes collectively to the articles in the November supplement on cardiology. Sudden cardiac arrest on the field can be a life or death matter and identification of those athletes at increased risk is clearly a high priority. Get hold of this issue and read through a few articles and you will be much better informed.

# The use of skinfold measurements to predict outcome of open-water swim attempts in Cook Strait

**Karen L Bisley**[1]

MBChB(Otago), Dip Sports Med(Auckland), MHealSc(Otago), FRNZCGP, FACSP

**Michael J Marfell-Jones**[2]

PhD, MSc, DipPE, DipTchng

[1] Sports Physicians ACT, Deakin, ACT, Australia

[2] Faculty Management, The Open Polytechnic of New Zealand, Wellington, NZ

*Correspondence*

Karen L Bisley

Sports Physicians ACT

Suite 5, 2 King Street

Deakin, ACT 2600

AUSTRALIA

Karen.bisley@gmail.com

Phone +61 2 62815999

Fax +61 2 62815779

## ABSTRACT

### Aim

To determine the relationship between skinfold thickness and resistance to changes in core body temperature and thus whether skinfold thickness can be a predictor of swim success or failure.

### Study Design

Prospective observational study.

### Setting

Cook Strait, a 26 kilometre wide channel between the North and South Island of New Zealand.

### Participants

Thirteen swimmers, who made 16 attempts to swim Cook Strait between January 2005 and May 2007.

### Methods

Anthropometric measurements of each swimmer were recorded before each attempt. The core body temperature of the swimmers was monitored using an ingestible sensor.

### Results

Nine of the 16 swim attempts were successful. These successful swimmers all had a sum of eight skinfolds greater than 100 mm (greater than 15% calculated subcutaneous fat) and triceps skinfold measurement greater than 13 mm.

Seven swim attempts were unsuccessful. In all four unsuccessful swim attempts (by three swimmers), where the sum of eight skinfold measurements of the swimmer was less than 100 mm or a triceps skinfold measurement less than 13 mm, the swimmers were removed from the water with hypothermia. Three swimmers with a sum of eight skinfolds greater than 100 mm or triceps fold measurement greater than 13 mm, failed for reasons not related to hypothermia. Only three swimmers of eight swim attempts where the water temperature was less than 17° C were successful compared to six of eight when the water temperature was greater than 17° C.

### Conclusion

The sum of eight skinfolds less than 100 millimetres is a strong predictor of hypothermia vulnerability and resultant swim failure in Cook Strait swimmers, particularly at lower water temperatures.

### Key Words

Swimming, Percentage fat, Subcutaneous fat, Core temperature, Hypothermia

## INTRODUCTION

Cook Strait is a 26 km (14 nautical miles) channel that separates the North and South Islands of New Zealand. To open water swimmers Cook Strait provides a challenge similar to that of the English Channel.

The time and distance swum varies considerably depending on the speed of the swimmer, tides and the weather conditions on the day. Swimmers are in the water, on average, for eight to ten hours. Water temperatures range between 14-19º C over the summer months.[2] To be officially recognised, swimmers who attempt Cook Strait are not allowed to wear a wet suit or any device that may provide buoyancy or heat protection.

Hypothermia, defined as a core temperature < 35º C, is one of the reasons cited for swimmers being unsuccessful in their attempts.[4,7] No deaths have occurred during Cook Strait attempts. However, swimmers attempting other open water swims around the world have died of hypothermia.[12, 14] Currently there are no specific criteria to be met by individuals who wish to attempt to swim Cook Strait. Swimmers are not required to obtain a medical clearance before, or engage medical support during, the crossing.

Extrinsic factors that affect the ability of a swimmer to maintain their core body temperature include water temperature and duration of the swim.[9] Intrinsic factors include swimming speed, fitness and the amount of subcutaneous fat of the individual.[3, 9, 19] The rate an individual cools is not only governed by the difference between heat generation and loss, but also by the body composition and fat thickness of the individual.[21] Fat becomes an effective means of body insulation at high heat flow rates - the situation seen in swimmers. One millimetre of subcutaneous fat during swimming provides ten times the insulation of the same amount of fat at rest.[19] A reciprocal linear relationship between the skinfold thickness and fall in rectal temperature in subjects immersed in cold water has also been observed.[16]

Arms have approximately twice the surface area to volume ratio compared to the lower limbs with consequent greater conductive and convective loss during exercise.[9] It has been suggested that local upper-limb muscle cooling and subsequent fatigue may be a main cause of swimming inability rather than whole body hypothermia.[22] Consequently if the upper limbs are susceptible to cooling in cold water, an increased amount of subcutaneous fat over the arms may decrease the amount of heat loss and reduce arm cooling. A recent report of accidental exposure scenarios for non-open water trained subjects, suggests triceps skinfold thickness was a better predictor of swimming distance covered before swim failure than percent fat.[23]

This study uses data collected during successful and unsuccessful Cook Strait swims to evaluate the relevance of subcutaneous fat to clinical hypothermia and outcome of the swim attempt.

It is hypothesised that swimmers with a lower sum of eight skin folds would be more prone to hypothermia.

## METHODS

A prospective observational study was conducted on 13 swimmers, who made 16 attempts to swim Cook Strait between January 2005 and May 2007. The Human Ethics Committee of the University of Otago approved the research project in 2004. It was performed in accordance with Ethical Standards in Sport and Exercise Science Research.[10] The research was not funded and there were no vested interests. The research project details were explained and informed written consent (or the parents of those swimmers under 18 years of age) was obtained from the swimmers. They also completed a medical questionnaire to identify any underlying medical problems.

Exclusion criteria related to the contraindications for use of the ingestible core body temperature sensor (CorTemp®, HQ inc, Florida, USA)[11] and no swimmers were excluded for this reason. However two swimmers were excluded because of language difficulties and two swimmers were excluded because the researcher was unavailable.

Each swimmer was coded by an identifying letter from A to M. When a swimmer made more than one swim attempt, the swim number was also recorded.

Anthropometric measurements were made using Slimguide calipers (Creative Health Products, Michigan, USA) at the first meeting with the swimmer. Measurements included body mass, stretch stature and eight skinfold measurements, according to the International Society for the Advancement of Kinanthropometry (ISAK) standard protocol, in which the researcher had been trained.[15] Two measurements were recorded for each location and if these varied more than 10%, a third measure was taken. The average of all readings was used.

As per the ISAK protocol, male percentage fat was calculated from the sum of seven skinfolds[27] and female percentage fat was calculated from the sum of four skinfolds.[28] Surface area to mass ratio was also calculated.[6]

The percentile ranking of each swimmer was calculated for age and gender and compared to the New Zealand norms.[25, 26] The New Zealand norms for individuals 15 years and greater have been calculated for a sum of six skinfolds (triceps, subscapular, supraspinale, abdominal, front thigh and medial calf). Individuals less than 15 years have been calculated from the sum of two skin-folds (subscapular and triceps). Consequently these skinfold numbers were used to compare the swimmers to the national norms.

Fourteen swim attempts (A-K) were observed by the researcher. Two swimmers (L and M) had their anthropometric variables taken prior to their attempt and the water temperature through their swims recorded. However their core temperatures were not measured because the researcher was not available. Core body temperature was measured before, during and after each Cook Strait attempt using the CorTemp® ingestible core body sensor, that was swallowed by the swimmer on transit to the starting point, about 20-40 minutes pre-swim.[24] The accuracy of this device is reported to be +/- 0.1˚C.[1]

The researcher worked in association with the Cook Strait swim coordinator and his support crew. Support vessels for this study included a 42-foot launch and an inflatable rubber boat (IRB). The navigator took course readings using a GPS (Global Positioning System, Garmin XL12, Kansas, USA) every 30 minutes and altered the course of the swimmer to compensate for the wind, tides and the swimmer's speed. Water temperature was recorded using a speed and temperature sensor integrated into a Furuno colour video sounder (Model FCV582, Furuno Electric Co. Ltd. Nishinomiya, Japan) and air temperatures recorded, using a Digital In-Out thermometer TA 20 (ApogeeKits, Texas, USA), at 30-minute intervals. The core body temperature of the swimmer was recorded as the swimmer departed the main launch; at 30 minute feed stops, then immediately after exit. Following each attempt, core temperature recordings were down-loaded using Microsoft 'Hyper Terminal' software, which was then imported into Microsoft 'Excel' for analysis. A Pearson's Correlation coefficient was calculated between sum of eight skin fold thickness and outcome. Outcome was assigned a value of '0' or '1' for unsuccessful or successful attempts respectively. Pearson's correlation values were also calculated between sum of eight skinfolds and the difference between pre and post swim core temperatures.

## RESULTS

### Anthropometric Measurements

Anthropometric measurements were recorded on 13 swimmers (6 male and 7 female) usually one day before each of their 16 swim attempts (Table 1). Two swims were not directly observed. One male swimmer made two attempts and one female attempted on three occasions. The age range of the swimmers was between 11 and 52 (mean = 35, SD = 14) years for males, and between 13 and 46 (mean = 28, SD = 14) years for females. The percentile ranking for body fat for each swimmer was compared to the New Zealand population for age and gender. Only swimmer B, I and M were observed to be above the eightieth percentile.

The course and distance each swimmer swam varied considerably with different starting and finishing points, winds and tides. The mean air and water temperatures ranged from 14.5- 20.7˚C and 13.4-18.9˚C respectively (Table 2).

### Successful Swimmers

Nine of the 16 swim attempts were successful. Where swimmers swam with a mean water temperature of greater than 17˚C, six of eight swim attempts were successful. When the mean water temperature was less than 17˚C, only three

## Table 1: Anthropometric Data of Participants

| Swimmer | Gender | Age | Stretch Stature (m) | Weight (kg) | Sum of eight skinfolds (mm) | Percent Fat | Surface area to mass ratio (m2/kg) | Triceps skinfold (mm) | Percentile ranking compared to NZ population * |
|---|---|---|---|---|---|---|---|---|---|
| A | M | 44 | 1.91 | 96.0 | 90 | 12.2 | 0.023 | 10 | 15 |
| B | M | 11 | 1.45 | 43.0 | 131 | 19.7 | 0.030 | 17 | *85 |
| C | F | 17 | 1.70 | 69.0 | 115 | 20.7 | 0.026 | 15 | 20 |
| D | F | 17 | 1.81 | 74.0 | 108 | 20.5 | 0.026 | 14 | 20 |
| E | F | 34 | 1.65 | 65.0 | 67 | 11.1 | 0.026 | 8 | 5 |
| F1 | M | 25 | 1.79 | 80.0 | 90 | 12.3 | 0.025 | 10 | 45 |
| F2 | M | 26 | 1.80 | 79.0 | 98 | 13.4 | 0.025 | 11 | 50 |
| G | F | 43 | 1.62 | 62.0 | 122 | 18.7 | 0.027 | 13 | 10 |
| H1 | F | 45 | 1.62 | 67.0 | 194 | 29.0 | 0.026 | 25 | 65 |
| H2 | F | 46 | 1.62 | 65.0 | 181 | 28.1 | 0.026 | 23 | 55 |
| H3 | F | 46 | 1.62 | 68.0 | 187 | 28.5 | 0.025 | 22 | 55 |
| I | M | 52 | 1.92 | 110.0 | 214 | 31.6 | 0.021 | 26 | 90 |
| J | F | 25 | 1.59 | 57.5 | 140 | 23.9 | 0.028 | 18 | 65 |
| K | F | 13 | 1.67 | 62.5 | 166 | 25.4 | 0.027 | 17 | *60 |
| L | M | 45 | 1.86 | 97.5 | 136 | 20.3 | 0.023 | 23 | 71 |
| M | M | 43 | 1.85 | 95.5 | 176 | 25.8 | 0.023 | 20 | 88 |

***Swimmers (excluding B and K) were ranked compared to the New Zealand norms for age and gender, using the sum of six skinfolds (triceps, subscapular, supraspinale, abdominal, front thigh and medial calf).**
**Swimmers B and K, aged 11 and 13 years respectively were compared to the New Zealand normative data for children of their age and gender using the sum of two skinfolds (subscapular and triceps).**
**M = Male, F= Female**

## Table 2: Water temperature, pre and post-swim core body temperature and outcome

| Swimmer | Water Temp (˚C) | | Air Temp (˚C) | | Core Temp | | | Time in Water (hrs: mins) | Outcome | Reason for Failure |
|---|---|---|---|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | Pre-Swim (˚C) | Post-Swim (˚C) | Change in Temp (˚C) | | | |
| A | 17.3 | 0.4 | 19.8 | 1.4 | 36.8 | 31.3 | 5.6 | 10:01 | Unsuccessful | Hypothermia |
| B | 17.7 | 1.3 | 17.3 | 2.8 | 36.8 | 35.6 | 1.2 | 9:09 | Successful | |
| C | 17.1 | 0.6 | 17.3 | 1.3 | 35.9 | 37.6 | -1.7 | 5:48 | Successful | |
| D | 17.1 | 0.6 | 17.3 | 1.3 | | 37.2 | | 5:48 | Successful | |
| E | 15.3 | 0.1 | 14.5 | 0.2 | 37.6 | 32.6 | 5.0 | 2:20 | Unsuccessful | Hypothermia |
| F1 | 15.9 | 0.4 | 17.1 | 0.6 | | 34.5 | | 3:10 | Unsuccessful | Hypothermia |
| F2 | 16.2 | 0.3 | 16.9 | 0.6 | 39.6 | 34.9 | 4.7 | 1:47 | Unsuccessful | Hypothermia |
| G | 15.4 | 0.5 | 16.6 | 1.1 | 37.4 | 33.6 | 3.8 | 8:26 | Successful | |
| H1 | 13.4 | 0.1 | 16.1 | 1.7 | 36.0 | 36.2 | -0.2 | 6:02 | Unsuccessful | Failure to Progress |
| H2 | 15.5 | 0.8 | 20.2 | 1.5 | 37.2 | 36.7 | 0.5 | 5:01 | Unsuccessful | Respiratory Problems |
| H3 | 17.5 | 0.7 | 16.1 | 1.8 | 37.2 | 35.6 | 1.6 | 8:44 | Successful | |
| I | 17.3 | 0.7 | 20.7 | 2.1 | 35.6 | 35.4 | 0.2 | 10:27 | Successful | |
| J | 17.4 | 0.2 | 18.6 | 1.2 | 36.9 | 35.4 | 1.6 | 4:19 | Unsuccessful | Failure to Progress |
| K | 15.4 | 0.3 | 14.8 | 0.6 | | 35.2 | | 8:10 | Successful | |
| L | 18.9 | 1.0 | | | | | | 11:00 | Successful | |
| M | 16.0 | 0.7 | | | | | | 7:11 | Successful | |

of the eight swim attempts were successful (Figure 1). All successful swimmers had a sum of eight skinfolds greater than 100 mm, calculated subcutaneous fat greater than 15% and a triceps skinfold thickness greater than 13 mm. The Pearson's correlation coefficient between sum of eight skinfold thickness and outcome was 0.58 (p = 0.04) with swimmer H excluded. Swimmer H had both successful and unsuccessful outcomes with similar anthropometry and consequently the data does not fit in either group.

The four swimmers under 18 years of age had a sum of eight skinfolds greater than 100 mm and were successful in their attempts. A Pearson's correlation coefficient of 0.91 (p < 0.05) was calculated between the sum of eight skinfolds (and calculated percent fat) and triceps thickness.

The mean core body temperature of the successful swimmers was 35.6˚C on boarding the launch following the swim. Swimmer G successfully completed the swim with a core temperature of 33.6˚C.

## Unsuccessful Swimmers

Seven swimmers were unsuccessful. Three swimmers on four attempts (A, E, F1 and F2) had a sum of eight skinfolds less than 100 mm (less than 15% calculated subcutaneous fat) and triceps skinfold thickness less than 13 mm. They were all removed from the water because of signs and symptoms consistent with hypothermia and a core temperature less than 35˚C.

Three swim attempts, by two swimmers, H and J, with a sum of eight skinfolds greater than100 mm, were unsuccessful. Swimmer H was a known asthmatic. She had no respiratory symptoms during her first attempt (H1), but was removed because of "failure to progress", as was swimmer J. Neither swimmer had a core temperature below 35˚C. During her second attempt (H2), Swimmer H was removed because of a respiratory problems, coughing and shortness of breath.

## Core Body Temperature

Pre- and post-swim core body temperatures of 11 swimmers were recorded (Table 2). Nine swimmers (A, B, E, F2, G, H2, H3, J and I) showed a decrease in their core body temperature from their pre-swim levels. Two swimmers (C and H1) showed a higher core body temperature recording post-swim.

Three swimmers suffered from seasickness and the sensor pill was not ingested until just prior to water entry (D and F2) or after water entry (F1). The high core body temperature of swimmer F2 before his swim reflects a hot drink taken soon after the sensor was swallowed. Pre-swim core body temperatures were not recorded before the two other swim attempts (D and F1). Swimmer K did not have her core body temperature recorded pre-swim due to a technical problem with the data recorder not detecting the ingestible sensor.

Swimmers with the greatest skinfold thicknesses had smaller temperature drops as shown by a linear regression (Figure 2). The Pearson correlation coefficient for the difference between the pre- and post-swim core body temperatures compared to the sum of the eight skinfold thicknesses for the 11 swim attempts (by nine swimmers, swimmer H making three attempts) was -0.68 (p = 0.02). Swimmers D, F1 and K were excluded because of absent water entry data.

**Figure 1: Comparison of sum of eight skinfolds and water temperature to outcome.**

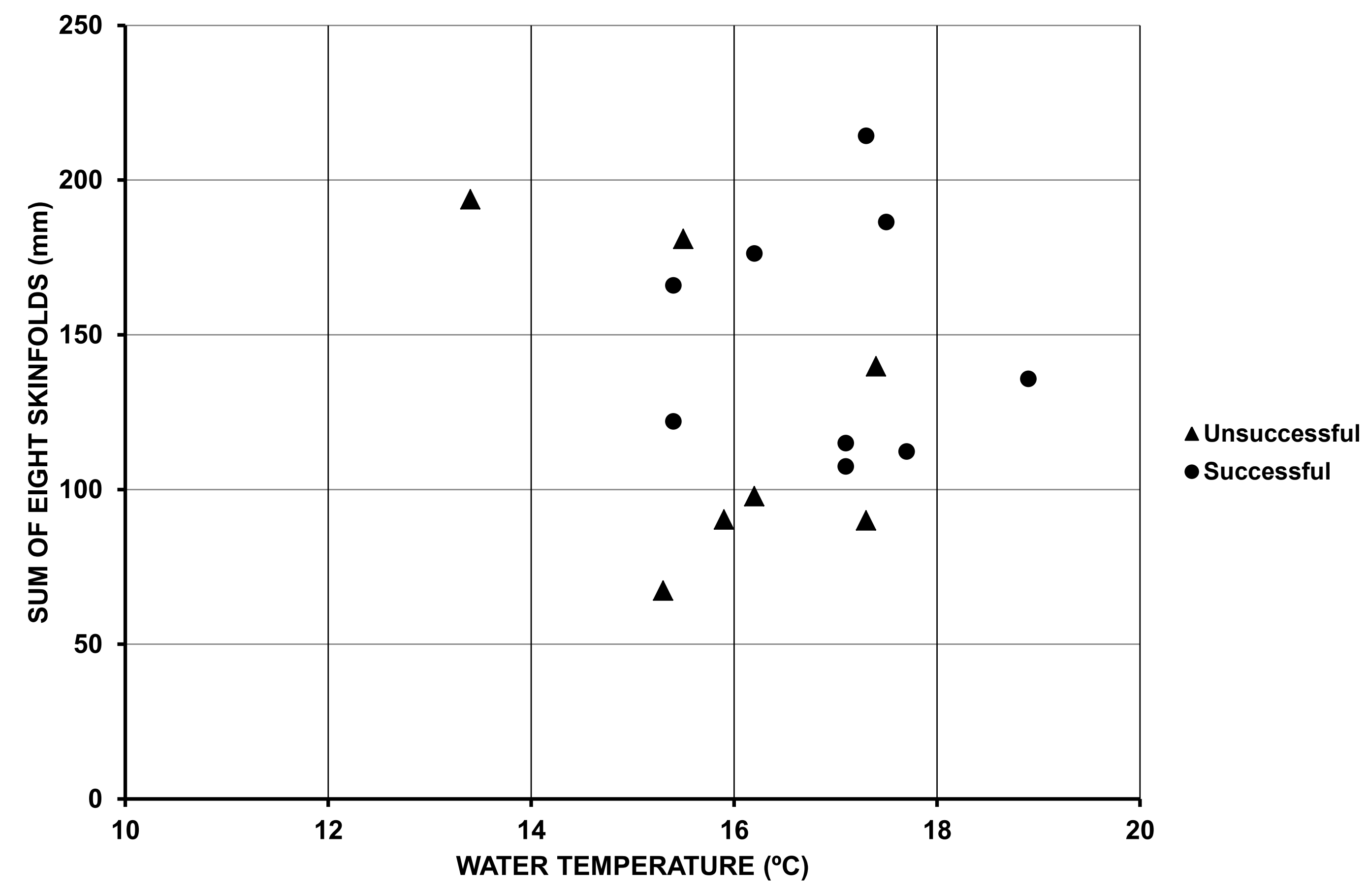
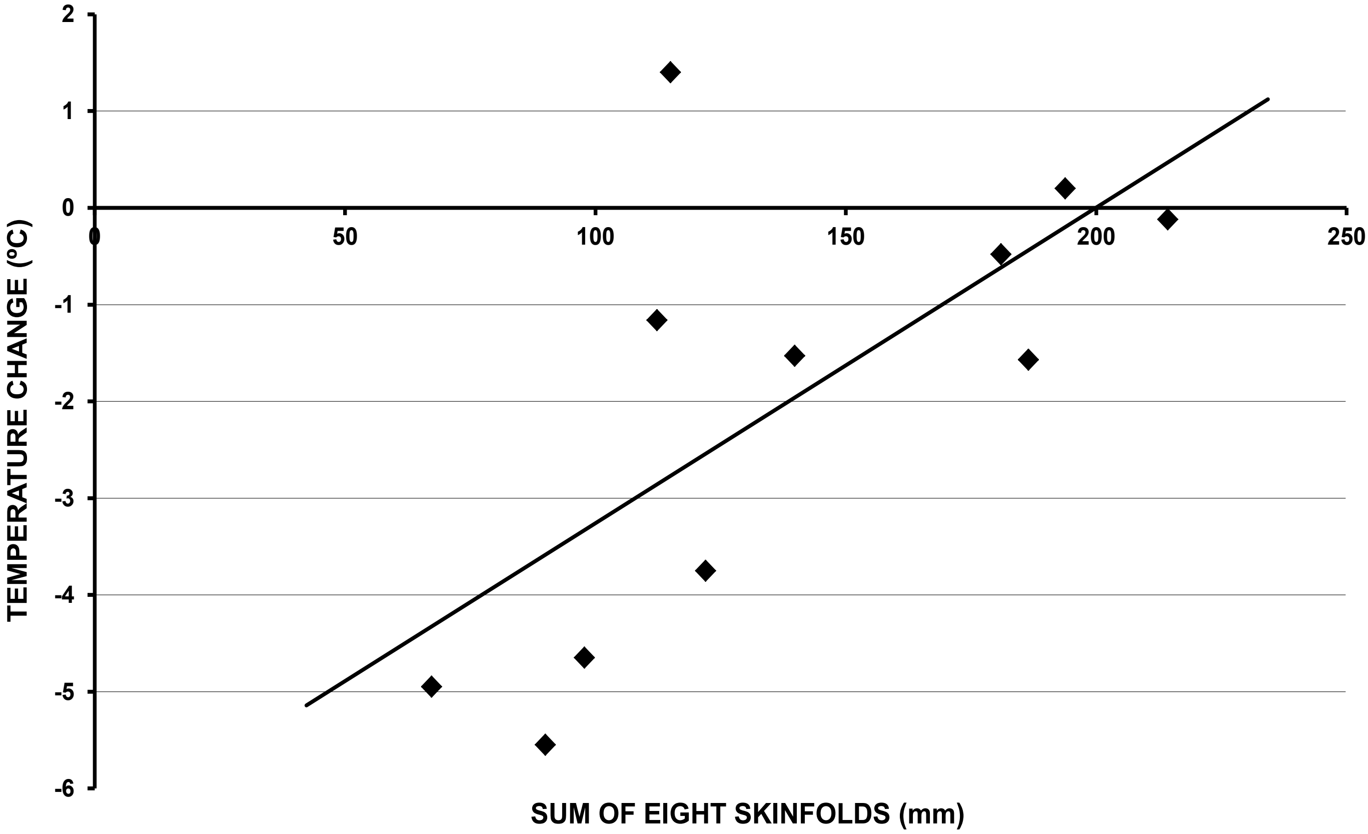


**Figure 2: Correlation of core body temperature difference and sum of eight skinfolds.**




## DISCUSSION

This study looked at the relationship between skinfold thickness and resistance to changes in core body temperature in 13 swimmers over 16 swim attempts, to determine whether skinfold thickness can be a predictor of swim success or failure.

Participants with a sum of eight skinfold measurements greater than 100 mm (greater than 15% calculated subcutaneous fat) or triceps skinfold measurement greater than 13mm showed a smaller drop in core body temperature than those with a lower skinfold measurement. This is supported by 9 of 10 swimmers with a sum of eight skinfolds greater than 100 mm being successful. The results from this study are consistent with the findings of previous researchers who have shown the importance of subcutaneous fat providing insulation of the swimmer, and consequently a slower rate of heat loss.[16, 19]

Three swimmers (A, E and F on two occasions) were removed with the symptoms of hypothermia. They all had a sum of eight skinfolds less than 100 mm. Swimmers E and F were removed from water less than 17˚C, having swum for less than 3 ½ hours. In contrast, swimmer A was able to swim for 10 hours at a mean water temperature of 17.3˚C before he was removed with hypothermia. The combination of the swimmer's low skinfold measurements and lower water temperatures put them at greater risk of losing heat to the cold environment, and hypothermia. It is likely that swimmers E and F never generated enough heat to offset losses. Swimmer A was able to generate enough heat to offset losses initially, but possibly fatigue secondary to prolonged cold water immersion and exertion prevented him generating enough heat in the later part of his swim.

Subcutaneous body fat is only one potential predictor of open water swim outcome. The fitness of the individual, speed, fatigue, water temperature, tides, wind, and length of time immersed in the water and any underlying medical conditions potentially influence swim outcome, but consideration of most of these parameters was beyond the scope of this study.[17, 18, 22] The Pearson's correlation of 0.58 (a moderate correlation) between sum of eight skinfold measurements and outcome is not an unexpected finding because there are so many other factors that impact in a swimmer's success or failure.

Two swimmers (H and J) had skinfolds greater than 100 mm and were unsuccessful. Neither swimmer had a core temperature below 35˚C on exit. They were unsuccessful because of respiratory symptoms (H2) and "failure to progress" (swim H1 and J). One of the swimmers, (H) was a known asthmatic and her symptoms may have been asthma. However anxiety, salt-water aspiration syndrome and pulmonary oedema may have also caused her symptoms.[13]

Local effects of cold water immersion causing impaired muscle function, may have been a factor in the attempts by swimmer J and H1, who were both removed because they did not swim sufficiently far across Cook Strait before the tide changed. They may have had a day where poor performance was idiosyncratic- an "off-day". However the effect of water temperature must also be considered. Swim failure and decreased efficiency of swimming has been reported as water temperature decreases.[22] Cooling of skin and muscles are thought to cause the muscles to become weaker and therefore decrease the efficiency of swimming. This could ultimately lead to incapacitation and swim failure.[19, 22] Swimmer H1 swam in the coldest water (mean 13.4˚C) over the research period. She still maintained a core body temperature of 36.1˚C when she was removed after 6 hours. Swimmer J experienced 'warmer' water temperatures, with a mean of 17.4˚C. However, her core temperature had decreased to 35.5˚C at the time she was removed from the water, indicating central cooling. Central and peripheral cooling may well have affected her swimming ability.

Tolerance to hypothermia was also observed when swimmer (G), completed the swim successfully despite finishing with a core temperature of 33.6˚C. Two swimmers (H1 and C) were observed to have post-swim core temperatures greater than their pre-swim recordings. Temperatures in the normal range after swimming in cold water have previously been reported.[17] Core temperatures of swimmers on exit, greater than pre-swim recordings suggests that these swimmers were able to generate enough heat to offset losses. However, it cannot be excluded that the temperature reading pre-swim may not have been the true core temperature reading because of the short time the sensor had been ingested.

It is acknowledged that the short period of time between pill ingestion and the start of the swim was a limiting factor in this study. However the ultimate decision to swim was usually not made until the swimmer was on the boat heading into Cook Strait. At this stage some of the swimmers felt or were sick. Consequently the pill was given when it was confirmed the swim was on and the swimmer was not obviously sea sick.

In thirteen of the fourteen attempts observed, swimmers were seen to apply grease to their bodies. The effect of the grease was not studied as part of the research and no conclusions can be formed regarding temperature maintenance or performance due to grease. There is minimal scientific evidence published on this. It is acknowledged that grease could be a compounding variable in this research. The effect of grease in open water swimming is a potential topic for further research.

Four of the swimmers could be classified as children, as they were less than 18 years of age. Sources vary as to whether a 17 year old is a child or an adult and no consistent definition was found. All four swimmers were successful on their first attempt and maintained a core temperature > 35˚C. Children have a higher surface area to mass ratio compared to adults. This greater surface area to lose or gain heat makes them more at-risk from environmental extremes of hot and cold.[8] A higher metabolic rate in exercising children and increased vasoconstriction may also explain how young swimmers have been able to tolerate the cold better than adults.[8] As children grow, the surface area-to-mass ratio decreases until they attain adult size. Three of the four young swimmers were female and had body sizes and surface area-to-mass ratios comparable to older females in the study. The fourth swimmer (B) was only 11 years old and weighed only 43 kilograms and was a mere 1.45 metres tall. He had the greatest surface area to mass ratio (0.03 m2/kg) of all the swimmers. His sum of eight skinfolds was 112 mm putting him at a percentile ranking of 85% for body fatness when compared to children in the New Zealand population for age and gender. All four swimmers had a sum of eight skinfolds > 100 mm, suggesting skinfold thickness may be the important factor in maintaining heat in children participating in open water swims, rather than the surface area of an individual. This is in keeping with findings previously observed where the cooling rate of children best correlated with an individual's subcutaneous fat thickness, rather than by age or gender, although an improved correlation allowing for differences in surface area to mass ratio has been observed.[20]

Women are thought to have a physiological advantage in open water swimming due to their thicker layer of subcutaneous fat. However when men and women are compared for fitness and similar body mass index little difference is found.[5] The small numbers in this study prevent any significant assessment of the effect of gender on swim outcome.

The major limitation to this study was the small number of swimmers observed. This reflects the small number of swimmers attempting Cook Strait each year.

## CONCLUSION

Swimmers with a sum of eight skinfold measurement greater than 100 mm were more likely to be successful in their Cook Strait attempts.

The combination of smaller skinfolds (less than 100 mm) and a lower water temperature predisposed the swimmers to hypothermia, which may lead to swim failure. Swimmers less than 18 years were at no greater risk of hypothermia. The authors concluded that lower skinfold sums are a strong predictor of hypothermia vulnerability in Cook Strait swimmers.

### Practical Implications

- It is recommended that all prospective swimmers should have their subcutaneous body fat measurements taken.
- All prospective swimmers should be advised of the hazards of attempting such a swim if the sum of their eight skinfold measurement is < 100 mm, or triceps skin measurement is < 13 mm.

## ACKNOWLEDGEMENTS

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## *Comment*

**Kelly Sheerin**

*Physiotherapist and Sport Scientist*

*AUT Millennium Institute*

Open water swimming is a sport that is growing rapidly in New Zealand, with the public participating in an ever increasing number of local swim events, and athletes looking for tackling a large array of significant challenges such as Cook Straight and Lake Taupo.

The authors should be commended for tackling a difficult research topic. They have done well to work around the technical and methodological challenges that research such as this entails. This paper offers insight into a novel topic that I'm sure will appeal to the interest of many readers of this journal.

# The use of a trunk-mounted GPS/accelerometer system to measure vertical impacts for injury risk factor analysis in Australian Rules footballers: A pilot study

**Craig C Panther**[1]

MBChB, MMedSci, PG DipSportsMed

**Chris J Bradshaw**[2]

MBBS, FACSP

[1] Unisports Sports Medicine, Auckland, New Zealand

[2] Geelong FC and Olympic Park Sports Medicine Centre, Victoria, Australia

*Correspondence*

Dr Craig C Panther

Unisports Sports Medicine

Auckland

NEW ZEALAND

Ph: +64 9 521 9815

Fax: +64 9 521 9812

Email: c.panther@sportsmed.net.nz

## ABSTRACT

### Aims

1 To assess the ability of a trunk-mounted Global Positioning System (GPS)/ accelerometer system to accurately measure vertical impacts at torso and sacral levels.

2 To compare and correlate impacts measured at each level.

3 To compare impacts recorded during a pre-season screening session with prospectively-gathered injury data in a cohort of semi-professional Australian footballers in order to examine any relationships between vertical load and non-contact lower-limb injuries.

### Methods

50 semi-professional Australian footballers had vertical impacts measured using the SPI Pro™ system during a pre-season training session, during a variety of sport-specific tasks. Impacts measured at sacral and torso level were compared. Players were followed longitudinally throughout regular season play and injuries were recorded. Associations between measured impacts and lower limb non-contact injuries were examined.

### Results

A small number of statistically-significant associations – some positive, others negative - were demonstrated between measured impacts and injuries. Overall, measured impacts did not conclusively predict injury, possibly due in part to technical factors and study design. Aberrant movement of the unit within the harness was a potential source of inaccuracy and there were further sources of measurement error inbuilt into the software package. The most consistent result showed a positive association between the difference in vertical load measured at the upper torso vs. the sacral levels during a sprint task, and both injuries and time out of sport. This difference may be due to greater mediolateral and/or anteroposterior load dissipation, and it is postulated that poor core stability may therefore be a factor in lower limb injury pathogenesis. There were stronger correlations between sacral and torso impacts for jumping tasks than for running tasks, but the clinical relevance of this is presently unknown. Players over 23 years of age were more likely to sustain injuries leading to a loss of training and/or match time. Players were more likely to miss training sessions than matches.

### Conclusions

There is no conclusive relationship between vertical load, as measured using this device, and lower limb, non-contact injury. Currently, technical issues limit the use of this system as a field research tool. Overcoming these issues via changes in software and harness design may result in more accurate assessments of accelerations, and associations between accelerations and injury risk may subsequently be demonstrable. The addition of a sacrally-mounted device facilitates comparison of sacral and upper torso impacts, but the clinical utility of this remains unproven. There may be potential in further examining the dissipation of load across the trunk along both vertical and horizontal planes, and its relationship to lower limb injury.

### Key Words

Accelerometer, Global Positioning System, Vertical Load, Injury Prevention, Australian Football

## INTRODUCTION

Prevention of injuries in sport can only be beneficial for all stakeholders. Apart from individual losses to players in terms of time lost to play or termination of employment, player unavailability imposes on clubs significant treatment costs and deprives them of key on-field assets. Finch's modifications[4] to van Mechelen's sports injury prevention model[18] advocate assessment of potential injury countermeasures in a field setting prior to any formal implementation. Accordingly, research tools and injury prevention methods must be easily accessible to teams. Technical assessments performed in biomechanics laboratories, with force plates and motion capture technology are often beyond the reach of sporting organisations, and may not permit analysis of certain sport-specific tasks. There is a need for assessment tools which are easily applied to the team setting and used by existing personnel. Portable Global Positioning System (GPS)/accelerometer units, currently used to track player movements, may meet this need. Many teams have already invested in the technology, and personnel have been trained in its use. Such systems are easily applied, comfortable for players, and data are easily downloaded and stored onto existing platforms.

Ground reaction force (GRF) is influenced by numerous intrinsic and extrinsic factors[10] and specific neuromuscular training has been shown to reduce vertical ground reaction force (vGRF) for a given jump-landing task.[8, 14] While opinion is divided as to whether a greater vGRF for a given task confers a greater risk of injury, the weight of opinion is in favour of a link between vGRF and lower limb overuse injury.[1, 3, 13] The majority of studies to date have measured impacts using a force platform and, in one instance, an accelerometer mounted over the proximal tibia.[13] While these might be considered industry-standard, they are certainly not practical in the field setting that is the professional sports club. By contrast, tri-axial accelerometers (TA) mounted to the lower trunk are proving increasingly popular as monitoring tools in the sports medicine setting, due to their portability and decreasing cost. While they have been shown to have excellent concordance with force platforms[12] test-retest reliability,[7] and validity in measuring centre of mass accelerations[20] some authors have challenged the validity of impact data gathered from TAs mounted on the upper torso.[17, 19]

This study aimed to assess the ability of a trunk-mounted GPS/accelerometer system to accurately measure vertical impacts during a variety of Australian football-related tasks performed in a pre-season screening session. Vertical impacts were recorded both at the torso and the sacral level, close to the body's centre of mass. Subsequently, impact data were compared with prospectively-collated injury data across a season to examine any relationship between vertical load measured using this device and lower-limb, non-contact injuries.

Figure 1: The SPI ProTM device (GPSports.com)

## METHODS

Ethics Approval was granted by the Deakin University Human Research Ethics Committee (2010-002).

### Participants

Five Geelong Football League (GFL) clubs accepted an invitation to take part in the study. All trained twice weekly, had a team physiotherapist willing to commit to weekly contact with the lead author and a nucleus of players meeting the inclusion criteria. Player inclusion criteria consisted of: male aged 18 or over; intending to play the entire season (i.e. no planned interruptions due to work, study or holiday); no low back, pelvic or lower limb musculoskeletal symptoms (pain, swelling, instability, stiffness, weakness) at the time of testing and no lower limb injury or surgery of any kind (excluding dental surgery) in the three month period prior to testing. All participants provided written informed consent.

### Equipment

The SPI Pro™ device (Figure 1) is designed to be worn between the player's scapulae inside a neoprene vest. Within each unit lie a GPS receiver, a piezoelectronic triaxial accelerometer (sampling frequency 100Hz), a magnetometer and a gyroscope.

### Data Collection and Analysis

Data collection was undertaken during a single pre-season training session. Following enrolment, demographic (playing position, age and weight) and impact data were obtained. Each subject was fitted with two SPI Pro™ devices. One unit was mounted in the usual interscapular region of the torso using the neoprene vest supplied by the manufacturer, and an additional unit was mounted using rigid strapping tape to the level of the lumbosacral junction, located using the sacral dimples. All participants completed five Australian football-related tasks, during which impact data were recorded:

#### 1 Run

Subjects were asked to run in a straight line at a self-estimated 60-70% of maximal pace, enabling impacts to be measured independent of acceleration, deceleration or change of direction.

#### 2 Linear Maximal Sprint

A "30-30-30" regime was used, whereby subjects accelerated for 30 metres from a jog start, maintained top speed for 30 metres, then decelerated over 30 metres.

#### 3 Multidirectional Sprint

Six cones were placed in a zigzag fashion at 90 degree angles, spaced 10 metres apart. This provided two changes of direction to the left and right respectively. Subjects ran through the course as quickly as possible.

#### 4 Vertical Jump

Subjects were instructed to perform a maximal jump and simulate the catching of a football above the head, five consecutive times, with a five metre jog in between.

### 5 Kicking

Subjects were instructed to simulate a maximal kick for goal, without the ball, off their dominant foot, five consecutive times, with a five metre jog in between.

Running, linear sprinting and multidirectional running were classified as "running" tasks. Jumping and kicking were classified as "jumping" tasks.

Impact data were not analysed until the season had been completed, to avoid any biasing effect on injury data collection. At season's end, impact data were imported into GPSports' Team AMS™ software. This programme provided a visual readout of impacts along 3 axes (x, y, z) as well as a vector summation of all three axes, representing "total bodyload" (T), for each of the five individual tasks. Plots representing each individual task were then analysed. Impact values (recorded in units of gravity, g) were obtained manually from the vertical axis and total bodyload graphs by hovering the cursor over the impact peak, and noting the value displayed. Each task was analysed in the following fashion and mean impacts recorded for total bodyload (T) and vertical axis (y):

- Run: 20 consecutive peaks were measured, with the subject at a stable speed.
- Linear maximal sprint: 12-20 consecutive peaks were measured over the middle 30 metre section, with the subject running at maximum speed.
- Multidirectional sprint: The three highest peaks at each direction change were measured.
- Vertical jump: Takeoff and landing peaks were measured independently.
- Kicking: Takeoff and landing peaks for each of the five kicks were measured collectively.

Mean impact values were then divided by the athlete's body weight to give four standardised values per kilogram of bodyweight for each task (total and vertical load for both torso and sacrum). For each value, the difference between sacral and torso impact was calculated, this value representing the difference in load between the lumbosacral junction and the upper torso (refer table 3).

**Table 1: Parameters recorded over the duration of the season.**

| |
|---|
| Games and training sessions completed |
| Significant lower limb non-contact injuries (LLNCIs) |
| Games and training sessions missed due to significant LLNCIs |
| Non-significant LLNCIs |
| Games and training sessions undertaken with non-significant LLNCIs |
| Other significant injuries (injuries other than LLNCIs leading to loss of game and/or training time) |
| Games and training sessions missed due to significant other injuries |

Injury data were obtained via a weekly report from club physiotherapists. Injury diagnosis was made by the team physiotherapist and/or the lead author. Each team completed a total of 18 regular season matches and 38 training sessions. The study finished at the end of regular season matches; as not all teams progressed to post-season play. As the season progressed, a timeline was maintained for each subject, charting their season in terms of the following (definitions outlined in table 2):

**Table 2: Definitions**

| Term | Definition |
|---|---|
| Injury | A musculoskeletal condition manifesting as localised pain, stiffness or loss of function arising during or following a training session or match. |
| Lower limb injury | An injury arising either from a bone of the lower limb or from a muscle, tendon, ligament or capsular structure with a direct anatomical attachment to the lower limb. |
| Non-contact injury | An injury not caused by direct impact from another player or equipment. |
| Significant injury | A lower limb non-contact injury directly leading to loss of training and/or game time. |
| Non-significant injury | A lower limb injury not leading to loss of training and/or game time, but requiring assessment and/or treatment. |
| Loss of training or game time | Missing, or modification to, a game or training session following the session in which the injury was sustained. |

## Statistical Analysis

Poisson regression and Chi-square analyses were used to examine relationships between individual load measurements and injury incidence. The Poisson regression was used because the injury data did not approximate a normal distribution. When assessing injuries, Poisson regressions were performed on the count data with parameters grouped into torso total, torso y axis, sacrum total and sacrum y axis. The association between each individual load parameter and injury was therefore measured after controlling for the other three load parameters. When assessing missed sessions, the training sessions and games missed were combined into a single Poisson regression model for each set of parameters. The type of session, match or training was included as a repeated measure. The sacrum vs. torso difference was investigated using a paired T-test, to assess the difference of the observed mean values from zero. In all analyses, a p value of $<0.05$ was used to indicate statistical significance. Pearson's r was used to correlate sacral and torso impacts.

## RESULTS

Sixty-one players enrolled in the study. Eleven were subsequently excluded due to:

1. Technical difficulties in impact data upload (six players)
2. Transferring to clubs not enrolled in the study (three players)
3. Retirement (one player)
4. Withdrawal due to injury prior to commencement of the season (one player).

Of the remaining players, three had either sacrum or torso data missing due to technical issues. This gave a total of 50 subjects, comprising 47 complete and 3 partially complete data sets.

Mean sacral impacts were larger than mean torso impacts for all running tasks, and for most jumping tasks, with the exception of jump-landing and kicking, where there was no significant difference between the

**Table 3: Mean impacts and impacts per kg.**

| Task | Site | Axis | Mean Load (g) | Mean Load/kg |
|---|---|---|---|---|
| Run | Torso | Vertical | 3.8304 | 0.048 |
| | | Total | 4.2294 | 0.053 |
| | Sacrum | Vertical | 5.3466 | 0.067 |
| | | Total | 5.586 | 0.070 |
| Sprint | Torso | Vertical | 3.8304 | 0.048 |
| | | Total | 4.5486 | 0.057 |
| | Sacrum | Vertical | 4.9476 | 0.062 |
| | | Total | 6.9426 | 0.087 |
| Zigzag | Torso | Vertical | 5.1072 | 0.064 |
| | | Total | 5.586 | 0.070 |
| | Sacrum | Vertical | 6.384 | 0.080 |
| | | Total | 7.581 | 0.095 |
| Takeoff | Torso | Vertical | 4.4688 | 0.056 |
| | | Total | 5.2668 | 0.066 |
| | Sacrum | Vertical | 5.187 | 0.065 |
| | | Total | 6.2244 | 0.078 |
| Land | Torso | Vertical | 6.9426 | 0.087 |
| | | Total | 7.5012 | 0.094 |
| | Sacrum | Vertical | 7.0224 | 0.088 |
| | | Total | 8.2194 | 0.103 |
| Kick | Torso | Vertical | 5.6658 | 0.071 |
| | | Total | 6.0648 | 0.076 |
| | Sacrum | Vertical | 5.6658 | 0.071 |
| | | Total | 6.5436 | 0.082 |

**Table 4. Mean sacral and torso vertical (y) and total (T) loads and mean differences between sites.**

| | Task | Mean Sacral Load* | Mean Torso Load* | Mean Difference# | P value § |
|---|---|---|---|---|---|
| Running Tasks | Run T | 0.087 | 0.057 | 0.027 | <0.0001 |
| | Run y | 0.062 | 0.048 | 0.014 | <0.0001 |
| | Sprint T | 0.070 | 0.053 | 0.027 | <0.0001 |
| | Sprint y | 0.067 | 0.048 | 0.019 | <0.0001 |
| | Zigzag T | 0.095 | 0.070 | 0.025 | <0.0001 |
| | Zigzag y | 0.080 | 0.064 | 0.016 | <0.0001 |
| Jumping Tasks | Takeoff T | 0.078 | 0.066 | 0.012 | <0.0001 |
| | Takeoff y | 0.065 | 0.056 | 0.009 | <0.0001 |
| | Landing T | 0.103 | 0.094 | 0.009 | <0.0001 |
| | Landing y | 0.088 | 0.087 | 0.001 | 0.8926 |
| | Kick T | 0.082 | 0.076 | 0.006 | <0.0001 |
| | Kick y | 0.071 | 0.072 | -0.001 | 0.6902 |

* Mean for all 50 players, in g/kg
# A positive value indicates mean sacral impact > mean torso impact
§ A p value <0.05 indicates a statistically-significant difference between sites

**Table 5: Pearson correlations between impacts recorded at sacrum and torso.**

| Parameter | r | Correlation |
|---|---|---|
| Takeoff Total | 0.724 | Strong |
| Kick Total | 0.669 | |
| Takeoff Y axis | 0.642 | |
| Zigzag Total | 0.509 | Moderate |
| Run Total | 0.468 | |
| Kick Y axis | 0.454 | |
| Landing Total | 0.408 | |
| Sprint Total | 0.345 | |
| Sprint Y axis | 0.344 | |
| Zigzag Y axis | 0.268 | Weak |
| Landing Y axis | 0.242 | |
| Run Y axis | 0.153 | |

**Table 6. Statistically-significant relationships between impacts and injuries and/or missed sessions**

| IMPACTS | | | |
|---|---|---|---|
| **Task/site/axis** | **Association with** | **Association** | **p value** |
| Takeoff torso Total | Significant injuries | Negative | 0.049 |
| Landing sacrum Total | Significant injuries | Negative | 0.011 |
| Sprint sacrum Total | Non-significant injuries | Positive | 0.038 |
| Landing torso vertical | Non-significant injuries | Negative | 0.013 |
| Jog sacrum Total | Non-significant injuries | Negative | 0.031 |
| Kick torso vertical | Missed sessions | Positive | 0.027 |
| Jog torso vertical | Missed sessions | Positive | 0.038 |
| Takeoff torso vertical | Missed sessions | Negative | 0.011 |
| Sprint torso vertical | Missed sessions | Negative | 0.008 |

**Table 7: Statistically-significant relationships between sacrum-torso impact difference and injuries and/or missed sessions.**

| SACRUM-TORSO DIFFERENCE | | | |
|---|---|---|---|
| **Task/axis** | **Association with** | **Association** | **p value** |
| **Sprint vertical** | Significant injuries | Positive | 0.005 |
| **Sprint vertical** | Missed sessions | Positive | 0.002 |
| **Zigzag vertical** | Significant injuries | Negative | 0.024 |
| **Landing total** | Missed sessions | Negative | 0.038 |

two sites (table 4). Stronger correlations were demonstrated between sacral and torso impacts measured during the takeoff phase of jumping and when kicking, with weak correlations demonstrated during jump-landing. (table 5). When examining relationships between measured impacts and injures and/or missed sessions, there were a number of statistically-significant associations spread across tasks and across axes (table 6). Neither axis, site of placement nor task group proved superior in demonstrating associations between variables. Similarly, a small number of statistically-significant associations were demonstrated between sacrum-torso differences and injuries and/or missed sessions (table 7).

## Demographic and Injury Data

The 50 players had a mean age of 23.5 ± 3.7 years and a mean weight of 79.8 ± 6.0kg. Twenty-nine players suffered a total of 46 significant and 47 non-significant injuries, outlined in figures 2 and 3. Players above the mean age were significantly more likely than players below the mean to report a significant injury ($p<0.05$) and to miss a session (either training or match) due to a significant injury ($p<0.05$). There were 14.7 significant injuries per 1000 player exposure hours. Players were more likely to miss training sessions than games due to injury ($p<0.05$).

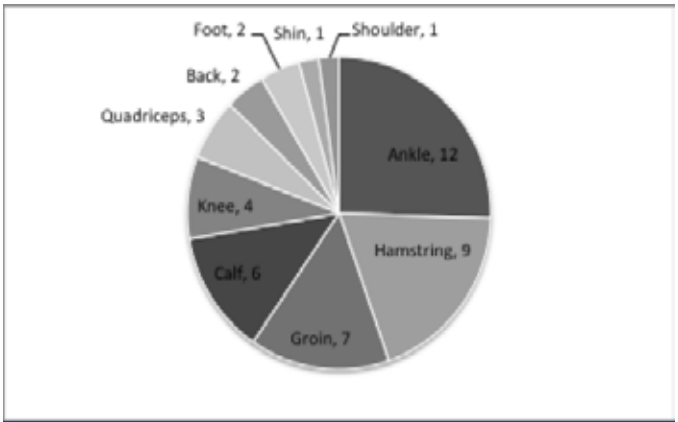


**Figure 2: Anatomical distribution of significant injuries.**

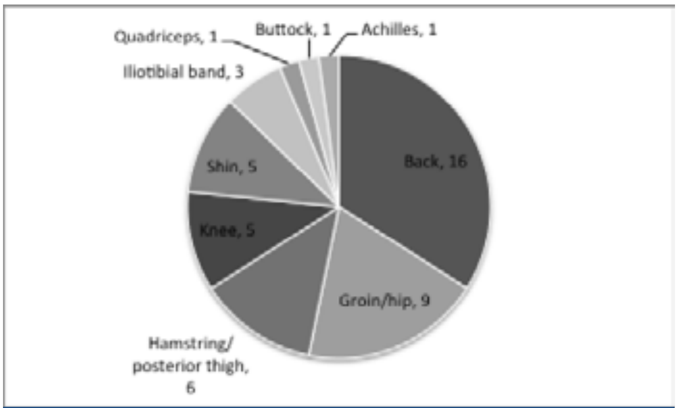


**Figure 3: Anatomical distribution of non-significant injuries.**

## DISCUSSION

This study aimed to assess the ability of a trunk-mounted GPS/accelerometer system to accurately measure (at both torso and sacral levels) vertical impacts generated in a pre-season movement analysis screen; and to compare impacts recorded at the torso with their sacral counterparts. Subsequently, these impact data were compared with prospectively-collated injury data across a season to examine any relationship between vertical load measured using this device and lower-limb, non-contact injuries. A number of sources of potential error appear to limit the accuracy of impacts, particularly at torso level. In particular, the harness used to hold the device between the scapulae may introduce significant error during running and jump-landing, calling into question the validity of comparison of impacts between sites and correlation with injuries. One pattern of association however may suggest a link between lumbopelvic stability and/or sprinting gait, and injury.

## Impact Data

Based on our data, we are not convinced that this system is able to measure impacts with sufficient accuracy for injury risk factor analysis. Previous work utilising this technology has questioned the accuracy of impacts recorded at torso level by the SPI Pro™;[17, 19] indeed several technical issues were identified in this study that introduced potential sources of error. Our observation of equal or greater mean vertical impacts at torso level for jumping tasks in particular may suggest paradoxic magnification of impacts between sacrum and torso level, likely due to the units moving aberrantly within the neoprene harness. Harnesses tend to come in one size fits all, are used up to six days per week, and are subject to degradation from hot water, sweat and detergents. Any error due to poor fit is likely to be tolerable for training purposes, where conditioning staff require only rough estimates of bodyload. For the unit to be used for field-based research however, assessment of various harness types, sizes and materials to determine the effect of altering these variables on impact values is required. Potential solutions include adding an adjustable tensioning strap to customise the current harness to the individual, or using a custom "research vest", built to minimise aberrant movement of the unit. Reaching overhead to catch a ball during the jumping task may elevate the harness further and introduce additional error. Other potential sources of error lie within the Team AMS™ software, which appears to artificially limit the value of impacts recorded on the vertical axis to 7.984g. Furthermore, impact peaks were measured manually, by hovering the cursor over the peak and recording the value. Not only was this time-consuming, but in some cases the impact peak itself was difficult to identify from surrounding data. In a number of cases - particularly on the vertical axis, on torso-mounted units, and when running at higher speeds - there was a double peak (figure 4b) suggesting the unit had bounced up and down significantly in the harness. It was not possible to differentiate with any certainty the impact peak from the rebound peak. One might assume the higher of the two might be the impact peak, however given the elastic properties of neoprene, this assumption cannot safely be made.

Figures 4a, 4b. Vertical (grey, apices upward) and total (black, apices downward) impact plots obtained at torso level during a run (a) and linear sprint (b). Note the relatively well-defined impact peaks during the run compared to the sprint, where peaks are less clearly defined and - in some cases - duplicate.

A further technical issue is that of sampling error due to sampling frequency, particularly when comparing the technology to a force platform. The TA in the SPI Pro™ unit has a sampling frequency of 100Hz, whereas force platforms may sample at frequencies of up to 960Hz or more.[13] This would not be modifiable in the foreseeable future however, and any sampling error needs to be placed in context with the rationale behind the study – namely to take impact measurement out of the laboratory and into the field.

Certain aspects of study design may limit the applicability of our findings to the clinical setting. Our subjects were assessed only once during a single pre-season session,

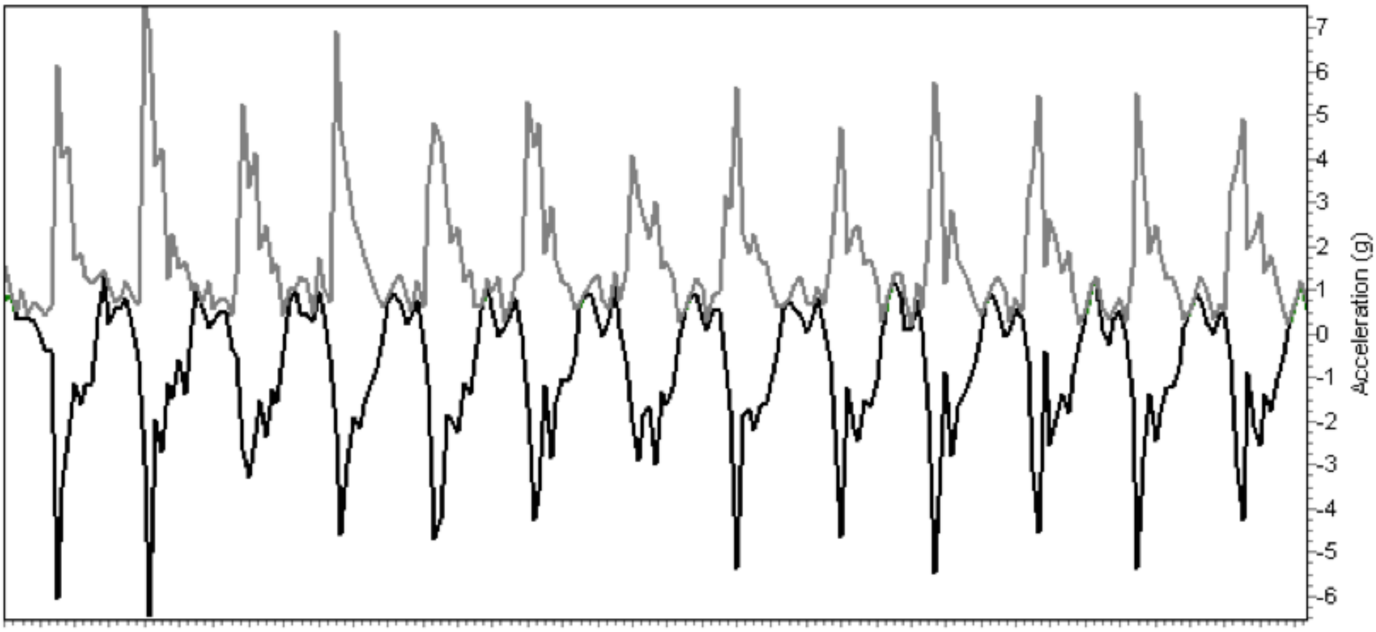


Figure 4a: Simultaneous vertical sacral impact plots for the same subject during a linear sprint task.

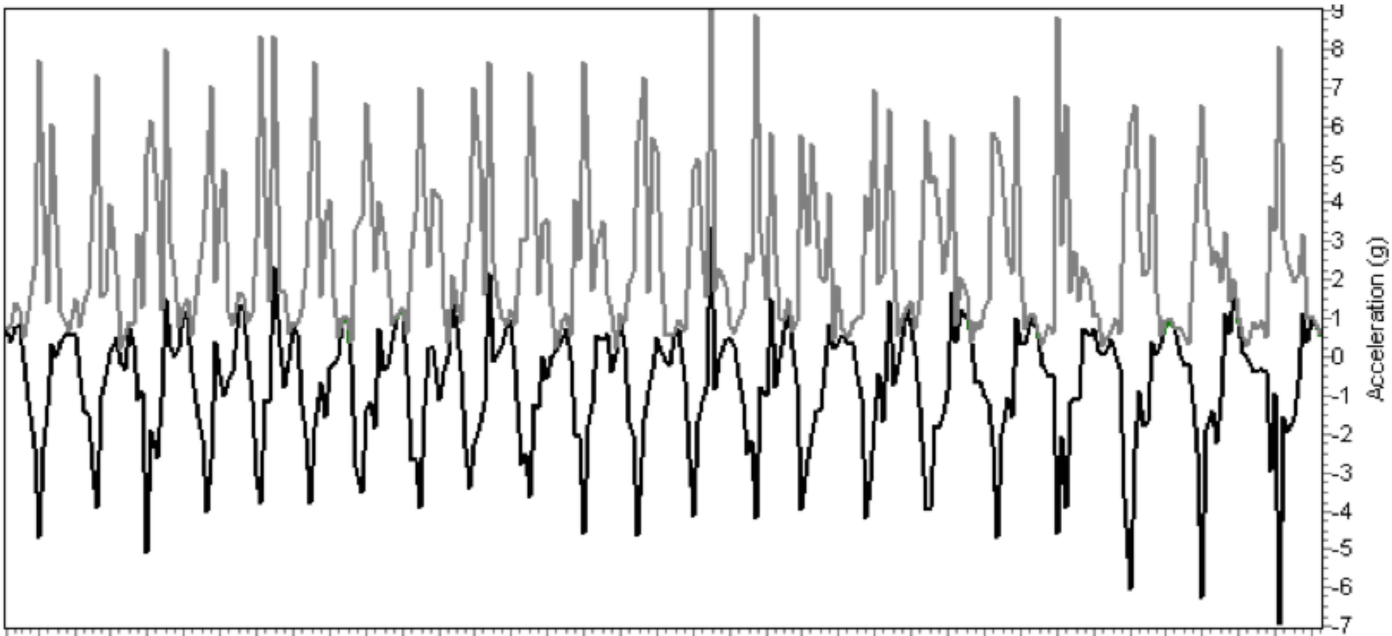


Figure 4b: Simultaneous vertical torso impact plots for the same subject during a linear sprint tas

whereas players assessed multiple times over the course of a season may demonstrate changes in load due to ground conditions, training periodisation, fatigue and/or injuries themselves. Thus, any relationship demonstrated using a single pre-season GPS/accelerometer measurement may be more accurate for the early part of the season than later on. We elected not to have subjects handling an actual ball, as it was felt that having other players deliver the balls would create too much variation in load. It is acknowledged however that the use of a ball is more realistic, and that the impact of the ball on the arms and upper torso may alter load, particularly in anteroposterior or mediolateral planes.

## Comparison of Sacrum and Torso Data

The lumbosacral unit was added as a reference point at a site approximating the body's centre of gravity. We were interested in measuring the relationship between sacral and torso impacts in light of previous literature questioning the validity of torso impacts.[17, 19] In addition, we wished to investigate any relationship between either (i) sacral impacts per se or (ii) the difference between torso and sacral impacts, and injuries. Should the validity of torso data prove questionable due to artefact, there might be useful data gathered from the sacrum that clubs could still use for gait modification. Due to dissipation of load in mediolateral and anteroposterior planes across the trunk it was anticipated that (i) mean vertical impacts would be greater at the sacrum, for all tasks, and (ii) there would be stronger correlations for total bodyload and weaker correlations for vertical load between the two sites. Significantly greater mean vertical impacts were indeed measured at the sacrum than at the torso for all running tasks, especially linear sprinting, but not for all jumping tasks. Contrary to expectation, mean vertical impacts at the torso for jump-landing and kicking were not significantly different from those at the sacrum. Stronger correlations between sacral and torso impacts were indeed demonstrated for total bodyload than for vertical load alone, and while stronger correlations were generally seen for jumping tasks than for running tasks a notable exception was the jump-landing, which correlated poorly, particularly with respect to vertical load. These findings again call into question the accuracy of impacts derived from the upper torso level, due to paradoxic magnification of vertical impacts due to the harness during jump-landing, kicking and running. Paradoxic magnification may not be the sole explanation for these observations however. Player gait and landing technique may indeed be relevant. These results may reflect the more vertical nature of taking off in comparison to a greater horizontal dissipation of load on landing. Some players may adopt a more rigid landing style, or indeed accelerate load through their torso upon impact, due to poor lumbopelvic stability. A greater mean sacrum-torso difference was observed for vertical impacts when sprinting, compared to submaximal running. In contrast however, the mean sacrum-torso differences for total bodyload were identical. This may reflect the smoother nature of sprint running,[11] with greater force dissipation along horizontal planes and potentially less paradoxic movement within the harness.

## Demographics and Injuries

Player demographic data were consistent with previously published findings in community-level Australian football. [2, 5] Our finding of 14.7 significant injuries per 1000 player hours is less than previously noted at community (27.2/1000)[2] and elite level Australian Rules football (38.2 to 43.3/1000).[15] Potential reasons for this include differences in conditioning, injury countermeasures, training and match intensity and sample size. The statistically significant age-related increase in both the number of significant injuries, and sessions missed due to those injuries, is however consistent with previous work showing age to be a risk factor for injury, particularly muscle injury[6] with age 23 years an apparent watershed for calf and hamstring strains.[15] These results lend further support to the careful management of conditioning and training load in older players. Acute ankle sprain was the most common significant injury, followed by hamstring and groin injuries respectively, mirroring their frequency seen in previous studies at community[2, 6] and junior[16] levels, but not at elite level however, where ankle injuries rank third in terms of prevalence.[15] This difference may be due to variations in quality of playing surface, rehabilitation or availability of preventive taping/bracing. Low back pain was the most frequently reported non-significant injury. This was also in line with previous work demonstrating that footballers across all codes have significantly more severe and frequent low back pain than non-athletes, and that incidence increases with the level of competition.[9] Players were more likely to miss training sessions than games. This was in keeping with expectations, as players will frequently modify their training loads during the week in order to be available for matchday selection.

## Relationship between Impacts and Injury

Overall, relationships between measured impacts and injuries were inconsistent, although when assessed alongside sacrum-torso difference data, one pattern does emerge. The difference in mean vertical impacts measured at the torso vs. sacral level was greatest during the sprint task, and this difference was associated with an increased risk of significant injury and time out of sport. Given the aforementioned concerns regarding accuracy of accelerometer data, it is possible that these associations are due to chance, particularly with a relatively small injury sample size and only a single measurement of load. An alternative explanation for this finding however is that during sprinting, greater dissipation of force medio-laterally and/or antero-posteriorly, particularly in the presence of poor lumbopelvic stability may increase stress on the low back, pelvic girdle and lower limbs, increasing the risk of injury. Medio-lateral and antero-posterior accelerations were not measured in this study, and it may be that measuring vertical impact alone is not sensitive enough to predict injury-prone players. While accelerations measured at torso level alone did not prove useful in predicting injuries, impacts measured near the centre of mass proved no better. Despite strong correlations between the two sites for some tasks, the areas of strongest correlation were no more likely to predict injury than the weakest. We infer from these results that with this technology in its current form there is no clinical utility in measuring isolated centre of mass impacts using this technology, although the simultaneous measurement of torso and sacral impacts may show promise. Several challenges were present in recording injury data across a season. We aimed to limit recall bias by minimising the number of athletes per club, with updates from club physiotherapists on a weekly basis. Overall, the feeling from the physiotherapists was that they were happy with the size of their assigned group and they felt able to accurately keep track of injury numbers and session attendance. Reporting bias is a potential challenge, for two reasons. The first pertains to the definition of a non-significant injury. While a significant injury has a relatively unambiguous definition (it leads to loss of training and/or match time), the definition of a non-significant injury is more open to interpretation and it is possible that non-significant injuries went unreported by both players and physiotherapists, even when players were asked directly. What is an injured calf to one may be perceived as normal post-game soreness by another. Secondly, players may withhold information due to a desire to not lose their place in the team, and/or to not be perceived as injury-prone or "soft" by team-mates or coaches.

## The Future

Although this study was unable to confirm any relationship between impacts measured using the SPI Pro™ and injuries, we believe there is room for future work in this area. For this system to be used in research, modifications to both hardware and software appear necessary. A future study comparing torso and sacral TA results in both "standard" and "research" vests to force plate data may provide insight into the role the harness plays in modifying impacts. With respect to software, the limitation of vertical impacts to 7.984 g will require rectification, and it may be possible for the software authors to enable Team AMS™ to calculate an average impact peak over a desired range of recordings. If this is not possible then the inter-rater reliability of the manual method of impact peak measurement will need to be assessed. This will likely require better quality impact data than were observed in this study. In terms of study design, future work incorporating the measurement of antero-posterior and medio-lateral loads, together with the use of video analysis to assess player running and landing technique, may assist in ascertaining whether or not technique, lumbopelvic stability and/or kicking style are relevant. Further work may also explore the value of addressing core stability, lower limb muscle balance and gait mechanics in reducing injury occurrence. This study did not differentiate on the basis of playing position or body type, however future work with a larger cohort of players could do so. The small sample size, time frame and number of injuries may have played a role in not finding associations. To demonstrate meaningful associations may require a larger player cohort than this study, and necessitate the collection of injury data over several seasons to ascertain which particular injuries are contributed to by vertical impact load, and the magnitude of any such contribution.

## CONCLUSIONS

Trunk-mounted GPS/accelerometer technology demonstrates potential as a club-based research tool, but at this point it is not possible to make firm recommendations regarding modification of load – based on measurements acquired via this TA system - in order to prevent injuries. Neither is it possible to recommend the current technology as a screening tool to predict players at risk of injury. There is scope however for future research into the hardware component of the technology used in this study - focusing particularly on the harness – and for modifications by the manufacturer to the software package. Once these technical issues have been worked through and the technology validated in the field, scope may exist for further investigation into associations between impacts and injury using this device.

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## *Comment 1*

**Mike McGuigan**, PhD
*Professor of Strength and Conditioning*
*AUT University*

The use of global positioning system (GPS) and accelerometry technology is becoming more widespread in professional sport. In recent times there have been a large number of published papers investigating the use of GPS technology, particularly in team sports (e.g. 2, 3, 4). This research has looked at quantifying the demands of sports such as Rugby Union, Rugby League, Soccer and Cricket. It has also attempted to assess the training demands of these sports in addition to providing more information about how to effectively train the physical capacities required in these sports. In this issue, the authors have conducted an interesting study where they quantified the vertical impacts using GPS/accelerometry during match play and training with specific reference to injury risk in Australian Rules Football players. This type of research has the potential to have a great impact on Sports Medicine/Sports Science as it will provide practitioners with greater insight into the physical demands and potential injury risk of the sports they are working with.

A recent case study is a good example of how GPS can be used to manage players returning from injury.[4] By identifying the positional requirements of the players and measures such as the amount of high speed running, the authors were able to manage the loading and make recommendations based on objective data. This has great potential impact, as it enables practitioners to identify objective targets that are specific to match play and should help to reduce the risk of re-injury. Another advantage of GPS is that it can be monitored in real-time. This is significant as it allows practitioners to more effectively monitor athletes during the training sessions. As always with technology, the challenge for us is how we can effectively interpret this information and use it to inform our practice. The type of research conducted by the researchers in this issue is a good example of how Sports Medicine can conduct these types of applied studies in elite sporting environments to increase our knowledge of sports and injury prevention. In terms of the future application of GPS technology an area of key focus should be greater integration of movement data with fitness, physiological, injury and tactical data. A recent Australian Football study investigated the relationship between Yo-Yo test (endurance) performance, high intensity running distance per minute and total ball disposals (a key performance indicator) in elite players.[3] This is an excellent example of how GPS data can provide an in-match performance measure, and the determinants of that performance can be understood through fitness testing. What is most significant from this work is the connection between physical capacity, fitness and actual match performance. However, greater understanding of the injury prevention applications of this information is also required and this is where researchers in Sports Medicine have a big role to play. There has been a rapid uptake of GPS technology by team sports and there is now a lot of information on the activity profile of athletes arising from GPS analysis. This includes total distance covered by players and distance in different velocity ranges.[1] However, there is relatively little practical information that is gained from simply reporting and comparing measures such as total distance covered. The use of distance per minute of match time may be more informative. In addition, breaking movement into velocity bands in order to locate periods of intense activity during matches, such as repeated sprint bouts, could have greater practical application.[2] The study reported in this issue goes beyond the basic measures such as distance covered and provides a more in-depth insight to the actual loads experienced by players, despite some technical limitations as noted by the authors. With an increased understanding of match demands of various sports from technologies such as GPS and accelerometry, this should allow us to make more informed decisions about training athletes, as well as having implications for injury prevention and managing the rehabilitation programmes of athletes returning from injury.

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## *Comment 2*

**Chris Hanna**
*Sports Physician*
*UniSports Medicine, Auckland*

This is a very interesting paper. It has identified some very important issues in the use of triaxial accelerometers in field based research, in particular the ceiling phenomenon of this particular software package when forces exceed a certain threshold (7.984g). The stability of harnesses may also need to be assessed before further research can be carried out in this field. In terms of injury prevention, the authors have identified one possible correlation between pre-season screening and the incidence of injury in that the difference between trunk and sacral forces during a sprint task correlated with a higher rate of injury and greater time out of sport. They postulate, logically, that this may indicate that poor core stability might be associated with an increased risk of injury. In order to prove this relationship, further research would be needed to show that improving an athlete's core stability through intervention reduces the difference between forces recorded at the torso and sacrum, and then they would have to show that this change reduced the rate of injury in the intervention group. This paper provides useful information for anyone planning of further research in this field. Personally, I believe that monitoring GRFs throughout the season is likely to be more useful in injury risk reduction than a one of pre-season functional screen.

# Sports medicine practitioners' assessment and management of upper respiratory illness in athletes

**Samantha Pomroy** MBBS BAppSci(Physio)
**David B Pyne** PhD
**Kieran E Fallon** MD FACSP
**Peter A Fricker** MBBS FACSP

***Affiliations:***

Medical School, The Australian National University

Sports Medicine, Australian Institute of Sport

***Correspondence:***

Samantha Pomroy
23a Kissing Point Road
Turramurra, NSW, 2074
AUSTRALIA
Tel: +61 4 0188 4313
Email: sampomroy@hotmail.com

## ABSTRACT

### Purpose

To identify the degree of uniformity in approaches used by sports medicine practitioners' to assess and manage upper respiratory illness in athletes, and alignment of contemporary practices with current guidelines and recommendations.

### Methods

A short 11-item web-based questionnaire was developed to inquire about the history, physical examination, investigations and management of athletes presenting with upper respiratory illness. A total of 24 sports physicians and six registrars in sport and exercise medicine completed the questionnaire.

### Results

Substantial variation was evident between respondents questioning an athlete for cough at night, inspiratory/expiratory effort and pain, rash, pleuritic pain and its effect on exercise tolerance, the amount of exercise that brought on cough and dyspnoea, family history of respiratory illness and smoking history. Investigations such as spirometry and peak flow were seldom or rarely conducted. Two-thirds of respondents reported their treatment and management varies according to the level of the athlete and sport. While all respondents reported training of the athlete was modified according to signs and symptoms, only a minority (23%) reported a reduction in performance. Twenty percent of respondents reported using the 'above neck rule' in training modification. The most frequent advice included ensuring adequate hydration, nutrition, rest, and exercising moderately to avoid aggravating symptoms.

### Conclusion

Substantial variation in approaches used for assessing and managing upper respiratory illness in athletes between sports medicine clinicians was evident. A standardised and evidence-based approach in assessment and management of upper respiratory illness in athletes may assist current practitioners and training of future sports physicians.

### Key words

illness, exercise, training, respiratory function, physician

## INTRODUCTION

Upper respiratory illness (URI) commonly affects athletes, particularly in relation to periods of intensive training and competition.[1] Of the 184 acute illnesses in athletes recorded by sports medicine staff at the 2009 FINA Swimming World Championships, about half involved the upper respiratory tract.[2] The frequency of URI in athletes and the potential effect on performance underlines the importance of effective assessment and management.[3]

The sports medicine practitioner faces a variety of causes of upper respiratory illness ranging from infection, to asthma and allergies. These causes often have commonality in their symptom presentation making it difficult to determine the exact cause of illness, especially at the initial presentation. The poor correlation of signs and symptoms with the presence of a particular pathogen, allergen or other aetiological agent, and the delay inherent in obtaining results of investigations, can limit management advice and effective prescription of medications.[4]

One study of illness in athletes identified pathogens in less than 30% of cases involving upper respiratory symptoms[1,5] leaving a large percentage of unidentifiable infectious or non-infectious causes. Another study reported substantial differences between sports physicians' use of clinical signs and symptoms and the results of laboratory findings.[6] Until point-of-care laboratory tests are routinely available, or higher specificity in diagnosis can otherwise be achieved, multiple causes of illness have to be considered at diagnosis. The importance of correct diagnosis is emphasised by potentially life threatening complications such as myocarditis,[7,8,10,19,20] exacerbation of asthma[8,10,19,20] and chronic symptoms such as post viral fatigue syndrome.[11] However absolute precision in diagnosis may not be vital in many cases as methods and medications for relief of common symptoms may be identical no matter the aetiology. To improve diagnostic accuracy, a comprehensive and reproducible clinical history must be undertaken. Respiratory questionnaires such as the WURSS-44[1,25] and the SF-36[1,12] to assess quality of life related to illness are methods of questioning the general population on symptomatology and functional impairment of respiratory health. However, a standardised respiratory symptom approach specific for athletes has not been reported.

Investigations for athletes who present with upper respiratory symptoms offer great scope for further research. Some studies have investigated screening strategies using salivary IgA[14,15] and salivary lysosome[14] levels to monitor risk of infection. This limited amount of research is surprising considering the highly competitive nature of elite sports and importance of minimising the risk of illness for individual and team sport athletes. In view of the high prevalence of upper respiratory illness in athletes it is important to review assessment by sports medicine practitioners of upper respiratory illness in athletes. The purpose of this study was to identify the degree of uniformity in assessment approaches used by sports medicine practitioners to detect upper respiratory illness in athletes, and alignment of contemporary practices of these practitioners with current guidelines and recommendations.

## METHODS

### Subjects

Sports medicine practitioners were initially approached through the Australasian College of Sports Physicians weekly newsletter. Sports Physicians and registrars on the Australasian College of Sports Physicians programme, and primary care physicians who had a Masters or Diploma of Sports Medicine were also contacted via mail, and in person. A total of 22 male and eight female clinicians completed the questionnaire. There was a broad distribution of experience in respondents, six respondents were on the registrar training programme for the Australasian College of Sports Physicians, 20 of the respondents had greater than ten years experience as a Sports Physician. The majority of Sports Physicians are Fellows of the Australasian College of Sports Physicians. This study was approved by the Ethics Committee of the Australian Institute of Sport (20091004) and the Human Experimentation Committee of the Australian National University (2009/557).

### Study Design

Sports Physicians, registrars and physicians who had sports medicine qualifications were invited to participate in a short 11 item questionnaire. The study was in the format of a cross-sectional survey. A questionnaire was developed by utilising existing respiratory questionnaires,[12,25] texts[8,9,13,17,19,20,22] and discussions with a small cohort of experienced respiratory and Sports Physicians.

### Questionnaire

The questionnaire consisted of four sections. The first section asked demographic information of the participants including gender, level of experience and specialist qualifications. Section two contained questions on signs and symptoms used to assess upper respiratory illness in athletes. Section three sought to outline specific elements of history taking including past medical history, family history, allergies, medications, investigations, and details of current sporting performance. Section four asked about management of athletes with upper respiratory illness. Responses were selected from a dichotomous scale (yes/no), ordinal scales (always, often, seldom, never) or open-ended questions. A link was provided to the online questionnaire as well as a password and login details to provide protection and ensure the identity of each respondent was not revealed to the research team.

**Table 1: Signs and symptoms of upper respiratory illness in athletes (percentage of respondents).**

| Question, 'How often do you assess:' | Never | Seldom | Often | Always |
|---|---|---|---|---|
| COUGH | | | | |
| Cough occurrence? | 0 | 3 | 10 | 87 |
| Cough is productive/dry? | 0 | 7 | 27 | 67 |
| Cough is causing waking at night? | 7 | 30 | 40 | 23 |
| How often do you assess the quality of the cough? | 3 | 23 | 40 | 33 |
| DYSPNOEA | | | | |
| How often do you check for dyspnoea? | 0 | 27 | 27 | 47 |
| Do you assess the mode of dyspnoea? (i.e. exertion, at rest) | 3 | 30 | 33 | 33 |
| Do you assess the severity of dyspnoea? | 7 | 30 | 40 | 23 |
| INSPIRATORY AND EXPIRATORY EFFORT | | | | |
| Do you assess if symptoms are worse on inspiration? | 43 | 10 | 13 | 33 |
| Do you ask if symptoms are worse on expiration? | 33 | 7 | 17 | 43 |

**Table 2. Symptom presentation (percentage of respondents).**

| Question, 'Do you assess for:' | Yes | No |
|---|---|---|
| Myalgia? | 100 | 0 |
| Arthralgia? | 93 | 7 |
| Pleuritic pain? | 63 | 37 |
| Inspiratory vs. expiratory pain? | 47 | 53 |
| Pain with cough and location? | 80 | 20 |
| Pharyngeal/laryngeal (sore throat)? | 100 | 0 |
| Headache and their characteristics? | 97 | 3 |
| Sinus discomfort? | 100 | 0 |
| Earache? | 100 | 0 |
| Duration of fever? | 93 | 7 |
| Hot and Cold Spells? | 90 | 10 |
| Shivering? | 93 | 7 |
| Night sweats | 93 | 7 |
| Allergy symptoms (watery and/or red eyes, runny noses)? | 87 | 13 |
| Rash? | 43 | 57 |

### Statistical Analysis

Descriptive statistics were employed to report the distribution of responses to each of the study questions.

## RESULTS

Signs and symptoms of upper respiratory illness in athletes

The type of symptoms and whether a cough was productive or dry was always assessed by the majority of respondents (Table 1). Questioning on whether the cough caused waking at night was reported by approximately two-thirds of respondents. Dyspnoea was often or always assessed in approximately two thirds of respondents including its occurrence at rest or on exertion. Inspiratory and expiratory effort and their relationship to symptoms showed significant variation in responses with one third never assessing for symptom presentation on inspiration or expiration, and another one third always assessing this characteristic.

Symptoms of pain including myalgia, arthralgia, pain with cough, sore throat, headache, sinus discomfort and ear ache were always inquired about by the majority

**Table 3. Exercise tolerance with symptom presentation (percentage of respondents).**

| Question, 'Do you:' | Yes | No |
|---|---|---|
| Measure or assess the amount of exercise that brings on cough and/or dyspnoea? | 60 | 40 |
| Ask if wheeze occurs during pre-training, during training or post training? | 83 | 17 |
| Ask if cough occurs during pre-training, during training or post-training? | 83 | 17 |
| Ask if pleural pain occurs during pre-training, during training or post-training? | 43 | 57 |
| Ask if dyspnoea occurs during pre-training, during training or post-training? | 87 | 13 |
| Ask about the effects of training on the symptoms? | 97 | 3 |
| Assess whether symptoms have affected training in regards to intensity? | 93 | 7 |
| Assess whether symptoms have affected training in regards to duration? | 80 | 20 |
| Assess whether symptoms have affected training in regards to frequency? | 73 | 27 |
| Ask about the overall effect of the illness on the capacity to exercise or train? (e.g. % reduction in training) | 83 | 17 |

**Table 4. Questions asked on the athlete's history (percentage of respondents).**

| Question | Never | Seldom | Often | Always |
|---|---|---|---|---|
| How often do you ask about past respiratory illnesses to assist in your diagnosis? | 0 | 30 | 47 | 23 |
| How often do you ask about asthma to assist in your diagnosis? | 0 | 0 | 33 | 67 |
| How often do you ask about allergies to assist in your diagnosis? | 0 | 17 | 43 | 40 |
| How often do you ask about the athlete history- level of training or competition schedule to assist in your diagnosis? | 0 | 7 | 23 | 70 |
| How often do you ask about smoking history to assist your diagnosis? | 3 | 47 | 27 | 23 |
| How often do you ask about family history of respiratory illness to assist in your diagnosis? | 3 | 47 | 37 | 13 |
| How often do you ask about medications to assist in your diagnosis (i.e. use of asthma inhalers)? | 0 | 7 | 23 | 70 |
| How often do you ask about the effectiveness of asthma inhalers related to current illness to assist in your diagnosis? | 0 | 3 | 37 | 60 |

**Table 5. Differential Diagnosis/other factors (percentage of respondents).**

| Question, 'How often do you:' | Never | Seldom | Often | Always |
|---|---|---|---|---|
| **OBSERVATION** | | | | |
| Observe the athletes general appearance? | 0 | 3 | 10 | 87 |
| Observe dyspnoea at rest? | 0 | 13 | 27 | 60 |
| Observe watery eyes? | 3 | 47 | 33 | 17 |
| **EXAMINATION** | | | | |
| Assess vital signs? | 0 | 17 | 27 | 57 |
| Conduct an ENT exam? | 0 | 20 | 20 | 70 |
| Conduct a respiratory exam? | 0 | 7 | 17 | 77 |
| Conduct a cardiovascular examination? | 3 | 20 | 43 | 33 |
| **INVESTIGATION** | | | | |
| Conduct spirometry? | 23 | 53 | 20 | 3 |
| Conduct a peak flow test? | 13 | 50 | 33 | 3 |
| Order a chest XRAY? | 7 | 93 | 0 | 0 |
| Obtain a sputum sample? | 20 | 80 | 0 | 0 |
| Conduct a throat swab? | 27 | 70 | 3 | 0 |

of respondents (Table 2). Approximately two thirds of respondents always assessed for pleuritic pain, and half for inspiratory/expiratory pain. The systemic presentations of fever and duration of fever were assessed by the majority of respondents. Allergy symptoms including runny nose and itchy eyes were generally assessed, but rash was assessed by less than half of the respondents. Exercise tolerance including wheeze, dyspnoea and cough occurring before, during and after training was assessed by the majority of respondents (Table 3). The amount of exercise that brought on cough/dyspnoea was noted by two thirds of respondents. The effect of symptoms on training intensity, frequency and duration was investigated by the majority. Pleural pain and its effects on exercise tolerance were asked about by fewer than half of the respondents.

## Athlete's History and Differential Diagnosis

When asked about the patient history the majority of respondents indicated they asked about past respiratory illnesses, asthma, allergies, the level of training and competition schedule, medications used and effectiveness of asthma inhalers in regard to current illness (Table 4). Questioning about smoking history and family history of respiratory illness was split with only half of respondents asking about these details. The majority observed the athletes' general appearance (Table 5) and checked for dyspnoea at rest. Half of the respondents often or always checked for the presence of watery eyes. Assessment of vital signs, ear, nose and throat and respiratory and cardiovascular examination were often or always conducted by the majority of respondents. Investigations (spirometry, peak flow, chest x-ray, sputum sample, throat swab) were seldom or never conducted by the majority of respondents.

## Treatment and Management of Athletes with Upper Respiratory Illness

Two thirds of respondents said they vary their treatment and management advice according to the level and type of sport. An athlete's training was generally modified based upon signs and symptoms and magnitude of decrease in training or competitive performance. Six respondents used the 'above neck rule'[26] (presence of above the neck symptoms such as runny nose and sore throat without below neck symptoms such as fever, severe cough or gastrointestinal upset allows the athlete to train at half intensity for ten minutes. If symptoms worsen training is ceased. If symptoms do not worsen training can continue as tolerated) to determine modification of training. In assessing when an athlete is able to return to sport, all respondents indicated a reduction or resolution in signs and symptoms as important determinants.

The advice given to the athlete on how to return to training ranged from general to specific. Sixteen respondents reported a graduated programme and nine indicated the athlete should progress as able. Eleven respondents used the principles of frequency, intensity, duration and specificity to guide the return to sport. Advice given to the athlete included decreasing the volume of training if symptoms worsened. Many respondents gave nutrition advice, reminders on hydration and suggestions to ensure athletes were getting adequate sleep.

Specific medical complications of an upper respiratory illness that respondents were concerned about included viral myocarditis, non-specified cardiac manifestations, and aggravation of asthma. Post-infection fatigue, Epstein-Barr virus infection and splenomegaly in contact sport athletes were also considered.

## DISCUSSION

The sports medicine practitioners' clinical practices identified in this study were generally consistent with current guidelines[10] and recommendations[1,8,9,19,20,25] for athlete presentation with upper respiratory illness. However, there was some variation in diagnosis, treatment and management of respiratory illness between respondents.

A notable difference was questioning of the athlete about the presence of a cough at night. This was seldom or never asked by one third of respondents. This may be an important question given an athlete's fatigue might be worsened by disrupted sleep. Cough at night can also be reflective of asthma[1,8,9,19,20,25] or chronic sinusitis, as a result of post-nasal drip where secretions track down into the larynx during sleep.[9,10]

A second discrepancy was questioning of symptom severity in relation in to inspiration or expiration. Failure to ask could mean stridor from an upper airway obstruction or vocal cord dysfunction might be missed.[19] Alteration in respiratory function is not an uncommon presentation within the athletic population especially those exercising at high intensities. Differentiating inspiratory stridor from symptoms of exercise-induced bronchoconstriction[19] is important to ensure correct diagnosis. Inspiratory/expiratory characteristics should be assessed routinely in athletes presenting with respiratory illness or problems.

Variability in approaches was also seen in questioning the athlete on the occurrence of pleuritic pain. One third of respondents did not assess this symptom. Pleuritic pain can be a symptom of pneumonia[9,10] and although uncommon in athletic populations, it is appropriate to exclude this complication. It may also be instructive for physicians to review chest pain or tightness in the athlete. This symptom can lead the clinician to check for pneumonia, asthma and cardiac abnormalities.[1,8,9,10,19,20,25] Both asthma and upper airway obstruction continue to be under diagnosed and undertreated[9] so more specific questioning may improve diagnosis.

A low clinical priority was given to the presence of rash as less than half of the respondents checked for its occurrence. Rash can be an important sign of viral illness and if associated with fever and upper respiratory tract symptoms can indicate meningococcal disease.[9] A rash can also be associated with infection by the Epstein Barr Virus.[2] Rash could also be a sign of atopy, and an allergic cause or asthma should be considered. Allergic conjunctivitis, another key feature of atopy, or viral infection of the upper respiratory tract might also be missed as less than half of respondents seldom or never observed for watery eyes.

Two important aspects of history taking which lacked consistency were questioning the athlete about family history of respiratory illness and the patient's smoking history. Current guidelines[8] and recommendations[9,10,1,19,20,25] support both lines of questioning. Family history of respiratory illness was seldom or never asked by half of the respondents. This questioning could assist in identification of asthma and/or allergic rhinitis[8] as causes for symptom presentation. Smoking history was asked by half of the respondents. Care needs to be taken to avoid making the assumption that athletes do not smoke. Appropriate questioning may also allow the degree of exposure to passive smoking to be assessed.[25]

Ordering of diagnostic tests was limited. This is not surprising as diagnosis and management of the majority of constellations of uncomplicated upper respiratory tract symptoms does not require them. As might be expected spirometry, which is generally only relevant if obstructive or restrictive airways disease is suspected, was performed infrequently with over two thirds of physicians seldom or never using peak flow measurements. If required these tests can be conducted at the initial presentation and are inexpensive in time and cost.[20] Diagnostic testing can give an objective measure of whether asthma is associated with, or causative of, several of the symptoms which athletes typically present.[10] Peak flow and spirometry are also helpful in cases of acute bronchitis as altered flow rates can indicate reduced pulmonary capacity, and thus full training loads may not be appropriate.[8] As some upper respiratory illnesses present with wheeze and cough,[1,9,10] use of these tests may improve the rate of diagnosis of asthma.

Other important considerations for history taking by sports medicine clinicians include the epidemiology of illnesses, particularly within the active 12-30 year age bracket. Epstein-Barr Virus[23] and asthma[22] should always be considered in a differential diagnosis, together with more serious conditions such as meningococcal disease, within this age group.

Many of the respondents included elements of current contemporary clinical guidelines[8] and recommendations[1,9,10,19,20,25] such as symptom based modification of training - however none included all components of these. Analysis of the specificity in management advice did not correlate highly with the years of clinical experience. Variability between clinicians' approaches may relate in part to care for teams as distinct from those competing in individual sports, experience with upper respiratory illness, or simply the willingness to report on the questionnaire. For example, some respondents gave explicit stages of progression for the athlete to resume full training whereas others left it up to the athlete - if the athlete felt well then resumption of training could occur.

Specific advice given by the sports medicine practitioner can eliminate confusion in the athlete and coach and limit the problems of a premature return to sport. The exact duration of an illness often cannot be determined as individual responses are unpredictable.[8] It is therefore not surprising that practitioners did not identify a specific time course for return to full training – a position consistent with previous reports.[8,21]

There was a clear distinction between clinicians with many years of experience and those on the registrar program in the type of physical examination techniques and tests ordered for upper respiratory illness. More senior clinicians with years of sports medicine experience typically ordered fewer tests and conducted an abbreviated physical examination. The shortcomings of pathology testing in an athletic population have been noted previously.[6] The training of registrars should include discussion of this issue.

The management advice reported by two thirds of respondents indicated treatment and management varied according to the level and type of sport. This observation aligns with the recommendations of Fricker et al.[8] However there is growing evidence of the possibility of adverse effects and increased bacterial resistance with increased antibiotic usage, particularly given that the majority of upper respiratory infections are viral. Sports physicians need to be mindful of prescription of antibiotics to limit increases in bacterial resistance and unnecessary side effects.

Clinical approaches to monitoring of symptoms, dietary management, supplements, and recovery post training/competing also varied. Athlete monitoring for worsening of symptoms, attention to hydration and nutrition and adequate sleep and rest were commonly reported, consistent with the literature.[8,9,10] However inconsistencies were evident among the respondents with a variety of other suggestions made, many not evidence based. While many suggestions were practical and appear warranted they lacked scientific support. Current medical practice must attempt to embrace evidence-based management.

Limitations of this survey included lack of a specific definition of upper respiratory illness. This omission may have resulted in varied responses. However the responses given were true to the clinician's own interpretation of an upper respiratory illness and what he or she considered when an athlete presented. In our view further research should address misconceptions on the definitions of upper respiratory illness, and on the development of a model for history taking. Consideration should also be given to identifying all potential causes of respiratory illness - particularly those with cardiac consequences.[1,7,8,9,10,25]

A standardised clinical approach for assessing and managing upper respiratory illness in athletes, utilising evidence based guidelines is warranted. The development of a reliable and reproducible approach could be developed in the future to assist in streamlining all sports medicine clinicians' approaches. An improved treatment and management approach should limit the recurrence of symptoms and more serious medical complications.

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# Reducing injury in elite sport - Is simply restricting workloads really the answer?

**Paul Gamble** PhD CSCS HPSA

*Affiliations*

Owner/Director of Informed Practitioner in Sport website and e-learning resources www.informedinsport.net

Sports Performance Research Institute New Zealand, AUT University, AUT-Millennium Institute of Sport and Health, Antares Place, Auckland 0632, New Zealand

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Player Management, Workloads, Monitoring, Injury Prevention, Team Sports

## INTRODUCTION

In elite team sports particularly, there is a growing emphasis on 'player management', largely based upon measures of 'workload' derived from training and competition. These magic numbers are frequently used to guide the prescription of training. Moreover, it is becoming increasing common for decisions on selection to be based on these parameters – for example, many teams employ a rotation policy whereby it is predetermined that a player will get rested for certain fixtures in the schedule. One of the central tenets of these policies is that controlling player's competition workloads and exposure to the stresses and conditions of fatigue involved in match play will reduce their risk of injury. Hence, the rationale for restricting the player's overall workload is to limit training-related stresses and residual fatigue, thereby reducing the number of injuries sustained in both training and competition. This commentary critically examines the evidence for these practices.

### The Theoretical Relationship between Workload and Injury Risk

The theoretical underpinning of player management policies and the practices of monitoring and restricting workloads is based largely on a small number of studies reporting a statistical relationship between gross measures of 'workload' and injury rates during training and matches.[4,5,6,7] Research efforts have been steered towards the reduction of non-contact overuse-type injuries resulting from repetitive, cumulative microtrauma occurring during training and competition. Implicit in these efforts, and the policies that have stemmed from them, is the notion that limiting the volume and stresses of training and thereby the level of residual fatigue that athletes are operating under will render them less prone to injury; likewise, reducing the exposure and level of physical strain experienced during matches will similarly reduce the number and perhaps severity of injuries sustained.

From the data published to date, the contention from some authorities is that a theoretical U-shaped curve exists between workload and injury risk.[5] According to this

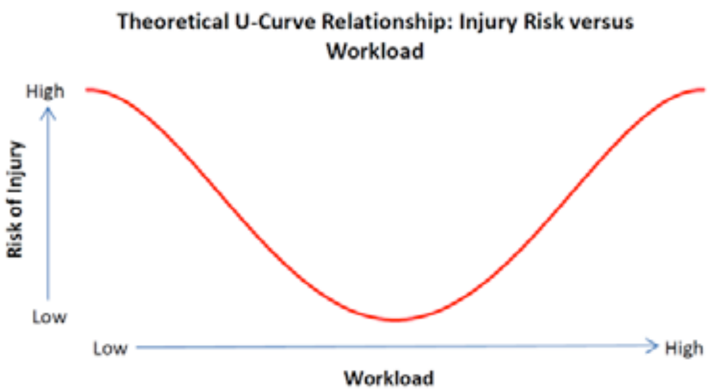


**Figure 1: Hypothetical U-shaped relationship between workloads and injury risk.**

model, both high and low workloads will predispose the athlete to a greater risk of injury.

In the case of high workloads, this is attributed to excessive cumulative stress that overwhelms the athlete's capacity to recover and ultimately exceeds the tolerance of the tissues. The increased risk associated with low workloads is less apparent, but the insufficient conditioning stimulus provided by less frequent exposure and/or lower volumes of work is a probable factor. By extension, it is implied that there is both an upper and lower threshold in terms of workloads that will serve as a protective effect

This theoretical relationship between workload and injury, and the notion of 'threshold' workloads are intuitively appealing. Certainly the concept of monitoring and limiting workloads in order to avoid exceeding the theoretical upper threshold has been adopted enthusiastically by sports medicine authorities, particularly those involved in elite sport. Unfortunately, it is an open question whether these policies have in fact had any positive impact upon the number or severity of injuries sustained by players in these sports. It is also noteworthy that sports medicine authorities have perhaps been less attentive to the possible risk of inadequate frequency and volumes of workloads with respect to injury incidence.

Investigators in this area have also noted that there may be negative consequences of limiting workload in terms of performance: higher training loads are associated with superior performance. By reducing workloads in matches and training the level of conditioning of players and in turn their performance may be compromised.

Furthermore, from an injury viewpoint it has been identified that there is a lower threshold in terms of workloads, whereby injury rates are increased with insufficient volume and frequency of exposure to workload.[5]

Equally, level of conditioning is a major risk factor for injury in team sports.[10] Inadequate conditioning is implicated in the higher rates of injury observed in team sports that occur early in the playing season and during the latter stages of playing periods in many studies.

### An Example from the Sport of Cricket

An illustrative and high profile example comes from cricket in Australia. As an organisation Cricket Australia has led the implementation of 'informed player management' policies and measures of workloads are routinely employed as part of the criteria for decisions on whether to rest players, including for international fixtures. Unfortunately, the Australian cricket team continues to experience a notably high occurrence of injury, particularly to fast bowlers – the main group that these policies are intended to protect. Moreover, these policies remain controversial among supporters and in the media given the perception that resting apparently fit players has cost the team in important matches. Regardless of these debates, the practice of monitoring and restricting workloads for bowlers particularly has been adopted widely at the elite level, not only in Australia but also by other major test playing countries. For example, in professional cricket in England leading county cricket teams have employed what is known as the '7-4-2 system', which stipulates that bowlers cannot exceed 4 days of bowling within a 7-day period, and are also not permitted to bowl for more than 2 consecutive days at any time.

Despite the widespread application of such player management practices, some practitioners working in elite cricket have begun to publicly question in the media whether the limits imposed upon players, particularly at development level, may have served the opposite effect and in fact increased their overall risk of injury in the longer term. Specifically, restricting workloads and thereby reducing the stimulus for adaptation and perhaps also the opportunity for technical development may have paradoxically reduced players' level of preparedness and compromised their resilience to the rigours of competition when these players progress to elite senior level.

Similarly, other authors have raised the question of whether the practice of imposing enforced rest creates a sporadic pattern of loading that may be poorly tolerated by players, once more serving to increase injury risk rather than reducing it.[13] The suggestion is that athletes respond much better to a relatively consistent level of loading, and so the large fluctuations in daily and weekly workloads that occur with enforced rest and player rotation may be an indirect cause of the injuries observed. There is some data to support this contention, including a recent study from elite Australian Rules football which found that marked week-to-week fluctuations in workloads were related to an increase in the number of injuries observed.[16]

## Re-examining the Evidence Relating to Workload and Injury in Team Sports

The statistical analyses employed in the studies that are often cited in support of player management practices have typically comprised simple correlation between exposure and injury rates, but this has subsequently been interpreted as evidence of a causal relationship. The lack of prospective studies to support this contention is a concern given that it is often presented as scientific fact by those advocating player management policies.

One of the original and most frequently cited studies of workloads and injury featured a case study of a sub-elite rugby league.[6] This study reported that reductions in overall training loads in successive years over a three-year period, mediated by modifying training duration in year two and intensity in year three, coincided with reduced rates of injuries sustained by players during training sessions in the preseason period, in comparison to year one. Among numerous methodological issues, most notably the lack of randomised counterbalanced study design, it should be noted that only training injuries were reported, and this concerned the preseason period only.

A similar study of professional rugby union in the United Kingdom reported that gross measures of weekly training volume (number of hours per week), based on questionnaires completed by the staff at each respective club, showed no statistical relationship with the number of injuries sustained by players during training or matches.[4] Despite the lack of apparent association with rate of injury based on the data presented, the authors nevertheless recommended modifying the overall volume and content of training (specifically reducing the hours spent in activities associated with relatively higher injury rates, such as contact training), in order to reduce the severity of injuries.

More recent studies have attempted to differentiate between different types of training load. For example, one investigation of professional rugby league reported training load values for different forms of training – i.e. field training versus strength/power training performed in the gym.[8] Once more overall combined training load was reported to correlate to injuries sustained during training sessions. The authors found an apparent association between strength/power training loads and number of injuries sustained during field-based training sessions.[8] This finding was attributed to the effects of residual fatigue.

Another study, once more in elite professional rugby league, subdivided running training loads by using GPS data gathered during running-based training sessions.[9] The categories of running activity employed were: very low; low; moderate; high; and very-high intensity with accelerations classified as 'mild', 'moderate', or 'maximum'. None of the running variables employed were associated with training injuries resulting in missed matches.[9] It was noted that there appeared to be more injuries when players recorded more than 9 metres of very high-intensity running in a session. Based upon this finding the authors recommended that the volume of sprinting performed by players in a training session should be restricted – presumably to less than 9 metres in total. For a high performance coach working in elite sport such a suggestion would appear challenging.

One of the seminal studies with respect to workloads and injury in the sport of cricket was published by Dennis and colleagues (2003)[5], as part of a wider initiative supported by Cricket Australia to investigate the relationship between bowling workloads and injury in a cohort of fast bowlers who were monitored over two seasons. There were two major trends from the data gathered:

1. bowlers who had less than 2 days between bowling sessions, or more than 5 days between sessions, appeared to suffer more injuries than bowlers who had 3-4 days between bowling
2. bowlers who averaged less than 123 balls bowled per week, or more than 188 deliveries per week, appeared to be at greater risk of injury than the group of bowlers who averaged between 123-188 deliveries per week

Another more recent study of cricket in Australia from Orchard and colleagues (2009)[15] presented data from fast bowlers gathered over 10 seasons. The major finding reported was that the relative injury rate per 1000 overs bowled was only higher for the group who bowled the very highest number of overs in a match (more than 50 overs bowled). The authors did however also suggest that there might be a delayed effect of acute match workload in terms of injury risk, as the relative risk of injury in the group who bowled over 50 overs in a match appeared to peak between 14 and 28 days following the match.[15] Such conclusions however remain speculative in the absence of prospective studies to verify this 'delayed effect' hypothesis.

## Do Measures of Workload Employed Provide a Valid Indicator of Stress/Recovery of Individual Athletes?

Whilst a comprehensive discussion of methods to assess training stress is somewhat beyond the scope of the present article, it should also be noted that there is currently a lack of evidence to validate the efficacy and sensitivity of measures of workload typically employed in elite sport. In the majority of cases both in the literature and in the field only very gross measures of volume are employed. For example, the 'volume' of work undertaken in training or matches is typically recorded in terms of duration only, or alternatively workload is calculated as the product of session or match duration multiplied by a measure of 'intensity', in most cases comprising rating of perceived exertion (RPE) for the session as a whole.[6]

Due to technological advances in some cases more sophisticated tools for quantifying workload are employed in elite sport, such as global positioning system (GPS) devices and heart rate (or a combination). Unfortunately methodological issues remain with accurately evaluating the intensity of intermittent activity that occurs during sports using such technologies.[1] Moreover, there is once more a lack of empirical evidence to elucidate the relationship between the derived measures of workload and injury risk.[9] For example, a recent study investigated a range of laboratory, psychometric and performance parameters to assess whether any of these markers would be sensitive to physical strain and overload experienced by elite soccer players during a 3-week period.[14] Laboratory testing included blood counts and other markers including creatine kinase, psychometric evaluation comprised a recovery-stress questionnaire, and performance assessments included vertical jump and maximum velocity scores. None of the parameters studied were able to discriminate between the period of high exertion (>270 minutes total match time) versus low exertion (<270 minutes).[14]

Fundamentally, the degree of stress, or 'internal load', experienced by an athlete is also highly individual. This was highlighted by a study of soccer players by Impellizerri and colleagues (2007) who reported that in a squad setting, despite a fixed external training load being employed for all players, the specific 'internal load' in terms of acute responses recorded from each individual player varied markedly.[12] Furthermore, the timeframe for recovery and adaption to a given stressor is likewise highly individual, as it is likely determined by factors such as genotype.[2,3] It is therefore probable that the individual stress/recovery response and overall tolerance to load will vary widely even between apparently well-matched players within a squad.

The workload or volume of activity performed is also only part of the picture with respect to overuse injury. By definition, injuries of this type are the cumulative result of biomechanical overload to the tissues. Rather than accepting the notion that activities undertaken by players in sports are inherently injurious and so exposure should be limited, it must be considered that dysfunction is likely to be a factor in many cases. Taking another example from the sport of cricket, a recent study identified that whilst all the bowlers examined showed asymmetry in cross-sectional area of different muscles of the spine, it was only those players who demonstrated reduced motor control of local stabiliser muscles who reported symptoms of back pain.[11]

Similarly, movement errors are likely to contribute to a number of the non-contact injuries seen in team sport. For example, many of the injuries that occur in training and competition are sustained during running activity. There is a growing body of evidence that running injuries can be reduced by a combination of gait retraining alongside other corrective training interventions. Therefore, assessing players' movement capabilities, including assessing running mechanics, with appropriate follow up and intervention should be a focus for injury prevention rather than solely focussing on the volume of running and other activity performed by players.

## CONCLUSIONS

From these discussions it is apparant that the relationship between workload and injury risk is far from straight-forward and as such, it is crucial to avoid oversimplification. There is currently no solid evidence to support the concept that enforcing arbitrary restrictions upon workloads will help to prevent injury during competition. Clearly more data is required to elucidate the complex relationship between workloads and injury rates before any evidence-based guidelines can be implemented in elite sport. Moreover, this relationship is likely to differ according to the sport, and as such it is probably unsafe to generalise the findings from one sport to another, or from one playing squad to another within the same sport or competition. Finally, the tolerance to workload is likely to vary according to the individual player, so any guidelines should be viewed as just that – such information must be interpreted in the context of the situation and individual. Injury prevention is about more than just reducing load.

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# Ethics in New Zealand Sports Medicine

**Lynley Anderson** PhD
Bioethics Centre
University of Otago, Dunedin

## INTRODUCTION

One of the most high profile medical roles must surely be that of a sports doctor. During televised sports events the sports doctor can often be seen running onto the field of play to attend to an injured athlete. Even when not part of the immediate action, the sports doctor is frequently identifiable in the background. For the public, it might appear that the work of the sports doctor is just like any other doctor – the only difference being the setting. From my research, the practice of medicine in sport and the ethical challenges that arise in this area are complex.

What sparked my interest in the ethical issues facing sports doctors arose from reading an advertisement for Warriors tickets in the back of a New Zealand SKY television magazine in 1999. The advertisement glamorised the resilience of the then Warrior's coach implying that he would expect the same level of toughness from team members. Among the extensive injuries listed in the advertisement, it stated that he had 'broken [his] wrist. He used to take it out of the cast, inject it with painkillers, play, then put it back in the cast.' While we could dismiss this claim as typical advertising hyperbole, clearly the athlete couldn't do this for himself; he required someone with medical skills.[i] Immediately questions arose; would this be acceptable in other areas of health care, and if not, what makes sports care so different.

Later that year a group of sports physiotherapists raised concerns that some physiotherapists were being pushed or were actively taking on activities that were ethically problematic; they wanted research carried out into this issue. Following further discussion this research was extended to include sports doctors.[1] At that time very little empirical research had been carried out into the ethical issues experienced by sports doctors, and with the exception of a group of researchers in the UK,[2,3,4,5] most articles on the topic were reflections by doctors looking back over their careers.[6,7,8,9,10] No research into the ethical concerns of sports doctors had been carried out within Australasia. The findings from the Anderson & Gerrard study gave tantalising glimpses of the ethical considerations of sports doctors, and so further research using in-depth interviews was planned to explore these concerns more fully. This paper summarises some of the key finding from the subsequent research as well as some interesting accounts from participants.

## BRIEF METHODOLOGY

Sixteen sports doctors working with elite athletes and teams in New Zealand were comprehensively interviewed. Each interview was recorded, transcribed, and returned to the participant for checking. Grounded theory was the method used for data analysis. Media interest in the activities of elite sports people runs high and therefore every effort was taken to ensure that personal information about doctors and their patients was safeguarded.

Participants in this study were all highly experienced clinicians because they worked at the pinnacle of sport in New Zealand. The participants had worked in the area of sports medicine for between 6-26 years. Seven participants were Fellows of the Australasian College of Sports Physicians (ACSP).

## KEY FINDINGS

Four key findings emerged from the research. These findings have been discussed in previous publications but are summarised here.

1 The environment in which sports medicine is practiced has the potential to limit a doctor's ability to provide quality care and compromise patient welfare.
2 Doctors working in sports medicine may have multiple obligations including both patients and employers. At times these responsibilities conflict leading to divided loyalties, where meeting one obligation will result in neglecting others.
3 Participants differed markedly in their approach to two aspects of medical practice:
   - Maintaining patient confidentiality
   - Risk taking
4 Sports doctors had limited ethical guidance and support

### The Sports Environment

It was apparent that the very environment of sport at the top level can place a great deal of pressure on sports doctors. One source of pressure arises from the commercial nature of sport at this level where the health and wellbeing of the individual athlete may be secondary to financial priorities (this aspect has been discussed in Anderson & Jackson, 2012).[13] For example, one doctor reported that where games are televised live and back-to-back, time is limited for injury assessment of athletes, and a decision about whether to return an athlete to play has to be made quickly. This doctor felt pressured to return injured athletes more quickly than they would otherwise feel comfortable with and this included situations where head injuries may be present.[13] The restrictions on time may assist broadcasters but may compromise good care. Some sports doctors raised concerns that competitions were sometimes planned for a time of the day that suited the broadcasters schedule rather than the welfare of players including the hottest part of the day.

Sponsorship of teams is also an issue. Teams want to attract sponsors in order to improve funding, but sponsors expect a return on their investment. One participant described how sponsors might influence which players are selected to play, so that players considered 'more marketable' are visible to the public. As team doctor this participant felt pressure to ensure these athletes were visible.[13] Sports doctors face ethical challenges arising from footwear sponsorship. Teams will often enter into a sponsorship deal with a footwear company where the sponsor provides footwear and team members must wear their product. Some athletes will find the supplied footwear unsuitable and doctors were often involved in assisting an athlete to find appropriate

[i] Mark Graham played for different teams in a number of countries, so no suggestion is made that this action (whether real or imagined) might have been carried out by a NZ health care provider.

footwear from an alternate company. To get around the sponsorship demands some doctors got involved in either blacking out the alternate company's logo on the footwear or altering it to match that of the team sponsor. One participant felt 'told off' for such actions:

> **Doctor:** *We try and actually blacken the boots out completely. But we get told off for that.*
> **Interviewer:** *Who from, the sponsor?*
> **Doctor:** *The sponsor. Yeah, they pay people to watch the games to check people are wearing the right stuff.*
> **Interviewer:** *I didn't realise that.*
> **Doctor:** *Yeah, there's big money. There's millions of dollars involved, so they do – yeah, we get phone calls after the game, so-and-so wasn't wearing the right boots – [we] get in trouble. So we're monitored.*[13]

Some doctors did inform the sponsor in an attempt to obtain suitable footwear, however many felt it necessary to resort to deceptive actions in an attempt to act in the best interest of their patients.

Dealing with the media poses problems for sports doctors. Sports doctors were commonly asked for information about athletes. Two participants described being told by reporters 'if you don't tell me, I'll make it up'. [13] The threat was clearly to encourage doctors to reveal more information about athletes. Different approaches to dealing with the media were described; some repeat facts the journalist already knows, or talk in generic terms about injuries. However some doctors are well aware of the necessary relationship between the media and sponsorship with one participant explicitly recognising that sports doctor's wages were paid by sponsorship agreements generated by media coverage. This raises questions about the implications for patient confidentiality?[13]

Sponsors, media and broadcasting demands coalesce to create an environment that contains subtle and not so subtle pressures. Not unexpectedly these pressures can be transferred to the medical team as one of the people relied on keep athletes fit and able to be part of the machinery of top level sport. These pressures add to the ethical complexity as doctors attempt to balance the demands arising out of the environment with the health needs of the athletes. Sports doctors are aware of the pressures involved and had developed some effective strategies for working in this environment.

Conflicting obligations/ divided loyalties

Some divided loyalties experienced by doctors in sports medicine arise from the expectations of employers and of the coach and manager; however medical obligations to the patient remain. Balancing coach demands and a commitment to the welfare of the patient often creates a dilemma, and where dispute arises it can make it difficult to promote player welfare. One doctor describes a situation where medical advice was routinely ignored:

> *I was involved with a team in which a key player was recovering from a stress fracture. The stress fracture was regarded as 'high risk' and required a long slow rehabilitation. On numerous occasions the coach ignored advice from the team physiotherapist, and me.*

Sometimes the conflict between coach expectations and consideration for player welfare is bought into stark relief as in a situation described by one participant:

> *Even me [as the doctor] trying to remove someone [an athlete] from the field of play and the coach have not wanted that player removed …and I say, 'look [this athlete] is struggling, he feels unable to go on, he's got this injury I think we have got to get him off' and I was told in no uncertain terms, that he is a wimp and he has to stay on and die for the cause.* [13]

However, it should be noted that not all coaches disregarded the views of the doctor. One participant's described how it was in their team:

> *The medical team's word is final, and there's no correspondence entered into … I've only ever known that environment, and I know it's different to others, but there is absolutely no coach pressure whatsoever to have somebody play who shouldn't otherwise be playing.*

Some participants would challenge the coach if they felt that athletes were being pushed into returning to play too early. But challenging the coach could raise concerns about ongoing and re-employment if they did not comply with coach demands.

> *Putting guys on to the field … at the start of the game [with] an injury. Yes, that has been tried on a few times and I basically say 'look you do that over my dead body, this is my area that you are tampering with, I don't come and tell you how to coach the team, and I am telling you how this is going to be.' And it has probably cost me, if I had of [re] applied for this job I might not have got it.*

Fear of not gaining re-employment was discussed by some participants. Some said these fears were more common when they were less experienced, however as they gained experience these doctors became more confident:

> *Ah, yes, that did initially bother me when I was still quite wet behind the ears [both laugh]. To be honest with you it did concern me a little bit, but now I realise that there are a lot of teams … management styles change and coaches change and I think that if you didn't compromise, people will eventually see the good in it. And to be honest with you, I think there are many teams. If you don't get a job here, you can get a job somewhere else. For me it's an issue of enjoying the job rather than feeling guilty and trying to work around issues like that.* [13]

Many talked about the need to retain their professional integrity rather than to stay in a job where they felt their values were compromised. One of them put it in a

*I was involved with a team in which a key player was recovering from a stress fracture. The stress fracture was regarded as 'high risk' and required a long slow rehabilitation. On numerous occasions the coach ignored advice from the team physiotherapist, and me.*

nutshell when he said; 'you've got to think about your philosophy about how you want to practice medicine.'

Clearly, doctors working in sports medicine are not the only ones who feel pressure at the top level; coaches, managers and athletes are all under pressure to succeed and secure future employment, or some other perceived benefit. Coaches have a financial interest in the success of the team as their own future career can be dependent on team success. They need to field their best players and this can bring them in conflict with doctor.

## Patient Confidentiality

Employment contracts between doctors and sports governing bodies, and athletes and sports governing bodies, frequently express expectations about sharing an athlete's health information with coaches and others.[11]

Participants were asked to indicate how they would respond if asked by an athlete not to pass on personal health information, and yet their contract and that signed by the athlete clearly indicated such information was to be passed on. Ten participants said they would not pass the information on while five stated they would pass this on (one was unsure). Of note, doctors were happier to retain confidentiality when the health information was not related to an athlete's ability to play.

> *Well, it's very tricky in that situation. It depends what it is. Most of them know they've signed those [contracts], and if [the injury] affects the team it's a problem.... I've had that happen a few times and you really have to go over with the person and try and get them to divulge it themselves to someone like the coach or the manager of the team. And nine times out of ten they will. And if they still really don't want to, and it's affecting their play, then you still can't divulge the information.*[11]

One participant justified telling the coach, stating:

> *If they've signed into a situation saying that I give free access of my information to the coaching staff, then I think they understand that I'm part of that structure, that I have a responsibility to pass that information on. …if they want it to be private then they have to go to another doctor. That's my feeling about that.*[11]

Many doctors found practical strategies for dealing with situations where the athlete did not wish to share information. These strategies varied from telling coaches limited amounts of information, to encouraging the athlete to share and then calling the coach in the presence of the athlete so that all could discuss openly. This group felt it was important for the athlete to know what was being said.

Many doctors who supported upholding patient confidentiality in this kind of scenario identified the importance of trust in the doctor-patient relationship and saw confidentiality as a necessary cornerstone of that trust. This group also saw potential harms arising from not maintaining confidentiality, including patients not informing the doctor and potentially putting themselves or others at risk. For this reason we might be concerned that employers expect doctors to abandon traditional obligations to patient confidentiality. On the other hand, we also need to consider that for a team to field the best athletes those making those decisions require information about medical evaluations, and this could be part of an employer's expectations. We could also ask questions about whether it is realistic to ask athletes to sign a confidentiality waiver at the beginning of a season saying they will share health information when the nature of such information is unknown.

A further concern surrounds the need for employees to act in good faith with their employer and doctors therefore need to consider the implications of signing a contract that encourages a deviation from traditional obligations, especially when they are aware they will not uphold such demands.

> ***… I think the problem is that if they lose their place in the team then it's hard to get back in, and they lose their job. So from an employment point of view they would be willing to risk their health to keep their job.***

Doctors differ in their response to the issue of what to do about personal health information that is related to the athlete's ability to play. Some favour maintaining confidentiality and therefore the patient's trust, while others will favour upholding the contract as they feel that the team needs to be able to field fit players. All sports doctors need to consider the obligations that are set up by the employment structure and the use of contracts.

## Risk Taking Behaviour

The second area where there was a difference in responses was regarding risk taking and how willing a doctor was to limit or assist an athlete to return to play with injuries. At one end of the spectrum it was reported by one doctor that he/she would do anything to assist an athlete to compete so long as it was not illegal (although this participant did not specify which regulations was being referred to). At the other end of the spectrum in order to minimise the risk, one doctor has it written into the contract that the doctor has the final say on whether the athlete plays or not.

One participant highlighted the difficulty that athlete's can find themselves in when they are injured and yet feel they must play in order to retain a team spot:

> *…people will still want to play…even if it means [causing] themselves more harm. …I think the problem is that if they lose their place in the team then it's hard to get back in, and they lose their job. So from an employment point of view they would be willing to risk their health to keep their job.*

Fear of losing a place in a team may encourage an athlete to play injured. One All Black who played despite having had a number of recent head injuries stated in a newspaper: 'There's no option. If you don't play flat out, you won't be effective, you won't be picked.'.[15] These kinds of comments raise concern as to whether athlete's decision making is always voluntary.

It was recognised that athletes were under pressure to return quickly, and this might lead them to request the doctor to assist them to return. Athletes might well be happy to trade good health for some other goal or desire they consider to be important.

> *I think most patients, most patients, will take your advice. There will be some*

> *patients who say, well I'm going to play, can you just help me to do it as safely as possible? Even though we believe that it's not safe for them to play. And that's a difficult situation but it is one that we will often say OK, let's try this sort of strapping or that sort of strapping to try to stabilise something that's not quite right and not to the point where we believe they should be playing.*

Doctor's perception and approach to risk taking is not always shared. Some participants identified that athletes did not always recognise the harm associated with risk taking, and all doctors thought it important to educate athletes about the risks associated with playing with an injury and took this role seriously. From reports it appears that doctors spend a great deal of time explaining about the risks of returning to sport too early, the pathophysiology of injury and the rehabilitation required.

The need to balance risk taking activities by athletes was an issue for sports doctors. Athletes may have desires and goals that are not always consistent with preserving or maintaining good health, and for this reason doctors saw it as their role to bring an element of level-headedness to the conversation.

### Ethical Support and Guidance

The last finding related to the level of guidance and support available to New Zealand doctors working in sport with many participants believing that there was inadequate guidance available. Many mentioned that if they had a particularly difficult issue to deal with they turned to their peers for assistance or to some of the older more experienced clinicians. While some formal ethical guidelines existed for sports doctors, these guidelines commonly did not cover the areas of concern as expressed in this research. The only local guidance that was available when I was carrying out this research was the ACSP Code of Ethics, but this document was written for College Fellows and so is not directly applicable to doctors who are not associated with the College. Further examination of the ACSP code revealed a number of significant problems with it which rendered the guidance unhelpful.[14] The lack of comprehensive guidance left sports doctors and physicians negotiating this complex ethical area with limited support. As a result of these findings and with the support of the ACSP I undertook drafting their new Code of Ethics. This code was formally adopted in April 2008, and utilises many of the topic areas and findings from this research.

## CONCLUSION

The findings from this research indicate that sports doctors work in an area that is ethically highly complex. These complexities arise from the context of practice; including the environment of top-level sport with its inbuilt commercial interests that can exert pressure on others including the sports doctor; the employment structure with its associated expectations on doctors that may be at odds with long-standing medical obligations to the welfare of the athlete or to concepts such as confidentiality of health information. A doctor working at this level may experience a number of pressures, from coaches, athletes, sponsors and others, all requiring a level of negotiation to ensure they are able to provide quality care to athletes that they feel is professionally acceptable.[13] It has to be acknowledged that some experienced sports doctors were more confident than others and had developed practical strategies for dealing with some of the pressures identified.

The sports environment (especially at the top level) has aims and goals that do not always align with the medical goals and aims of the sports doctor. While this is not surprising, it does pose some concern that doctors may not always be able to provide quality care in such a setting. The lack of formal guidance available at the time of this research was concerning, particularly for those new to the area of sports medicine who may find asserting professional values difficult in the face of the pressures inherent in sport at the top level.

## ACKNOWLEDGMENTS

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# Australasian College of Sports Physicians Code of Ethics and Professional Behaviour

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### Preamble

The objective of the Australasian College of Sports Physicians (ACSP) Code of Ethics and Professional Behaviour is to provide a comprehensive set of guidelines for the professional behaviour expected of registrars and Fellows of the College. It is based on longstanding ethical and professional principles of medicine; it considers the many aspects of the sport and exercise medicine physicians' professional life; and it responds to areas of concern that have been identified in the sports medicine literature over recent years.

The Code was developed recognising that, in addition to medical knowledge and technical expertise, excellent medical care in the area of sport and exercise may require cooperation with others including sporting management, collaboration with colleagues and other health professionals, while maintaining a clear understanding of the primacy of the health, wellbeing and autonomy of the patient.

### The work of a sport and exercise medicine physician

The Code acknowledges the varied work environments of a sport and exercise medicine physician. The sport and exercise medicine physician is recognised as a medical specialist and is therefore not a primary care practitioner. Sport and exercise medicine physicians work in the following ways:

- Office or clinic. It is recognised that the majority of work will be referral-based consultations carried out in the sport and exercise medicine physician's own office or clinic. A general practitioner will refer most patients in this setting.
- Sports body employee (e.g. Netball Australia). A sport and exercise medicine physician receives referrals from that source.
- Team physician. Here a sport and exercise medicine physician is employed by a sporting franchise or team to provide sports medical services for team members at games or events.
- Military employee. Employed by the military to provide sports medical services to military sports teams.

Each area of work raises particular ethical concerns for sports doctors. For example sport and exercise medicine physicians employed as team physicians may experience divided loyalties between the needs of their patient and the demands of their employer. The code covers ethical concerns for sport and exercise medicine physicians working in all areas.

### Legal Obligations

This code should be read in conjunction with legislation in the country of practice. The ACSP Code of Ethics and Professional Behaviour is not intended to vary the legal obligations and duties of sport and exercise medicine physicians in Australia and New Zealand. Legislation varies from state to state, and between Australia and New Zealand. It is the responsibility of the physician to identify the particular legal obligations and responsibilities applicable in his or her own jurisdiction.

### Relationships with other codes of ethics

This code should be read in conjunction with the AMA Code of Ethics and the NZMA (adopted by the Medical Council NZ) Code of Ethics. This code does not seek to alter these codes, but seeks to supplement, explain and interpret concepts identified in the AMA and NZMA Codes.

### Format and style

The term 'must' is used to indicate that the associated statement sets a minimum standard that all sport and exercise physicians must achieve. The term 'should' reflects a standard that the ACSP aims to promote and nurture.

The Australasian College of Sports Physicians acknowledges the Royal Australasian College of Physicians Code of Professional Behaviour from which the ACSP Code of Ethics and Professional Behaviour has been adapted and the World Medical Association Declaration on Principles of Health Care for Sports Medicine (1999) and the International Federation of Sports Medicine (FIMS) Code of Ethics (1997).

## THE CODE

### SECTION ONE - Good Patient Care

Good patient care requires a range of clinical, interpersonal and management skills. The nature of the physician-patient relationship is critical to quality of care and achieving positive outcomes. Sport and exercise medicine physicians must pay attention to all aspects of this relationship, and must also be familiar with legislation and guidelines within their jurisdictions. Sport and exercise medicine physicians must also pay attention to any employment relationship that may affect the ability to provide care.

### 1.1 Standard of clinical practice

The sport and exercise medicine physician must:

i. Understand the special physical and mental demands placed on patients through their participation in sporting activities.
ii. Provide a good standard of clinical care, consistent with the prevailing standards of sport and exercise medicine, within the constraints of systems and resources.
iii. Treat all patients according to medical need, without discrimination on the grounds of age, gender, ethnicity, disability, religion, lifestyle, beliefs, culture or sexual preference.
iv. Insist upon professional autonomy and responsibility for all medical decisions.
v. Work within the scope of his or her competence, and refer on to an appropriately qualified practitioner where appropriate.
vi. Not permit clinical judgement and practice to be affected by economic interest in, commitment to, or benefit from professionally related commercial enterprises of any kind.

The sport and exercise medicine physician should:

vii. Care for patients using the best available evidence.
viii. Work collaboratively with other professionals and organisations in optimizing patient care.
ix. Arrange for the patient to be transferred to an appropriate facility in circumstances where adequate resources are not available on site.
x. Be willing to facilitate a second opinion for the patient when appropriate.
xi. Be willing to provide an honest and frank second opinion when it is sought.

### 1.2 Continuity of care

The sport and exercise medicine physician must:

i. In an emergency, be prepared to care for other sport and exercise medicine physician's patients if that sport and exercise medicine physician is unavailable.
ii. Ensure that arrangements are made for appropriate hand-over when care of patient is transferred.
iii. Ensure that arrangements are made with patient's general practitioner regarding the care of any medical issue still requiring care at discharge or cessation of treatment.

The sport and exercise medicine physician should:

iv. Facilitate good and appropriate post-discharge care.

### 1.3 Relationships with patients

#### 1.3.1 Communication and education

The sport and exercise medicine physician must:

i. Listen to, and respect the views of patients (including parents/legal guardians where the patient is a minor) while remembering that the best interests of the patient is the underlying value that should guide management.
ii. Discuss with patients (including parents/legal guardians where the patient is a minor) the nature of the injury or health problem. This may include the likely aetiology, the projected recovery, implications of the injury for training and competition, and the short and long term implications from the injury.
iii. Discuss with patients (including parents/legal guardians where the patient is a minor) the available treatment options, including no treatment; outline the relevant risks of treatment and provide the opportunity for questions to be asked.
iv. Communicate with patients with empathy, honesty and respect (including parents/legal guardians where the patient is a minor).

The sport and exercise medicine physician should:

v. Where practicable, make use of a trained interpreter if language barriers exist to ensure effective communication with patients.
vi. Discuss and educate patients about injury prevention strategies, including protective gear and clothing.

#### 1.3.2 Consent

The sport and exercise medicine physician must:

i. Obtain consent from a patient prior to providing medical care or intervention.
ii. Respect patients' rights to seek all relevant information in order to make an informed decision about their own care.
iii. Be aware of legal, professional and institutional requirements for gaining consent from patients (including minors, or those who may be compromised in their ability to consent).
iv. Document appropriately all matters relevant to the consent process;
v. Be aware that competent people have the right to refuse treatment.

The sport and exercise medicine physician should:

i. Discuss with the patient the problems associated with getting informed consent in high pressure situations of competition.
ii. Where a high pressure situation of competition is limiting the ability of a patient to make an informed decision, negotiate for removing the patient from the setting to

complete the consent process.

### 1.3.3 Other

The sport and exercise medicine physician must:

i. Respect patient dignity.

ii. Be aware that he or she is not obliged to provide treatment where it is his or her professional judgement that the treatment would be either of no benefit or would harm the patient, or is considered unethical.

iii. Be sensitive to and respect the cultural values of all patients, including Aboriginals, Torres Strait Islanders, Maori, and Pacific peoples.

iv. Refrain from unethical relationships with patients (sexual, financial and other).

*Commentary:* Where a doctor is employed to care for team members, those athletes are to be considered patients whether they have currently received medical attention or not.

The sport and exercise medicine physician should:

v. Provide care in an environment that respects the privacy of the patient.

## 1.4 Record keeping

The sport and exercise medicine physician must:

i. Ensure maintenance of legible and contemporaneous records (preferably signed and dated), including adequate records of discussions with patients (and parents/ guardians where that patient is a minor).

ii. Be aware of legal requirements about collection, storage, and dissemination of personal health information about patients.

iii. Not allow access to medical records by third parties except with the consent of the patient.

iv. Ensure appropriate transfer or storage of patients' records upon cessation of practice.

## 1.5 Employment structure and relationships

*Commentary:* When a sport and exercise medicine physician is employed by a team or sports governing body, sport and exercise medicine physicians may have multiple responsibilities to others including: individual patients, a team, coaches and team management, the governing body, the medical profession and the general public. Some responsibilities are laid down specifically within an employment contract, while others rely on time-honoured understandings and relationships. At times responsibilities may conflict leading to divided loyalties or competing obligations, where to meet one obligation will require the neglect of the other. For sport and exercise medicine physicians, the most common divided loyalty is that between the employer and the patient. Problems are more likely when the potential for conflict is not recognised and one party is not aware that the sport and exercise medicine physician has other competing obligations. This section is designed to assist sport and exercise medicine physicians in situations where the aims of the employer place demands on the sport and exercise medicine physician, via the employment contract, that have the potential to undermine the ability to provide effective care for patients.

General statement: A sport and exercise medicine physician as an employee should not be asked within an employment contract to:

- act outside the law.
- act contrary to a code of ethics of the professional group to which he or she belongs.

### 1.5.1 Trust in the sport and exercise medicine physician-patient relationship

*Commentary:* The doctor-patient relationship is a structure that lies at the heart of any medical encounter where care is offered. It is through the doctor-patient relationship that the patient receives attention for his or her concerns and the physician is able to use professional skills. The patient is vulnerable for a number of reasons including the presence of injury or illness that they themselves are unable to correct. The patient commonly reveals extensive health and personal information to the physician in order for the sport and exercise medicine physician to diagnose and offer treatment. A patient usually has a lesser degree of knowledge about the body and medical concepts. And, because of the highly technical nature of medicine, patients are generally unable to assess the adequacy of treatment. Therefore a patient must place a great deal of trust in his or her sport and exercise medicine physician to do the very best for him or her. Sport and exercise medicine physicians are obliged to respect that trust and avoid situations or demands that may undermine it. Anything that undermines trust will inevitably impact negatively on the ability to provide the patient with the care required.

### 1.5.2 Divided loyalties and contractual obligations

*Commentary:* Here a distinction is made between a therapeutic role and an assessment-only role.

#### Therapeutic role

The sport and exercise medicine physician is employed in a therapeutic role for the patient or team, and in this situation a physician-patient relationship exists.

#### Assessment-only role

There are times when a sport and exercise medicine physician is employed solely for one-off assessment purposes of patients and is not involved in care. The most common example of this is when a patient is transferring between clubs and a medical assessment has to be completed, or if a patient has been selected for a tour or event, subject to passing a medical/ fitness assessment. Here the relationship between the sport and exercise medicine physician and the patient is different than a therapeutic relationship. In assessment only situations the patient must be fully informed of the role of the sport and exercise medicine physician and that relevant information will be shared with sports management. (Can be compared to a doctor carrying out a one off insurance assessment.)

#### When signing an employment contract

The sport and exercise medicine physician must:

i. Act in good faith with their employer.

ii. Not sign an employment contract where he or she is aware that obligations will not be upheld.

The sport and exercise medicine physician should:

iii. Seek legal advice prior to signing.

iv. Inform the employer where there are elements of a contract that forces a physician to breach his or her professional code of ethics.

#### When employed in a therapeutic role

The sport and exercise medicine physician must:

i. Recognise his or her duty to the patient as the first concern and contractual and other responsibilities are of secondary importance.

ii. Act in his or her patient's interests.

iii. Not be party to an employment contract that forces or encourages him or her to abandon a commitment to the patient.

iv. Not take on a role within a team context for which he or she is not suitably qualified or is outside his or her scope of practice.

*Commentary:* Sport and exercise medicine physicians who are not qualified as, or who have no experience as general practitioners, should not take on this kind of work for patients.

#### When employed in an assessment role

The sport and exercise medicine physician must:

i. Inform the patient of the sport and exercise medicine physician's role prior to the assessment.

ii. Inform the patient that the sport and exercise medicine physician is not working for the interests of the patient.

The sport and exercise medicine physician should:

iii. Consider whether the separation of an assessment role from a therapeutic role is appropriate.

*Commentary:* Ideally an assessment and therapeutic role should be separated, however it is recognised that this may be too difficult or impractical in some situations.

## 1.6 Confidentiality

*Commentary:* Confidentiality of health information about athletes is an issue for all sport and exercise medicine physicians. However, this is likely to be more problematic when a sport and exercise medicine physician is employed by a team or sporting franchise. Here the sport and exercise medicine physician is often faced with a divided loyalty dilemma, that is either share health information in line with contractual obligations (and employer expectations) but against the wishes of the athlete, or, respecting the wishes of the athlete, but breaching contractual obligations (and employer expectations). Sport and exercise medicine physicians employed by teams or sporting bodies are advised to read this section in conjunction with section 1.5 Employment structure and relationships.

General statement: Failure to respect confidentiality of personal health information about a patient may result in a patient choosing not to confide in the sport and exercise medicine physician, resulting in unnecessary risk to the health of the individual patient or others.

The sport and exercise medicine physician must:

i. Maintain the patient's confidentiality, except where legal requirements direct otherwise, or a strong ethical justification exists and such disclosure is permitted under the law.

ii. Seek permission from the patient prior to each disclosure of health information to a third party.

*Commentary:* It is recognised that some sports teams or sporting bodies require athletes to sign a health information release form at the beginning of the season or on joining a team. This may or may not specify who the information is to be released to, however at the point of signing no one can predict the injuries or illnesses that might occur or the implications of this information. A health information release form signed by an athlete at the beginning of the season or on joining a team does not discharge the sport and exercise medicine physician from the responsibility of seeking permission to each disclosure of health information about the patient to a third party.

The sport and exercise medicine physician should:

i. Where necessary, educate coaches, trainers, team management and sports governing bodies of the need for confidentiality between a sport and exercise medicine physician and a patient.

ii. Inform patients of the advantages of sharing health information with coaches and team management to effective patient management.

In situations where a sport and exercise medicine physician is employed for one-off assessment purposes only, the sport and exercise medicine physician must:

iii. Inform the patient that relevant health information gathered during the assessment will be passed to the employer.

*Commentary:* In such situations, the sport and exercise medicine physician must document the following:

- That the patient was informed that relevant health information will be passed to a third party.
- That the patient agreed to the assessment under these conditions.

iv. Limit the disclosure of health information about a patient to those who are entitled to such information.

v. Recognise the commercial and media sensitivity of personal health information about athletes.

### 1.7 Needs of special populations

#### 1.7.1 Caring for children

The sport and exercise medicine physician must:

i. Recognise the particular vulnerability of children in sport.

ii. Be aware of the effects of sport on children with health issues.

iii. Consider the short and long-term health risks (physical and psychological) of training regimes and competition on a child.

iv. Obtain informed consent from a legally appropriate adult for any proposed treatment of a child. (Be aware that legal requirements may vary between jurisdictions).

v. Involve the child in decisions about treatment and seek informed consent from the child to any proposed treatment on a developmentally appropriate basis.

vi. Where necessary, refer children to an appropriately qualified child health practitioner.

The sport and exercise medicine physician should:

vii. Educate the child/parents/caregivers/coaches of short and long-term health risks (physical and psychological) of training regimes and competition on children.

viii. Take particular care to identify children who are being required to undertake severe training regimes and competition (this may require speaking to the child in private).

ix. Advocate for children who are being required to undertake severe training regimes and competition or competition against their wishes.

x. Be aware of the possibility of non-accidental injury or risk of harm to a child and report this to the appropriate authority within the legal framework of the jurisdiction in which the sport and exercise medicine physician is working (being aware that legal requirements vary between jurisdictions).

xi. Contribute to sports regulations relating to the participation of children.

*Commentary:* For example, setting age limits for participation in a marathon.

### 1.8 Risk taking

The sport and exercise medicine physician must:

i. Acknowledge that risk taking is necessarily the responsibility of the patient where that patient is competent and the decision is freely made.

ii. Assess the likelihood and severity of risk to the patient from returning to sport following injury.

iii. Inform the patient (where possible) of the potential for harms associated with returning to sport following injury including the likelihood and severity of injury or further injury, the patho-physiology of injury, and the implications of injury on quality of life and future career;

iv. When advising athletes about return to sport following an injury discourage choices to participate in sport where a patient's condition creates a high likelihood of a severe outcome (loss of life or severe incapacity).

*Commentary:* Where a choice to participate in sport is freely made and the patient is competent, then the patient should be informed of the potential consequences of his or her action and left to exercise their choice. Where a choice to participate in sport is highly likely to result in a severe outcome due to the patient's condition, then this action should be actively discouraged. This is not an attempt to place doctors in opposition to any particular sporting activity e.g. boxing, motor racing and parachuting where the risks for a catastrophic event exist but are unlikely when undertaken with standard precautions by a well individual. However it could include these sports if some other consideration exists in the individual such as a motor racing driver with untreated epilepsy, or a boxer with a detached retina.

v. Ensure that a decision to participate in sport when that participation involves high levels of risk taking is freely made by the patient.

vi. Advocate for the patient (with the patient's consent) where it is thought the patient is being pressured into taking high levels of risk.

The sport and exercise medicine physician should:

vii. Inform the patient (or direct to someone who can) of protective gear that may be worn to reduce further injury.

viii. Work with sporting organisations to reduce injury risks to athletes.

### 1.9 Facilitating risk taking

The sport and exercise medicine physician must:

i. Not knowingly facilitate a return to sport following injury where there is a high likelihood of a severe outcome for the patient (loss of life or severe incapacity). This includes providing pain masking injections, medications, or other clinical interventions.

ii. Use caution when providing assistance (pain masking injections, medication, or other clinical interventions) to return a patient to sport following injury.

iii. When providing assistance (pain masking injections, medication, or other clinical interventions) to return a patient to sport following injury; inform the patient of the risks involved. Note that such discussion should be documented.

iv. Be aware that he or she is under no obligation to assist a patient to return to sport following an injury if he or she considers the risks are unacceptable.

*Commentary:* When assisting an athlete to return to sport following an injury the sport and exercise medicine physician may feel some degree of responsibility for further injury or exacerbation of an injury. The sport and exercise medicine physician must feel able to refuse to assist if he or she feels considers that the potential for injury is unacceptably high. Sport and exercise medicine physicians may wish to factor into decision making the risks associated with the patient playing without medical assistance, but should not feel pressured into assisting against his or her better judgement.

### 1.10 The use of performance enhancing drugs in sport

The sport and exercise medicine physician must:

i. Be aware of and work within the regulations regarding the use of banned performance enhancing drugs of the governing body of the sport the athlete is involved in.

ii. Not assist patients to evade authorised drug testing.

The sport and exercise medicine physician should:

iii. Educate patients, teams, coaches, trainers, other health professionals and the general public about the risks of performance enhancing drugs.

## SECTION TWO – Sponsorship, industry and media

### 2.1 Sponsorship

The sport and exercise medicine physician must:

Not endorse any product that brings the College into disrepute. (Note that product endorsement may be prohibited in some jurisdictions)

The sport and exercise medicine physician should:

i. Ensure that decisions regarding the supply of health products to the patient or team are evidence based.

ii. Advocate for the patient (with that patient's consent) where the sponsors product may negatively affect the health of the patient.

iii. Advocate for the patient (with that patient's consent) where the sponsors demands to compete may negatively affect the health of the patient.

iv. Avoid sponsorship of the medical team that is in conflict with good health (e.g. alcohol sponsorship).

v. Be cautious when giving personal endorsement of any product.

### 2.2 Relationship with industry

The sport and exercise medicine physician must:

i. Not accept sponsorship to cover the cost of travel, attendance or meals at conferences or meetings for family or friends.

ii. Not obtain benefit from the sale of a medical device to one's own patients.

The sport and exercise medicine physician should:

iii. Not accept a fee or equivalent consideration from representatives of industry for seeing them in a promotional capacity.

iv. Be cautious when accepting offers of industry sponsorship to attend conferences and scientific meetings. Acceptance usually should be restricted to those in which he or she is to make a formal contribution. In such instances a clear and public declaration of such support should be made.

v. Ensure the planning, content, speaker selection and subject matter of any conference, meeting or educational gathering, is not influenced by the commercial interests of industry sponsors.

vi. Declare any relationship with industry when presenting at conferences and scientific meetings.

### 2.3 Dealing with the Media

The sport and exercise medicine physician must:

i. Be aware that he or she has no duty to provide personal health information about patients to the media.

ii. Not provide personal health information about a patient to the media without the consent of the patient.

The sport and exercise medicine physician should:

iii. Only provide information that is truthful to the media.

*Commentary:* While it is recognised that sporting bodies do occasionally release untruthful medical reports for the purpose of misleading the opposition, this is not the domain of a sport and exercise medicine physician.

## SECTION THREE - Responsibility to society

### 3.1 Community role

The sport and exercise medicine physician should:

i. Use his or her knowledge of sport and exercise medicine to improve individual and public health.

ii. Promote public awareness of medical issues that relate to sport and exercise medicine (e.g. management of fractures, concussion etc.).

iii. Provide emergency medical care for the public at sporting events. If attendance at events is expected to be high, assist in arranging on-site medical services.

iv. Participate, if invited, when new sports regulations are being drawn up.

### 3.2 The presence of sport and exercise medicine physicians at high-risk events

The sport and exercise medicine physician should:

v. Feel able to refuse to attend a sports event which he or she considers has an unacceptably high risk of a severe outcome, and/or where he or she considers his or her presence is being misused.

## SECTION FOUR – Continuing Professional Development

### 4.1 Maintenance of professional standards

The sport and exercise medicine physician must:

i. Comply with the continuing professional development program requirements specified by the College and be diligent in the documentation of such compliance.

It is noted that such compliance is compulsory in New Zealand.

ii. Be aware of other recertification requirements within their jurisdictions.

The sport and exercise medicine physician should:

iii. Take an appropriate leadership role in planning, undertaking and measuring practice improvement activities, including using the principles of evidence based practice and continuous practice improvement.

iv. Not undertake treatments or procedures beyond his or her current training.

v. Endeavour to obtain training in new treatments and procedures.

### 4.2 The sport and exercise medicine physician's health

Sport and exercise medicine physicians should maintain good physical, psychological and emotional health and develop insight and humility in dealing with situations where health is impaired.

The sport and exercise medicine physician must:

i. Refrain from practicing while impaired by alcohol or drugs or when physical or mental disability impairs his or her performance.

The sport and exercise medicine physician should:

ii. Have his or her own general practitioner

iii. Endeavour to recognise when fatigue, stress, physical or mental illness or another condition reduces his or her clinical or procedural skills, and request the assistance of an appropriately qualified colleague.

iv. Endeavour to recognise when the symptoms of the ageing process may affect performance and seek and comply with advice.

v. Take appropriate remedial steps to bring his or her performance to an acceptable standard when impairment is recognised.

vi. Recognise impaired health in his or her colleagues and take appropriate action including support and, if the impaired colleague does not volunteer such a deficiency, consider whether to report such ill-health to the appropriate authorities, subject to appropriate legal requirements.

## SECTION FIVE - Professional relationships

### 5.1 General practitioners

*Commentary:* The relationship between a sport and exercise medicine physician and the patient's general practitioner is centrally important to effective patient care. The general practitioner coordinates the health requirements of the patient; referring the patient to the sport and exercise medicine physician where necessary, and often directing any follow-up care that is necessary. It is therefore important to keep the general practitioner informed of any findings on assessment and care provided.

The sport and exercise medicine physician must:

i. Maintain good working relationships with a patient's general practitioner.

ii. Inform the referring general practitioner, with the patient's consent, of the assessment findings, any treatment provided, and any ongoing care that may be necessary.

iii. Inform the referring general practitioner if the patient is to be referred to another health care provider or service.

iv. When employed as a team physician, liaise with the patient's general practitioner and provide a discharge summary at the end of the season, and where a patient leaves the team prior to the end of the season.

### 5.2 Other sport and exercise medicine physicians

The sport and exercise medicine physician must:

i. Respect another sport and exercise medicine physician's training, knowledge, experience and culture.

ii. Avoid impugning the reputations of other sport and exercise medicine physicians with patients, coaches, team management and others.

*Commentary:* Having a high profile sportsperson as a patient can bring standing within the sporting community and raise the profile of a sports health provider. Impugning the reputation of another medical provider is not an acceptable means of gaining patients.

iii. Refrain from criticising colleagues in any untruthful, misleading or deceptive way.

iv. Not denigrate another sport and exercise medicine physician publicly (unless required by law).

v. ot plagiarise another's work or research, or use it without appropriate acknowledgement.

vi. Refrain from harassing or bullying other sport and exercise medicine physicians in any way.

The sport and exercise medicine physician should:

vii. Work closely with and co-operate with other sport and exercise medicine physicians.

viii. Participate in peer review.

### 5.3 Registrars

The sport and exercise medicine physician must:

i. Provide appropriate supervision of registrars to minimise risks to the patient, and accept responsibility for the welfare of the patient.

ii. Be honest and fair in all dealings with registrars.

iii. Refrain from bullying or harassing registrars.

The sport and exercise medicine physician should:

iv. Acknowledge a responsibility to encourage and train future sport and exercise medicine physicians.

### 5.4 Other members of the sports health team

The sport and exercise medicine physician must:

i. Work in a spirit of collaboration and co-operation with other health professionals as a team member, respecting the contribution of all members of the sports health team to patient care.

### 5.5 The College

The sport and exercise medicine physician must:

i. Comply with the obligations expressed in this Code of Ethics and Professional Behaviour at all times.

ii. Respect and co-operate with the College's disciplinary proceedings.

## SECTION SIX - Conducting research

### 6.1 Research

The sport and exercise medicine physician must:

i. Perform all research with approval of an appropriate research ethics committee.

ii. Ensure that all research meets the ethical standards that would be applied by an accredited research ethics committee.

iii. Declare to research participants and proposed publishers of research results where research has been funded by industry.

The sport and exercise medicine physician should:

iv. Ensure that financial compensation for participating as an investigator in a clinical trial is commensurate with work performed.

Make publicly available all results of research, negative as well as positive, wherever possible.

# Adhesive capsulitis

**Judith May** BHB, MBChB, FACSP
Sports Physician
Grace Sports Medicine, Tauranga

Adhesive capsulitis (AC) or "frozen shoulder" is a common condition of the glenohumeral joint which is characterized by a progressive increase in pain and global loss of passive and active range of motion. Affecting 2 to 5% of the population, it most commonly affects females aged between 40 and 60, with an increased incidence in diabetes mellitus, thyroid and autoimmune disease.[3,11] Approximately 20% of both type 1 and 2 diabetics will develop the condition, and they will often have a more severe, protracted clinical course, that is recalcitrant to treatment.[1] The natural history for AC is a self-limiting course that will resolve spontaneously over 1 to 3 years; however, a significant number may still report residual symptoms after 3 years.[14] The condition can be primary or idiopathic, with no apparent precipitating factors, or secondary and triggered by trauma, immobilisation or surgery.

Adhesive capsulitis is typically described as having 3 phases.[12] The first stage is the "freezing" phase where there is progressive pain with activity. The second "frozen" phase is characterised by gradually reducing pain but a progressive loss of range of glenohumeral motion. In the third "thawing" phase there is a gradual improvement in range of motion and function.

The typical history is of a graduated onset of pain in the anterior and lateral shoulder that can refer into the deltoid region. There is frequently a dull ache at rest but a sharp pain with movement such as reaching, and a night pain with difficulty sleeping on the affected side. Many will describe minor trauma such as reaching behind a seat in the car for a handbag prior to the onset of symptoms. If in the freezing phase they will complain of increasing stiffness and difficulty with doing activities of daily living such as brushing hair or doing up their bra. It is important to get a past medical history especially any history of diabetes or autoimmune disease.

On examination there is often wasting to the spinati and deltoid. There may be tenderness to the anterior and posterior capsule. I would first assess active range of motion which is usually globally restricted, with external rotation and abduction usually the most significantly affected. I will then attempt further movement with passive range of motion which will have a firm mechanical endpoint due to capsular restriction. It is important to ensure there is no compensatory scapulothoracic motion when assessing range of motion.

An understanding of the pathology of adhesive capsulitis is important to help guide which treatment may be effective in each stage. Arthroscopic and histological studies have shown that the painful "freezing" phase is characterised by a hypertrophic hypervascular synovitis, but there is normal capsular tissue. As the condition moves to the stiff "frozen" phase the capsule becomes dense and fibrotic with large numbers of fibroblasts and myofibroblasts, with the synovitis gradually resolving.[11] Cytokines and matrix metalloproteinases (MMPs) have recently been implicated in the pathogenesis of AC[7] with cytokines involved in the proliferation of fibroblasts and production of collagen.[7] MMPs are important in tissue remodelling processes and an imbalance between MMPs and their inhibitor TIMP-2 has been implicated.[7]

Studies assessing the role of MMPs in menstrual bleeding have shown that estrogen has a significant role in the expression and activation of MMPs and their inhibitors.[13] This may explain the increased frequency of adhesive capsulitis in postmenopausal women. Similarly, the role of cytokines in the pathogenesis may explain the increased prevalence of AC in sufferers of autoimmune disease and diabetes.

It is important to differentiate adhesive capsulitis from other causes of a stiff painful shoulder such as osteoarthritis of the acromioclavicular or glenohumeral joint, calcific tendinopathy, rotator cuff pathology and neoplasm. This can usually be achieved with a shoulder X-ray in conjunction with the history and examination. If the patient is in the stiff "frozen phase" then usually the diagnosis can be made clinically, and further imaging is not necessary. However, if there is any inconsistency in the clinical findings, further investigation is probably warranted. In this case, an ultrasound may show thickening of the coracohumeral ligament,increased vascularity in the rotator interval, but a lack of other pathology may help support the diagnosis.[9] An MRI is rarely indicated but thickening of both the coracohumeral ligament and joint capsule in the rotator interval, and obliteration of the fat triangle may be observed.[15] Due to the incidence of adhesive capsulitis in diabetes I would recommend assessing a fasting glucose on most patients, particularly if a patient has co-morbidities or a recaltritrant course.

## Management

My management begins with education on the natural history of adhesive capsulitis so the patient has a realistic expectation on the time course their condition. As with any condition in which the pathogenesis is unclear there are many treatment options available. I base my management decisions on the phase of the disease and the associated pathology. If the patient is in the painful phase where synovitis is a component of the pathology I offer an intra-articular corticosteroid injection, which I typically perform using a posterior approach without imaging guidance; a Cochrane review has shown that there does not appear to be any additional benefit by doing the injection under imaging guidance.[4] Studies have suggested this approach can give improvement in pain levels for approximately six weeks.[2] I warn the patient that it is unlikely to improve their range of motion or the long term outcome, however most are grateful to get pain relief while they are going through the most painful phase of the condition. I do not generally recommend physiotherapy in this phase and any stretching of the capsule seems to aggravate the condition. I recommend regular passive range of motion and pendulum exercises and encourage returning to daily activity within pain limits..

If the patient is in the frozen phase with a marked reduction in range of motion I consider an ultrasound guided hydrodilation. In this phase the capsule has become fibrotic though there may still be high pain levels due to on-going synovitis. The procedure involves distending the capsule with 20 ml of saline and glucocorticosteroid under local anaesthetic. I have found this to be well tolerated, and can give substantial gains in range of motion, reduction in pain levels and improved function. It is most beneficial in the stiff phase of frozen shoulders.[5]

While there is little scientific evidence for using physiotherapy as a stand-alone treatment in AC,[8] there is some support for its use after hydrodilation.[6] After the procedure I consider physiotherapy to supervise a rotator cuff and scapular stabilising programme to help restore shoulder function, especially if there is a pronounced difference between active and passive range of motion.

If a patient is reluctant to have corticosteroid injection therapy, other options that may help pain and function are acupuncture and oral non-steroidal anti-inflammatories.

I have rarely sent a patient for surgical intervention, but occasionally there are patients who are recalcitrant to treatment and who have a severe restriction in range of motion lasting several months. Arthroscopic capsular release is increasingly preferred over manipulation under anaesthetic as the surgical procedure of choice due to its lower complication rate and quicker recovery time.[10]

I suspect most conservative management is providing analgesia and improvement in quality of life while going through the most debilitating phases of the condition, without altering the natural history of the condition. I recommend considering which phase of the condition and hence the associated pathology when determining treatment options. In the future treatments that address the pathogenesis targeting cytokines and metalloproteinases may be able to influence both short and long term outcomes.

## *Comment 1*

**Chris Hanna**
*Sports Physician*
*UniSports Medicine, Auckland*

Thanks for a great overview Judith. That is very much in line with my understanding of this interesting problem. I would add the following points:

When taking the history, possibly due to the presence of the ACC system in New Zealand, or possibly due to human nature, most of the patients I see with adhesive capsulitis report a minor injury as the trigger. I suspect that what the patient interprets as being the cause of the pain, is actually pain caused by suddenly taking the inflamed joint into an end range position, bringing the problem to the patient's attention.

I see a number of patients with adhesive capsulitis who report night pain and numbness into the hand. Neurological examination is normal, and these symptoms are abolished by intra-articular cortisone.

I do not see a progressive loss of range of motion in the frozen phase. My experience is that in the freezing phase there is increasing pain and loss of range of motion. In the frozen phase there is a gradual reduction in pain, much less night pain, and fewer episodes of sudden movement pain. I consider the first significant increase of range of motion to be an indicator of the end of the freezing phase, and expect not to need further cortisone from that point on. In the thawing phase there is minimal pain (although impingement due to capsular restriction and the resultant scapulothoracic dysfunction is quite common), and a slow melting away of the capsular restriction. Natural history papers report that full range of motion is often not regained, but that the restriction in end range is usually similar to the other shoulder and therefore it probably is normal for age.

In the examination of the frozen shoulder, I find that the most sensitive test for assessing restriction of range of motion is to have the patient lying supine, fix the scapular with the ipsilateral hand (ie left hand if examining the left shoulder) to prevent scapular movement, then abduct the arm as far as possible.
The normal range of Glenohumeral and scapulothoracic abduction is 180 degrees, 120 degrees from the Glenohumeral joint, and 60 degrees from the scapulothoracic articulation. So the normal range of abduction of the arm with the scapula fixed should be 120 degrees. Less than this may be an indicator of restriction. If you bring the arm back to 90 degrees abduction, there should be 90 degrees of external rotation and about 80 degrees of internal rotation in this position in a normal arm. In adhesive capsulitis, these measurements of rotation in abduction are the earliest signs of restriction. If the arm cannot be abducted to 90 degrees, then measure the amount of abduction, and record the range of rotation in the maximal amount of abduction. This gives you a very easy way to detect and document progress over time. The other test that I find very useful in adhesive capsulitis is the Load-Shift test, which is usually used to assess instability. In AC, the opposite is found, and there is a marked reduction in accessory movement in the affected shoulder when compared to the normal shoulder.
I also compare and record the range of motion of internal rotation in the Hawkins impingement test position between the two shoulders.

My philosophy on investigations is that plain films are mandatory in anyone with a history of previous malignancy or red flags like weight loss. As strength is usually not compromised by adhesive capsulitis, I also request ultrasound imaging in patients who are weak. If I am getting blood tests, I have previously used random blood glucose and TSH, although labs in Auckland are now using HbA1C as a screen for impaired glucose tolerance. I tend to reserve these tests for patients with significant restriction or protracted courses, because patients with diabetes or autoimmune disease are more likely to have a more severe disease course. In younger patients, I also include a screen for inflammatory diseases, as rheumatoid arthritis and sero-negative oligoarthritides can present as isolated glenohumeral capsulitis.

ACC and the New Zealand Guidelines Group published guidelines on soft tissue shoulder injuries. The only condition that they strongly recommend corticosteroid injection be considered in the shoulder is adhesive capsulitis in the acute inflammatory phase. They concluded that exercise can exacerbate the pain in the acute phase but is of benefit once the acute pain has settled. I recommend intra-articular corticosteroid, and use the same approach as Judith. I use ultrasound guidance, and consider hydrodilatation in patients who do not respond as well as I expect. It is always important to consider alternative diagnoses in these patients as well. Cardiac ischemia, cervical referral, and pathology involving the diaphragm or peridiaphragmatic organs can all refer pain to the shoulder, but do not usually reduce range of motion.

There are currently two schools of thought about rehabilitation after corticosteroid injection in adhesive capsulitis. Some practitioners see the administration of cortisone as an opportunity to aggressively push range of motion. There is no evidence that any intervention speeds up the resolution of this disease. It is also possible to create more pain through aggressive assisted mobilisation, and even self mobilisation in the acute phase. My approach is to recommend intra-articular corticosteroid until such time as there is no longer night pain or sudden movement pain. I like patients to have a four week break between the predicted end of the previous cortisone injections duration of effect, and any subsequent injection. During this phase of the disease, I prescribe inner range strengthening, but no stretching. Deep tissue release of trapezii, paraspinals and sternomastoid can be of benefit to patients who have developed cervical pain and headaches due muscle spasm secondary to shoulder pain. Once the patient is not requiring cortisone (and this decision can only be made six weeks after their most recent corticosteroid injection), I am happy for them to return to range of motion work, but they must continue with their strengthening. I do not usually see the patient again after that.

When I am recommending intra-articular cortisone I point out that cortisone is a synthetic copy of a natural hormone, cortisol, that we make every day. We make it to wake ourselves up, and we make more when we want to exercise or we get stressed. We stop making it when it is time to go to bed, and it has a half-life of 2 hours, which is why most patients wake up with pain 2-4 hours after they get to sleep. I mention that interrupted sleep saps our energy, makes us cranky and can interfere with our interpersonal relationships and in some cases our business decisions. I point out that cortisone is not a cure, and that until the process burns itself out, symptoms can return, and a further injection may be considered; but intra-articular cortisone has been proven to reduce night pain and improve quality of life.

I would add that there is a 10-20% chance of developing adhesive capsulitis in the other shoulder, and I inform patients of that. Also, a number of studies have reported a persisting limitation of range of motion, despite resolution of symptoms. Vastamaki and Vastamaki in their paper with a 23 year follow-up of patients who underwent MUA make the point that, although range of motion was very good initially, it deteriorated between 6 and 16 years after the manipulation, however they note that this restriction reached the level of the contralateral shoulder.[2] They suggested that this loss of range of motion may be due to the natural process of aging. Other studies continued to compare the range of motion in the involved shoulder, with the range of the uninvolved shoulder as it was documented at the time of initial consultation.

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## *Comment 2*

### Margie Olds


### Graeme White

*Sports and Manipulative Physiotherapist*
*UniSports Medicine, Auckland*


### Diagnosis

People with 'Adhesive capsulitis' (AC) or 'Frozen shoulder' are difficult to treat and making an early/timely diagnosis is an important part of their conservative management.. Our suspicion for AC is heightened when passive shoulder range of motion (ROM) is the same as active shoulder ROM. Pain with external rotation is also a common finding, however it is important that a posterior glide of the humeral head (relocation test) does not relieve the pain felt with external rotation as this may indicate anterior shoulder instability. Adhesive capsulitis is more common in females,[9] diabetics,[7] those with Dupytren's[11] and those aged between 40-65 years.[10] This together with a pain pattern that is painful at night and unrelieved by rest constitutes our differential diagnosis. Differential diagnoses includes GHJ instability (decreased pain with posterior glide in external rotation), and osteoarthritis (degeneration/osteophytes visible on plain X-Ray).[13] Classification of primary (idiopathic) or secondary AC (due to conditions such as diabetes, cervical disc, or rotator cuff tears) may also be useful.[6]

### Pathophysiology

The precise aetiology of AC remains unclear although some authors have proposed elevated serum cytokines to be part of the process.[6] Bunker et al (2000) proposed that a minor insult could lead to an exaggerated healing response and propagation of type I and III collagen. Fibroblasts differentiate into myofibroblasts, causing contraction of the new Type III collagen.

Although many authors[6,10] have described 3 stages Wiffen et al (2002) describes AC as having four stages. In stage 1 there is dull pain at rest and sharp pain at end of range. There is progressive loss of active ROM but passive ROM remains near normal. Arthroscopic investigations in this stage describe a hypertrophic vascular synovitis coating the capsule lining. This hypertrophic vascular synovitis is also present in Stage 2 although perivascular scar formation now is beginning to appear. The pain persists and there is progressive loss of range. Stage 3 describes a painful stiffening of the shoulder, and then the symptoms gradually improve to a relatively pain free but stiff shoulder. There is loss of the axillary fold in this stage and arthroscopy shows patchy synovial thickening without the hyper-vascularity. Biopsies of this stage contain dense, hypercellular tissue. Stage 4 describes slow and steady recovery of ROM.[12]

## Management

The stage system described above provides the framework for our conservative management. Identification of AC within Stage 1 or 2 is important as these people seem to respond well to corticosteroid injection into the joint space. This steroid is thought to have an effect on the hypervascular synovitis. There is some evidence in the literature that corticosteroid injections are more effective than physiotherapy intervention especially in decreasing pain in the two weeks following an injection,[1] although many of these studies did not discriminate between the different stages of AC. We typically refer for an injection under ultrasound guidance as there is some evidence in the literature[14] that this will result in better outcomes for the patient.[5]

Our treatment in these early stages is around education of the condition and techniques to avoid aggravation. Any mobilisation in this stage needs to be pain-free and passive stretches should focus on restoration of normal range, once again avoiding pain. Working into pain will merely aggravate an irritated capsule. Some authors have proposed that the sympathetic nervous system also plays a role in recalcitrant AC,[12] and we have found that thoracic mobilisation, neural sliders such as long sitting, or sympathetic slump mobilisations have been helpful in reducing pain. Gentle closed kinetic chain ROM exercises in four point kneeling (rocking forwards and backwards) can also be helpful.

When the patients are in stage 3 or 4, we typically use stretches in a home exercise programme. Occasionally we will accompany this with mobilisations to the glenohumeral joint[8,4] but only if we see progressive improvement as a result of the mobilisation. Otherwise we monitor their stretches on a monthly basis, and increase the stretches as appropriate. Favourites include hands on a bench and hips into 90 degrees flexion, resulting in increased flexion at the shoulder. Floor stretches are also a favourite as they result in more support through the lumbar spine. Patients with low irritability (0-3/10) are encouraged to hold the stretches at end range for 10 seconds 3-4/day, while patients of moderate/high irritability (>3/10 VAS) for no more than 5 seconds 3 times per day.[3] We emphasise the need for patients to monitor their symptoms after exercise – if there is any aggravation of symptoms beyond an hour of finishing their exercise or the resumption of night pain then exercise intensity must be reduced.

In summary, early identification of this condition is essential to optimal clinical management. Treatment includes range of motion stretches and education of the condition in the early stage. In the latter stages of AC, mobilisation of the joint capsule and end of range stretches have been found to be useful.

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BRUCE HAMILTON

# Ride the Wave: AMSSM Annual Meeting San Diego, 17-21 April 2013

The American Medical Society for Sports Medicine (AMSSM) annual meeting has typically played second fiddle in terms of international profile, to both the more well-known American College of Sports Medicine (a massive, multi-disciplinary annual meeting and aligned with the Medicine Science in Sport and Exercise journal) and the orthopaedic driven American Orthopaedic Society for Sports Medicine (AOSSM – aligned with the American Journal of Sports Medicine). Established a little over 20 years ago, the AMSSM caters for non-orthopaedic Sports Medicine specialists, and has grown in that time from a handful of enthusiastic participants to over 1400 attendees this year. The title of the conference, "Ride the Wave! The Future of Sports Medicine" reflects the positive optimism which characterised the entire meeting. Other than a dozen or so international visitors, all participants were from the United States, predominantly it seemed employed in University (College) Sports Medicine clinics, and to a lesser extent private institutions, professional codes and Olympic sports. Most eye opening for me was the extent of the "Fellowship" programme which is the entry point into working in non-orthopaedic Sports Medicine. By far the majority of candidates for the Fellowship programmes, driven out of seemingly dozens of Universities and hospitals, come from a strong family medicine background, although a number of candidates come from other medical sub-specialties – this creates a strong medical knowledge base within the organisation, with the evolution of equally strong Sports Medicine sub-specialties. Competition for positions on the Fellowship programmes is seemingly intense, and this conference was a recruiters dream, with current Fellows required to present (either verbally or a poster) and prospective Fellows desperately trying to meet key leaders. To give an example of the desire from Fellows to present a clinical case (other than research), only 22 Fellows were able to orally present clinical cases (a great way to be noticed), from over 250 applications – the quality of both the work up, and the presentations, from young clinicians was exceptional.

Given the nature of the participants, it was not surprising that the majority of sessions were medically oriented, and of high quality. Many of the speakers were names that were recognisable from the literature, and it was a pleasure to have the opportunity to hear them speak directly. Dr Jonathon Drezner was the current (outgoing) President of AMSSM, well known for his excellent work in cardiac screening and cardiac management research. As such it was guaranteed that there would be a heavy emphasis on cardiac issues. The cardiac sessions were characterised by the presentation of new US-based epidemiological data, overtly challenging some of the aging but remarkably original and timeless work of Dr Barry Maron. The value of ECG in cardiac screening was emphasised, reflecting a move (at least academically if not practically) towards the European approach to cardiac screening of Athletes. A further key message was the importance of Automated External Defibrillators (AED's) in all training facilities – a timely reminder for us all. Finally, it is worth highlighting the "Seattle Project", a multi-national effort to develop a relevant ECG education programme for Sports Practitioners. Driven by Dr Drezner, this programme is now available to us all, free, on the BJSM website!

A second feature of the conference were the excellent sessions dedicated to concussion diagnosis and management. Once again, these sessions were both academically stimulating, and practically useful – a great combination for maintaining interest.

A particular feature of the conference was the large number of early morning "Instructional Course Lectures" which (after you paid additional money), provided hands on clinical training in areas such as Hamstring injuries (I went to this one), Ultrasound diagnostics, fracture care and many many more. As you may expect, these did vary in quality, but if you picked the right one, you had the opportunity to pick up the odd nugget.

I admit to carrying some biases on Sports Medicine in the USA from both what I've seen on TV (For example, episode 12, series one, House; Broken arm = cadmium poisoning), and what one reads about the protective practicing (ie. Investigate everything before seeing the patient), based on the litigious nature of the society. Pleasingly, I would like to say that the quality of the people I met at this conference, and the evidently high level of understanding of sport related medical issues, firmly debunked many of my pre-formed beliefs. The litigious nature of the society was however highlighted in one case presentation, with an ultimate diagnosis of "swimming induced pulmonary oedema". Paradoxically, while the Fellow presenting the case was happy to provide a medical clearance to his patient to compete in an ironman – in his patient who had experienced multiple attacks of pulmonary oedema in open water swims of 2 km or more, he was unable to get medico-legal clearance to perform a controlled provocative test to confirm the diagnosis, and thereby potentially manage and prevent future episodes (if this can actually be done!). Am I crazy, or is this just a little messed up?

A final note on the exhibitors area. If this is any reflection on the direction that Sports Medicine is taking, then its difficult to know what the future holds. The two exhibit types that were constantly busy and engaged in active marking were ultrasound and Platelet Rich Plasma – each having seven individual exhibiting companies. The cynic in me is not sure what to make of this.

My conclusion. An excellent clinical conference. Well worthy of making the effort to attend, and in 2014, a great opportunity to explore New Orleans!

NAT ANGLEM

# IOC Advanced Team Physician Course Saltsjobaden, Sweden, May 2013

I was invited to attend this conference as the Medical Director of the NZ Wintersport Programme, with particular view to lessons and connections that might be valuable, particularly with the upcoming Olympic Games in Sochi , 2014.

The trip itself was a long one. In fact the duration of travel almost exceeded the duration of the conference, and the risk was that the jet lag would limit how much I could actually benefit from the conference. However, as the saying goes: "going west is best", and I perhaps should have worried more about my return to work after, rather than the conference itself!

The conference was set in Saltsjobaden, near Stockholm, in the Swedish Archipelago with 40,000 islands scattered through the region. The Director in charge of the Medical and Scientific department of the IOC, Richard Budgett welcomed us and set the stage for a meeting that aimed to "Protect the health of the athlete".

There followed a very busy programme for 3 days with almost 60 presentations and case discussions! There were themes of ACL management, sports team management and return to sport criteria among others.

One of the greatest benefits of this course for me was the contact with other practitioners from around the world. While there wasn't much time unaccounted for, there was a chance to meet with other team physicians, make contacts and discuss experiences.

While there were many lessons, and I gained many insights during the conference, the greatest overall lesson for me was:

"Beware the risks of returning the athlete too quickly to sport". This theme was encountered again and again, and while in one sense the job of a sports physician can sometimes be seen as achieving a fast return to play, there were many thought provoking discussions with reference to the risks to the athlete, the team and indeed the medical team, of early exposure of the athlete to normal training and competing. Warnings were made of the presentation of research that used return to play as an end point for study, and the risk of returning to play but suffering setback or reinjury was highlighted.

Roland Thomee, a Swedish professor of physiotherapy and PhD described an holistic approach to rehabilitation, noting that predictors of good outcome from ACL surgery included:

1 High pre-operative self efficacy scores (the individual has belief in a good outcome, as opposed to a doomed or hopeless mindset)
2 Good pre-operative strength
3 Low pre-operative pain scores

He also described the benefit in assessing overall health status and social status in regard to the injury, and then a battery of knee function tests. He uses 6 tests which are a mixture of 3 endurance (for example 90 second lateral hop test) tests and 3 power (for example maximal distance hop). He stressed the importance of testing that involves a component of fatigue.

This presentation was followed by the well published Grethe Myklebust, who noted that it can be common for orthopaedic surgeons to focus on markers such as pain, swelling, range of movement and clinical tests of graft stability, rather than functional tests to guide return to play. She cautioned listeners on the safety of this approach with a raft of data and examples to illustrate the point.

These simple but sensible messages were well received as I considered their application in my own practice.

Also of personal interest was a presentation by Fredrik Bendiksen of the Norwegian Olympic team discussing the Norwegian team approach to the Sochi Olympics and some of the specific risks that will likely be encountered with a Russia-hosted Olympic Games.

The benefits of a conference with such a "rock star" cast as this one are obvious, but I might also add that I felt the content of the conference was weighted a bit heavily to the mechanical aspects of health. While acknowledging that the artistic aspects of medicine are much harder to study, and therefore publish, I believe that in a clinical and performance based context more space needs to be made for the psychological aspects of health and wellbeing. In this regard, I think the content of the meeting was too light.

With such a busy programme and such a lot of travel, by the time I returned home I felt somewhat exhausted. However, there is no time to rest! With the end of May approaching the snow has begun to fall and a New Zealand winter season (and chance to observe the fruits of our ACL prevention programmes) is upon us!

I extend many thanks to the IOC, NZOC and to High Performance Sport NZ for the opportunity for me to travel to this prestigious meeting. The next instalment in Monaco, April 2014 will be very much worth attending.