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Contents

FROM THE CEO 2

Sports Medicine in the 21st Century: Roald raises the bar

Dr J 4

Will a Nobel ever be awarded to someone in sports medicine or science?

DOPING IN SPORT 7

Adam Firth: The new Australian Sports Anti-Doping Authority 7

Adam Firth: The Mark French case 10

Grant Schofield & Geoff Dickson: Ethics and doping: an issue of context 11

ANOTHER GOOD YEAR: Australian Sports Commission annual report 15

SEASONAL AND GEOGRAPHIC ANALYSIS OF ACL INJURY RISK IN AUSTRALIA 20

John Orchard, Ian Chivers and David Aldous

BULLETIN 28

Cover photograph: Australian Sports Commission

Sports medicine in the 21st Century: Roald raises the bar

Gary Moorehead

Chronic disease management by general practitioners with attendant pathology tests and length of time spent in patient consultation have all increased substantially since 1998.*(Australian Institute of Health and Welfare (AIHW) "General Practice Activity in Australia 2004-2005 report".)*

What has this to do with sports medicine?

According to Professor Roald Bahr, a keynote speaker at the recent SMA Conference -- which combined sports science and medicine, physical activity promotion and sports injury prevention Conference – it has everything to do with sports medicine!

Professor Bahr, whose background as a sports physician, sports injury epidemiologist and chair of Norway's physical activity taskforce uniquely qualified him as a plenary speaker at the Conference, made the fundamental assertion that treating the rising tide of chronic disease will become an increasing part of all sports medicine practice. *(Professor Roald Bahr: "Redefining sports medicine: from sprained ankles to clogged arteries." Plenary Lecture, Australian Conference of Science and Medicine in Sport, 13 October 2005.)*

More importantly, Professor Bahr asserted that a sports medicine and science background uniquely qualified practitioners for this role. But, before dealing with Professor Bahr's claims, we need to set the scene in a little more detail.

How serious is this trend in the increase in chronic disease?

The AIHW report quoted above (covering the years 1998-2004/2005) cited an increase in the treatment of chronic disease from 46% to 51%, an increase in long consultations as a proportion of visits from 7% to 10% and 5.6 million more pathology tests than in 2000-2001. *(AIHW "General Practice Activity in Australia".)* These increases are consistent with other predictions made about the likely increase in chronic disease in Australia. The recent New South Wales Health futures planning project estimated an increase in diabetes over the next twenty years of 176%. *(Bellew, Bauman. Booth et al. "Chronic Disease: the sleeping giant of health expenditure." NSW Health futures planning project 2005.)*

All of this is perfectly consistent with the projected changes to the pattern of population in Australia as the largest cohort of the population, the babyboomers, enters old age. What makes this even more alarming for health economists is that the babyboomers, the largest cohort of the population, are also the most overweight and obese - and the least physically active - cohort of the population. This will make them even more prone to chronic disease – a fact that is just starting to emerge from the AIHW report.

How is the Government responding to this crisis? (In Australia we should ask how are the "governments" responding, because both state and federal governments share responsibility for health.)

On the state government front, there are numerous initiatives, some of which (like the work of the WA Premier's physical activity taskforce and the "10,000 steps Rockhampton" project) are outstanding and probably unique in the world. Other initiatives (and governments) have a more patchy effort, with re-inventing of the wheel, under-funding of interventions and squabbles over intellectual property.

The Federal Government policy seems to be led by a back-bencher, Senator Guy Barnett from Tasmania, who seems to be a one-man band in the area and the Government's solo policy unit.

Certainly what can be said about federal initiatives is that they are focussed almost exclusively on children. Federal Health Minister Tony Abbott opened a one day forum organised by Senator Barnett recently by stating "two thirds of Australian men and more than half the women are overweight or obese" - and then spent the rest of his discussion on children. Increases in overweight and obesity in children are alarming, but two facts stand out:

1. The babyboomers are going to be a crisis for the health system first, and
2. The babyboomers also prove you cannot obesity-proof people in childhood. The babyboomers had an obesity rate in childhood of only about 1%. *(Professor Wendy Brown. "Obesity: don't just blame the kids and food" SMA media release 1 December 2005.)* Now it is 21%.

How have other organisations responded?

Unfortunately, our messages appear a little bit mixed and a little bit tinged with self-interest.

The Australian Medical Association (AMA) recently released a "Position Statement on Nutrition" which it pre-badged with the heading "Nutrition the Key in Fight Against Obesity Epidemic" *("Nutrition the key in Fight Against Obesity Epidemic – AMA Position Statement on Nutrition" www.ama.com.au/web.nfs/doc 30/11/2005.)*

The Dietitians Association of Australia (DAA) responded with a gentle sledge about how encouraging it was to see the AMA taking "a more population-based public health approach" and then proceeded to get stuck into numerous errors of fact and detail that it identified in the document. *(Claire Hewat APD, Executive Director DAA. "Initial comments on the AMA Position Statement on Nutrition. December 2005")*

Could this be interpreted as a message to the doctors to "stay off our turf"? SMA responded with a media release supporting the thrust of the AMA statement, but making the point that, with obesity, it takes two to tango – poor nutrition habits, but also a lack of physical activity.

The President of the Australian Association of Exercise and Sports Science (AAESS), Dr David Bishop, editorialised in the latest (December 2005) edition of the *Journal of Science and Medicine Sport* (JSAMS) on the role of physical activity versus "specific, targeted, and prescribed exercise". *(Dr David Bishop. "If physical activity is the answer, what is the question?" JSAMS 8:4. December 2005.)*

While this paper makes some very good points, as with the AMA and DAA pieces, there is also a sense of the exercise physiologists out there with the doctors and dietitians, elbows thrusting, to be at the head of the pack.

So back to Professor Bahr.
Roald Bahr's thesis can be summarised quite simply. He believes that an essential policy approach is one based on keeping ageing populations active for as long as possible. This will mean that the sports medicine practitioners' expertise in musculoskeletal medicine will become essential in both maintenance of the increasingly injury-prone ageing population and also passing this information on to other health professionals. The AIHW report cites an increase of 1.5 million in GP consultations giving patients education or counselling about their weight and nutrition, so there is some positive movement in this area, but it is probably timely that the DAA is moving to make sure that the GPs get these messages right.

Professor Bahr maintains that the skills and knowledge of the sports medicine and science practitioners will move to the front line of healthcare. While hardly as glamorous as expectations of working with elite sporting teams, this work will be both plentiful and necessary.

But it is critical that we get the messages right.

Messages such as:

- Weight control is a function of energy balance. When discussing obesity, we must talk about nutrition AND physical activity.
- There is health benefit in physical activity WITHOUT any consequent weight loss.

This latter point seems to get overlooked in the current stampede/reaction to the obesity crisis. All focus seems to be on getting or keeping the weight off, with little or no mention of the health benefit of increasing physical activity even if there is no change in weight. One of the leading researchers in this area is Dr Steven Blair from the Cooper Institute in Dallas, whose research findings are best summed up by the statement:

"*The research showed that death rates were similar for moderate and highly fit men in all BMI categories, and death rates for men with low fitness levels were higher regardless of their BMI category*". (Steven Blair "Fitness, Not Fatness is the Issue" WELL newsletter for Wellness, 1, II, Fall 1999.)

Sports Medicine Australia has made a great step forward with the recent combined Conference. The importance of the event can be measured in a variety of ways:

- The enthusiastic response of delegates (from all areas) who attended the event.
- The desire of our conference partners, the National Heart Foundation, the Department of Health and Ageing and the NSW Sporting Injuries Committee, to continue the partnership into the future.
- The speed and enthusiasm of the South Australian Government to provide support to sign up the Conference for Adelaide in October 2007.
- The fact that all our overseas speakers want to come back in 2007 (but maybe that was just a testimony to our partying!!!)

Will a Nobel ever be awarded to someone in sports medicine or science?

By Dr J

It is a time for great celebration that we have just had two Australian medical doctors awarded the Nobel Prize for medicine and physiology (Robin Warren and Barry Marshall). Their discovery was that the bacterium *Helicobacter pylori* is in fact the major cause of stomach ulcers which can now be successfully treated with antibiotics. Those of us in sports medicine should greet this award with a similar level of elation that we felt, for example, when Cathy Freeman won the 400 m at the Sydney Olympics. Admittedly the Freeman gold might have warranted more instantaneous joy in that the 'event' lasted less than a minute but there are more than one hundred Australian Olympic gold medallists yet only a dozen Australian Nobel Prize winners.

The only Australian Nobel Prize winners in medicine and physiology are:

- Warren and Marshall in 2005 for their discovery of *Helicobacter pylori*,
- Peter Doherty (along with Rolf Zinkernagel, a Swiss working in Australia) in 1996 for their discoveries in immunology,
- John Eccles (along with Hodgkin and Huxley of the UK) in 1963 for his discoveries regarding nerve cells,
- Frank Macfarlane Burnett (along with Peter Medawar) in 1960 for his discoveries in immunology, and
- Howard Florey (along with Fleming and Chain of the UK) in 1945 for the discovery of penicillin.

In terms of the impact on improving the human condition, the discovery of penicillin (which was the biggest ever breakthrough in the field of antibiotics) would rank as highly as any of the Nobel prizes awarded for medicine. Alexander Fleming is credited with discovering that the mould penicillium could inhibit the growth of bacteria, but the Australian Sir Howard Florey (who has an institute named after him in Melbourne) is considered to have been most responsible for introducing the antibiotic penicillin to clinical practice.

Warren and Marshall deserve the highest of our praises for making a discovery which vastly improves a common disease in clinical medicine, for being prepared to challenge existing dogma about the causation of peptic ulcer and, locally, for conducting all of their work within Australia (in the city of Perth). You should take any chance you get to read about the story of Warren and Marshall, including the free text in the Christmas edition of the *Med J Aust* at

http://www.mja.com.au/public/issues/183_11_051205/van11000_fm.html

With respect to the field of sports medicine, a recent Nobel award has major relevance (Paul Lauterbur and Peter Mansfield in 2003 for the discovery of magnetic resonance imaging). In 1998 three Americans (Furchgott, Ignaro and Murad) shared the Nobel Prize for medicine for their discoveries with respect to the role of nitric oxide in the cardiovascular system. Their work has probably inspired that of George Murrell and Justin Paoloni who have discovered that nitrates can improve the clinical outcome of tendinopathy, which may one day be worthy of a major international award in the field sports medicine. George Murrell has just won the FE Johnson Memorial Fellowship of the NSW Sporting Injuries Committee for 2005, whereas Justin Paoloni has already won the David Garlick Memorial Scholarship for this work.

There was an IOC Olympic Prize in sports science and medicine which was awarded every two years between 1996 and 2002, but not awarded in 2004 because of the withdrawal of sponsorship from the Pfizer company. This award, if it is resurrected, may possibly be seen as the "Nobel" equivalent in sports science and medicine. Yet it would only be an equivalent for as long as it was considered impossible for a sports medicine researcher actually to win a real Nobel Prize.

Those small-minded folk who think that I have tenuous grip on reality would probably suggest to me that sports medicine experts should stick to the task of proving to the Australian Government that we actually exist as a distinct area of medicine before anyone starts worrying about winning the Nobel prize for a sports medicine study. Even though we tend to equate sports medicine with sports injuries, if we start to think along the sports and *exercise* medicine paradigm, perhaps it won't be long before we see an exercise medicine Nobel laureate. Researchers such as Jeremy Morris, Ralph Paffenbarger and Stephen Blair must surely be close to that elusive Nobel for their work proving that exercise can prevent heart disease and cancer.

If we switch back to Marshall and Warren, there are lessons for us to learn. Firstly, that you can be an Australian and living and working in Australia and still beat the rest of the world to making a unique discovery. Secondly, even if your abstract is rejected from your society's annual conference (as it was – see the MJA article for evidence), it doesn't mean you won't end up winning a Nobel Prize for the research. Thirdly, you can be a touch on the eccentric (mad) side, as Robin Marshall obviously was when he drank a helicobacter solution to give himself gastritis, and it may actually help you be a great scientist. Fourthly, you might do well to think that infection could have an undiscovered role in a common condition where the ruling view is that is has no role.

One of my all-time favourite articles I have ever read was called "A New Germ Theory" written by Judith Hooper and published in The Atlantic Monthly in February 1999. This article focused on the theories of Greg Cochran and Paul Ewald, who believe (via Darwinian theory) that any common medical condition which has been around for generations but which substantially reduces human fitness should be considered an infectious disease until proven otherwise. For example, not only do they believe that peptic ulcer is caused by an infectious agent, they assert that cardiovascular disease must be too, along with diabetes, rheumatoid arthritis, Alzheimer's disease and many cancers, etc.

If you consider this concept to be preposterous, remember that mainstream gastroenterologists have only accepted in the last decade that *Helicobacter pylori* causes peptic ulcers. There is some evidence that various chlamydia organisms are associated with cardiovascular disease, although this has not yet been proven to nearly the same degree as the helicobacter/peptic ulcer connection. For a summary of of the Atlantic article, please refer to: http://www.injuryupdate.com.au/forum/showthread.php?p=1066#post1066. And for a more formal reference, try Cochran GM, Ewald P and Cochran K ("Infectious Causation of Disease: An Evolutionary Perspective) in Perspectives in Biology and Medicine 43(3), Spring 2000, pp. 406-448.

It is worth noting that the "New Germ Theory" does not pose a threat to the importance of public health, because of the ability for microorganisms to evolve rapidly. For example, the HIV virus is an infection which is known to mutate according to its environment. In Africa, where unfortunately sexual practices are not generally very safe, HIV is far more virulent, as it is usually given ample opportunity to spread from victim to victim, even if the victims die relatively quickly of the disease. The strains of HIV which are seen in Western countries have, by contrast, become far milder, presumably due to the widespread institution of safe sex practices. Because there is less opportunity for the virus to spread from patient to patient, it 'evolves' to become more benign, as it would be disadvantageous to kill its hosts before there was a chance to spread.

If, for example, the proponents of the "New Germ Theory" are right about Type-II diabetes, that it might involve an infectious agent, then it would still be important to push the public health message about exercise and good nutrition. In a society where there is a high population of overweight and obese people, if an infectious agent can cause diabetes in these people, from an evolutionary perspective it can afford to be a far nastier agent, as the potential pool of victims is huge (and from the agent's viewpoint it will not affect its spread if a few victims die of the disease). In a society (which unfortunately is now a hypothetical one) where everyone exercised regularly and ate moderate amounts of food, if you were a diabetes-causing virus you would quickly mutate to a more benign form. It would be very costly to kill your victims due to the difficulty in finding replacement victims (given that the virus might need a high-fat host environment in which to live). Therefore, even if there are infectious agents that cause diabetes that we are yet to discover, we can limit their spread by increasing rates of exercise and improving nutrition.

Which diseases in sports medicine might be caused by infection? The number one candidate, in my view, would have to be "chondral degeneration" in the knee joint, in particular. How many times do you see a patient go in for a knee arthroscope for a meniscal tear, and in which the surgeon also finds grade 1-2 chondral degeneration in the joint, followed by a rapid deterioration after the arthroscopy? A year later another arthroscopy is performed and this time the patient has grade 4 chondral damage (that is, frank osteoarthritis) and a disability that will last a lifetime. Of course, the ruling dogma is that the "early" chondral damage seen in the first arthroscopy constituted a joint "weakness" that after further "mechanical loading" deteriorated to frank arthritis. Yes, I believe that early wear of the knee joint can later become advanced wear, but in the average patient this normally takes 20-30 years. How come it can happen to some poor victims in under 12 months when they don't run a single step due to the fact that they have a knee effusion for the entire year? In my mind, the likely culprit is an infectious agent and, sadly, the likely source of entry to the joint is the initial knee arthroscopy itself.

OK, some of you sceptics out there who may actually be medicos who have treated patients with chronic effusion post-arthroscopy may be able to tell me that:

1. Whenever you have sent a knee effusion in this scenario off for a culture it has always come back negative AND
2. If you have ever happened to treat a patient in this scenario with a standard antibiotic (eg, Amoxil) it hasn't helped with the knee effusion.

This is where a read of the story of Marshall and Warren is extremely valuable. They only managed to culture *Helicobacter pylori* when one of their plates was accidentally left in a laboratory over the Easter break. Normally in pathology if a culture is not positive after 48 hours,

the plates will be discarded and a negative result recorded. *Helicobacter pylori* managed to evade detection for many years because it takes longer than 48 hours to multiple on an agar plate. When you think about it, based on Darwinian theory, if you are an infectious agent in modern times (such as a bacterium, virus or fungus) what would be the most important characteristic you could evolve to ensure your survival? The mainstream thinking is that "antibiotic resistance" (or anti-viral resistance) is the major evolutionary defence mechanism that microorganisms have. What about inability to grow on an agar plate in a pathology lab? Wouldn't that be a far more valuable characteristic to develop compared to antibiotic resistance? If you are resistant to an antibiotic, the humans will just hit you with a different antibiotic until they nail you. However, if you refuse to conform to their belief that they must be able to see you grow within 48 hours on an agar plate in a pathology laboratory, they probably won't even know that you exist and therefore won't be throwing any antibiotics in your direction in the first place.

If the bacteria (or other non-bacterial microorganisms) which are most likely to infect a knee after an arthroscopy happen to be resistant to amoxicillin and don't grow on agar plates, then they can continue on their merry way eating through the layers of articular hyaline cartilage whilst the doctors who are supposed to be treating the patient nod their heads about the inevitability of cartilage breakdown. I can remember a case from my intern year of a woman who had a persistent effusion after a knee arthroscopy and was stuck on my orthopaedic ward for weeks due to severe knee pain. Eventually the pathologists isolated *Kingella kingii* bacterium from her knee, but it was thought to be possibly a benign pathogen.

There is a case report which suggests this may be a cause of septic arthritis in *J Rheumatol* (1981 May-Jun;8(3):501-3): "Septic arthritis due to Kingella (Moraxella) kingii: case report and review of the literature", by Vincent J, Podewell C, Franklin GW and Korn JH. This short PubMed abstract states that Kingella (Moraxella) kingii, a gram-negative bacillus, was isolated as the cause of septic knee arthritis in an adult. Three previous cases (one adult and two children) of septic arthritis due to Moraxella species have been reported. All cases have been characterised by difficulty in identifying the organism, indolent clinical course and slow response to antibiotic treatment.

Does this (underlined section) sound to you like the standard progress of a post-arthroscopy patient with a chronic effusion? What if there are actually dozens of organisms out there like *Kingella kingii*, which can chew through knee articular cartilage but are difficult to identify and don't respond to standard antibiotic treatment? Apparently *Kingella kingii* does not grow well in the laboratory within 48 hours and if not transported in blood culture bottles so, from a routine tap of the knee joint, a *Kingella kingii* infection will generally return a negative result (just like *Helicobacter pylori* used to do with peptic biopsies). For more info, read http://www.medterms.com/script/main/art.asp?articlekey=33658.

One of my personal areas of clinical expertise is the treatment of Achilles tendinopathy, and I occasionally think about whether an infectious agent might be responsible for the failure of Achilles tendinopathy patients to repair their degenerative lesions. We know that tendon degeneration is very common (eg, the Jill Cook studies on patella tendons) yet we know that many people with tendon degeneration don't get pain and many cure their own radiological tendinopathy spontaneously. Could it be that those who don't spontaneously cure possibly have an infectious agent responsible for the ongoing degeneration? I'm not saying that this is necessarily the case, but I can hypothesise that it wouldn't be an in-your-face bacterium like *Staphylococcus aureus*, or someone would have already cultured it.

I regularly notice that many of my Achilles tendinopathy patients have cracked heels, presumably due to low-grade skin fungal infection (see figure). A lot of the general population also has low-grade fungal infection of the heel, but is it more common in Achilles tendinopathy patients? I don't know, but perhaps one day in the future I will do a case-control study to test this hypothesis, and on another occasion I might treat some of my non-response Achilles tendinopathy patients with Lamisil to see how they go.

The great thing about being involved in science is the thrill of watching our knowledge base evolve. Fifteen years ago the internet didn't exist and, 25 years ago, no one suspected that *Helicobacter pylori* was a common cause of peptic ulcer. If you are working in sports and exercise medicine, you are working in an area which, despite its snubbing by the mainstream medical profession, is one which is critical to the advancement of human health. Maybe we won't see a Nobel Prize-winning discovery in sports medicine in our lifetime, but maybe we will. What is assured is that there will be new and successful ways to prevent and manage major sports injuries that are discovered in our lifetime, and that some of them will be discovered in this wonderful country of ours.

The new Australian Sports Anti-Doping Authority

Adam Firth

The year 2004-05 has been a landmark in Australia's anti-doping effort, Chairperson Brian Sando says in the latest -- and probably the last -- annual report of ASDA before the Government turns it into ASADA, the Australian Sports Anti-Doping Authority.

Acting Chief Executive Kim Terrell points out in the report that the establishment of ASADA, implementing one of the biggest testing programs ever undertaken in Australia and the work on the 2006 Commonwealth Games will be high priorities for 2005-06. For example, the Agency will conduct more than 7,000 drug tests in 2005-06 -- on average, that's at least 19 athletes tested every day of the year.

Sport Health here publishes extracts from the report on issues of special interest to its readers, such as no advance notice testing, trends in notifiable events and the prospects for an online athlete whereabouts system.

On 23 June 2005 the Australian Government announced its intention to establish the Australian Sports Anti-Doping Authority (ASADA), which from early this year will take over from the Australian Sports Drug Agency (ASDA) as Australia's NADO under the World Anti-Doping Code (WADC), but with significant additional functions to ASDA in the fight against doping in Australian sport.

No doubt ASADA is motivated at least in part by the Australian cycling controversies of the past two years and the experiences in the United States with the BALCO scandals. Its enabling rules and regulations are not yet finalised and accordingly this article can only make comment on some features that have been announced and in relation to such a body generally.

ASADA's powers

It has been confirmed that ASADA will replace ASDA in handling the responsibilities of sample collection and testing, and education and advocacy. It will also play a role in policy development relevant to sports doping, and most significantly will act as the investigator and prosector of all allegations of anti-doping rule violations relating to sports whose governing bodies in Australia sign on to use ASADA for such purposes.

It will be a condition of government funding and other support that sports submit all their anti-doping operations to ASADA, and ensure that their members and staff cooperate fully with ASADA in the performance of its functions. It will also be a requirement that the sport accepts any adverse finding of ASADA against any of its athletes (or other persons within the sport's jurisdiction), ensures that infraction notices are served on such persons and enforces penalties imposed in accordance with the sport's anti-doping rules. The Government has used purse string control to good effect in forcing all Australian sports to sign on to the WADC and it can be expected that it will pursue use of ASADA with the same intent.

More specifically, in addition to ASDA's existing powers, ASADA will have:

- power to conduct investigations on the basis of information acquired from its drug testing and other activities, or where it has received information from any other person, or on its own initiative;
- power to receive, use and disclose (where appropriate) information from Australian Customs Service or other law enforcement agencies where relevant to a possible anti-doping policy breach;
- power to present the prosecution case before a tribunal (whether or not ASADA investigated the case). This may include prosecuting adverse analytical findings in respect of a sample tested by ASADA; and
- the ability to publish results of any hearing where it is in the public interest.

The effect will be to have a common procedure and consistent practices throughout Australian sport in pursuing anti-doping rule violations and enforcing anti-doping policies. Consistency between and within sports can only be a positive thing in reducing uncertainties that have in the past been seen in anti-doping matters in Australia and around the world.

The most significant new features of ASADA are its investigative and prosecutorial functions. An independent, government-funded body fulfilling such a role has been sought by many sports organisations in this country for some time as the burden of anti-doping policy enforcement distracts time and resources from developing their sport, their competitions and their athletes. This is particularly the case

with smaller sports that, dedicated as they are to drug-free sport, lack the resources to undertake enforcement proceedings without detracting from their other core functions. Cultural issues also may arise where a sport, wanting to treat its athletes more like family, is confronted with the prospect of having to prosecute them vigorously. ASADA will bring independence to that process.

Adoption of the WADC provides standardised anti-doping rules throughout Australian sport and the step towards centralising enforcement of anti-doping rule violations is an obvious and sensible one. It provides the opportunity to develop a specialised pool of knowledge and experience in anti-doping matters that no individual sport is capable of matching. The result should mean that enforcement becomes more efficient, consistent and accurate in its outcomes across sports while at the same time removing a significant burden from individual sports.

Anti-doping rule enforcement can be very complex and holds significant consequences to all those involved. Thus far, sports organisations have been dealing with and learning about anti-doping enforcement largely 'on the run' as ad hoc matters arise within their sport. This has led to results that have at times been unsatisfactory, particularly in cases involving allegations such as trafficking or use of prohibited substances based on evidence other than a positive sample. The cycling cases of 2004-05, and in particular the *French* decision (see .....on p??), provide lessons to those investigating and prosecuting anti-doping allegations, and highlight the need for a prosecution to run more like a criminal prosecution, with specialist people undertaking 'crime scene' investigation, questioning of witnesses and evaluation of evidence with good understanding of the evidentiary requirements to prosecute the offence successfully.

Initial observations

Certainly the vast majority of those involved in the administration of Australian sport will welcome ASADA and happily hand over their anti-doping enforcement to this independent body. There is little doubt it should prove a positive step for Australian sport but, although details are presently thin, there are at least three issues that stand out at this early stage:

1. independence of its functions and appropriate review mechanisms,
2. sufficiency of its powers to compel the giving of evidence, and
3. level of resources.

Independence

ASADA will be responsible for sample collection and testing, investigation of potential doping offences and conduct of the prosecution. These functions need to be sufficiently independent of each other to ensure integrity and accountability, as well as ensuring that matters are given adequate inquiry prior to any decision being made to prosecute.

Independence between investigators and prosecutors has rightly been reflected in criminal investigation and prosecution by the state (ie, police and crown prosecutors respectively). The rationale is that the evidence should be given independent review prior to prosecution to ensure that only matters with sufficient prospect of success are brought before the courts. This serves the dual functions of ensuring efficient use of court resources and providing fairness to an accused by preventing many prosecutions unnecessarily being instituted, such as with 'witch hunts'. An independent prosecution can evaluate the available evidence at face value without being influenced by experiences in the investigation that may cause bias, even where such bias is innocent or subconscious.

Independent assessment of a case against an athlete is also relevant where there has been an adverse analytical finding in respect of a sample. The prosecution should ask the same questions a defendant would ask relating to the integrity of the sample, including collection, storage and chain of custody, or the possibility of contamination. These are all matters that will be within the responsibility of ASADA and the risk is that where one person (or group) is responsible for collection and testing, and also prosecution, any mistake made or matter overlooked at an early stage may remain uncovered. There should therefore be sufficient separation of functions and those responsible for prosecuting an alleged violation must objectively test all evidence collected by others. Where necessary the prosecution should provide useful evidence to the defendant or make a decision to not proceed with a prosecution.

Of course there must also be a procedure for external review of decisions, as with all government departments, and ASADA (like ASDA now) will be subject to the Commonwealth Ombudsman, the Administrative Appeals Tribunal and the Federal Court or Federal Magistrates Court under the *Administrative Decisions (Judicial Review) Act 1977*. Such review does however require a complaint or appeal to be made in respect of action by ASADA and there may well be costs in taking such legal avenues. This again highlights the need for adequate internal checks so as to reduce the risk of inappropriate action in the first place.

Powers to obtain evidence

ASADA investigators must have the necessary powers to obtain evidence and where necessary to compel witnesses to provide evidence. Present indications are that ASADA will not have expansive powers in that regard for fear that it may be too coercive. This writer disagrees with that view. Fears that the coercive power may be abused can be readily addressed through processes of objection and review to and by the courts. Rules may also be developed so that evidence provided under compulsion cannot be used against the deponent. These measures can provide safeguards to protect civil liberties while maximising the usefulness of the evidence gathered in an investigation before an allegation is made.

Individuals can be compelled to give evidence before a tribunal or court through the subpoena process. However, to reduce the burden on the tribunals (and potentially accused athletes), ASADA should be given similar powers so that it has access to all available evidence before deciding whether or not to proceed with a prosecution. The Government appears unlikely to provide such powers to ASADA on the basis that it may be perceived as coercive. It is worth noting that through requirements set out in contracts with AIS scholarship holders those persons questioned in the Anderson inquiry were instructed to do so completely and truthfully. For government to take the view that scholarship holders can be required to provide truthful statements in such an inquiry but not the broader sporting community in similar circumstances seems somewhat confusing. Given the seriousness of doping allegations for an accused athlete and the consequences of doping to sport generally, there is a need to compel the giving of truthful evidence at the investigation stage, with suitable checks and accountability procedures in place to ensure proper use of such power by ASADA.

The Court of Arbitration for Sport (CAS) said in its *French* decision:

"Such offences ought be investigated in a thorough and timely manner and pursued if there is a proper basis for doing so. This requires an assessment of the evidence available and of the prospect of proving the case on the basis of that evidence according to the required standard of proof. Prosecuting authorities should not be dissuaded from that course because of the risk that their case might not be proved."
As the CAS Award notes, the counsel for the ASC in his closing submission "*properly submitted that the evidence did not prove that French had committed a doping offence as defined in the ASC Anti-Doping Policy.*" That assessment arose from the further investigations in the Anderson inquiry and throughout appeal process but the question should be asked whether or not it should have occurred before any allegations were made against the athlete concerned in the first place. While it should be noted that the investigations on behalf of the ASC continued in great detail and at considerable cost to the ASC even after the first hearing concluded in June 2004, it appears that the assessment of all the evidence known as a result of this thorough investigation significantly altered the ASC's earlier view as to whether any doping offence contrary to the ASC policy could be established. Clearly, it is preferable where possible that complete inquiry be undertaken prior to tribunal proceedings being commenced.

It is the view of this writer that ASADA should have power to require sporting organisations to include in their anti-doping policies requirements that athletes and athlete support personnel cooperate fully and truthfully with ASADA investigations under threat of sanction. The ASADA rules should then set out specific procedure for appropriate checks, objections and review in any individual case.

Another issue relating to evidence collection is the power to compel the provision of a DNA sample. Athletes are already compelled to provide blood and urine samples for testing and analysis under the anti-doping regime. The rationale is that any loss of individual liberty is more than offset by the public interest and individual health benefits of drug-free sport. Why should these powers not be taken further to include the provision of DNA samples in cases such as French? The provision of a DNA sample is less invasive than giving a blood or urine sample and accordingly the above rationale should at least equally apply. Again, rules can be developed to ensure that the sample may only be used for purposes relating to an anti-doping rule allegation.

Adequate resources

Having adequate resources is important from the point of view of financial support, but also in securing the services of sufficiently qualified and experienced personnel within each of its core activities. While most anti-doping rule enforcement proceedings arise out of a positive sample, the cycling cases in Australia and BALCO in the United States show the potential complexity and breadth of anti-doping violations under the WADC. These types of prosecutions lie outside the realm of strict liability (as in the case of positive samples) and require in some cases establishing intent and other elements to a standard that may be seen as approaching the criminal standard of beyond reasonable doubt. This standard is reasonable given the effects on an athlete of a proven anti-doping rule violation but it highlights the need for ASADA's investigative and prosecutorial personnel to include individuals with experience and knowledge in investigating criminal matters and correctly identifying, collecting, handling, analysing and preserving evidence.

Of course, there must be sufficient financial funding for ASADA to carry out its functions properly and in this regard I note that the Government has committed to this. An additional $5.87 million is to be provided over the next four years for the establishment and operation of ASADA, in addition to the existing approximately $35 million allocation to ASDA over the same period. It remains to be seen whether there will be any level of 'user pays' with ASDA, particularly with the professional sports, but, as the ASC presently funds anti-doping policy enforcement in any event through its funding of individual sports, there are good arguments for the majority of instances that ASADA to be fully government-funded.

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The Mark French Case

Adam Firth

In December 2003 a plastic bucket, used by Mark French and others as a waste bucket, and a bag were found in a room previously occupied by French at the AIS cycling facility in Del Monte. The bucket was alleged to contain prohibited substances. French was served with infraction notices alleging doping offences, including for use of glucocorticosteroid and/or equine growth hormone (eGH) (both being prohibited substances); or alternatively being concerned in prohibited doping use by others. In June 2004 French was found at an initial hearing of the charge to have breached both the Cycling Australia and Australian Sports Commission anti-doping policies and given (among other consequences) a 2-year ban. French won his appeal of that decision in July of this year, after effectively serving a year of the ban.

French admitted injecting himself with a substance called Testicomp and placing the waste products in the bucket. He named five other cyclists[1] as being involved in group-injecting sessions at Del Monte, although he said he didn't know what they were injecting. An information leaflet that accompanied a used packet found in the bucket indicated that Testicomp contained among its ingredients *Cortisonacetat Dil*, which is a glucocorticosteroid. However, no analysis was done of the bottles of Testicomp to determine whether or not they in fact contained the glucocorticosteroid (or any other prohibited substance). Reliance was simply placed on the leaflet together with the admission. The Court of Arbitration for Sport (CAS) in the *French* case followed its earlier decision in *AOC v Eadie*[2], that for doping allegations, which are very serious to an athlete, the standard of proof requires a higher level of evidence than an assumption based upon written materials accompanying a product. In this instance (as in *Eadie*) it required analysis of the bottles to determine whether or not they did in fact contain a prohibited substance.

Another evidentiary problem involved one of the needles in the bucket, which was shown to contain eGH. There was, however, no analytical proof that it was French who actually used the needle, as compared to another person, nor could it be concluded with sufficient certainty that the eGH was in the needle when it was used and not subsequently contaminated by another source while sitting in the bucket. As part of his inquiry into these matters, the Hon Robert Anderson QC had DNA analysis undertaken on the bucket materials. Jobie Dajka, Sean Eadie and Shane Kelly provided comparative DNA samples but French did not. Of the 230 items in the bucket that were tested, 74 were from a single source DNA profile and seven were matched to Dajka[3]. Four of the items yielded a mixed DNA profile, which was consistent with having been contributed to by both the "unknown male" and Dajka. The needle shown to be containing the eGH was matched to the "unknown male". The evidence did not show whether the needle was capped or where in the bucket it was located. It was conceded that, if the needle was at the bottom of the bucket near to liquid residue found there, it was possible that it could have become contaminated after use.

Further to the above, the CAS was critical of evidence of the safe chain of custody of the materials from the time that they were found until the time that they were analysed to ensure that the materials were not contaminated or otherwise affected. All these matters affect the reliability of evidence before the CAS in matters where a standard of proof above mere balance of probabilities is required because of the significant consequences by which an accused person is confronted.

Had the investigation been better performed it is to be hoped that sufficient and reliable evidence would have been put before CAS to prove the anti-doping rule violation or a decision made that there was insufficient evidence to successfully prosecute the allegation. Either scenario is preferred to what in fact took place, which was a protracted process of some 18 months, with no doubt several hundred thousand dollars or more in costs incurred, and significantly an athlete serving a ban from competition for more than a year for an offence that ultimately was shown on appeal to not have been sufficiently proven.

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1. Shane Kelly, Sean Eadie, Jobie Dajka, Brett Lancaster and Graeme Brown. Other than Dajka (see note 3), no action was taken against any of these cyclists, and other evidence did not substantiate the claims.
2. CAS (A4/2004) Partial Award 21 July 2004. In that case, allegations were made against Eadie of trafficking because a parcel addressed to him contained tablets labelled as containing anterior pituitary peptides (APP). CAS held that the case was not proved against him without analytical proof that the tablets contained APP.
3. This finding resulted in an investigation by the Australian Olympic Committee against Jobie Dajka, which ultimately led to his non-selection to the Australian Olympic team for bringing himself into disrepute in breach of his Team Membership Agreement by lying to the Hon Anderson QC during the inquiry in saying to him that he did not inject.

Ethics and doping in sport: an issue of context?

What is sport?

Both Radford (1998) and Wright (1998) argue that sport is more than entertainment and business. They assert that there is some sort of deeper quality that defines sport. This quality is something beyond winning, something more worthwhile. They argue that modern sport cannot be understood simply as a profit-driven business open to the market forces. Radford talks of ethical and moral codes of conduct that are part of this deeper quality that makes participation in sport "worthwhile". Indeed this is the essence of the amateur sports person: someone who is involved in sport for the enjoyment of the process.

Sport, however, is different things to different people. The context in which the sport operates and is contested makes a significant difference to what is acceptable and what is not. This applies equally to behaviour on and off the sporting field. Take, for example, the professional foul. In elite competition this might be seen as quite acceptable behaviour to ensure that the player's team secures a victory. On the other hand, the same action in the context of junior sport will more likely be considered unethical, or "the wrong thing to do". The point is that, depending on the context, the unwritten codes of conduct will differ. Importantly, this must also mean that what sport is about in different contexts has implications for what the outcome of participation means to the athlete.

In the amateur contest the athletes do not compete for money. They are in it for the challenge, the enjoyment, and perhaps the attainment of other ideals of sport such as fitness, health or the pursuit of excellence. This is very different from the full-time professional athletes who first and foremost must make a living from their chosen profession. By and large this will depend heavily on results obtained on the sporting field. This can be (and usually is) quantified fairly easily in terms of winning and losing. The aims of the amateur and the professional will clearly be quite different because the context is very different. Sport may have certain qualities that distinguish it from other forms of entertainment and business. However, these qualities really do depend on the nature and context of the sport. Heikkala (1993) and Volkwein (1993) both contend that, in certain situations such as many professional sports, these qualities are lost. Whether or not this is desirable is questionable. The public, the media, and we as sports scientists can debate the loss of the central qualities of sport at this level. However, the fact remains that at the professional level sport must maintain a business model.

Context and ethics in sport

It is our thesis that the context in which a particular sport is played influences the moral code that is accepted by the participants. An extension of this hypothesis means that the illicit use of performance-enhancing substances is seen as a necessary part of "making a go" of many top level sports. Take the transparent professionalism evident in the National Football League (NFL). Clubs are simply franchises that run to make money. In this system outcomes and sponsorship depend entirely on winning football matches. Contrast this with a local soccer match at a club level. Players are amateurs. They play for no financial reward. Indeed there will be a financial cost for them simply to participate. It is our argument that media and personal reactions to the use of banned substances at these different levels should be quite different.

At first glance the use of banned performance-enhancing substances seems completely wrong. The minority who are caught are labelled by the media and public as cheats, which of course they are because they are breaking the rules of their sport. However, a closer examination of the issues behind banning certain substances reveals that this position is less clear cut.

Why are certain performance-enhancing substances banned?

In a nutshell, substances may be banned because they are illegal in most countries, they are not a food and provide an unfair advantage or they are health harming. In 1996 Juan Antonio Samaranch, then President of the International Olympic Committee (IOC), defined doping as:

"Doping is cheating. Doping is akin to death. Death physiologically, by profoundly altering, sometimes irreversibly, normal processes through unjustified manipulations. Death physically, as certain tragic cases in recent years have shown. But also death spiritually and intellectually, by agreeing to cheat and conceal one's capabilities, by recognizing one's incapacity or unwillingness to accept oneself, or to transcend one's limits. And finally death morally,

by excluding oneself de facto from the rules of conduct required by all human society."

More specifically WADA gives the rationale for a World Doping Code as:

"Anti doping programs seek to protect what is intrinsically valuable about sport. This intrinsic value is often called the spirit of sport; it is the essence of Olympism; it is how we play true. The spirit of sport is the celebration of the human spirit, body and mind, and is characterized by the following values:

1. Ethics, fair play, and honesty
2. Health
3. Excellence in performance
4. Character and education
5. Fun and joy
6. Team work
7. Dedication and commitment
8. Respect for rules and laws
9. Respect for self and other participants
10. Courage
11. Community and solidarity."

We contend that the basis for banning substances, although sound in principle, may suffer some problems in practice. These are critically examined below.

Illegal substances

Some substances (eg, marijuana) are banned not because they are performance-enhancing but because they are illegal in most countries. Why should the IOC and sporting bodies concern themselves with this? Surely this would be a police matter in that country? Why are athletes more in need of being "clean" of these illegal substances than others in the community? Surely, workers such as pilots, bus drivers, teachers or police for example are in a position where they hold more responsibility in society than athletes? It is acknowledged that in certain situations it is not safe for competitors to be competing in an altered mind state. However, this is no different from any other member of the public. It is our contention that testing athletes specifically for illegal but non performance-enhancing substances is an invasion of civil liberties. This invasion is not offset by the gains made by the possibility of having drug-free athletes.

Substances potentially harmful to health

This appears to be the key area, and we agree with this. Substances are banned because there is scientific evidence that they may be health harming. On the other hand, many sports are inherently dangerous (eg, motor racing, cycling, boxing) but they continue to enjoy participation. Training for most elite endurance and speed sports can be detrimental to an athlete's health simply because of the physical and mental demands. Training and competing at the highest level may make the athlete more susceptible to injury and illness. It is well known, for example, that extensive endurance training suppresses immune system function.

The substance is not a food and provides an unfair advantage

If a substance has a performance effect and it is not a food then it may be banned. What are the reasons for banning non-foods that are performance-enhancing? The IOC Medical Commission argues that performance-enhancing substances mean that athletes are unable to compete on a level playing field. The level playing field argument is not sufficient. Perhaps the use of some performance-enhancing substances pales into insignificance when you consider the entourages that support modern elite athletes from some countries. The line taken by some is that non-foods are simply "not natural". Performance gains from these substances are therefore above and beyond what a human being might expect under "normal" conditions. What about cases where the substance is taken for therapeutic purposes? Surely, this induces an unnatural state. However, some argue that returning an athlete to a "normal" state is different. What about gains in performance through elaborate and expensive training regimes and/or equipment? For example, if the danger of using red blood cell booster erythropoietin (EPO) is that the blood becomes dangerously thick because of the increased red cell mass, then the other endurance boosters which have exactly the same effect need to be examined. It is not uncommon for an elite athlete to achieve an elevated haematocrit through altitude training, altitude simulation or altitude tent sleeping. All of these methods are expensive, not unilaterally accessible and potentially dangerous to health in the same way as EPO. These differences here need to be defined more clearly by the IOC Medical Commission and WADA.

Black (1996) argues that societal welfare would actually be improved with drugs in sport unregulated. Black contends that a fairer contest and improved access to medical advice for athletes would lead to better overall outcomes. Similarly, it has been argued that the above criteria for banning certain substances are simply not reasonable in the context of modern professional sport (Konig, 1995, Volkwein, 1995). Professional athletes compete for money to make a living. Winning is what they must do on a regular basis. Losing with dignity may be the nice thing to do. Right or wrong, this is the reality for many of our top sports people in what is clearly a competitive and cutthroat business. As sports scientists we can debate the problems with such an attitude. But this is the attitude of many, if not most, elite athletes.

The paradox of the Olympics

An interesting paradox exists in the marketing of the Olympic Games. The Games are sold to the public as the pinnacle of human excellence. They have a "wholesome" feel replete with national pride, tradition and ceremonies. On the other side exist the politics, power plays, corruption and big business that is the modern Olympiad. Athletes compete in conditions of professional sport where an Olympic gold medal is as good as money in the bank. The future livelihood of the athlete and his/her entourage (including sport scientists) is dependent upon producing results. The context in which the athlete and support staff operate is vastly different from that sold to the public.

Since the virtual abolishment of the amateur athlete in the 1992 and 1996 Olympic Games, it is our opinion that the IOC has failed to come to terms with the effect this change has had on the context in which business is now conducted. The rhetoric continues from the IOC about the frontline campaign against drugs in sport. But until the real issues are dealt with, the present farce will continue.

The future of sport

So what of the future of sport as we know it? What can be done, if anything, to stem the use of performance-enhancing substances that have a negative effect on sport? What can be done to return some of the ethos to top-level sport? A number of options and possible outcomes are discussed below.

A free for all?

Under this scenario the use of any performance-enhancing substance is legalised. This situation is unlikely to work because publicly-funded sports programs would simply not be tolerated by the taxpayer under these circumstances. Funding for sports programs would need to come from the corporate sector. Athletes would then be competing for their corporation rather than their country. This would destroy the concept of the modern Olympics. Given the business interests in the modern Olympics, this is unlikely.

A second disadvantage would be that the role models that sport stars portray would be unattainable without doping. This may indirectly promote the use of performance-enhancing drugs in lower level competitions. For example, recreational bodybuilders may take anabolic steroids because they feel that that is the only way they can achieve the look of the drug-boosted bodybuilders they see in magazines. Many would argue that this is the present situation in sport anyway.

Finally, athletes who choose not to take performance-enhancing drugs would find themselves at a competitive disadvantage and may feel pressure to engage in doping. As mentioned above, critics would argue that this is no different to the present situation in many sports. In cycling, for example, it is the belief of many athletes that it is impossible to maintain a position at the top of the sport drug-free.

Doping control that is effective

If the public continues to regard the use of performance-enhancing substances as unethical, then real contingencies need to be put in place. By real contingencies, we mean doping detection procedures that guarantee in the strictest letter of the law that those who are doping will be caught and appropriately sanctioned. The large number of legal challenges to drug violations would suggest that this is unlikely. However, this scenario still seems to be the most popular idea. Indeed all that needs to be developed is a method whereby athletes do not take banned substances. There are three possible ways to stop athletes doping.

1. Change human nature. That is, change the propensity to cheat, the need to achieve the end by any means available. Change the belief that winning is the most important outcome of a sporting contest.
2. Develop technology capable of 100% detection of illegal drug use. This would eliminate the drug problem instantly as long as the means to do so were freely available. No athlete would take the drugs for competition purposes if they knew they were going to get caught and appropriately sanctioned. This technology would not stop recreational users who do not compete.
3. Develop performance-enhancing substances that do not possess any harmful side effects. This effectively eliminates two of the three reasons utilised by the IOC Medical Commission, and the level playing field argument pales into insignificance once the first two issues are dealt with. If new substances could be produced which could provide the same benefits without the side effects, then there is little in the way that can be done to distinguish them from substances presently not banned such as creatine monohydrate or glycerol.

A change in the human condition (Option 1 above) is never going to happen -- morality cannot be legislated. Increases in penalties for those caught doping are also unlikely to be effective. One way of moving morality back in the right direction might be a return to the amateur athlete. Because athletes would be competing at a non-professional level the context would change and the old ethics of sport might be applicable again. It is difficult to see how this could happen given the nature of sport as a consumer good. Legislating against the professional athletes is fraught with difficulties as history tells us.

Finding an effective testing procedure which is perfect and unbeatable is feasible but it is obviously many years off at best. Developing non-harmful substances is similar to developing effective testing procedures. The technology is clearly a long way off. Interestingly, the latter two options revolve around technology.

Conclusions

The issue of ethics in modern professional sport is an issue of the context in which the sport is played. Doping, one of the most contentious issues in modern sport, is an ethical issue. As a result doping may be regarded by athletes as acceptable under certain conditions. It is argued that the conditions of professional sport provide a suitable context for doping to be acceptable. Interestingly,

the Olympic movement is struggling with this concept as the emphasis in the Games moves from amateur to professional sport. To solve the doping problem in modern sport several actions are needed.

Firstly, the IOC Medical Commission needs to develop a doping policy that is defensible. The present reasons for banning substances are not necessarily sound in the context of the professional athlete. Doping might be controlled by changing human nature and the attitude towards winning at all costs. If history gives any clue to the future behaviour of the human race this appears an unreasonable goal. Developing technology to ensure detection and sanctioning of athletes involved in doping practices or producing effective and safe performance-enhancing substances both appear to be worthwhile goals. Technology is the key to the future of sport and sport scientists clearly have a role to play.

The public's unfavorable view of health-harming but performance enhancing substances is unlikely to change. Similarly, the financial rewards and "win at all cost" mentality of elite sport are unlikely to change in the foreseeable future. So the solution must be safe ergogenics or safe use of ergogenics. Those athletes who take performance-enhancing substances under this regime would at least be able to seek overt advice from experts. The experts would have an incentive to find out about the best usage and associated health risks of those substances. Although not an ideal outcome because some athletes will unnecessarily feel a need to take substances in order to be competitive, the situation would at least be better for the overall health of athletes than the present high covert use of such substances. A better solution is only possible through a resolution of the present mismatch of public perception of sport ethics and the pressure to perform placed on our athletes by the same public. This will not be resolved in the foreseeable future.

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Another good year: ASC Annual Report

The year 2004-05 was another good year for Australian sport, say Chairman Peter Bartels and Chief Executive Officer Mark Peters, and a year of substantial achievement for the ASC itself.

In the ASC annual report for 2004-05, they highlight "unprecedented levels of support from the Australian Government" for the role of the Australian Sports Commission in enhancing Australia's national sports system.

The 2005-06 Federal Budget provided "significant additional funding to support national sporting organisations and high performance athlete development," they report.

"Of special note, the Budget included funding to establish a training base in Europe with accommodation, training facilities and equipment storage, and where high-quality sports medicine, sport science and other support services can be provided to Australian athletes training and competing in Europe.

"The primary purpose of the European training centre is to facilitate consistent and regular training and competition in Europe by offering a high level of support service, at a lower cost, that Australian sports currently receive. The ASC has entered into a partnership with the Province of Varese in northern Italy to develop a purpose-built centre, design work on which has commenced, and it should be operational in 2007.

"This is an innovative and exciting development for Australian sport, which should provide distinct benefits to our athletes in the lead-up to the 2012 Olympic and Paralympic Games in London, and beyond."

Funding for sports

The following table shows the allocations of grants to particular sports in 2004-05.

SPORT	AIS	HIGH PERFORMANCE	SPORT DEVELOPMENT	OTHER*	TOTAL
Archery	558 500	310 000	25 000	3 000	896 500
Athletics	1 095 000	2 370 000	135 000	292 162	3 892 162
Australian football	200 000	111 000	200 000	60 000	571 000
Badminton	–	155 000	25 000	0	180 000
Baseball	–	1 190 000	135 000	49 000	1 374 000
Basketball	1 080 400	2 220 000	200 000	310 500	3 810 900
BMX	–	89 000	80 000	102 000	271 000
Bocce	–	26 000	25 000	0	51 000
Bowls	–	378 000	135 000	267 750	780 750
Boxing	314 900	105 000	50 000	3 000	472 900
Calisthenics	–	0	25 000	2 000	27 000
Canoeing	657 000	1 235 000	100 000	0	1 992 000
Cricket	488 700	361 000	190 000	167 500	1 207 200
Croquet	–	0	10 000	0	10 000
Cycling	1 196 700	2 280 000	110 000	71 000	3 657 700
Diving	445 500	470 000	25 000	0	940 500
Equestrian	–	1 240 000	80 000	25 000	1 345 000
Fencing	–	30 000	25 000	0	55 000
Golf (men)	196 750	242 000	60 000	120 000	618 750
Golf (PGA)	–	–	60 000	0	60 000
Golf (women)	196 750	201 000	20 000	65 000	482 750
Gymnastics	1 055 000	990 000	206 667	10 000	2 261 667
Handball	–	30 000	–	0	30 000
Hockey	964 200	3 240 000	156 667	190 000	4 550 867
Ice racing	–	65 000	5 000	0	70 000
Ice skating	–	52 000	10 000	0	62 000
Indoor cricket	–	219 000	15 000	0	234 000
Judo	–	385 000	15 000	10 000	410 000
Karate	–	158 000	25 000	3 000	186 000
Lacrosse (men)	–	0	25 000	7 500	32 500
Lacrosse (women)	–	0	25 000	0	25 000
Modern pentathlon	–	40 000	–	0	40 000
Motor sports	–	277 000	60 000	0	337 000
Motorcycling	–	308 000	60 000	0	368 000
Netball	573 400	726 000	170 000	246 200	1 715 600
Orienteering	–	76 000	60 000	0	136 000
Parachuting	–	38 000	–	0	38 000
Polocrosse	–	61 000	60 000	0	121 000
Pony clubs	–	30 000	25 000	0	55 000
Powerlifting	–	32 000	5 000	0	37 000
Roller sports	–	189 000	145 000	108 000	442 000
Rowing	1 392 700	3 070 000	80 000	0	4 542 700

SPORT	AIS	HIGH PERFORMANCE	SPORT DEVELOPMENT	OTHER*	TOTAL
Rugby league	200 000	111 000	150 000	185 000	646 000
Rugby union	200 000	111 000	170 000	150 000	631 000
Sailing	393 000	2 270 000	135 000	210 000	3 008 000
Shooting (association)	–	1 160 000	70 000	10 000	1 240 000
Skiing	–	570 000	15 000	10 000	595 000
Soccer	1 070 800	4 233 000	141 667	50 000	5 495 467
Softball	373 600	1 302 000	150 000	208 000	2 033 600
Squash	364 000	370 000	110 000	9 500	853 500
Surf lifesaving	–	270 000	150 000	80 000	500 000
Surf riders	–	380 000	80 000	300 000	760 000
Swimming	1 089 900	3 265 000	110 000	275 000	4 739 900
Synchronised swimming	–	60 000	–	0	60 000
Table tennis	–	85 000	45 000	40 000	170 000
Taekwondo	–	625 000	25 000	4 000	654 000
Tenpin bowling	–	283 000	80 000	60 000	423 000
Tennis	447 700	165 000	150 000	220 000	982 700
Touch	–	251 000	135 000	110 000	496 000
Triathlon	299 400	625 000	90 000	25 944	1 040 344
Universities	–	30 000	–	0	30 000
Volleyball	1 000 600	1 130 000	60 000	100 000	2 290 600
Water polo	953 500	1 435 000	60 000	0	2 448 500
Water skiing	–	331 000	20 000	4 750	355 750
Weightlifting	–	320 000	20 000	30 000	370 000
Wrestling	–	30 000	–	0	30 000
Other — deaf sports		25 000	–	0	25 000
Other — winter sports	370 000	–	–	0	370 000
Dragon boat	–	–	–	4 000	4 000
Ice hockey	–	–	–	4 200	4 200
Total	17 178 000	42 436 000	4 830 001	4 203 006	68 647 007

*excluding Aussie Able grants

SPORT	AIS	HIGH PERFORMANCE	SPORT DEVELOPMENT	OTHER*	TOTAL
Australian athletes with a disability	–	197 600	–	–	197 600
Australian Blind Sports Federation	–	77 500	–	–	77 500
Riding for the Disabled	–	80 225	–	–	80 225
Disabled Winter Sports	–	45 000	–	–	45 000
AUSRAPID	–	87 775	–	3 000	90 775
Special Olympics	–	45 000	–	–	45 000
Deaf Sports	–	99 200	–	28 443	127 643
Transplant	–	55 850	–	–	55 850
Paralympics	–	5 750 000	–	–	5 750 000
Total		6 438 150		31 443	6 469 593

*excluding Aussie Able grants

Junior Sport

Another major area of interest in the ASC annual report for Sport Health readers concerns national junior sport, which incorporates the Active After-school Communities program and other junior sport initiatives that help develop safe, fun and quality environments for sport for young people.

Active After-school Communities

The Active After-school Communities program, a major component of the Australian Government's Building a Healthy, Active Australia package, is a four-year $90 million program launched in June 2004 to provide more opportunities for primary school-aged children to participate in structured physical activity in the after-school timeslot. The ASC has employed 147 staff at national, state and regional levels to develop and implement the Active After-school Communities program, the report says.

"Nineteen schools and out of school hours care services participated in the pilot program in term 1 of 2005.

"The first phase roll-out of the Active After-school Communities program has been successfully completed, with 897 primary schools and out of school hours care services nationally participating in the program in term 2 of 2005.

"These schools and out of school hours care services have received a total of $1,516,716 in grants to assist them in running the Active After-school Communities program. This first phase has engaged 37,557 children across Australia.

"Over 5,000 deliverers, including local club personnel, teachers, private providers and students, have completed the Active After-school Communities Community Coach Training Program. This training program has a strong philosophical approach that incorporates strategies which ensure children are maximally engaged in structured physical activity that is high quality, fun, safe and inclusive.

Junior Sport Framework

The ASC continued to provide leadership to national sporting organisations in adopting the Junior Sport Framework and developing junior sport-specific policies. The ASC has been working closely with nine pilot national sporting organisations during the development of their junior sport policies. These nine sports are swimming, netball, tennis, golf, football, basketball, hockey, wrestling and volleyball. The policies and processes undertaken by these sports will be documented and shared with other sports. An additional 26 national sporting organisations have requested and received copies of the Junior Sport Framework.

Other initiatives

During the reporting period, the ASC also continued with the implementation of the following initiatives:

- Out of School Hours Sports Program — in partnership with VicHealth, Northern Territory Health and the South Australian Office for Recreation and Sport, the ASC has been involved in piloting out of school hours sports programs in their respective states and territories. All the pilots are in their final year, and the research and evaluation of the pilots will be made available on the completion of each pilot. These pilots have informed the development of the Active After-school Communities program. All of the out of school hours care services involved in the Victorian pilot have been invited to participate in the Active After-school Communities program.
- Active Australia Schools Network — the ASC continued its partnership with the Australian Council for Health, Physical Education and Recreation to assist the development of school–club links. The Active Australia Schools Network supports more than 1100 member schools representing metropolitan and non-metropolitan schools (including regional and rural) around Australia.
- Good Sport Monitor — the Good Sport Monitor program supports safe, fun and nurturing junior sport environments by making resources and strategies available to sporting clubs and organisations that can be modified and implemented to address inappropriate behaviour in junior sport. The pilot was conducted in the ACT with four sports: basketball, tennis, netball and football. The results of the pilot will be made available for other sports to implement."

Athlete and Coach Services

The report points out that the major responsibility of AIS's Athlete and Coach Services is to support such areas as clinical disciplines and sports science. Twenty AIS-employed staff were seconded to the Australian Olympic Committee to support the Athens teams. Staff also conducted research to identify best practice in elite athlete development and to provide innovations to the AIS and Australian elite sport network, some of which were utilised at Athens.

Some brief reports on activities of special interest to *Sport Health* readers follow:

Biomechanics

Biomechanics has continued its cutting-edge reputation in the areas of technique enhancement, competition analysis and specialised feedback procedures for the coach and athlete in a variety of AIS sports. Biomechanics is organised into five streams, with each stream concentrating on servicing a particular sport (canoe/kayak, cycling, rowing, swimming, and track and field). Each stream includes a biomechanist, a professional support officer and a postgraduate scholarship holder. In addition to focusing on these sports, Biomechanics provided access to all other AIS sports for biomechanics services as required.

Cricket Australia funds a sub-stream within the department and this includes a professional support officer, a postgraduate scholarship holder and a PhD scholarship holder. In addition to the above staff, the Biomechanics department has a research and development technical officer, a maintenance technical officer and an office administrator. During the reporting period, Biomechanics had five postgraduate scholars and a PhD scholarship for the 12-month period, as well as two staff completing their PhDs.

Sports Medicine

The department continued to deliver outstanding sports medicine services to AIS and other elite athletes. Research within Sports Medicine in 2004–05 focused on fatigue in elite athletes, haematological and biochemical screening of athletes, the interpretation of blood test results in elite athletes, tendon injuries and osteitis pubis. PhD-level research was conducted on the effects of a range of alternative therapies on muscle soreness and inflammation. The department forged strong links with the new ANU Medical School, which will lead to increased research opportunities in the future.

Nutrition

The AIS Recovery Bar program and copies of Survival Around the World (the third in the series of the AIS Survival cookbooks) were provided to all Australian Olympic sports programs via Medical HQ. Both received much positive feedback. The department embarked on the last year of the four-year contract with Deakin University, due to finish in December 2005. The AIS Sports Supplement Program, managed by the Nutrition department, has increased its recognition at national and international level, with plans to expand its availability to national sporting organisations and the state and territory institute and academy of sport network. The Gatorade and Nestlé Fellowships in Nutrition continued to be successfully conducted.

Performance Analysis

Performance Analysis supports coaches in their observations and analyses of athlete performance in training and competition. Staff work with coaches to identify how innovations in information and communications technology

can improve their effectiveness as coaches. Staff work closely with colleagues in Athlete and Coach Services to develop integrated approaches to performance excellence. During the reporting period, Performance Analysis worked with all AIS sports to deliver a variety of services. During 2004–05, Performance Analysis was also involved in developing a corporate digital repository to store and share digital resources around the AIS Canberra campus.

Performance Psychology

With a greater emphasis on evidence-based practice in service delivery, the Performance Psychology department has completed over a dozen projects with sports that quantify the impact that mental skills have on performance. A substantial up-skilling of AIS performance psychologists that service sports has also seen a greater acceptance of psychological services that deliver tangible results.

Skill Acquisition servicing expanded from focusing solely on AIS developmental programs to supporting some elite-level national sporting organisation programs. Research activity was aimed at identifying avenues to further develop athlete perceptual motor skills outside of the usual practice environment. To this end, a three-dimension visual simulator and a number of computer-based vision training tools were developed and implemented. Skill Acquisition also had a strong educational role through the supervision of sport-based PhD scholars and ongoing involvement in a variety of coach education programs.

Physiology

The Physiology department provided intensive support to a range of AIS sports and national sporting organisations, with the pilot sport-based PhD scheme continuing to provide a vehicle for high levels of direct interaction with coaches and athletes. The capacity for effective monitoring of athletes in their normal training and competition environments was enhanced by the availability of new equipment developed jointly with the Cooperative Research Centre for MicroTechnology. Devices originally developed for use in rowing and swimming were successfully modified for application in numerous other sports.

Physiology staff members assisted in the preparation of Australian athletes for the Athens 2004 Olympic and Paralympic Games, both as members of official scientific support groups travelling with national teams, and through the completion of special projects such as the development of methods to protect rowing boats from excessive water intake in rough conditions. Cooling garments produced through collaboration between AIS Physiology and RMIT University were used by Australian athletes during the lead-up to the Olympics and Paralympics, as well as during Paralympic competition.

A number of the sport-based PhD scholars completed their tenure and new scholars were recruited. A sport-based post-doctoral program was established, enabling the retention of some of the graduating PhD scholars within the national sports system. One of the PhD scholars received a prestigious award from the organisers of the largest sports science/medicine conference in the world.

Major areas of applied research included exercise immunology, environmental physiology, enhancement of recovery from exercise-induced fatigue and refinement of methods for athlete assessment. Physiology staff also played a leading role in a Talent Search initiative aimed at enhancing Australia's competitiveness in the women's skeleton event at the 2006 Winter Olympics.

Physical Therapies

Post-Olympics, the Physical Therapies department has taken the opportunity to finetune servicing to AIS sports in the daily training environment in Canberra, the states and within competition environments. The benchmarking process of the department continued throughout 2004–05 with the project nearing completion. A commitment to research has continued with near completion of projects for the inaugural Beiersdorf PhD Fellow, examining the differences between cyclists and triathletes in electromyographic patterns of the lower limb. Physical Therapies' second PhD scholarship position will examine the relationship between bicycle set-up and performance and injury. A collaborative PhD with Latrobe University has recently been initiated, which will examine aspects of patellar tendinopathy.

Strength and Conditioning

Strength and Conditioning continued its proactive coordination of, and quality-assurance role for, AIS sports located in the states and in Canberra. It also played a leadership role with state and territory institute and academy of sport personnel in the ongoing development of national protocols for testing and exercise prescription to provide consistency for elite athlete development. It has continued its role of service delivery for all Canberra-based sports programs and provided management of all service providers for state-based programs. Staff were made available to the Australian Olympic team to support a new initiative that provided Australian athletes with a recovery and gym facility.

Technical Workshop

Technical Workshop staff provide a high level of electronic and mechanical expertise for all departments within the Athlete and Coach Services and Technical Directions sections. In 2004–05, a priority was to research, design and prototype equipment for the new AIS pool. This has included the mounting system for the force measuring turn wall, a video trolley system and a new force measuring start block.

Other projects that the workshop has been involved with in 2004–05 include the skeleton project, a ruggerised housing for a portable display unit developed for the Performance Analysis unit, an adjustable throwing frame for athletes with disabilities, adjustable load bicycle pedal cranks, strain gauge transducer beams for Biomechanics and dynometer adaptors for a range of bicycles for Physiology.

Applied Sensors

In January 2003, the AIS and the Cooperative Research Centre for MicroTechnology jointly funded a position to design and develop leading-edge software for coaches and scientists. The success of these projects, most of which involve acquisition and automated analysis of data from sensors and video, prompted the name Applied Sensors.

Projects undertaken during the reporting period include a system to analyse training data from sensors attached to swimmers, the successful development of a three-dimensional video aid for computer-based skill-testing, refinements to a PDA-based trackside timing system for cycling and analysis of GPS and sensor data from equipment attached to athletes, boats and sleds. Projects commenced during the period include a new generation swimmer-tracking system for competition and player tracking in Rugby Union.

Technical Direction

Technical Direction provides leadership to Australia's high performance sport through national programs in athlete career and education, elite sports research, talent identification and laboratory standards, in addition to benchmarking services and facilitating discussion on topics of current interest.

Benchmarking, best practice and innovation

The Benchmarking and Innovation program takes a national leadership role in identifying future directions for innovation and world-leading practice for the AIS. It achieves this by researching emerging technologies, innovative service delivery methods, operating strategies and management systems within Australia and overseas.

During 2004–05, the program followed up a benchmarking study on Physiotherapy and Soft Tissue Therapy with an investigation into the value-add of alternative physical therapies, including chiropractic, osteopathy, podiatry, clinical Pilates and acupuncture. A third and final report on Physical Therapies was delivered on a proposed best-practice structure and operational model for Physical Therapies at the AIS. Investigations have also begun into program practices in AIS sports and how sports can optimise the effectiveness of support services.

National Elite Sports Research Program

During 2004–05, the National Elite Sports Research Program established the AIS Sports-based PhD Scholarship Program, and over 50 applications were received from around the world. A total of 11 scholarships were offered (and accepted) involving nine universities and seven sports. Scholarships were filled within the disciplines of physiology, biomechanics and physiotherapy.

AIS research — through the National Elite Sports Research Program and the AIS/National Elite Sports Council's discretionary research program — continued to deliver research outcomes that are recognised for their contribution to scientific knowledge and their practical application to the preparation of Australia's elite athletes. The AIS Research Publications Database at www.ais.org.au/research provides information on research outcomes presented at conferences and/or published by AIS researchers.

National Talent Search

Throughout 2004–05, the National Talent Search program conducted a range of talent detection programs in partnership with state and territory institutes and academies of sport, and directly through the AIS. New programs were conducted in the sports of sprint and endurance track and road cycling; heavyweight and lightweight rowing; sprint, slalom and wildwater canoeing; basketball; orienteering; triathlon; and women's skeleton. These programs were conducted within a broad age group, using a variety of Talent Search models, including the talent transfer approach for many of the older athletes.

Cooperative Research Centre for MicroTechnology

During 2004–05, the AIS continued its productive collaboration with the Cooperative Research Centre for MicroTechnology. The fundamental aim of this initiative is to develop unique unobtrusive monitoring equipment that can be used in training and/or competition. A major highlight of the reporting period was nearly daily use of the fourth generation prototype equipment by AIS and national rowers, and occasional use in national and international regattas. The same equipment was used by kayakers and sailors during training. Late in June 2005, a Melbourne-based company — SportZCo Ltd —signed an agreement to manufacture this unit, which in order to retain a competitive advantage, will be one step below the fifth generation prototypes.

Investment in SportZCo is an extension of the Cooperative Research Centre for MicroTechnology program, with SportsZCo holding the intellectual property emanating from collaboration between the AIS and the Cooperative Research Centre. With minor adaptations, the fifth generation rowing device was found applicable to team sports players and initial trials suggest scope for its use in any outdoor sport. The data generated by the fifth generation units offer unprecedented detail and insight into numerous sports.

The same is true of a device initially produced for swimming but is now being used for hammer throw, running, snowboarding, mogul skiing and skeleton. This device has the potential to be used in all sports that involve repeated jumping and rapid changes of direction.

The ASC's annual report for 2004-05 can be found at www.ausport.gov.au.

Seasonal and geographical analysis of ACL injury risk in Australia

John Orchard, Ian Chivers, David Aldous

There are northern (warm-season) and early-season biases for ACL injuries in the AFL that have been revealed by a long-standing reliable injury surveillance system[1-3]. Recent study has suggested that the underlying explanation for these trends is the relative predominance of high-traction grasses in the northern states and early in the football season[3]. Little is known about the relative risk of ACL injury at non-professional level in Australia or in the NRL competition.

Recently, many media commentators have claimed an increase in injuries on dry sporting fields, possibly caused by drought in Australia and subsequent water restrictions in major centres[4, 5]. Unfortunately there is no national injury surveillance system in Australia to investigate these claims. A national sports injury insurance scheme, the Accident Compensation Corporation (ACC), exists in New Zealand[6]. Although New Zealand has a superior system of monitoring injuries that occur in sport, its methods are not perfect because of lack of exposure data (number of sports participants and matches played). There is also little climatic variation between the different regions of New Zealand to test any hypothesis based on geographical differences.

In the United States, ACL injuries in the NFL show a strong early-season bias for matches played outdoors on Astroturf, but not indoors[7]. There is a small early-season bias for matches played on natural grass. The Astroturf data is consistent with the observation that shoe-surface traction on Astroturf positively correlates with the ambient temperature[8], which is dropping over the course of the season in outdoor stadiums, but not in indoor stadiums.

ACL injuries are particularly common in the major football codes (Australian football, rugby league, rugby union, soccer) and in snow sports. They also occur at a slightly lower rate in basketball, netball, volleyball and martial arts. ACL injuries are thought to be very common in netball, although the likely reason why this is considered a higher risk sport in Australia (compared to basketball) is that it is played mainly by females, who have a much higher relative risk for ACL injuries than males[9, 10].

The first section of this study examines available data for operations performed on the cruciate ligaments across Australia to see whether there is evidence of any northern (warm-season) bias at the community level. Estimates of the number of ACL injuries in Australia can be made, as the Health Insurance Commission (HIC) provides details of the number of item numbers claimed for each procedure under Medicare in each of the states and territories of Australia each month, with data going back to July 1994. The second section of the study examines ACL incidence in the NRL competition to look at both the geographical and temporal spread of ACL injuries occurring in first grade matches.

One hypothesis to be tested is that there will be a northern (warm-season) state bias for number of reconstructions performed in males, due to the popularity and high risk of the football codes, and the expected risk that warm-season grasses in Australia may pose a greater risk of ACL injury. As somewhat of a control, the figures for females will be examined, with the expectation that any northern (warm-season) state bias would be minimal, as the higher risk sports that are popular with females are generally not played on natural grass. The hypotheses to be tested with respect to the NRL data are that there will be warm-season and early-season biases in a similar fashion to the AFL competition.

Methods

HIC data for cruciate ligament primary reconstructive surgery from the decade July 1994 to June 2003 in each Australian state and territory was downloaded from the website

http://www.hic.gov.au/statistics/dyn_mbs/forms/mbs_tab4.shtml.

The item numbers which were assessed were 49536, 49539 and 49542, which cover all primary cruciate ligament reconstructions. Item 49551 was not included, which is used for revision surgery for 49536, 49539 and 49542, where either the first operation has failed or the ACL has been re-injured.

Participation figures for various states were taken from the report by the ABS of Participation in Sport and Physical Activities 1999-2000[11].

Population figures were taken from the Australian Census 2001.

The ACT and Northern Territory are territories rather than states, but will be referred to as states for the purposes the data presentation and discussion.

Table 1 - Major sports at risk for ACL injury in young males, along with estimated grass profiles for various states of Australia

STATE	MAJOR FOOTBALL CODE(S)	PROXIMITY TO SNOWFIELDS	GRASS PROFILE	EXAMPLES OF COMMON GRASS TYPE(S) ON COMMUNITY FIELDS
New South Wales	Rugby league and union, soccer	Close	Mainly warm-season	Kikuyugrass
Queensland	Rugby league and union, soccer	Very distant	Warm-season	Bermudagrass and Queensland blue couch
South Australia	Australian football, soccer	Distant	Mainly cool-season	Ryegrass and annual bluegrass
Tasmania	Australian football, soccer	Distant	Cool-season	Ryegrass and annual bluegrass
Victoria	Australian football, soccer	Close	Mainly cool-season	Ryegrass and annual bluegrass
Western Australia	Australian football, soccer	Very distant	Warm-season	Kikuyugrass and Bermudagrass
ACT	Rugby league and union, Australian football, soccer	Very close	Cool-season	Ryegrass, annual bluegrass, Kentucky bluegrass, fescues.
Northern Territory	Australian football and rugby league	Very distant	Warm-season	Kikuyugrass and Bermudagrass

Comparisons of relative risks with 99% confidence intervals are performed using the Taylor series expansion method[12].

This study also examined ACL incidence data for natural grass surfaces in the NRL to see whether or not there is a northern (warm-season) bias, similar to that seen in the AFL.

A player status for all first grade players in the NRL was kept by the author over the time period 1999-2004 inclusive, based on media reports of injuries. Where players were missing through injuries and the diagnosis was available in the media, a record of injury was kept. Media reports are definitely not 100% accurate, yet for serious diagnoses like ACL tears in professional sport the accuracy probably approaches 100%[13]. ACL injuries are so important and serious (particularly the vast majority which require immediate surgical reconstruction) that, if a first grade player suffers one in a major game, it is almost certainly reported extensively in the media. Surface characteristics for each stadium were assessed by the primary author (who as club doctor for the Sydney Roosters visited each ground once per year on average) in conjunction with Michael Finch, the ground manager for Aussie Stadium (Table 2).

Table 2 – Grounds analysed in the NRL

STATE	GROUND	GRASS TYPE
NSW	Aussie Stadium, Sydney	Bermudagrass and ryegrass
	Telstra Stadium, Homebush	Bermudagrass and ryegrass
	Showgrounds, Homebush	Bermudagrass and ryegrass
	Campbelltown Stadium	Bermudagrass and ryegrass
	Leichhardt Stadium	Kikuyugrass
	OKI Jubilee Stadium, Kogarah	Kikuyugrass and ryegrass
	Brookvale Stadium	Kikuyugrass and ryegrass
	Penrith Stadium	Kikuyugrass and ryegrass
	Energy Australia Stadium, Newcastle	Bermudagrass, ryegrass and Kikuyugrass
	WIN Stadium, Wollongong	Bermudagrass and ryegrass
	Parramatta Stadium	Bermudagrass and ryegrass, 2003-04 some annual bluegrass ('poa')
	Express Advocate Stadium, Gosford	Bermudagrass and ryegrass
	Toyota Park, Cronulla	Bermudagrass and ryegrass
Queensland	Suncorp Stadium	Bermudagrass and ryegrass
	ANZ Stadium	Bermudagrass and ryegrass
	Dairy Farmers Stadium	Bermudagrass
ACT	Canberra Stadium	Ryegrass
Melbourne	Olympic Park	Ryegrass
New Zealand	Ericsson Stadium	Bermudagrass. ryegrass and annual bluegrass

Results

The states and territories of Australia are listed in Table 1, along with the most common football codes played, proximity to snowfields and expected major grass types on football fields.

The number of cruciate ligament reconstructions performed in the private system over the decade 1994-2003 are listed in Table 3. The majority of these were in people aged 15-44, with reconstructions more common in males than females. Population figures for Australia in 2001 from the Census data are listed in Table 4.

Table 5 and Table 6 show estimates, for males and females respectively, of participation in those sports considered to have a significant risk of ACL injury. For males, sports were grouped into high risk sports (outdoor contact football codes and snow sports) and medium risk (touch football, basketball, netball, volleyball and martial arts). For females, a single group of high risk sports was created (netball, soccer, Australian football, snow sports, touch football, basketball and martial arts). Participation numbers were taken directly (or estimated, for shaded figures) from the ABS report[11]. Participation data for other popular sports such as cricket, tennis, hockey, swimming, cycling, running, golf and aerobics were not considered in this analysis as the risk of ACL injury in these sports was considered to be low.

Table 7 shows the ratio of male to female reconstructions (among age group 15-44) in each state. There were more reconstructions performed in males in every state, despite that the relative risk of ACL injury is known to be higher in females. The explanation is almost certainly a participation bias, with males far more likely to participate in higher risk sports (Table 5 and Table 6). The male:female ratio was higher in the warmer northern states of Queensland, Western Australia and New South Wales, and lower in the cooler states of Tasmania, Victoria, South Australia and the ACT.

Table 8 shows the percentage of various populations estimated to have undergone cruciate reconstruction over the decade July 1994-June 2003. Although there are many assumptions and systematic errors within these estimations, the errors may be similar for each state. Table 9 shows the risk for each state compared with the Australian averages (including 99% confidence intervals for the rows involving male and female reconstruction rates per high risk sport participant). These figures show a significantly lower cruciate reconstruction rate in males in Tasmania (compared to the rest of Australia) with a similar trend in Tasmanian females that was not nearly as strong. In males there is also a significantly lower reconstruction rate in Victoria and, with respect to participation in high risk sports, a higher rate in Queensland and Western Australia, neither of which is seen in females.

For the section of the study involving ACLs occurring in the NRL, there were 51 reported ACL injuries occurring in first grade matches (including representative matches and finals) over the period 1999-2004 inclusive. There were eight in 1999, seven in 2000, eight in 2001, thirteen in 2002, nine in 2003 and six in 2004.

There was no obvious northern bias present for ACL injuries (Table 10), with the rate of injuries at northern venues (18.2/1000 games) being comparable to Sydney venues (21.8/1000 games) and southern venues (23.4/1000 games). The highest individual stadium rates were Ericsson Stadium in Auckland and Parramatta Stadium, both of which have generally had a mixed grass profile of annual bluegrass, ryegrass and bermudagrass, although the ACL injury rates at both of these venues was not substantially higher than other grounds.

There was no significant difference between grounds with a bermudagrass profile in the early season (17.1/1000 games) and grounds with a kikuyugrass profile in the early season (26.9/1000 games), although kikuyugrass stadiums had higher absolute rates of ACL injury. The relative risk for kikuyugrass compared to bermudagrass was 1.58 (95% CI 0.80-3.11).

There was however a strong early-season bias, with 33 ACL injuries occurring in rounds 1-13 of the NRL season and only 16 occurring in rounds 14-26 or the finals (risk ratio 2.1, 95% CI 1.1-3.8).

Discussion

The first section of this study examines Medicare data for cruciate reconstruction in the various states of Australia. Medicare is responsible for all insurance claims in the private hospital setting, which is where the majority of ACL reconstruction surgeries take place. ACL reconstructions are performed in public hospitals on public patients, but a waiting list of 1-2 years makes this option a difficult one for active sportspeople. Therefore many young Australians who play the sports that are at risk of ACL injury will either have private health insurance to use if they suffer an ACL injury or will pay for the procedure privately using cash and/or the proceeds from alternate sports insurance. Table 11 shows that private health insurance rates are fairly similar in each state[14] with in fact Tasmania having the highest rate of private health insurance and Queensland the lowest.

The HIC item number data also cover ACL injuries that do not occur playing sport (other than work-related or traffic accident injuries) and PCL reconstructions, although these would be small in number, as most ACL injuries are either sport- or work-related and most PCL injuries are not reconstructed.

It is presumed that the majority of sports-related ACL injuries occur in sports listed in the results. The majority of the high risk sports in which males participate are played

Table 3 – Primary cruciate ligament reconstructions performed in the private medical system in Australia over the decade July 1994 - June 2003

STATE	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	AUST
Cruciate ligament reconstructions	18822	12165	8145	5056	5580	671	1423	584	52446
Males aged 15-44	11869	7241	5113	2989	3456	404	794	352	32218
Females aged 15-44	5360	4017	2386	1763	1733	232	493	194	16178

Table 4 - Population for states of Australia (by state and for males aged 15-44), 2001 Census

STATE	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	AUST
Population (total)	6593840	4784260	3592503	1519607	1874670	483666	322089	197780	19368414
Males aged 15-44	1358610	1006297	763135	307897	405864	91853	72743	51678	4058077
Females aged 15-44	1367095	1026791	778122	304903	404386	95058	74477	47754	4098586

Table 5 - Participation rates in high risk sports for males, by state, Australia 1999-2000 (Australian Bureau of Statistics) 11

MALES	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	AUST
Aussie Rules	12000	84400	10000	31600	25800	8000	2000	1500	184000
Rugby total	85000	1000	35000	500	3000	0	4000	2500	121600
Soccer	67500	26300	20900	14300	20200	4000	3400	1700	158200
TOTAL Outdoor football	164500	111700	65900	46400	49000	12000	9400	5700	463800
Snow Sports	48300	38700	3000	3800	2000	1000	4100	500	106200
TOTAL high risk sports	212800	150400	68900	50200	51000	13000	13500	6200	570000
Touch football	66700	2000	39300	1000	11200	2400	4600	2600	134700
Basketball	48700	98800	23800	21900	19800	3000	2400	1300	219700
Netball	9800	10900	22400	1400	8700	900	1900	600	56500
Volleyball	21200	34300	13700	3800	11300	1000	2700	1600	90500
Martial Arts	50700	39000	27800	6700	23000	1900	3500	1100	153600
TOTAL medium risk sports	197100	185000	127000	34800	74000	9200	15100	7200	655000
TOTAL high-medium risk sports	409900	335400	195900	85000	125000	22200	28600	13400	1225000

Table 6 - Participation rates in high risk sports for females, by state, Australia 1999-2000 (Australian Bureau of Statistics) 11

FEMALES	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	AUST
Soccer	11200	7000	9600	1300	3600	800	500	200	34200
Snow Sports	34000	33700	2000	3000	1000	500	3400	0	77600
Touch football	29200	1000	19000	500	2800	600	3500	1300	57900
Aussie Rules	500	3300	500	400	300	100	200	200	5500
Basketball	31600	24000	10900	5000	16400	2000	1500	900	92300
Martial Arts	56000	30000	30100	12500	15900	2100	2600	1100	150300
Netball	91100	80100	40900	32400	57500	9500	5700	2400	319600
Volleyball	11500	12000	16900	4000	10800	500	1500	1900	59100
TOTAL high risk sports	265100	191100	129900	59100	108300	16100	18900	8000	796500

Table 7 - Ratio of cruciate reconstructions performed in males compared to females (ages 15-44) for the decade July 1994 - June 2003

ACL RECONSTRUCTION RATE FOR 15-44	NSW	VIC	QLD	SA	WA	TAS	ACT	NT
Male:Female	2.2	1.8	2.2	1.7	2.0	1.8	1.6	1.7

Table 8 - Rates of private cruciate reconstructions in various populations for the decade July 1994 - June 2003

	NSW	VIC	QLD	SA	WA	TAS	ACT	NT	AUST
Total population	0.29%	0.25%	0.23%	0.33%	0.30%	0.14%	0.44%	0.30%	0.27%
Males 15-44	0.87%	0.72%	0.67%	0.97%	0.85%	0.44%	1.09%	0.68%	0.79%
Females 15-44	0.39%	0.39%	0.31%	0.58%	0.43%	0.24%	0.66%	0.41%	0.39%

Table 9 - Rates of cruciate reconstruction per state compared to Australian averages

ACL RECONSTRUCTION COMPARISON WITH AUSTRALIAN AVERAGES	NSW	VIC	QLD	SA	WA	TAS	ACT	NT
Total population	1.05	0.94	0.84	1.23	1.10	0.51	1.63	1.09
Males 15-44	1.10	0.91	0.84	1.22	1.07	0.55	1.37	0.86
Females 15-44	0.99	0.99	0.78	1.46	1.09	0.62	1.68	1.03
Males 15-44 (playing contact football codes)	1.04	0.93	1.12	0.93	1.02	0.48	1.22	0.89
Males 15-44 (playing high-medium risk sports)	1.10	0.82	0.99	1.34	1.05	0.69	1.06	1.00
Males 15-44 (playing high risk sports)	0.99 (0.96-1.02)	0.85 (0.82-0.88)	1.31 (1.26-1.37)	1.05 (1.00-1.11)	1.20 (1.14-1.26)	0.55 (0.48-0.63)	1.04 (0.95-1.14)	1.00 (0.87-1.16)
Females 15-44 (playing high risk sports)	1.00 (0.96-1.02)	1.03 (0.99-1.08)	0.90 (0.85-0.96)	1.47 (1.38-1.57)	0.79 (0.74-0.84)	0.71 (0.60-0.84)	1.28 (1.14-1.45)	1.19 (0.99-1.44)

Table 10 – ACL injury rates by NRL ground

GROUND	PREDOMINANT GRASS TYPE(S)	MATCHES	ACL INJURIES	RATE (N/1000 TEAM GAMES)
Gosford	Bermuda/ryegrass	36	2	27.8
Aussie Stadium	Bermuda/ryegrass	159	5	15.7
Toyota Park	Bermuda/ryegrass	76	2	13.2
Telstra Stadium	Bermuda/ryegrass	75	1	6.7
Dairy Farmer's	Bermudagrass	74	2	13.5
Parramatta	Bermuda/rye/annual bluegrass	74	6	40.5
ANZ Stadium	Bermuda/ryegrass	58	2	17.2
Campbelltown	Bermuda/ryegrass	41	1	12.2
WIN Stadium	Bermuda/ryegrass	39	0	0.0
Showgrounds	Bermuda/ryegrass	32	1	15.6
Suncorp Stadium	Bermuda/ryegrass	29	2	34.5
Colonial (Telstra Dome)	Bermuda/ryegrass	13	1	38.5
Newcastle	Kikuyu/ryegrass	78	2	12.8
Penrith	Kikuyu/ryegrass	74	5	33.8
Brookvale	Kikuyu/ryegrass	54	4	37.0
Leichhardt	Kikuyugrass	39	2	25.6
OKI Jubilee	Kikuyu/ryegrass	15	1	33.3
Ericsson	Bermuda/rye/annual bluegrass	78	7	44.9
Canberra	Ryegrass	74	3	20.3
Olympic Park	Ryegrass	61	2	16.4

on natural grass. Netball is probably the most common sport associated with ACL injury in females in Australia and, although some games are played on natural grass, the vast majority are played on hard courts.

The major confounder in this analysis, in terms of trying to prove the hypothesis of a 'northern bias' for males in sports played on grass, would be ACL injuries that occur during skiing and other medium risk sports, such as basketball and martial arts.

Tasmania, which is the southernmost state of Australia, has a statistically significantly *lower* rate of private cruciate reconstruction for males 15-44 playing high risk sports than all other states and territories. It also has absolute lower rates of cruciate reconstruction. This is unlikely to be a bias due to Tasmania being a small state (in terms of either population or geography) as a low rate is not seen in the ACT or Northern Territory. Proximity to snowfields may possibly explain the higher rate of ACL injury seen in the ACT than in Tasmania. In the bottom two lines of Table 9, rates of participation in snow sports were taken into account, but it is unknown whether this adjustment (simply assuming that a snow sport participant has a similar annual ACL injury risk to that of a football player) was sufficient. With respect to the confounder of private health insurance rates, Tasmania has the highest rate of private health insurance for all Australian states (Table 11) which would be expected to lead to a higher percentage of surgery being performed in the private system, if anything. Being the coolest climate of all states in Australia with high rainfall, Tasmanian conditions are most suitable for ryegrass, which is probably the major grass used on the vast majority of football grounds in Tasmania.

Victoria, which is the second southernmost state, has a lower rate of ACL reconstruction in high-risk participation males (15-44) than South Australia and Western Australia which is also statistically significant. For the AFL-playing states, there is a distinct trend for fewer cruciate reconstructions in males in states that are further south (reconstruction rate of WA>SA>Victoria>Tasmania).

Table 11 – Percentage of the population with private health insurance (2001), by state 14

STATE	CAPITAL CITY	REST OF STATE
NSW	50.4%	43.3%
Vic	49.6%	41.0%
Qld	45.4%	45.0%
SA	50.5%	41.7%
WA	53.9%	48.5%
Tas	56.7%	43.0%
National	50.2%	43.5%

The ACT has the highest overall risk of cruciate reconstruction per head of population, and this may be partially due to a higher proportion of the population who are active males from 15-44 and also a much higher proportion of the population who ski. There may be a slight correlation between the fact that the ACT is a dry climate and is the region where temperatures fall below freezing commonly in winter and cool-season grasses that are more tolerant of the cold (such as Kentucky bluegrass and fescues) may be more commonly used. Kentucky bluegrass may be a higher risk grass for ACL injury than ryegrass because of greater thatching potential[7, 15-17]. There is no 'southern' bias seen for ACL injuries in the US National Football League and this may be because Kentucky bluegrass is the primary turfgrass used in the northern parts of the USA where it, in fact, has higher thatching rates[18]. In the USA, the predominant grass types used for NFL football tend to be heavy thatch forming grasses and turf managers are encouraged to use thatch as a method of providing extra cushioning for players[19].

From Table 9 it can be seen that Queensland has lower absolute rates of ACL reconstruction than the Australian average but, because the proportion of males aged 15-44 playing high risk sports (football and snow sports) is lower than in other states, the risk per male high risk sport participant is actually significantly higher than in other states (RR 1.31, 95% CI 1.26-1.37)

There are some variations in the figures by state for Australian females (Table 9), but in general these are less than the variations seen in males. The absolute rate of cruciate reconstruction in females is highest in South Australia and the ACT (Table 8), which may partially reflect the popularity of the sports of netball and skiing respectively in these regions, although their rates for females are still higher than other states when participation rates are adjusted for.

There is a general trend of a 'warm-season bias' for cruciate reconstruction for males in Australia in the states where Australian football is the predominant male sport (WA>SA>Vic>Tas). This trend is seemingly absent for females in these four states, supporting the hypothesis that in Australia, warm-season grasses are a risk for ACL injury in Australian football.

With respect to ACL injuries in the NRL competition, an early-season bias for ACL injuries is definitely present. Since most grounds use either bermudagrass and ryegrass or kikuyu and ryegrass, the cool-season species of ryegrass is likely to be predominant later in the season (late autumn and early winter). Either the presence of rye later in the season or the reduction in thatch through abrasion related to regular use, or both, is/are likely to be responsible for the early-season bias for ACL injuries in the NRL[3]. There is minimal difference between both grass type and location and injury rates and location in the NRL, hence it can be stated that there is no apparent northern (warm-season) bias in the NRL. Ryegrass

tends to produce less thatch than bermudagrass (Figure 1) which may explain why it is associated with a lower rate of ACL injury[3, 15].

Although there are limitations in the quality and quantity of data in the NRL component of the study, they suggest that there is no evidence that either annual bluegrass or kikuyugrass compares favourably to bermudagrass with respect to ACL injury risk.

Previous research from Conway et al. (2003) using a similar data set to the one in this paper, suggested that North Queensland Cowboys, who are the most northern team in the NRL, had a similar rate of ACL injuries to the rest of the competition[20]. They found their rate of ACL injury for North Queensland to be 2.73 injuries per 1000 player hours from 1998 to 2002, and found this to be not significantly different from other teams[20].

With respect to risk of rugby league injury in general (rather than for ACL injuries) at the various times of the season, most of this work in this area has been published by Gabbett, who in the climate of South-east Queensland in Australia has consistently found higher match injury incidence towards the end of the playing season in semi-professional and amateur rugby league[21-24]. This is in contrast to the trends observed in other football codes played in winter[25]. Gabbett has found that the intensity of matches increases towards the end of the playing season and he attributes this increase in intensity as the likely cause of the increased injury incidence towards the end of the season[21, 22, 24]. The Gold Coast, where his studies have been conducted, being a subtropical climate with a generally wet autumn, may not exhibit the same changes in grass composition as traditional autumn-winter football season in a cooler climate[25].

Studies of rugby league injuries in the United Kingdom, where the professional competition changed from a winter to a summer season in 1996, have consistently showed a higher injury incidence in summer than winter rugby league[26-28]. When

Figure 1 - A comparison of ryegrass (left; shinier, darker, less thatch, some bare areas) and bermudagrass (right; lighter green, duller, thicker) on a NSW rugby league field

injuries were analysed by stage of the season and month of the year, it was found that summer months had a much greater correlation with risk of injury than stage of the season[26]. That is, injuries were more common in the warmer months irrespective of whether these months were at the start or finish of the season. The 'dry-season' (summer) bias is proportionally greater in backs, who tend to suffer non-contact injuries, than in forwards, who tend to suffer contact-mechanism injuries[27]. Authors who have noted an increased injury incidence in summer rugby league have attributed the dry-season (summer) injury bias to differences in the playing surface, particularly hardness[26-28]. Obviously historical confounders (other changes in the way that rugby league was played pre- and post- shift to a summer season) may have affected the results.

Notwithstanding that the NRL data presented in this study are unofficial and may contain some minor inaccuracies, they present further evidence that the rate of ACL injury on grounds which are ryegrass predominant (which includes most NRL venues in the second half of the season), is lower than for warm-season grasses like kikuyugrass and bermudagrass. The confounding effect of the progressive reduction in thatch depth over the season is also likely to be contributing to a lower ACL injury rate in the second half of the season.

Although this study has many details which are unknown, including accurate details about grass types at venues throughout Australia, it is further secondary evidence that grass type may be responsible for fewer ACL injuries occurring in certain locations (ie, ryegrass in the more southern states in Australia leading to lower ACL injury rates). It is noted that there are many weaknesses and assumptions in this analysis. It would be far preferable for Australia to have a centralised sports injury surveillance system, as New Zealand does[6], to monitor state by state trends in injuries.

The ACL injury rate and overall injury rates in the AFL have been lower over the past few seasons, possibly due to changes in preparation in grounds once the risk factors associated with various ground conditions have been published[3, 29, 30]. It may be possible to reduce the rate of ACL injuries in Australia, particularly in the northern states, by changes to the way that community football grounds are prepared. These may include promotion of ryegrass as a preferred species, watering of dry, hard grounds and scarification of grounds with an excessive layer of thatch[3, 15, 25]. Because of the cost of ACL injuries to the community, it is strongly encouraged that a national ACL register is developed with measures taken in the longer term to reduce the rate of ACL injuries.

Conclusions

- There was a strong early-season bias for ACL injuries in the NRL competition over the period 1999-2004.
- No obvious geographical bias for ACL injuries was seen in the NRL competition over the same time period.
- In the 'AFL' states of Australia in the community, for males there is a 'northern' bias towards greater number of ACL reconstructions in the warmer states (WA and SA) compared to the southern states (Vic and Tas), in a similar fashion to the trend already seen in the AFL.
- In the 'rugby' states there is no evidence of a 'northern' bias.
- The NRL data are more similar to the data previously published for the US NFL, where there is also an early-season bias but no geographical bias.
- There is little evidence of a northern-bias for females for ACL reconstructions in the community.

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BULLETIN

Knee injury research

AUSTRALIAN PHYSIOTHERAPY ASSOCIATION
Sports Physiotherapy Australia

Many factors contribute to the successful management of musculoskeletal injuries. They include the pathological process, and the biological, biomechanical, physiological or biopsychosocial effects of our interventions. Sports physiotherapy is a craft that integrates all of these factors and its quality in Australia is acknowledged by peers and colleagues.

While many patients benefit from the intervention of physiotherapists, it is the role of science to try to ascertain (i) which treatments improve the pain and disability experienced by patients, (ii) which aspects of our treatments have the effect and (iii) mechanisms that underpin the treatment effects. Sports physiotherapy clinicians need to be aware of the recent science and scientific findings in order to enhance their craft. Integral to this awareness is an understanding that inherent in the structure of scientific studies (large numbers, double-blinds, placebo, control groups, etc) is the importance of the therapist-patient relationship and the presence of individual differences. Furthermore, treatment efficacy alone does not prove the theoretical basis of the treatment. I am fortunate enough to be asked to write an update on the research into sports related knee injuries. This article will allow me to highlight the breadth and quality of research in this area.

Over the past five years there has been much research interest and output directed at the optimal management of knee injuries/conditions. When we are looking at sporting injuries, we have to be mindful that often the funding for research into this area is quite limited. Furthermore, the numbers of individuals with the conditions to be studied, while considerable to the treating practitioner and disabling to the athlete, do not necessary lend themselves to large randomised controlled trials (RCTs). But, we can learn a lot from lower levels of evidence, to help guide our clinical practice.

In this article, I will focus on, (i) management of patellar tendinopathy; (ii) management of patellofemoral pain; (iii) the role of 'core stability'; (iv) prevention of ACL injuries. So, what does the research tell us?

1. Effective treatment strategies for patellar tendinopathy

Patellar tendinopathy is a significant overuse injury, mostly encountered by athletes who load their tendons with jumping activities. Its recalcitrant nature makes it a frustrating condition for the athlete and the physiotherapist. It has therefore been the focus of much research, both internationally and within Australia.

The main players here are (in_ Australia) Jill Cook (La Trobe University), Karim Khan (OK, he works at the University of British Columbia and lives in Vancouver, Canada, but we still think of him as one of us) and Craig Purdam (Australian Institute of Sport). Internationally, they are Roald Bahr (Norway), Hakan Alfredson (Sweden) and Louis Almekinders (USA). The main findings, earlier, identified that patellar tendinopathy is not an inflammatory condition but rather one of degeneration. Current research is investigating the source of pain and the pathological processes, including the role of neovascularisation.

Physiotherapy interventions were traditionally focused on eccentric strengthening, with progressions guided by maintenance of painfree environment. Research pioneered by Alfredson led to changes in clinical practice and subsequent research to evaluate these changes. Currently, small RCTs and case series have indicated that:

- eccentric quadriceps training can reduce patellar tendinopathy symptoms; and.
- a decline squat exercise (where the feet are positioned on a board, declined at 25 degrees to the horizontal) designed to load the extensor mechanism maximally and performed with moderate tendon pain may have greater benefits for the injured athlete, although further research is required.

Furthermore, the research to date suggests that ultrasound-guided sclerosing of surrounding neovessels performed by experienced practitioners (usually radiologists) may also assist in reducing the pain associated with patellar tendinopathy

2. Effective treatment strategies for patellofemoral pain

Patellofemoral pain is the most common single diagnosis encountered by running athletes. It is typified by anterior or retro patellar pain that is aggravated by activities that load the patellofemoral joint, including stair ambulation, squatting, running and jumping activities. Its prevalence, especially among recreational and sub elite athletes, has led to a large body of research dedicated to understanding the cause of pain and to evaluating optimal interventions.

The main players here are (in Australia) Kay Crossley (ie, me), Sallie Cowan and Kim Bennell (at The University of Melbourne), Jenny McConnell (The University of Sydney) and Bill Vicenzino and Paul Hodges (The University of Queensland) and, internationally, Irene Davis and Chris Powers in the United States and Erik Witrouw in Belgium.

Multi-modal physiotherapy interventions that include vasti retraining, patellar taping/bracing, hip muscle retraining and stretching/ mobilisation are commonly used by physiotherapists. These have been evaluated in well-controlled RCTs.

Current research has shown that:

- multi-modal physiotherapy is effective in reducing the symptoms of patellofemoral pain;
- multi-modal physiotherapy can restore imbalances in the onset of the medial relative to the lateral vasti;
- patellar taping can reduce patellofemoral pain, improve the coordination of the vasti, and enhance quadriceps function, and
- patellar bracing can reduce the loads on the patellofemoral joint.

There is much research underway at present, both here in Australia and internationally. Current research projects include:

- evaluating the effectiveness of in-shoe orthotic devises, in isolation and in combination with a multi-modal physiotherapy intervention (Vicenzino);
- evaluating the timing of gluteal muscles in individuals with patellofemoral pain (Cowan);
- using biomechanical models to evaluate patellofemoral joint stress (Powers);
- investigating risk factors for patellofemoral pain in female runners (Davis); and
- evaluating motor unit synchronisation in people with patellofemoral pain (Hodges).

3. 'Core Stability' plays a role in the development of knee injuries

The term 'core stability' is used to describe the neuro-motor control of the lumbar spine-pelvis-hip region. It has long been recognised by clinicians as playing an important role in many lower limb injuries, including knee injuries. The main problems with researching this area have arisen from difficulties in defining and in measuring core stability. While good quality research in this area is still lacking, this is an area that is developing substantial interest.

Main players: in Australia, nil at present; internationally: Tim Hewett , Irene Davis and Michael Fredericson (all in USA).

Main Findings: Hip muscle torque, measured with a hand held dynamometer (hip abduction, external rotation) is commonly being used as a surrogate measure for 'core stability': Using these measures, researchers have shown that hip abduction and external rotation strength is:

- lower in individuals with overuse knee injuries,
- lower in females than males, especially after puberty, and
- related to knee joint loading patterns

Further research is being directed towards the measurement of common clinical tests, including jumping and landing manoeuvres.

4. Anterior cruciate ligament injuries

There is a strong gender bias with respect to anterior cruciate ligament (ACL) injury incidence, especially in non-contact situations, with women two to eight times more likely to sustain an ACL rupture. This bias has led to considerable research interest on non-contact ACL ruptures. The research in this area has focused on intrinsic ligament and muscle properties and the assessment of biomechanics in activities known to load the ACL (cutting, jumping and landing). Another group of researchers hase been investigating the role of exercises (mostly neuro-muscular/balance type exercises) in the prevention of acute knee injuries in general and ACL in particular.

Main players: in Australia, David Lloyd (The University of Western Australia), Di Hopper (Curtin University), Adam Bryant (University of Melbourne) and Julie Steele (University of Wollongong) and internationally, Tim Hewett (USA), Roald Bahr (Norway), Edward Wojtys (USA) and Scott McLean (USA).

Main Findings:

Oestrogen: Doesn't appear to have a direct effect on the mechanical properties of the ACL itself. May affect soft-tissue compliance and visco-elastic properties of muscles.

Compared to males, females:

- run, land and cut with greater valgus loading,
- demonstrate timing of muscle activation that is less protective of the ACL,
- have greater torsional stiffness of the leg in both the passive and the active muscle state, and
- have lower limb muscles which are more compliant.

Prevention of injury: Probably the most significant article to come out in the area of injury prevention is 'Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial' by Olsen O-E, Myklebust G, Engebretsen L, Holme I and Bahr R in the British Medical Journal in 2005 (pp 330-449). This can be found on the internet using the searching program, PubMed' or at:

http://bmj.bmjjournals.com/cgi/content/full/330/7489/449.

Furthermore, there a number of researchers based at La Trobe University in Melbourne who are looking at ACL reconstruction; in particular at the effects of different graft types (hamstring or patellar tendon) on outcomes and biomechanics and also the effectiveness of different rehabilitation programs on outcomes after ACL reconstruction. These researchers include Kate Webster, Julian Feller and Randall Cooper.

Where is the research?

Research into sporting injuries is benefiting from the boom in biomechanical modelling. In the past we have had to rely on the use of surgically implanted strain gauges (not used too often -- for obvious reasons) to provide information on the loads encountered by biological tissues during physical activities.

As three-dimensional motion analysis systems become more readily available and user friendly and with more accurate information about muscle forces, mathematical models can better predict the loads in relevant tissues. This information will greatly expand our understanding of all injuries, including aetiology and mechanisms of treatment effects.

As physiotherapists, we need to be able to use this information, to help us to devise better treatments and to identify individuals who are most likely to benefit from these interventions.

Dr Kay Crossley, BAppSc (Physio), PostGradDip (Research), PhD. School of Physiotherapy, is at The University of Melbourne and also practices at the Olympic Park Sports Medicine Centre, Melbourne

For your library

The Little Black Book of Sports Medicine (414pp)

Eds: TM Howard and JD Butcher

Published by Jones & Bartlett, distributed by Elsevier

ISBN 0763738654

The 2nd edition of the Little Black Book is out, with updated information for physicians and support staff for diagnosing and treating injury and illness.

Year Book of Sports Medicine 2005 (426pp)

Ed. In Chief: RJ Shephard

Published by Elsevier Mosby

ISBN 0323021174

Traditional format, with new material on preventive medicine, epidemiology, sports injury and ergogenic aids and doping.

Handbook of Fractures (442pp)

Eds: JA Elstrom, WW Virkus and AM Pankovich

Published by McGraw-Hill

ISBN 0071443770

The 3rd edition in 10 years, this aims to provide basic information on classifying, diagnosing and managing specific fractures, with material added on radiologic evaluation and injury related athletic competition.

Practical Applications in Sports Nutrition (545pp)

HH Fink, LA Burgoon and AE Mikesky

Published by Jones & Bartlett, distributed by Elsevier

ISBN 0763726575

The objective here is said to provide exercise and nutrition professionals with the latest research on diet and performance, with a focus on research, current guidelines and the practical application of the information available.

Human Movement (297pp)

Eds: M Trew and T Everett

Published by Churchill Livingstone Elsevier

ISBN 0443074461

This is the 5th edition of a textbook on human movement that was first published in 1981. There is new material in each chapter indicating new research since the last edition in 2001, with more examples of how theory relates to movement and more text boxes and case studies.

General Medical Conditions in the Athlete (463pp)

M Cuppett and KM Walsh

Published by Elsevier Mosby

ISBN 0323026230

The objective here is to help the athletic trainer to recognise medical conditions and to understand when to go for the doctor. Comes with a free DVD-ROM.

Athletic Training and Sports Medicine (707pp)

C Starkey and G Johnson

Published by Jones & Bartlett, distributed by Elsevier

ISBN 0763705365

This is the 4th edition of the "multipurpose, multicourse" text on management techniques for orthopaedic injury, with such new features as clinical presentation, surgical technique and clinical technique boxes, rehabilitation timelines and new material on therapeutic exercises.

The Healthy Body Handbook: A Guide to the Prevention and Treatment of Sports Injuries (336pp)

DC Saidoff and S Apfel

Published by Demos, distributed by Elsevier

ISBN 1932603042

Intended for active adults, with information about the basic structure and function of the musculoskeletal system and advice on how to exercise it safely.

Research Methods in Athletic Training (399pp)

BL Arnold, BM Gansneder and DH Perrin

Published by FA Davis, distributed by Elsevier

ISBN 0803607784

A guide for certified and student athletic trainers to conducting, publishing and finding funding for research

Immune Function in Sport and Exercise (332pp)

Ed: M Gleeson

Published by Churchill Livingstone Elsevier

ISBN 0443101183

Another textbook for students of exercise and sports science, this one dealing with the effects of exercise on immune function and susceptibility to infection.

Pharmacology Application in Athletic Training (235pp)

BC Mangus and MG Miller

Published by FA Davis, distributed by Elsevier

ISBN 0803611277

The aim here is to help athletic trainers and allied health professionals understand how drugs work in the body, the indications and adverse effects on rehabilitation and participation, the types of drugs that are typically abused, the legal aspects of medicines and emergencies involving medications.

Conference 2005: An overwhelming success

Our combined conference in October 2005 was an overwhelming success, with 1,115 delegates and 78 trade exhibitors attending. So, on behalf of the 2005 Organising Committees, I would like to thank all sponsors, speakers, trade exhibitors and delegates who supported this year's event.

Evaluation forms and other anecdotal feedback were overwhelmingly positive, with special mention made of the quality of the keynote speakers and workshops.

The "experiment" of combining ACSMS with the national physical activity and sports injury prevention conferences was also perceived as adding substantially to the value of the overall event.

This was highlighted in Roald Bahr's opening address (*Redefining sports medicine - from sprained ankles to clogged arteries)* in which he captivated the audience with his immense knowledge and understanding across all three areas. Due to the overwhelming success of the 2005 event, Sports Medicine Australia and the National Heart Foundation have agreed to organise a repeat version in Adelaide from 13 to 16 October in 2007.

SMA gives a special thank you to major sponsors Asics, Tourism Victoria, Australian Department of Health and Ageing and the Department for Victorian Communities, whose support ensured that we could mount a conference of the highest calibre. We would also like to thank the Heart Foundation, the NSW Sporting Injuries Committees and Vichealth for their support.

The ASMF Fellows Awards were once again a huge drawcard, Dr Karim Khan winning the Asics Medal valued at $5,000 for his paper *Action Schools! BC: daily physical activity increases bone strength in prepubertal boys.* A complete list of prizewinners is published below.

For those who were unable to attend the 2005 conference, the Organising Committee of the 2006 Asics Conference of Science and Medicine in Sport invites delegates to join them in Fiji from 19 to 21 October 2006 to experience three intriguing days of conferencing that can be combined with active or more passive leisure-time activities. SMA is pleased to report that Asics has increased its level of support in 2006 to ensure that an exciting boutique event is developed.

For those who have not been to ACSMS before, it is a multidisciplinary meeting held annually for professionals with an interest or a specialisation in sports medicine, sports science, physical activity promotion and sports injury prevention. In 2006 the theme will be *Sports medicine in paradise: perspectives from the Pacific*. It will provide an excellent opportunity for delegates to keep abreast of the latest findings and developments in research.

The program will include several outstanding speakers from Australia and around the world, who are leaders in sports medicine research and practice. Confirmed speakers include the Refshauge Lecturer, Dr Tim Olds, the anthropometrist from the University of South Australia. Invited speakers include Dr Peter Fricker, Director of the Australian Institute of Sport, Professor Stephan Rossner, the endocrinologist from Huddings University Hospital in Sweden, Professor Wendy Brown, the physical activity expert from The University of Queensland, and Dr Jill Cook, the leading researcher from La Trobe University.

Abstract submission for the 2006 Conference is also open. To submit your abstract, please visit www.sma.org.au/acsms/2006/ and click on the appropriate link. Abstract sSubmission will close on 31 March 2006.

SMA looks forward to welcoming delegates to Fiji and encourages visits to www.sma.org.au/acsms/2006/ to obtain further information. Alternatively, the conference secretariat can be contacted at acsms@sma.org.au.

2005 Australian Sports Medicine Federation fellows awards

Best Paper Awards

ASICS Medal - Best Paper Overall
Karim Khan, University of British Columbia
Action Schools! BC: daily physical activity increases bone strength in prepubertal boys
Co-Authors: H Macdonald, S Manske, K Reed and H McKay

ASICS Best Paper - Lower Limb
Jill Cook, Latrobe University
Painful tendons with normal imaging: are they a true clinical diagnosis
Co-Author: P Malliaras

ASICS Best Paper - Clinically Relevant Conditions
Gabriel Ng, The Hong Kong Polytechnic University
Therapeutic laser and running exercise promote tendo-achilles healing: a rat model
Co-Author: D Fung

ASICS Best Paper - Performance Enhancement and Basic Science
Daniel Green, The University of Western Australia
Do skinfolds accurately assess changes in body fat in obese adolescents?
Co-Authors: K Watts, E Davis, T Jones, B Beeson, A Siafarikas, . Bell and T Ackland

ASICS Best Paper - Health Promotion
Kylie Ball, Deakin University
Socioeconomic inequalities in leisure-time walking: are poor environments to blame
Co-Authors: A Timperio, J Salmon, B Giles-Corti and D Crawford

Sport and Recreation Victoria Best Paper – Injury Prevention
Leonie Otago, University of Ballarat
The risk management knowledge of basketball coaches and their influence on the injury prevention strategies of their player
Co-Authors: J Swan and S Ramage

Best Young Investigator Awards

ASICS Best Young Investigator - Lower Limb
Stuart Warden, Indiana University
Knee ligament healing is accelerated by low-intensity pulsed ultrasound and delayed by a non-steroidal anti-inflammatory drug
Co-Authors: K Avin, E Beck, M DeWolf, M Hagemeier and K Martin

John Sutton Best Young Investigator - Basic Science
Sonya Marshall-Gradisnik, Southern Cross University
Natural Killer cell numbers and natural killer cytotoxic activity after 6 weeks of testosterone enanthate administration in health young males
Co-Authors: S Rogerson, G Deakin, R Meir, R Coutts, S Zhou and R Weatherby

NSW Sporting Injuries Committee Best Young Investigator - Injury Prevention
Rochelle Eime, University of Ballarat
A controlled evaluation of a squash eyewear promotion strategy
Co Authors: C Finch, R Wolfe, N Owen and C McCarty

ASMF Fellows Award Best Young Investigator - Health Promotion
Corneel Vandelanotte, Ghent University
Efficacy of a computer-tailored intervention for increasing physical activity in a sequential or simultaneous intervention mode
Co-Author: I de Bourdeaudhuij

Best Poster Awards

Queensland Academy of Sport Best Poster- Clinically Relevant Conditions
Mark Watts, Brisbane Orthopaedic and Sports Medicine Centre
Tibial interference screw position in soft tissue ACL graft fixation: biomechanical considerations
Co-Authors: D Hayes, G Tevelen and R Crawford

AOK Health Best Poster Performance Enhancement and Basic Science
Karen Beatty, The University of New South Wales
Measurement of load during gymnastics training
Co-Author: A McIntosh

Journal of Science and Medicine in Sport Best Poster - Injury Prevention
Tania Pizzari, La Trobe University
Stress fractures of the base of the second metatarsal in elite female classical dancers
Co-Authors: G Davidson and S Mayes

Sports Medicine Australia Best Poster - Health Promotion
Elizabeth Cyarto, The University of Queensland
Is the CHAMPS physical activity questionnaire for older adults reliable in an older Australian sample?
Co-Authors: R Dickinson, A Marshall and W Brown

ASMF Fellows Best Poster - Health Promotion
Vincent Learnihan, The University of Western Australia
Influence of Data Scale in Walkability Analyses

Special Categories

Wendy Ey Women In Sport Award
Kay Cox, The University of Western Australia
Type of exercise determines short and long-term health benefits of a swim and walk program in older women: the SWEAT 2 study
Co-Authors: V Burke, L Beilin, I Puddey, J Grove and B Blanksby

Honourable Mentions

Honourable Mention ASICS Best Paper Performance Enhancement and Basic Science
Magnus Hagmar, Karolinska University Hospital
Endothelial function: is exercise more important than estrogen in post-menopausal women?
Co-Authors: MJ Eriksson, C Lindholm, K Schenck-Gustafsson and A Lindén Hirschberg

Honourable Mention AOK Health Best Poster Performance Enhancement and Basic Science
Deirdre McGhee, Unversity of Wollongong
How does respiratory state and measurement method affect brassiere size calculations?
Co-Author: J Steele

Honourable Mention Wendy Ey Women In Sport Award
Kathy Martin, WTA Tour
The WTA Tour Ten-Year Age Eligibility and Professional Development Review
Co-Authors: V Burke, L Beilin, I Puddey, J Grove and B Blanksby