

## REVIEW

# Blood borne infections in sport: risks of transmission, methods of prevention, and recommendations for hepatitis B vaccination

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*Br J Sports Med* 2004;38:678–684. doi: 10.1136/bjism.2004.011643

Athletes are at risk of blood borne infections through bleeding injuries or injection of drugs with contaminated syringes. Prevention should focus on reducing non-sport associated risky behaviour, as well as dealing appropriately with bleeding injuries. The risk of transmission of hepatitis B virus is particularly high in athletes in contact and collision sports, those who live in or travel to endemic regions, injecting drug abusers, and those who practice first aid when there is no healthcare practitioner available. It is recommended that such athletes, and also adolescent athletes, should be vaccinated against the virus as a routine.

## METHOD

A search was performed using Medline (1966–2003) and SPORTDiscus (1949–2001). The search parameters used (including different combinations of the words) were “Blood borne infection”, “HIV”, “AIDS” and “Hepatitis” and “sport” and “athlete”. The reference lists of all relevant articles and reviews were back searched for additional studies. The world wide web, using the Google search engine, was searched using the same key words. Studies with data on possible ways of transmitting blood borne infection in sport and related methods of prevention were reviewed. No study with high quality methodology—for example, randomised clinical trial and cohort—was found. Studies are mainly case reports, the opinion of experts, and consensus statements. Review of these studies suggested that blood borne infections may be transmitted in different situations in different sports and this is discussed below.

## POSSIBLE WAYS OF TRANSMISSION IN SPORT

### Bleeding injuries

There is a theoretical risk of blood borne infections being transmitted during sporting activities, from bleeding wounds or exudative skin injury of an infected athlete to the injured skin or mucous membrane of other athletes. It is generally reported that this risk is extremely low.<sup>3–8</sup>

This risk may be higher in contact and collision sports, especially wrestling, boxing, and taekwondo, because of the higher risk of bleeding injuries and prolonged close body contact.<sup>3 6 9 10</sup> Athletes taking part in these sports should be aware of these small theoretical risks.<sup>5</sup> Players of basketball, field hockey, ice hockey, judo, soccer, and team handball are at a moderate risk, and those who participate in sports that require little physical contact such as baseball, gymnastics, and tennis are at the lowest risk.<sup>5 10</sup>

### HIV

According to researchers in the Centre for Disease Control and Prevention (USA), the risk of transmission of HIV during sports, except boxing, is small—less than one potential

**B**lood borne infections such as hepatitis B virus (HBV), hepatitis C virus (HCV), and HIV are all major health problems. According to the World Health Organization (WHO), there are 34–46 million people with HIV world wide, about 5 (4.2–5.8) million of them newly infected.<sup>1</sup> Approximately 3 (2.5–3.5) million people died of AIDS in 2003. WHO also reported that “Hepatitis B is one of the major diseases of mankind and is a serious global public health problem”. There are more than 350 million people who have chronic, lifelong, infections of HBV world wide. These carriers are at high risk of serious diseases such as liver cirrhosis and primary liver cancer which kill more than one million of them a year.<sup>2</sup> The American Medical Society for Sports Medicine and the American Orthopaedic Society for Sports Medicine have suggested that these infections are increasing among athletes, and they create important and complex problems for sports medicine practitioners.<sup>3</sup> News of infected athletes with HIV, especially well known athletes, causes concern among other athletes.<sup>4</sup>

HIV is transmitted through sexual contact, parenteral exposure to blood and blood components, contamination of open wounds or mucous membranes by infected blood, and perinatally from an infected mother to fetus or infant.<sup>5</sup> Hepatitis B and C are spread through the same routes as HIV.<sup>5</sup>

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Accepted 4 May 2004

transmission in one million games.<sup>4</sup> This risk is calculated by other researchers to be one transmission in 43 (range 1–85) million games, based on the following factors: (a) the estimated prevalence of HIV among athletes; (b) the risk of percutaneous HIV transmission in health care; (c) the risk of a bleeding injury in American football.<sup>11 12</sup> However, this calculated risk may still be an overestimate because it has been back calculated from the risk through needle stick injuries, and this is probably much greater than the risk resulting from skin injury in sports.<sup>12</sup>

There are no confirmed reports of HIV transmission during sport.<sup>3 5 9</sup> Torre *et al*<sup>13</sup> reported one case of seroconversion of HIV as a result of a bleeding injury during a football match in Italy. However, it was later suggested that this report was not sufficiently well documented to confirm that the transmission occurred during sports activity. Transmission in a non-sports setting for this man, who worked in a drug dependency rehabilitation centre, could not be ruled out.<sup>3 8</sup>

Transmission of HIV during bloody street fights has been reported in the literature.<sup>14 15</sup> Generally, street fist fights can be considered similar to contact sports. However, the manner of physical contact—for example, repeated banging of the forehead of one fighter against the face and forehead of the other in a vigorous street fight—is less likely in typical sports settings.

HIV cannot be transmitted through normal body contact such as touching and sharing sports equipment or using facilities such as locker rooms or bathrooms or contact with contaminated surfaces such as wrestling mats or toilet seats.<sup>4 7</sup>

## HBV

The concentration of HBV in blood is higher than of HIV, and HBV is also more stable in the environment. Therefore the risk of transmission of HBV is 50–100 times higher than transmission of HIV.<sup>8 16</sup> The estimated risk of transmission of blood borne infections after percutaneous exposure in healthcare workers is calculated to be 0.2–0.5% for HIV, 2–40% for HBV, and 1.8–10% for HCV.<sup>17 18</sup> HBV is resistant to drying, ambient temperatures, simple detergents, and alcohol and can be stable on environmental surfaces for at least seven days.<sup>2 17</sup> Hence transmission of HBV can occur via inanimate objects—for example, environmental surfaces.<sup>17</sup> Therefore the risk of HBV transmission in sport is probably greater than that of other blood borne infections.

The theoretical risk of transmission of HBV in sport (calculated using the same methods as used for HIV<sup>11 12</sup>) is between one transmission in every 850 000 to 4.25 million games and one transmission in 10 000–50 000 games.<sup>12</sup> The range of these theoretical risks is wide, but they do give an indication of the risk of transmission in sport. As an example, in 1995–1996, about 800 000 high school boys participated in American football (17% of all school athletes).<sup>19</sup> If every

footballer had an average of three training sessions a week and had 10 months training a year, their risk would be calculated as between 68 (range 23–113) and 5760 (range 1920–9600) transmissions in 1995. In 1995, it was estimated that 400 new occupational HBV infections occurred in US healthcare workers. This has decreased from 17 000 in 1983 because of the implementation of standard precautions and vaccination.<sup>17 20</sup> Therefore, theoretically, the numbers of potential transmitted cases of HBV in sport are significantly higher than those now occurring in health care, presumably because of a lack of prophylaxis in sport.

Two papers, both from Japan, report HBV transmission in sport.<sup>21 22</sup> Kashiwagi *et al*<sup>22</sup> reported an outbreak of hepatitis B infection in a high school sumo wrestling club. Five of 10 members of the club developed hepatitis B during one year. The authors identified an asymptomatic HBV antigen-e positive carrier as the source of infection. They suggested that HBV was transmitted from the carrier to the others through skin cuts and abrasions caused by wrestling. Wrestlers in that club were known to continue to wrestle even when they were injured and bleeding from skin wounds.

More recently, Tobe *et al*<sup>21</sup> reported an outbreak of HBV among members of a university American football team. They detected 11 cases of HBV infection (five of acute hepatitis and six of subclinical infection) among 65 members of the team over a period of 19 months. For these student footballers, the incidence of HBV infection was 20%, which was significantly higher than the 1.8% recorded for a comparison group of non-footballing students ( $p < 0.01$ ). The authors found a carrier of HBV as the source of transmission and suggested that transmission had probably occurred as a result of contact with open wounds of the carrier during sporting activity.

Ringertz and Zetterberg<sup>23</sup> reported an outbreak of 568 cases of HBV infection among Swedish cross country track finders during 1957–1963. They believed that the transmission had occurred through skin lesions mainly during washing after the competition. Over 95% of track finders had scratches and skin lacerations. They reported that the epidemic was brought to an end when adequate protective clothing was made a compulsory regulation. However, this regulation was abolished when another smaller outbreak occurred in 1965–1966 among track finders who wore the appropriate protective clothing.<sup>23</sup>

One epidemiological study evaluated the prevalence of HBV infection among athletes. Siebert *et al*<sup>24</sup> evaluated the prevalence of markers of past hepatitis B infection in footballers in South Australia. The prevalence was not different from blood donors of the same age. The prevalence of chronic HBV in South Australia is reported to be very low at 0.16%.<sup>24</sup>

**Table 1** Epidemiology of hepatitis B and vaccination strategies<sup>2 46 47</sup>

Endemicity*	% of carriers in population	% of infected population	Age of infection	Strategy for vaccination
High	>8 (8–20)	70–90 < the age of 40	Mostly perinatal and childhood period†	Universal infant and high risk group
Intermediate	2–8	20–70	Both childhood and adult‡	Universal infant and high risk group
Low	<2	<20	Mostly high risk adolescents and adults§,¶	Universal infant or adolescent and/or high risk group

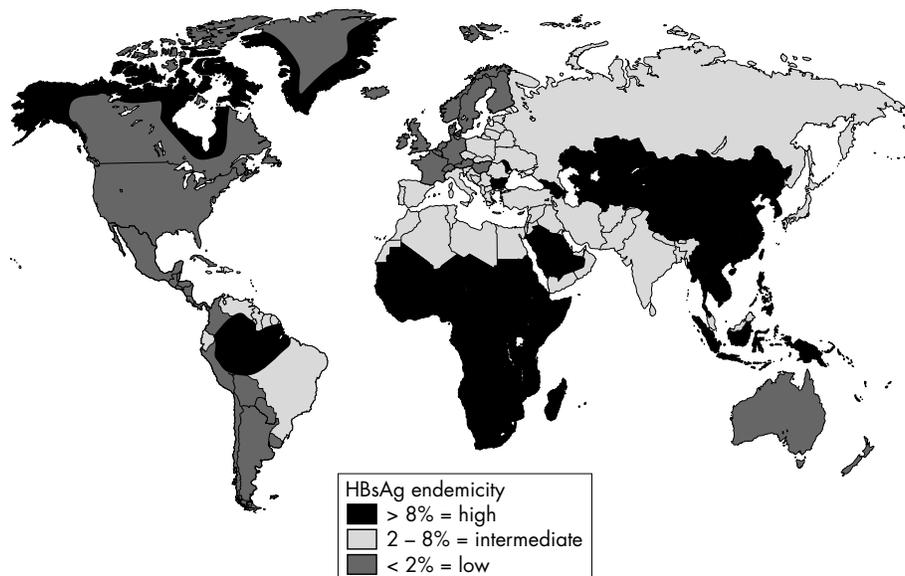
\*Endemic: prevalent continuously to some degree in a community or region.

†In children, infection is rarely acute with 25–90% becoming chronic carriers.

‡In adults, infection is often acute with 5–10% becoming chronic carriers.

§High risk groups such as sexual/household contacts of infected person, healthcare workers, injection drug users, those receiving non-sterile acupuncture or tattooing, homosexual and active heterosexual men.

¶30% of those with acute infection do not have identifiable risk factors.



**Figure 1** Geographic pattern of hepatitis B prevalence, 1997. Taken with permission from *Introduction of hepatitis B vaccine into childhood immunization services*. Geneva: WHO, 2001; WHO/V&B/01.31; data as of 6 April 1998. Endemic: prevalent continuously to some degree in a community or region.

It has been suggested that blood borne infections may be transmitted through sharing a water container, because bleeding around the mouth is common in contact sport.<sup>25</sup> Therefore it is now recommended that water containers should be available individually for each player in contact sports. Athletes should use squeeze water bottles which they do not put in their mouth.

### Doping and drug abuse

Blood borne infections can be transmitted through blood doping. There is also a risk from sharing needles which may be associated with drug abuse in sport. Injectable drugs used in sports include steroids, hormones, and vitamins.<sup>4</sup>

Three separate cases of HIV infection associated with sharing needles among bodybuilders have been reported, two in the United States and one in France.<sup>26-28</sup> In one of the cases, there was simultaneous infection with HBV.<sup>27</sup> In none of the cases was there a history of participation in any other risky behaviour. One case of hepatitis C infection has been reported as a result of a recreational weightlifter sharing needles to inject anabolic androgenic steroid.<sup>29</sup>

Parana *et al*<sup>30</sup> reported three soccer players from one amateur club who were infected with HCV as a result of sharing a syringe to inject intravenous vitamin complexes. They suggested that during the 1970s and 1980s intravenous vitamin complexes were abused by many athletes in Brazil. Syringes have often been shared by athletes who inject vitamins minutes before a game.<sup>30</sup>

A 1993 study estimated that, in the United States, there were one million people who were either current or past users of anabolic androgenic steroids.<sup>31</sup> Of these, 50% were intramuscular drug users, and about 25% had shared needles.<sup>32</sup> Therefore it seems that the risk of transmission in this way may be considerable among athletes, especially bodybuilders.

### Sexual activity

Blood borne infections can be transmitted through sexual activity. Having homosexual sex with men and having multiple partners are the most significant risk factors for these infections. However, the most common method of transmission of HBV during adulthood is heterosexual

contact with an infected individual (because this exposure occurs most commonly), followed by injected drug abuse, and then homosexual contact.<sup>33-34</sup> There is no firm evidence that transmission of blood borne infections among athletes through sexual activity is more common than for the general population. There is limited literature in this controversial area. Some studies have suggested that some high risk sexual activities may be more common among male athletes than non-athletes, and athletes may perform more sexual activity,<sup>35</sup> less safe sex,<sup>36</sup> have a greater prevalence of sexually transmitted diseases,<sup>37</sup> and have a greater number of sexual partners.<sup>36-37</sup> Other studies, mainly on high school sports participants, did not show significant differences among male athletes and non-athletes with regard to their level of sexual activity<sup>38-40</sup> and number of sex partners.<sup>38-40</sup> One study<sup>38</sup> reported that white male and female athletes have fewer multiple partners than the non-athlete, but African American male athletes have more multiple partners than their comparative non-athlete group. There is some evidence that sexual activity<sup>35-38-41</sup> and having multiple partners<sup>38-40</sup> are less common among female high school athletes than non-athletes.

### Travelling

According to WHO, "living in regions or travelling to regions with endemic hepatitis are risk factors for the HBV infection."<sup>33</sup> Some athletes, especially at the professional levels, travel regularly to different areas of the world; therefore these groups of athletes may be at an even higher risk.

### Lack of trained healthcare providers

Healthcare professionals in sport such as first aid providers and team doctors are at particular risk of blood borne infections because they treat bleeding injuries. During sports training sessions in developing countries, there may be no healthcare professional available, as was typically the situation in the United Kingdom in the past for less professional teams and clubs, where coaches and/or other athletes have routinely performed first aid treatment. In such situations, coaches and athletes are at risk of blood borne infections in the same way as healthcare professionals. Moreover, they may be at more risk because of their more

limited knowledge and skills. Bourliere *et al*<sup>42</sup> reported a case of hepatitis C infection as a result of sharing a handkerchief to dry bleeding wounds after a bloody fisticuffs. This example of transmission could occur in the sports setting when the first aider is not an “expert”. Therefore all coaches and athletes should be educated about first aid, infection control, and hygiene.

## PREVENTION

The following position statements and recommendations on blood borne infections and sports have been documented in the literature (see the web site references):

- Position statement of the American Academy of Pediatrics on “Human immunodeficiency virus and other blood-borne viral pathogens in the athletic setting” (1999).<sup>6</sup>
- Position statement of the Canadian Academy of Sport Medicine on “HIV as it relates to sport” (1999).<sup>7</sup>
- Consensus statement of the International Federation of Sports Medicine<sup>5</sup> and WHO on “AIDS and sports” (1997).<sup>5</sup> This is based on the Joint position statement of American Medical Society for Sports Medicine and the American Orthopaedic Society for Sports Medicine.
- Policy statement of Sports Medicine Australia on “infectious diseases with particular reference to HIV (AIDS) and viral hepatitis (B, C, etc)” (1997).<sup>25</sup>
- Joint position statement of the American Medical Society for Sports Medicine and the American Orthopaedic Society for Sports Medicine on “Human immunodeficiency virus (HIV) and other blood-borne pathogens in sports.”<sup>3</sup>

It is highlighted that the main methods of transmission of blood borne infections in athletes are not through sports activity, but are similar to those for the general population—for example, unsafe sexual activity and sharing needles.<sup>3,4</sup> Therefore efforts to prevent these infections among athletes should also be focused on the prevention of these “non-sporting” methods.<sup>8,9</sup>

### “Education is the most important task in prevention”

The theoretical risk of blood borne infection in sport is from contact with blood, body fluids, and other fluids containing blood. Therefore prevention in sport should focus on the most appropriate way to deal with bleeding injuries and related hygiene, summarised in the following.<sup>3,5</sup>

- Prompt and appropriate treatment of bleeding sports injuries
  - Using proper equipment—for example, gloves
  - Cleaning the blood from wounds with soap and water or an antiseptic
  - Removing athletes with bleeding injury, not minor cuts or abrasions, from event as soon as possible
  - Prompt changing of blood soaked uniforms
- Any skin injuries acute or chronic—for example, abrasions, cuts, or oozing wounds—should be covered during sports activities with an occlusive dressing until complete healing has taken place.
- All wounds and injuries should be promptly detected and reported by athletes and coaches
- Appropriate protective equipment should be used at all times by athletes, including mouth protectors, in contact sports

- The healthcare provider must follow the guidelines provided by WHO as universal precautions (see <http://www.who.int/hiv/topics/precautions/universal/en/>)
- Any equipment contaminated with blood should be removed from the sports activity area; if this is not possible—for example, a wrestling mat—the item must be cleaned and dried appropriately (using disposable cloths and a fresh solution of one part household bleach to ten parts water).

Education is the most important task in prevention. Athletes, their families, healthcare providers, coaches, officials, and others involved in sports should be educated.<sup>3,5,9</sup>

## Testing

The recommendations for testing of blood borne infections in athletes are as follow.

- **Mandatory:** Mandatory testing or widespread screening of athletes for blood borne diseases is not recommended because these tests could not be used effectively for prevention, the costs would be excessive, and there are additional legal and ethical issues.<sup>3,5,7</sup> However, some athletic organisations, such as the International Federation of Associated Wrestling Styles and the International Boxing Federation, have now ordained that the AIDS detection test should be compulsory for participants in their sports. In addition, the International Amateur Boxing Association has recently recommended that an HIV test should be carried out in pre-participation physical examinations.<sup>4,43,44</sup>
- **Voluntary:** voluntary testing should be recommended for all high risk athletes in the same way as for non-athletes—for example, if they have multiple sexual partners, inject drugs (including drugs of abuse and doping with ergogenic aids), or have sexual contact with at risk persons.<sup>3</sup>

## Vaccination

HBV infection can be prevented by vaccination, which is safe and 95% effective.<sup>2,45</sup> Different immunisation strategies have been recommended for different regions of the world because of the different epidemiological patterns of HBV infection (table 1, fig 1). WHO has recommended that all countries should integrate hepatitis B vaccination into their national immunisation programmes since 1992.<sup>2</sup>

Athletes have not yet been categorised as a high risk group “to be vaccinated”. The International Federation of Sports Medicine and WHO do not recommend immunisation against HBV for athletes.<sup>3</sup> There is no clear evidence on the magnitude and the exact risk of transmission of HBV in sport. However, this review of current studies suggests that the following groups of athletes are at significant risk and should now be recommended to receive hepatitis B vaccine.

- Non-infected athletes living in regions with endemic hepatitis B
- Athletes who live in low endemic region but regularly travel to regions of high endemicity
- Athletes who practice first aid in the absence of healthcare providers, including coaches
- Athletes suspected of doping (injecting drug abusers)
- Athletes who have other risk factors (table 1)
- Participants in contact and collision sports such as wrestling and boxing

Some influential groups, such as Sports Medicine Australia, have strongly recommended that "all participants involved in contact/collision sports and playing under adult rules be vaccinated against hepatitis B", and the American College Health Association has recommended hepatitis B immunisation for all student athletes since 1994.<sup>9</sup>

Most HBV infections in the low endemicity regions occur in young adults.<sup>33</sup> Adolescent vaccination could protect non-vaccinated children before they enter this high risk period. The American Academy of Pediatrics has recommended that all children and adolescents should be immunised against HBV,<sup>6</sup> a recommendation that has received wide support.<sup>8 48</sup> The non-vaccinated adolescent athletes should be recommended to be vaccinated against HBV.

The cost of vaccination might have been a real problem for the immunisation of athletes in the past.<sup>49</sup> However, the cost of HBV vaccine has dramatically decreased, and it has been shown that global HBV vaccination is cost effective for large populations.<sup>47 50</sup>

The strategy of vaccinating groups considered to be at high risk of contracting hepatitis B has not been successful in significantly reducing the incidence of new infections. This may be because of difficulties in identifying and approaching high risk groups, lack of compliance, participation in high risk behaviour before identification, and lack of recognised risk factors in some infected people.<sup>51</sup> Therefore universal vaccination of children and adolescents before the age of 13 has been recommended.<sup>33</sup>

### Infected athletes

It seems that moderate intensity exercise is not harmful to the patient with HIV.<sup>3 5</sup> There is some evidence that moderate exercise may have some psychological and immunological benefits, especially for the patient with HIV.<sup>3</sup>

HIV infection alone is not a reason to prevent athletes from continuing with their sports activities.<sup>3 5-7</sup> However, the decision to take part in sport at a highly competitive level should be down to the individual, based on factors such as the state of health of the athlete, the HIV status, the risk of infection transmission, and the level of psychological and physical stress of the sport.<sup>3 5</sup> There are no studies on the effect of strenuous exercise on the HIV positive athlete in the literature. However, it has been shown that very strenuous exercise has some suppressive effects on the immune system of healthy athletes, which does need to be considered.<sup>5 52</sup>

There is no evidence that high level competitive sports activity is a problem for asymptomatic HBV carriers.<sup>3 5-7</sup> In the case of acute HBV infection, return to sporting activity should be made on the basis of clinical signs and symptoms such as fever, fatigue, and hepatomegaly.<sup>3</sup>

The risk of transmission from athletes infected with HIV, HBV, or HCV to other athletes is very low; therefore, on the basis of risk of infection, most athletes with these viral infections should be allowed to participate in all sports<sup>6</sup> with the main emphasis being placed on preventive activities.

### CONCLUSIONS

There is a small risk of transmission of blood borne infections in athletes through bleeding injuries or injecting (as in drug abuse). Prevention should focus on non-sporting risky behaviours. In the sport setting, prevention should be mainly related to the most appropriate way of dealing with bleeding injuries. The risk of HBV transmission is higher than other blood borne infections in sports. Some groups of athletes are at more risk of HBV infection, such as participants in contact and collision sports, athletes who live in or travel to highly endemic regions, and injecting drug abusers. It seems

### What is already known on this topic

There is a real risk of transmission of blood borne infections in athletes as a result of bleeding injuries and sharing needles for those who inject drugs. Some preventive recommendations have been published in this field.

### What this study adds

This study reviews the different ways of transmitting blood borne infections in sport and attempts to quantify the risks based on the limited scientific evidence available. It summarises the preventive recommendations, and vaccination against hepatitis B is strongly recommended for many current athletes.

that vaccination against HBV should be recommended for these athletes, as well as for adolescent athletes. However, the small number of studies published in this field are mainly case reports, and more research in this area is needed.

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Conflict of interest: none declared

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## COMMENTARY

This paper is a good review of what is known about the topic in question, and presents viewpoints that are consistent with most experts in the field. In my opinion (which dissented from the other reviewers of this paper), there is not a sufficient highlight of not only the current lack of scientific knowledge in this field, but also the difficulty in obtaining the knowledge we would like to have. The hard questions in this field are: (1) what is the real risk of transmission in a contact sport that an infected athlete poses to teammates and opponents? (2) Is this risk sufficient to justify mandatory notification to other players and/or exclusion?

Calculations for risk of transmission in sport (which are reported in this review to be less than one in a million) are presented based on the randomly selected athlete. It should be noted that the risk of transmission (both theoretical and actual) becomes considerably higher when it is known that at least one athlete on the field is HIV or hepatitis positive. The risk of transmission does not need to be divided by the prevalence of these diseases in the population in this scenario.

The authors reject the report of Torre *et al* of sporting transmission of HIV based on arguments previously published. However, although this is not a proven case of sporting transmission, it remains a possible one. The burden of proof may be impossibly high with respect to sporting transmissions. In a hospital, whenever there is a needlestick injury, an incident report is filed and blood is immediately taken from the patient and injured staff member. This does not happen in sport. It is rare for blood/blood contacts to be recorded in injury surveillance systems, and there is no expectation that competitors will undergo blood tests after matches if contact has occurred. Therefore, even if an HIV transmission did occur during a sporting activity, it is likely that this would be either missed or considered not proven, even if suspected. Based on current expert opinion, many athletes would have at least one risk factor in their personal sexual or other history that would be considered more likely to be the source of their infection than a bloody collision they had suffered on the sporting field.

Because immunisation for hepatitis B is available, a notification and/or exclusion policy for this disease is probably not justified, although it presents a difficult dilemma for potential opponents who have attempted immunisation but who do not seroconvert. I would suggest that athletes infected with hepatitis C or HIV who wish to continue playing contact sports present a dilemma that even the most knowledgeable experts cannot resolve at this stage. A mandatory notification and/or exclusion policy in a contact sport may be considered to be unfairly discriminatory, yet it may be equally unfair to expose potential opponents and team mates to a slightly increased risk of a life threatening transmissible disease without their knowledge and consent.

Now that a decade has passed since the Magic Johnson saga and there are no proven cases of sporting transmission

of HIV, experts can feel safer in determining the risk of transmission to be “very low”. But in that time, how many HIV positive athletes have continued to play contact sports, and if they have, do we have the follow up of all opponents and team mates to prove that none have been infected? The most important lesson from the Magic Johnson saga is that team mates and opponents did not feel comfortable playing

against him, and I suspect that this aspect of the case has deterred the vast majority of HIV positive individuals from considering continuing participation in contact sports.

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