EPIDEMIOLOGY

From a practical standpoint, prevention of infections is an important consideration for any medical doctor caring for elite athletes. Although research exists stating that infections might be more frequent in athletes compared to the general population\(^1\) the evidence is not conclusive\(^2,3\). One possible reason for this shortcoming is a methodological one: athletes are much more likely to go to a doctor with a minor infection than non-athletes. Also, they might have a tendency to observe themselves more closely because of the more severe consequences on training and competition arising from the occurrence of an infection. Therefore, questionnaires as well as more objective tools such as laboratory results may give a biased picture of infection incidence. In contrast, both mentioned phenomena together may result in an overestimation of the frequency of infections in athletes compared with the general population.

Nevertheless, manifest infections in elite athletes should be taken seriously due to the fact that several unwanted sequelae can result from not doing so:

- Transmission to teammates\(^4\)
- Prolonged absence from training and competition or overtraining
- Organ affection (at its most severe: myocarditis).

This gives rise to the importance of preventive measures, the most effective of which is vaccinations. However, since only a few infections are preventable by vaccination, behavioural adaptations represent an important measure in avoiding the spread of infectious agents.

Activity in various sporting disciplines may lead to different infection ‘patterns’ because the sport itself or typically related circumstances (like the use of shared dressing rooms) can predispose the athlete to acquiring certain infectious agents, such as herpes gladiatorum in wrestlers or infected blisters in football players. This points to sport-specific knowledge which may be required to ensure the appropriate preventive strategies are used. Although it is impossible to outline them all here, this article will try to give some general guidelines how to prevent and manage infectious diseases in elite athletes.

PREVENTION OF INFECTIONS

By far the most effective means of avoiding infections are vaccinations. Although the calculation of the benefit-
risk ratio for a given vaccination can be quite complex for athletes, the result of such considerations generally tends to be in favour of vaccinating. The main reason for recommendations to vaccinate, is the major benefit to the athlete of avoiding severe infections, which clearly exceeds that of the non-athlete. Common side effects can be completely avoided or at least their consequences for training and competition reduced, by choosing an appropriate vaccination time point (typically shortly after a competition and as far as possible from the next relevant intensive training or competition) and by using the most appropriate technique (Figure 1).

While the advantages of vaccination are usually accepted, the risks are frequently overestimated. One can observe a general reluctance in elite coaches and athletes to undergo vaccinations, despite there being no good rationale for such behaviour. Table 1 gives a comprehensive overview of vaccinations that should be present in all athletes regardless of their home country (provided that no contraindications exist, of course). Athletes fully vaccinated against a certain disease do not usually have to follow the preventative measures described when they are directed against this specific disease.

Avoiding or reducing contact with infectious agents are additional preventative measures which should be employed, depending on the potential mode of transmission.

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**Table 1**

<table>
<thead>
<tr>
<th>For all athletes</th>
<th>For epidemiological reasons only</th>
<th>Due to an underlying disorder</th>
<th>Critical benefit-risk ratio</th>
<th>Not particularly relevant to athletes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tetanus/diphtheria</td>
<td>Tick-borne encephalitis</td>
<td>Pneumococcal disease</td>
<td>Rubella</td>
<td>Cholera</td>
</tr>
<tr>
<td>Pertussis</td>
<td>Yellow fever</td>
<td>Haemophilus influenzae type B</td>
<td>Papilloma virus</td>
<td>Rabies</td>
</tr>
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<td>Influenza</td>
<td>Japanese encephalitis</td>
<td></td>
<td></td>
<td>Herpes zoster</td>
</tr>
<tr>
<td>Hepatitis A</td>
<td>Poliomyelitis</td>
<td></td>
<td></td>
<td>Bacille Calmette-Guérin (BCG)</td>
</tr>
<tr>
<td>Hepatitis B</td>
<td>Typhoid fever</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Measles/mumps/varicella</td>
<td>Meningococcal disease</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Vaccination recommendations for athletes (according to Gärtner/Meyer 2014).

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**Figure 1**

- Choose the least potent available adjuvant (may lead to lower antibody titers, however).
- Check if an alternative route of administration to the intramuscular one exists (oral, intranasal, intradermal).
- Use the correct injection technique (Petousis-Harris 2008): skin disinfectant completely dry; two separate needles for filling of syringe and injection, to avoid granuloma; intramuscular route preferable to subcutaneous one (higher titers, fewer granulomas); longer needle (25 mm), fast speed of injection, fast withdrawal of the needle (Ipp et al 2007); angle of 90° for intramuscular injections.
- Choose the most appropriate injection site (e.g. no buttock injection for runners; non-dominant side in racquet sport): usually the deltoid muscle is preferred.

Figure 1: How to reduce side-effects of vaccinations.
disease. Therefore, when travelling to foreign destinations for training camps or competition, it is always wise to consult websites and other advisories that reflect the most current epidemiological situation, e.g. those of the WHO. This is particularly true for vector-borne infections with a rapidly changing epidemiology such as malaria, Dengue fever or Chikungunya.

To prevent airborne infections, athletes and members of the team staff should be advised to follow some general rules. Close contact with infected or unknown persons should be restricted to the minimum. An appropriate safe distance is usually an arm's length, except for instances where the infected individual is coughing or sneezing. For additional protection, the infected person should cough or sneeze into their elbow rather than their hand. Particularly in endemic situations, it has to be understood that the individual may be infectious before they start to develop symptoms. As droplets and thus, infectious agents do not only follow the aerial route, hand hygiene measures are also important. Washing one's hands with soap several times a day (including before and after all meals) is usually considered sufficient in a situation with no known transmission. Disinfectants to prevent airborne infections in the general population have not been shown to be more effective than handwashing with soap. However, they may represent effective 'reminders' for athletes and helpful tools to maintain proper hygiene. Moreover, they may be advisable if a member of the team is infected or where there is a high risk of infection, e.g. Olympic games during an influenza season.

Due to their infectiosity and severe long-term side effects, measles and mumps have to be taken particularly seriously. Isolation of infected individuals is usually necessary and teammates have to be checked for their immunity (antibody titers) against these diseases. Contacting the regional health administration is mandatory.

Prevention of faecal-oral transmission generally warrants the same measures of hand hygiene but in addition, food and water hygiene has to be considered. Particularly in countries/areas with a hot climate and/or lower hygiene standards, foodborne infections and food poisoning as well as impaired quality of drinking water may occur. The simple rule 'cook it, boil it, peel it or forget it' has been advice for millions of tourists and generally works well. Therefore, it can also be the basis for athletes' eating behaviour. However, this may interfere with the requirements of sports nutrition in training camps or prior to important competitions. Moreover, since during stays in hotels food is usually not prepared by staff members, even boiled food can be contaminated by hotel staff, who may be infected with different diseases. Buffets in particular imply a certain risk, since food can additionally be contaminated by other hotel guests. Under such circumstances, only the hygienic control of the entire process of food production e.g. own cook and supervision, can give sufficient safety. Of note, the hygiene of all the tools involved in this process (knives, forks, plates etc.) has to be ensured, too. As a general rule when deciding between the competing interests
of hygiene and sports nutrition, it can be said that when in doubt, hygiene is more important than an optimal balance of nutrients!

Some simple rules apply to the daily use of water. Only bottled water can be considered safe for drinking and cleaning teeth, whereas showering is usually safe provided none of the water is drunk. That also means that smears from shower heads are usually not indicated, particularly because the most relevant infectious agent which can be detected under these circumstances, *Legionella pneumophila*, usually affects immunocompromised and older patients. Even those athletes who acquire an elevated number of infections are not considered immunocompromised.

For contact infection, the main routes are contact with saliva and skin-to-skin contact with injured skin. Thus, it is important to avoid injuries of the skin if possible. Since sports equipment might be involved in transmission, the use of disinfectants should be considered.

For vector-borne infections, preventive strategies must focus on the vector, mostly ticks/mosquitoes and sometimes rodents. The main target is to decrease the likelihood of being bitten. This can be accomplished by avoiding the breeding areas of the respective insects (like water basins/holes for the Dengue fever-transmitting tiger fly) or times of preferred activity (like the early evening for malaria-transmitting anopheles). A thorough search of information about the country and disease (including vector properties) is vital. Of course, long trousers and long sleeves are effective barriers, but in warm countries (like the ones where vector-borne infections typically occur), their use may be inconvenient. In any case, repellents – for skin and clothes – should be used. At present, N,N-Diethyl-m-toluamid (DEET) is considered the most effective agent for non-specific protection against tick/mosquito bites.

Altogether, before starting a training camp or competition in a foreign country, the epidemiological situation should be checked as well as local access to diagnostic and therapeutic measures. It is wise to check team members and staff for their immunity against relevant diseases including their vaccination status. Some written information about the necessary hygiene and measures to prevent infections is recommended. For longer stays, this should include an inquiry about existing chronic diseases and resulting constraints.

**MEDICAL CARE OF INFECTED ATHLETES**

When members of a team – athletes or staff – show signs of an infection this typically leads to a lot of attention and the fear of transmission to other athletes. Particularly during the early stages of such a disease, the attention of the team doctor is also required for other team members who might have been infected from the same source but are still asymptomatic. Of major concern is ensuring that appropriate measures are employed to avoid the possible spread of infectious agents. Isolation of the affected individual is a safe option, but not always necessary. In the case of vector-borne diseases, for obvious reasons, there is no realistic risk of interpersonal transmission of the infectious agent. For other transmission modes, the decision about necessary isolation depends on the route of transmission, the infectiosity of the disease and the sport of the player in question.

To avoid transmission of airborne and droplet infections it is vital to ensure a safe distance is maintained between the infected individual and other athletes. Usually, an arm’s length is sufficient for that purpose, however, this does not hold true for sneezing and coughing and in instances where the infected athlete stays for a long period of time in a small room. In such cases, a distance of two arm lengths may represent a reasonable rule of thumb to follow (albeit lacking in evidence). Affected individuals should sneeze and cough into their elbow instead of their hand and even while following this recommendation, it is important to use appropriate hand hygiene as an additional precaution.

Faecal-oral and contact transmission of infectious diseases can only be avoided when strict measures of hand and food hygiene are maintained. Infected athletes should thoroughly wash their hands with soap for at least 30 seconds several times a day and always do so before and after meals. In addition, they should be advised to use liquid disinfectant. Shaking hands with teammates and shared use of handheld tools (including mobile phones) is strictly forbidden. The visible offer and use of disinfectants may serve well to remind athletes that they have to be thorough with body hygiene.

History and physical examination should, of course, aim at verifying the infection and possibly its source. However, a major point for the immediate management of the disease lies in the differentiation between

**“By far the most effective means of avoiding infections is vaccination”**
local and generalised disease, because it is assumed that in generalised infection viruses, bacteria or other infectious agents enter the circulation and may reach vital organs like the heart resulting in increased danger of myocarditis. Signs for a generalisation are malaise/fatigue, fever and palpable lymph node swelling.

In elite athletes, laboratory blood screening of inflammatory parameters should be obligatory – particularly when findings from the initial clinical assessment indicate that suspension from training and/or competition is possible. A determination of the (differential) blood count and C-reactive protein level, possibly together with liver enzyme levels to check for an organ affection, may be justified. They can also help with differentiating between viral, bacterial (more severe leukocytosis) and parasitical (possibly eosinophilia) disease. Finally, the course of the inflammation indicators, particularly that of C-reactive proteins, can help decide when to restart training/competition. Blood sedimentation rate is of minor relevance. It seems noteworthy that C-reactive protein values below the accepted clinical cut-off value of 5 or 6 mg/l may be relevant in athletes who often show negligible blood concentrations. Therefore, a highly sensitive kit is often helpful because even tiny increases to 3 or 4 mg/l may have meaning when they are accompanied by typical infection symptoms.

Given the ease of performing a resting electrocardiogram and the meaningfulness of possible changes (indicator for possible myocarditis), it should be part of the routine examination in infection assessment for elite athletes, who may return to intense training quickly. However, a baseline resting ECG in a healthy state is vital for an appropriate ECG evaluation, to make sure that no sport-related changes are interpreted as pathological ones. In case of infection-associated ECG changes, further examinations have to be initiated until myocarditis is proven or ruled out.

The therapeutic management of infected athletes follows the (known or suspected) infectious agent. For bacteria and parasites specific therapies such as antibiotics may exist, whereas viral diseases, except for influenza and herpes viruses, can only be treated symptomatically. However, the treatment of symptoms has to be taken seriously to enable a return to training and competition as soon as possible. Especially in high-level players, a trivial rhinorrhea may relevantly affect their well-being and physical performance in training and competition. Several local treatments can apply (nasal spray, eye drops, ear drops, lozenges etc.) but very often a non-steroidal anti-inflammatory medications such as ibuprofen or paracetamol give some relief from generalised and local symptoms. Acetyl-salicylic acid may have a stronger anti-inflammatory effect but can lead to gastric problems. In addition, it has an anti-coagulative effect for several days which may be unwanted, particularly in contact sports, because it can outlast the disease itself and lead to more severe bleeding after minor injuries.

Figure 2 summarises recommended drugs for infection treatment in the medical care of travelling athletes.

RETURN-TO-PLAY AFTER INFECTIONS

It should be noted that no established guidelines exist for assessing the eligibility for return-to-training or return-to-play after infectious disease. This lack of guidelines is in contrast to other conditions, for example concussion, which has been more extensively studied and for which even an international consensus group has been
established. Although the term ‘return-to-play’ has been used over the years, we should differentiate between ‘return-to-training’ and ‘return-to-competition’. Because competition demands cannot easily be controlled and usually include high exercise intensities, athletes should be completely healthy before returning to competition.

Before returning to play, athletes must receive a final comprehensive medical check-up. The athlete should be free of symptoms and have no abnormal findings on physical examination. Blood values for inflammation must be normal (white blood cell count, C-reactive protein) or almost normal, showing a significant decrease over the previous few days (C-reactive protein). If necessary, (when changes were present in the initial ECG), an ECG at rest or even during exercise should be performed. Before competing, athletes should return to training and lighter exercise with mild intensities on the first day and – if well tolerated – can increase exercise intensity stepwise on an individual and day-to-day basis. Depending on the kind and severity of the resolved infection, maximal exercise intensities can be reached within 3 to 5 days after most of the common infectious diseases.

**Figure 2**

- **Antibiotics:** azithromycin (infections of the upper respiratory tract; short treatment time!), clindamycin (tissue/skin infections), cotrimazol-sulfamethoxazol (urinary tract infections, gastrointestinal infections), rifaximin (diarrhoea)
- **Anti-malarial drugs** according to the most current resistance situation (check websites of WHO and foreign ministry)
- **Non-steroidal anti-inflammatory drugs:** ibuprofen (400 mg tablets), aspirin (second choice but also useful for other indications and strong anti-inflammation)
- **Vasoconstrictive nasal drops** (xylometazolin or similar)
- **Vasoconstrictive eye drops**
- **Lozenges for sore throat** (may have local anaesthetic as ingredient)
- **Loperamide for diarrhoea**
- **Fusafungin spray for laryngitis**
- **75 mg zinc lozenges** (possibly shortening the symptomatic period when applied in the early stages of upper respiratory tract infections for 3 days)

**Figure 2:** Drugs for the treatment of infections.

**References**


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